12 Climate Change and Greenhouse Gases

12.1 Introduction

12.1.1 This chapter of the ES was prepared by Buro Happold and presents an assessment of the likely significant effects of the Proposed Development on Climate Change and Greenhouse Gases (GHGs). Mitigation measures are identified, where appropriate, to avoid, reduce or offset any significant adverse effects identified and/or enhance likely beneficial effects. The nature and significance of the likely residual effects are reported.

12.1.2 This ES chapter is supported by Appendix 12.1: Greenhouse Gas Calculation Inputs.

12.1.3 The assessment of climate change through the ES shall focus on both GHG emissions associated with the Proposed Development (i.e., climate change mitigation) and the effects of climate change on the Proposed Development itself (i.e., climate change resilience and adaptation). As these are two separate but linked issues, this ES chapter is split into the following two parts following the 'legislation, planning policy and guidance' section:

- Part A: Greenhouse Gas Emissions. This section follows a traditional EIA approach of assessing the significance of effects, in line with the Institute of Environmental Management and Assessment (IEMA) Guide to Assessing GHG Emissions and Evaluating their Significance 2nd Edition (2022)[1]; and
- Part B: Climate Change Resilience Risk Assessment. In line with the IEMA Guide to Climate Change Resilience and Adaptation 2nd Edition (2020)[2], this section follows a risk assessment approach, rather than a traditional EIA approach of assessing the significance of effects.

Competence

12.1.4 This assessment has been prepared by Courtney Cooper, with support and oversight from Charlotte Ainsworth. Courtney is a Graduate Environmental Consultant with Graduate Membership of IEMA. She has an Architecture MA(Hons) and an Environmental Management MSc. Charlotte is a Graduate Environmental Consultant with Graduate Membership of IEMA. She has a Geography BSc and a Climate Change MSc, with 2 years' experience of climate change EIA.

12.1.5 This assessment has been reviewed and signed off by several people, with complimentary backgrounds, including Neil Shankland, Hannah Clement and Mark Crowther. Neil Shankland is a Principal Consultant and has a PhD, BEng Mechanical Engineering with Energy Studies. Hannah Clement is a senior environmental consultant, with a BSc (Hons) Geography. Mark Crowther is Director of Environmental Assessment and Management at Buro Happold with a BSc Environmental Geology and MSc Catchments Dynamics and Management. Mark has undertaken reviews of climate change ES chapters over several years, primarily focused on how such assessments are presented in EIA terms.

12.2 Legislation, Planning Policy and Guidance

Legislation Context

12.2.1 The following legislation is relevant to the Proposed Development:

- The Climate Change Act 2008 (2050 Target Amendment) Order 2019[3];
- The Carbon Budget Order 2021[4]; and
- The Building Regulations 2010, 2013, 2016 and 2021 (as amended)[5].

12.2.2 International Agreements:

- Paris Agreement (2015)[6];
- Kyoto Protocol (1997)[7];
- Montreal Protocol (1987)[8];
- Geneva Convention on Long-Range Transboundary Air Pollution (1979)[9]; and
- Vienna Convention (1985)[10]

Planning Policy Context

12.2.3 The following national, regional and local planning policy is relevant to the Proposed Development:

National

- National Planning Policy Framework (2021)[11]; and
- Planning Practice Guidance (2021)[12].

Local

- Adopted Cherwell Local Plan 2011-2031[13];
- Adopted Local Plan 1996 saved policies[14]; and
- Cherwell Local Plan 2011-2031 (Part 1) Partial Review - Oxford's Unmet Housing Need (2020)[15].

Guidance

12.2.4 The following guidance is relevant to the Proposed Development:

ES Chapter:

- CDC's Greenhouse Gas Report 2019-2020[16];
- CDC's 2020 Climate Action Framework[17];
- Climate Change Committee (2019) Net Zero – The UK's contribution to stop global warming[18];
- Climate Change Committee (2020) Sixth Carbon Budget[19];
- Grantham Institute for Climate Change Briefing Paper No 6. Low Carbon Residential Heating[20];
- IEMA EIA Guide to Assessing Greenhouse Gas Emissions and Evaluating their Significance, 2nd Edition (IEMA, 2022) ('IEMA GHG Guidance')[21];

- ISO 14090:2019 Adaptation to Climate Change – Principles, Requirements and Guidelines (BSI, 2019)[22];
- London Energy Transformation Initiative (LETI) Embodied Carbon Primer (LETI, 2020)[23];
- Mayor of London's Whole Life-Cycle Carbon Assessment Guidance[24];
- Royal Institute of Chartered Surveyors (RICS) Whole Life Carbon Assessment for the Built Environment (RICS, 2017)[25];
- The British Standards Institute (2016) PAS 2080:2016[26];
- The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting (Defra, 2018)[27];
- UK Green Building Council ('UKGBC') Embodied Carbon: Developing a Carbon Brief (UKGBC, 2017)[28];
- WRAP Procurement Requirements for Carbon Efficiency (WRAP, 2011)[29];
- WRAP Cutting Embodied Carbon in Construction Projects (WRAP, 2011)[30];
- World Resources Institute ('WRI') The Greenhouse Gas Protocol[31]; and
- World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol[32];

Climate Change Risk Assessment (CCRA):

- BS EN 15978 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Calculation Method (BSI, 2011)[33];
- C40 Cities Climate Change Risk Assessment Guidance (C40 Cities, 2017)[34];
- Department for Business, Energy and Industrial Strategy ('BEIS') Greenhouse Gas Reporting: Conversion Factors 2021[35];
- UK Climate Change Risk Assessment (HM Government, 2022)[36];
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA, 2020) ('IEMA Climate Change Resilience Guidance)[37];
- Intergovernmental Panel on Climate Change ('IPCC') Global Warming of 1.5ºC Special Report[38];
- Met Office (2018) UK Climate Projects 2018 (UKCP18)[39]; and
- Met Office UK Climate Averages[40].

12.3 Part A: Greenhouse Gas Emissions

Assessment Methodology

Consultation

EIA Scoping Opinion

12.3.1 A request for a Scoping Opinion was submitted by the Applicant to CDC on 9th December 2022. A Scoping Report accompanied the request (Appendix 3.2). A Scoping Opinion was issued by the CDC on 27th January 2023 (Appendix 3.3) which included comments from statutory consultees. Table 12.1 summarises key comments raised by the statutory consultees of relevance to this assessment, which accompanied the EIA Scoping Opinion, and how the assessment has responded to them.

Table 12.1: EIA Scoping Opinion Response

Consultee and Comment	Response
Cherwell District Council (27 January 2023)	
Oxfordshire councils have ambitious targets to reduce the amount of waste generated and increase the amount recycled as demonstrated in our Joint Municipal Waste Management Strategy 2018-2023. Enabling residents of new dwellings to fully participate in district council waste and recycling collections is vital to allow Oxfordshire's high recycling rates to be maintained and reduce the amount of non-recyclable waste generated.	Please refer to the Site Waste Management Plan and Operational Waste Management Plan accompanying the planning application.
Given the pressing urgency of climate change and the need to embed the principles of the circular economy into all areas of our society, we encourage the applicant to consider including community spaces that help reduce waste and build community cohesion through assets such as community fridges, space for the sharing economy (library of things), refill stations, space for local food growing etc. We encourage the use of local, natural and sustainable materials with as much reuse and as little waste as possible in line with Circular Economy objectives. At the detailed application stage, we expect to see plans for how the developer will design the development in accordance with waste management policies in Cherwell District Council's waste planning guidance. Bin storage areas must be able to accommodate the correct number of mixed recycling, refuse and food recycling bins; be safe and easy to use for residents and waste collection crews and meet the requirements of the waste collection authority.	Mitigation measures referring to the implementation of circular economy principles are set out in the mitigation sections of this ES chapter.
Other aspects of climate change should also be considered through addressing the requirements of Policies ESD1-5 of the Cherwell Local Plan Part 1 2011-2031. The use of renewable energy provision on site should be considered alongside an energy strategy for the site.	**Policy ESD 1: Mitigating and Adapting to Climate Change** A Climate Change Resilience Risk Assessment forms Part B of this chapter. This sets out resilience and adaptation options for the Proposed Development. **Policy ESD 3: Sustainable Construction**

Consultee and Comment	Response
	The Proposed Development will comply with the requirement that water use is limited at 110 litres/person/day. Please refer to the Sustainability Statement, submitted as a standalone planning report, for more information. **Policy ESD 2, ESD 5 & ESD 5** Please refer to the Sustainability Statement, submitted as a standalone planning report, for more information.

Summary of Assessment Scope

12.3.2 The metric for assessing the climate change impacts of GHG emissions in this assessment is Global Warming Potential (GWP). This is expressed in units of CO_2 equivalent (CO_2e) over 100 years. This allows for the emissions of the seven key GHG: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6) expressed in terms of their equivalent global warming potential in mass of CO_2e.

12.3.3 As outlined within the EIA Scoping Report, and as agreed with CDC via the EIA Scoping Opinion, the scope of the assessment within this chapter is limited to the following assessment of effects:

Construction

12.3.4 Sources of GHG emissions during the construction phase are as follows:

- GHG emissions associated with demolition, site clearance and waste removal;
- GHG emissions associated with the extraction and manufacturing of building materials (i.e., the product stage); and
- GHG emissions associated with the transport of materials to the Site and construction and installation of products on-site (i.e., the construction process stage).

Completed Development

12.3.5 Sources of GHG emissions during the operational stage are as follows:

- GHG emissions associated with maintenance, repair, replacement and refurbishment within the buildings (i.e., the embodied carbon);
- GHG emissions associated with the operational energy requirements for the day to day running of the building (i.e., heating, cooling, lighting etc.);
- GHG emissions associated with operational water consumption for the Proposed Development;
- GHG emissions associated with operational transport (i.e., deliveries, staff journeys and occupant journeys), where appropriate transport figures are available for the Proposed Development; and
- GHG emissions associated with end-of-life demolition.

Non-Significant Effects

12.3.6 The following sources of GHG emissions have been scoped out of the assessment:

- Operational waste: The opportunities for design and construction decisions to significantly influence the reduction of GHG emissions associated with operational waste are low as it is highly dependent on occupant behaviour and waste processing at the regional scale by the relevant authority. The emissions associated with operational waste are not considered to be material in quantity to influence the overall significance of effects, and are therefore scoped out;
- Carbon sequestration of green infrastructure: GHG emissions associated with carbon sequestration of proposed green infrastructure will be low relative to total GHG emissions over the whole life of the Proposed Development, therefore the offset benefits will not be quantified. The emissions associated with carbon sequestration of green infrastructure are not considered to be material in quantity to influence the overall significance of effects, and are therefore scoped out; and
- Beyond building lifecycle: GHG emissions associated with beyond building lifecycle stage cannot be guaranteed, for example material and component re-use, therefore potential benefits will not be quantified and taken as an offset. The emissions associated with the beyond building lifecycle are not considered to be material in quantity to influence the overall significance of effects, and are therefore scoped out.

Study Area

12.3.7 The study area covers the area inside the Site boundary, and any GHG emissions that directly occurs as a result of development within the Site boundary. This does not include the manufacturing and production of construction materials, which happens off-site (lifecycle stage A1-A5), as shown in Figure 12.1. The impacts and effects discussed are considered to be global, as the receptor for GHG emissions is the global atmosphere.

Establishing Baseline Conditions

12.3.8 The baseline for the Proposed Development is defined as the current GHG emissions arising from activities and infrastructure within the Site boundary, in line with the IEMA GHG Guidance. Baseline emissions from the Site have been estimated as a point of comparison. This has been estimated over a 60-year period for the future baseline scenario.

12.3.9 The area of existing Begbroke Science Park buildings has been provided by OUD. The areas of the farm buildings currently on site has been estimated based on a plan provided by OUD. Typical electricity and fossil-thermal benchmarks taken from the Chartered Institution of Building Services Engineers (CIBSE) Technical Memorandum 46 (TM46) have been applied to the current land uses. The Department for Business, Energy and Industrial Strategy (BEIS) Greenhouse Gas Reporting: Conversion Factors 2022 for gas and grid electricity have then been applied to these figures in order to provide an estimate of annual GHG emissions from the Site for the assessment year (2023). GHG emissions figures are based on the current building occupancy rates.

12.3.10 The baseline GHG emissions attributable to the agricultural land on site have been estimated using European Union (EU) benchmark which states that the average CO_2 equivalent emissions is 2.5tCO_2 per hectare in the UK (EU, 2017)[41].

12.3.11 The baseline GHG emissions associated with operational transport at the Site has been estimated by applying an emissions factor to baseline trip numbers provided by the transport consultant, and a worst case scenario trip distance figure, estimated by NimbleFins[52] (See Appendix 12.1). The carbon factor for average car with unknown fuel has been used to account for the mix of diesel and petrol cars in use. The BEIS Greenhouse Gas Reporting: Conversion Factors 2023 states that the carbon factor for the average car with unknown fuel car is 0.16674 kg CO_2 per km.

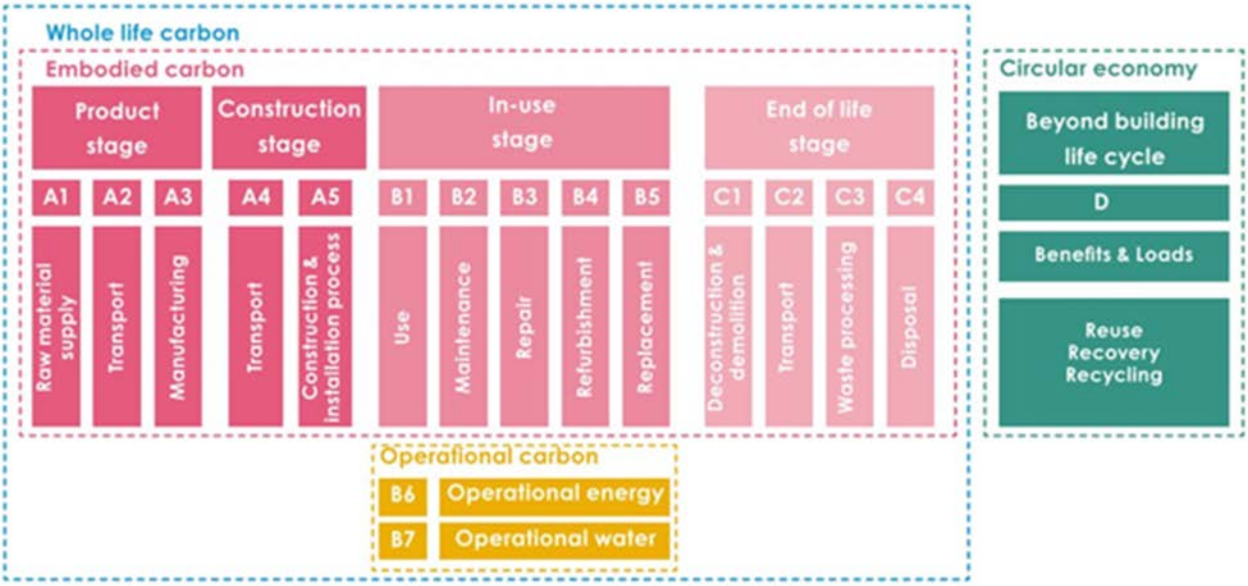
12.3.12 Circa 5.2ha of the Site is occupied by a historical landfill. The ground engineering consultant (Hydrock) has confirmed that there are low concentrations of ground gases (methane and CO_2) within the soils at the landfill, being emitted at a slow rate. It is assumed that these low-level emissions will remain constant, and will not change as a result of the Proposed Development. Therefore, the change in emissions is not considered significant, and are of negligible impact on the global scale. Due to a lack of available benchmarks, the baseline GHG emissions from the landfill have not been quantified. Please refer to the ES Chapter 15: Ground Conditions and Contamination for further information on emissions from the historical landfill.

Assessing Likely Significant Effects

12.3.13 There is currently no standard methodology for quantifying GHG emissions within the EIA process. IEMA GHG Guidance instead advocates for flexibility and proportionality to suit the Proposed Development under assessment.

12.3.14 For the purposes of the assessment, the Proposed Development has been split up into lifecycle stages, as per BS EN 15978: 2011 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Calculation Method, as shown in Figure 12.1.

Figure 12.1: Diagram showing the stages of a lifecycle GHG emissions assessment



Source: Diagram taken from LETI (2020) Embodied Carbon Primer[13], based on lifecycle stages set out in BS EN 15978:2011 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Calculation Method.

12.3.15 The decision to include or exclude a source of GHG emissions is based on:

- The relative contribution of a GHG emission source to the total GHG emissions over the whole life of the Proposed Development;
- The availability of published benchmarks and certainty over future technologies and scenarios to meaningfully estimate the GHG emissions; and
- The opportunities for design and construction decisions to significantly influence the reduction of a GHG emissions source.

12.3.16 Where emissions cannot be quantified due to lack of available benchmarks, a qualitative assessment on their likely contribution to significance has been made based on professional judgement.

12.3.17 GHG emissions caused by an activity are often categorised into 'scope 1'. 'scope 2' or 'scope 3', following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents.

12.3.18 The ES chapter does not refer to scope 1, 2 and 3 emissions throughout, instead referring to emissions by lifecycle stage. However, the following section provides an overview of which scope the assessed emissions fall within.

12.3.19 Scope 1 emissions include direct emissions from owner or controlled sources. With respect to the Proposed Development, this may include:

- Emissions from fleet vehicles e.g. Heavy Goods Vehicles (HGVs); and
- Process emissions released during on-site manufacturing.

12.3.20 Scope 2 emissions include indirect emissions from purchased energy. With respect to the Proposed Development this may include:

- Electricity, steam, heat or cooling generated offsite, purchased and consumed by the Proposed Development.

12.3.21 Scope 3 emissions include indirect value chain emissions, resulting from the activities of assets not controlled or owned by the Proposed Development occurring before or after they have control of an asset. With respect to the Proposed Development this may include:

- Upstream emissions related to the purchase of required goods and services; and
- Downstream emissions related to goods leaving the Proposed Development.

Construction

12.3.22 Based on the criteria set out in Figure 12.1, the assessment of the construction phase takes into account the following sources of GHG emissions:

- A1-A3 Product stage: GHG emissions associated with the material extraction, transportation and manufacturing of construction products. These fall within scope 3 emissions; and
- A4-A5 Construction process stage: GHG emissions associated with product delivery to Site and the installation process. These mainly fall within scope 1 and scope 2 emissions.

12.3.23 Embodied carbon associated with the construction stage of the Proposed Development, including demolition works, has been estimated by applying appropriate embodied carbon benchmarks based on floor area and the building typology. Embodied carbon benchmarks have been taken from the Atkins Carbon Critical Tool[42] (as cited in the RICS Methodology to Calculate Embodied Carbon of Materials, 2014)[43], WRAP Embodied Carbon Database (2018)[44], the University of Washington Embodied Carbon Benchmark Study (2017)[45] and the Building Research Establishment Green Guide (2009)[46]. These are considered the most appropriate publicly available benchmarks at present. A summary of the assumptions that have been made when calculating estimated GHG emissions can be found in Appendix 12.1.

Completed Development

12.3.24 Embodied carbon associated with the operational stage (i.e., lifecycle stage B1-B5) has been estimated by applying appropriate embodied carbon benchmarks based on floor area and the building typologies. A summary of the assumptions that have been made when calculating estimated GHG emissions can be found in Appendix 12.1.

12.3.25 Based on the criteria set out in Figure 12.1, the assessment of the operational stage takes into account the following sources of GHG emissions;

- B1-B5 In-use stage: This use stage captures GHG emissions associated with the operation of the built asset over its entire lifecycle, from practical completion to the end of its service life. These fall within scope 3 emissions;
- B6 Operational energy: GHG emissions associated with the estimated total operational energy. These fall within scope 2 emissions;
- B7 Operational water: GHG emissions associated with operational water consumption and foul water. These fall within scope 2 emissions; and
- C1-C4 End of Life Stage: GHG emissions associated with the demolition and disassembly of the Proposed Development, as well as the exploration of circular economy principles. These mainly fall within scope 1 emissions.

12.3.26 Additionally, the assessment considers operational transport emissions, which is not included in Figure 12.1. Operational transport emissions are considered due to the significant role these play in the UK's overall GHG emissions. Surface transport (e.g. cars, HGVs and trains) is the largest source of GHG emissions in the UK, accounting for 24% of 2019 emissions according to the Committee on Climate Change (2020)[47]. This falls within scope 1 and scope 2 emissions.

B1-B5 – In-use stage

12.3.27 Embodied carbon associated with the operational stage of the Proposed Development has been estimated by applying appropriate embodied carbon benchmarks based on floor area and building typologies.

12.3.28 Regulated energy use intensity per square metre of floor area has been applied to the estimated floor area based on appropriate benchmarks (i.e., Chartered Institute of Building Service Engineers (CIBSE) TM46 for Office[48] and figures included in the UKGBC's 'Building the Case for Net Zero' report for residential[49]). The BEIS Greenhouse Gas Reporting: Conversion Factors 2022[50] for grid electricity have then been applied to provide an estimate of annual operational energy GHG emissions associated with the Proposed Development.

A summary of the assumptions that have been made when calculating estimated GHG emissions figures can be found in Appendix 12.1.

B7 - Operational water

12.3.29 Estimated water consumption for the residential units has been based on CDC ESD Policy 3 requirement of a maximum water use of 110 l/p/d (0.11 cubic metres (m^3)). The number of people in the residential units has been estimated on one person per bedroom.

12.3.30 Estimated water consumption for the Science Park and ancillary uses have been based on building occupancy densities and estimated water consumption from the Building Services Research and Information Association (BSRIA) Rules of Thumb Guidance for Building Services (BSRIA, 2011)[51].

12.3.31 Estimated water consumption for the educational buildings has been based on agreed pupil numbers and water consumption benchmarks from the BSRIA Rules of Thumb Guidance for Building Services.

12.3.32 Estimated foul water has been assumed to be equal to water consumption.

12.3.33 The BEIS Greenhouse Gas Reporting: Conversion Factors 2023 states that the carbon factor for water supply in the UK is 0.177 kg CO_2e per m^3 of water supplied, and 0.201kg CO_2e per m^3 for the treatment of foul water.

12.3.34 A summary of the assumptions that have been made and benchmarks used when calculating estimated GHG emissions from operational water consumption can be found in Appendix 12.1.

Transport

12.3.35 An assessment of GHG emissions associated with operational transport has been carried out for vehicles arriving at the Site.

12.3.36 GHG emissions associated with cars traveling to the Proposed Development have been estimated by applying an emissions factor to trip numbers provided by the transport consultant, and a worst case scenario trip distance figure, estimated by NimbleFins[52] (see Appendix 12.1).

12.3.37 Average car with unknown fuel has have been used as the worst case scenario to account for the mix of petrol and diesel cars in use. The BEIS Greenhouse Gas Reporting: Conversion Factors 2023 states that the carbon factor for the average car with unknown fuel is 0.16674 kg CO_2 per km.

12.3.38 A summary of the assumptions that have been made when calculating estimated GHG emissions figures can be found in Appendix 12.1.

C1-C4 - End of life

12.3.39 GHG emissions associated with the end-of-life stage (lifecycle stage C1-C4) have been estimated by applying appropriate benchmarks based on the proposed floor area and the building typologies.

Cumulative Effects

12.3.40 Unlike other environmental effects discussed in the ES that have a direct or indirect effect on the Site and local area, effects from GHG emissions are not localised but contribute to the global atmospheric concentration of greenhouse gasses and consequently contribute to the global climate change effect. Therefore, assessing emissions from the Proposed Development in terms of combined effects with other nearby developments is extraneous and immaterial in terms of localised effects, and will not be carried out within this chapter. The Proposed Development should be viewed, rather, in the context of developments and construction projects globally as it contributes to a global climatic effect. As there are GHG emissions associated with almost all new developments globally and that we are approaching a global climate tipping point, cumulative effects are considered to be significant, but the quantification of the GHG emissions associated with cumulative developments is scoped out of this chapter.

Determining Effect Significance

12.3.41 The assessment of the potential impacts and likely effects as a result of the Proposed Development has taken into account both the construction phase and the operational phase. In line with the IEMA guidance, the sensitivity of the receptor (i.e., the global atmosphere) in relation to GHG emissions is always considered to be 'high'. The criteria for determining the significance of effects are outlined in Table 12.2. The significance level attributed to each effect is based on the best practice guidance from IEMA (2022).

Table 12.2: Criteria for Determining Significance of Change / Impact

Significance	Descriptor
Major adverse	The Proposed Development's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.
Moderate adverse	The Proposed Development's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
Minor adverse	The Proposed Development's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.
Negligible	The Proposed Development's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.

Significance	Descriptor
Beneficial	The Proposed Development's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

12.3.42 Effects may be described as 'permanent or temporary' and 'short, medium and long-term'. Effects associated with GHG emissions are deemed to be permanent and long-term.

12.3.43 Effects of the Proposed Development on global atmospheric GHG emissions concentrations may be described as being direct. The result of increased atmospheric GHG emissions concentrations include indirect effects associated with climate change.

Assumptions and Limitations

12.3.44 When calculating GHG emissions associated with the construction and operation of the Proposed Development, appropriate energy and carbon benchmarks have been used based on floor area, building use and estimated journey distances. Whilst these benchmarks have given an estimate of the scale of GHG emissions associated with the Proposed Development, they will not be completely accurate due to variations in geography, construction processes and construction materials used for the Proposed Development compared to the buildings that the benchmarks are based upon. However, these are considered the best available methods for estimating GHG emissions given the information available.

12.3.45 It is assumed within this assessment that aspirations presented in the list of documents below, are committed to by the applicant. These aspirations are set out in the Embedded Mitigation section of this chapter, and have been considered within the significance of effects reported.

- Framework Energy and Sustainability Strategy;
- Construction Environmental Management Plan (CEMP);
- Site Waste Management Plan (SWMP);
- Draft Construction Traffic Management Plan;
- Framework Site-Wide Travel Plan; and
- Framework Delivery and Servicing Management Plan.

12.3.46 The calculations have assumed a construction programme of February 2025 to January 2033, and a full occupation starting in 2034.

12.3.47 The calculation of GHG emissions arising from operational transport are based on the transport modelling data received. This modelling only included trip generation for cars, however there will be delivery and servicing trips (likely via HGV) which have not been accounted for. Future improvements to fuel efficiency and electrification have not been considered in the assessment due to the lack of available data. It is anticipated that future technological advancements and changes in trip numbers are likely to result in emissions lower than reported in this chapter.

12.3.48 The assessment of baseline emissions from the disused landfill on Site have not been assessed as there is a lack of available benchmarks to quantify the emissions. The emissions levels are low, will remain constant over the lifecycle of the Development, and will not change as a result of the Proposed Development. Therefore, the change in emissions is not considered significant, and are of negligible impact on the global scale.

Baseline Conditions

12.3.49 In line with IEMA GHG Guidance, the current baseline for the Proposed Development is defined as the current GHG emissions arising from activities within the Site boundary for the assessment year (2023). The Site is currently occupied by Begbroke Science Park and agricultural fields.

12.3.50 Table 12.3 provides a summary of the current building uses by area for the Site. Total GHG emissions are between 894 - 1,609 tCO_2e for the 2023 baseline year.

Table 12.3: Current land use schedule

Land use type	Total estimated area m^2	CIBSE TM46 building type
Farm buildings	888	Storage facility
Christian Building	1,467	University Campus
Units 5&6	891	University Campus
Hirsch Building	2,553	University Campus
IAT Building	4,468	University Campus
APL	325	University Campus
CIE Building	4,096	University Campus

12.3.51 The majority of the plot (approximately 156ha) is currently agricultural land. Therefore, the estimated annual emissions associated with agriculture on the Site is 390 tCO_2e/y for the baseline year.

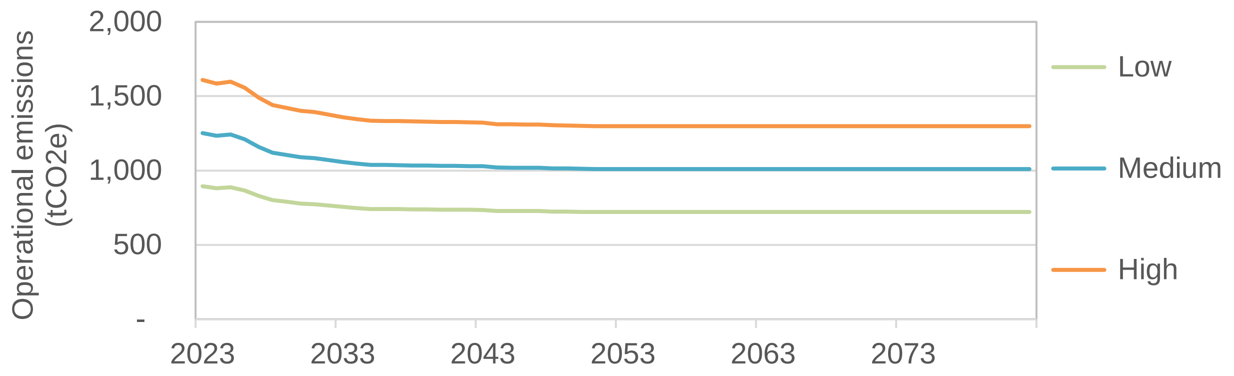
12.3.52 The estimated emissions from operational transport at the Site is 930 tCO2e/y for the baseline year.

Future Baseline

12.3.53 The future baseline represents the scenario without the Proposed Development and the current land-use of the Site remain in situ over the study period.

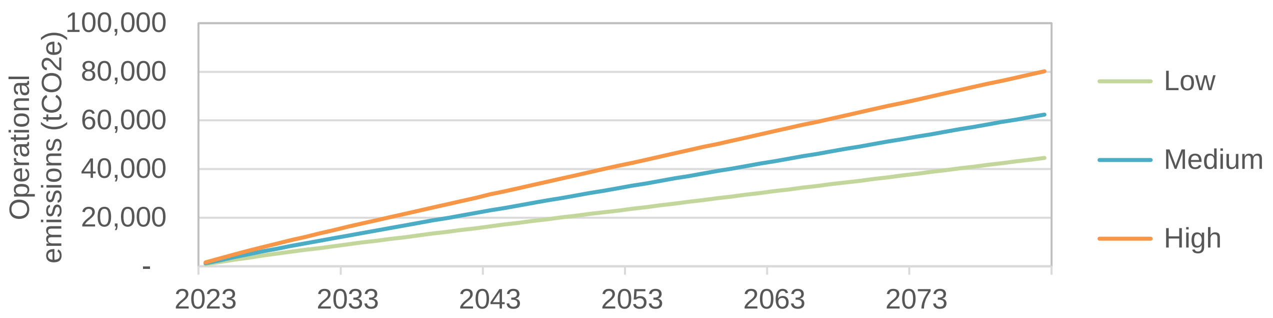
12.3.54 Figure 12.2 shows the estimated annual operational energy GHG emissions for the land uses currently on the Site for a 60-year period from 2023. Relevant BEIS carbon factors have been applied for each year over the 60-year study period. This shows that GHG emissions associated with current land uses on the Site will become less intensive in the future as the electricity grid decarbonises, with the phase out of fossil fuels in favour of more renewable energy sources. Annual GHG emissions reduce to 721 – 1,298 CO_2e/y in 2050, a reduction from 894 – 1,609 CO_2e/y in 2023. Beyond 2050, the annual emissions remain between 721 – 1,298 tCO_2e/y as BEIS projections assume near zero carbon for grid electricity by 2050 before plateauing in their projections to 2100. Since the carbon factor for gas remains constant, and this is assumed to be the dominant energy use in existing building stock for heating and hot water, the majority of the remaining GHG emissions can be attributed to gas consumption. Although it is expected that gas boilers will be replaced with electric heating, it is unknown when this will occur, therefore a worst-case approach has been used.

Figure 12.2: Estimated annual operational energy GHG emissions for current land use on the Site over the 60-year study period. A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied.



12.3.55 Figure 12.3 shows the cumulative operational energy GHG emissions associated with the current land uses on the Site over a 60-year period. Total cumulative emissions over the 60-year period are estimated to be 44,600 – 80,200 tCO_2e.

Figure 12.3: Cumulative operational energy GHG emissions associated with current land use on the Site for the 60-year study period. A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied.



12.3.56 It could be assumed that agricultural GHG emissions will remain consistent with current land uses. In reality, GHG emissions associated with current land uses will become less intensive in the future as the electricity grid decarbonises with the phase out of fossil fuels in favour of more renewable energy sources. Beyond 2050, BEIS projections assume near zero carbon for grid electricity, with any remaining emissions being attributed to gas consumption as this is assumed to be the dominant energy use in existing buildings for heating and hot water.

12.3.57 The estimated emissions from operational transport for the future baseline scenario are 55,800 tCO2e over the 60-year study period.

Summary of Receptors and Sensitivity

12.3.58 As outlined in Table 12.4, the sensitive receptor which has been considered in the assessment is the global atmosphere.

Table 12.4: Summary of Receptor Sensitivity

Receptor	Sensitivity (Value)
Existing	
Global atmospheric GHG concentrations	High

12.3.59 GHG emissions arising from the construction and operation of the Proposed Development are considered the key impacts, with the principal receptor being atmospheric GHG concentrations. The consequence of GHG emissions associated with the Proposed Development is that atmospheric GHG emissions are pushed closer towards their environmental limit, triggering subsequent effects on the global climate system.

12.3.60 Sensitivity is defined by taking into consideration the value, vulnerability and reversibility of the receptor. With regard to global atmospheric GHG concentrations, sensitivity is considered 'high' based on the following conclusions:

- Value of the resource: the atmosphere and its role in regulating the global climate is of high ecological social and economic value and underpins life on the planet therefore is of global critical value;
- Vulnerability: it is recognised by the Paris Agreement (2015)[53] that the GHG concentrations in the atmosphere are already approaching their environmental limit and the effects of climate change are already evident; and
- Reversibility of the effect: climate change is considered irreversible, with a delayed effect in any actions or technologies employed to reduce concentrations of GHG emissions already in the atmosphere.

Embedded Mitigation (Scheme Design and Management)

Construction

12.3.61 The Proposed Development will come forward in accordance with the Principle 21.1 of the Development Specification. The following supplementary planning documents set out the mitigation measures committed to for the construction phase of the Proposed Development:

Framework Energy and Sustainability Strategy

- A circular approach to materials, with an aspiration to obtain ~20% of materials via circular sourcing; and

- A circular approach to waste, with an aspiration to divert all non-hazardous waste from landfill and ability to reuse ~80% of on-site construction materials.

Construction Environmental Management Plan (CEMP)

- The Waste Hierarchy will be followed.

Site Waste Management Plan (SWMP)

- The Waste Hierarchy will be followed; and
- Up to 5% saving in waste from the application of mitigation measures set out within Table 5-2 of the SWMP.

Draft Construction Traffic Management Plan

- Re-use of excavated material for fill will be considered, depending on its suitability;
- The re-use of soils for landscaping will be maximised; and
- Where practicable, local suppliers will be sought for construction materials.

Completed Development

12.3.62 The following supplementary planning documents set out the mitigation measures committed to for the operational phase of the Proposed Development:

Framework Energy and Sustainability Strategy

- Air source heat pumps, Solar PV and heat recovery systems are confirmed technologies. These will contribute to an up to 85% improvement on Part L;
- Maximise renewable energy generation;
- Deliver Net Zero buildings in operation;
- The Proposed Development will be designed with Passivhaus principles;
- Limit water use to 110 l/p/d in line with the local plan;
- A circular approach to water, with rainwater capture and reuse;
- Reduce the reliance on cars by focusing on active travel across the Site; and
- Implement sustainable travel, prioritising the pedestrian and cyclist where ‘the car takes a back seat’.

Framework Delivery and Servicing Management Plan

- Deliveries from couriers and online shopping will naturally consolidate vehicle movements at source; and
- The Travel Plan Co-ordinators (TPCs) will encourage the commercial occupants to consolidate and/or backload as much as possible and/or use delivery agents that adopt such a practice.

Framework Site-Wide Travel Plan

- There will be an electric Car Club onsite for both residents and employees; and
- There will be a car sharing scheme.

12.3.63 Due to the fact the estimated GHG emissions associated with the Proposed Development is based on benchmarks, these embedded mitigation measures are not necessarily fully reflected in the GHG emissions figures presented. However, these measures have been considered when determining the significance of effects.

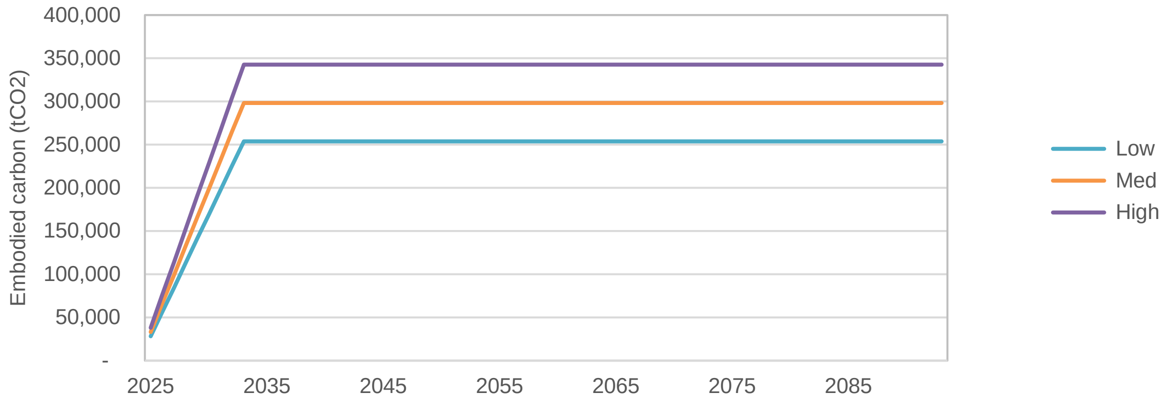
Assessment of Effects - Construction Stage

12.3.64 This section identifies and assesses the scale and nature of the main effects arising from the Proposed Development during the construction phase.

Embodied carbon associated with the product stage (lifecycle stages A1-A3) and the construction process stage (lifecycle stage A4-A5)

12.3.65 The total estimated cumulative embodied carbon associated with the construction of the Proposed Development has been calculated to be between 254,000 – 343,000 tCO_2e. A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks based on location and material and construction efficiencies. Figure 12.4 provides a summary of the cumulative embodied carbon associated with the construction phase.

Figure 12.2: Cumulative embodied carbon for the construction period of the Proposed Development. A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied.



12.3.66 For the worst-case scenario, a total of 337,000 tCO_2e can be attributed to the raw material phase, 4,500 tCO_2e to the construction phase and 1,014 tCO_2e the delivery and transportation phase. The main source of GHG emissions during demolition and construction is the raw material phase.

12.3.67 There are commitments in place to reduce the embodied carbon associated with the construction phase of the Proposed Development. These include applying a circular approach to the sourcing and disposal of materials, and implementing the waste hierarchy.

12.3.68 The sensitivity of the receptor is high, the significance of effects of embodied carbon associated with the product and construction stages of the Proposed Development are of moderate adverse significance, and the effects are long term.

Summary of Effects

Table 12.5 provides a summary of demolition and construction effects in relation to GHG emissions. This considers embodied carbon associated with the raw material, construction, and delivery and transportation of materials.

Table 12.5: Summary of Effects during Construction Phase

Receptor	Sensitivity	Description of effect	Effect significance
The global atmosphere	High	Embodied carbon associated with the product stage (lifecycle stages A1-A3).	Moderate adverse
The global atmosphere	High	Embodied carbon associated with the construction process stage (lifecycle stages A4-A5).	Moderate adverse

Additional Mitigation, Monitoring and Residual Effects

12.3.69 Table 12.6 includes a summary of construction supplementary mitigation measures for the Proposed Development.

Table 12.6: Summary of construction supplementary mitigation measures for the Proposed Development

Adverse effect	Mitigation measure	Responsibility / mechanism for implementation	Timing
Demolition and construction stage GHG emissions (lifecycle stages A1-A3)	Put in place a commitment to reduce lifecycle embodied carbon by 10% compared to the business-as-usual baseline. The business-as-usual baseline is defined as the design of the residential or commercial unit using current standard best practice construction materials and techniques. An appropriate baseline should be defined for the Proposed Development, taking into consideration industry benchmarks set by LETI and RIBA, and reduction secured through further design refinement.	Developer/ contractor To be committed to at the reserved matters stage, secured by planning condition	Prior to commencement of development, (other than enabling and associated works), within the relevant phase
Demolition and construction stage GHG emissions (lifecycle stages A1-A3)	Explore the possibility of using cement replacement where possible to reduce embodied carbon.	Developer/ contractor To be reviewed at the reserved matters stage	
Demolition and construction stage GHG emissions (lifecycle stages A1-A3)	Review opportunities to minimise internal finishes such as dry lining, ceilings and decorative floor screeds / covering where not technically required (e.g. for acoustics or fire protection), opting for fair faced finishes instead.	Architect and Structural Engineer To be reviewed at the reserved matters stage	

Adverse effect	Mitigation measure	Responsibility / mechanism for implementation	Timing
Demolition and construction stage GHG emissions (lifecycle stages A1-A3)	A whole life carbon assessment should be undertaken for each building to identify opportunities to reduce embodied carbon through design, material specification and construction processes.	Developer/ contractor	To be completed at the reserved matters stage, secured by planning condition
Demolition and construction stage GHG emissions (lifecycle stages A4-A5)	Review opportunities to reduce energy association with construction installation processes.	Developer/ contractor	To be reviewed at the reserved matters stage
Demolition and construction stage GHG emissions (lifecycle stages A4-A5)	Explore the use of off-site modular construction to consolidate delivery requirements, and for energy efficient assembly and minimising site installation process.	Developer/ contractor	To be reviewed at the reserved matters stage

12.3.70 With the implementation of the supplementary mitigation measures proposed in Table 12.6, the residual effect during the construction phase of the development, for lifecycle stages A1-A5 would be minor adverse.

Assessment of Effects - Completed Development

12.3.71 This section identifies and assesses the scale and nature of the main effects arising from the Proposed Development during the operational phase.

Operational Embodied Carbon (lifecycle stage B1-B5)

12.3.72 Embodied carbon associated with the in use (maintenance) stage has been estimated to be approximately 300,000 tCO_2e over the 60-year lifecycle of the Proposed Development.

12.3.73 There are embedded mitigation measures in place to reduce this, including the implementation of circular economy measures with regards to the sourcing of materials and waste. Therefore, the effects of operational embodied carbon associated with the Proposed Development are of moderate adverse significance. The effects are long term.

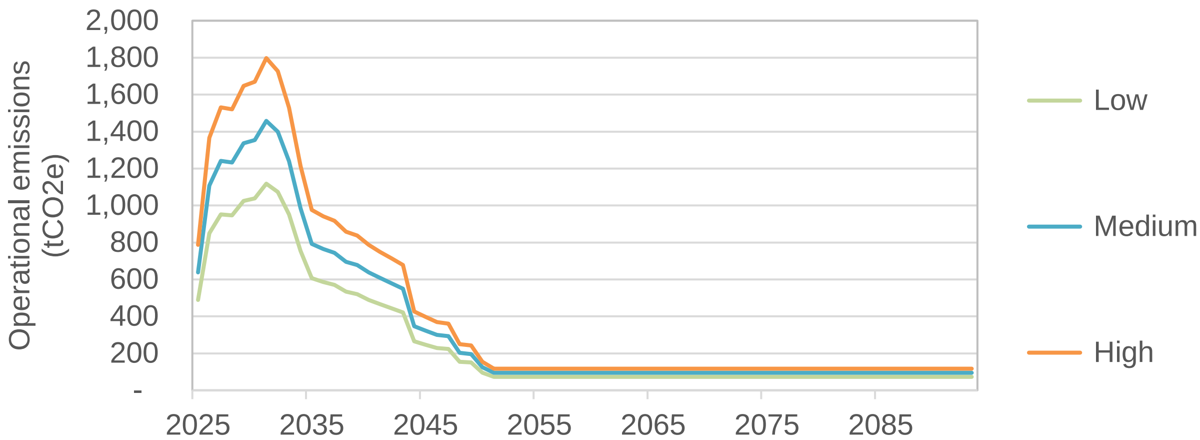
Operational Energy Consumption (lifecycle stage B6)

12.3.74 Figure 12-5 shows the estimated annual GHG emissions for operational energy associated with the Proposed Development for a 60-year period from 2034. Relevant BEIS carbon factors have been applied for each year over the 60-year study period. This shows that

GHG emissions associated with the Proposed Development will become less intensive in the future as the electricity grid decarbonises with the phase out of fossil fuels in favour of more renewable energy sources. Annual GHG emissions associated with operational energy peak at between 1,074 and 1,726 tCO_2e/y in 2031 when the Proposed Development is nearly fully built out.

12.3.75 Annual GHG emissions associated with operational energy are then predicted to reduce to between 73 and 117 tCO_2e/y by 2050, which is the year that the BEIS conversion factors stretch to. Beyond 2050, it is assumed that the energy grid will be net zero carbon, in line with the Climate Change Act 2008 (2050 Target Amendment) Order 2019, with any residual GHG emissions being offset at a national scale. A range of values (i.e., low, medium and high) have been provided to allow for variations in energy consumption for building typologies, taking into account factors such as building location, building orientation and building materials used.

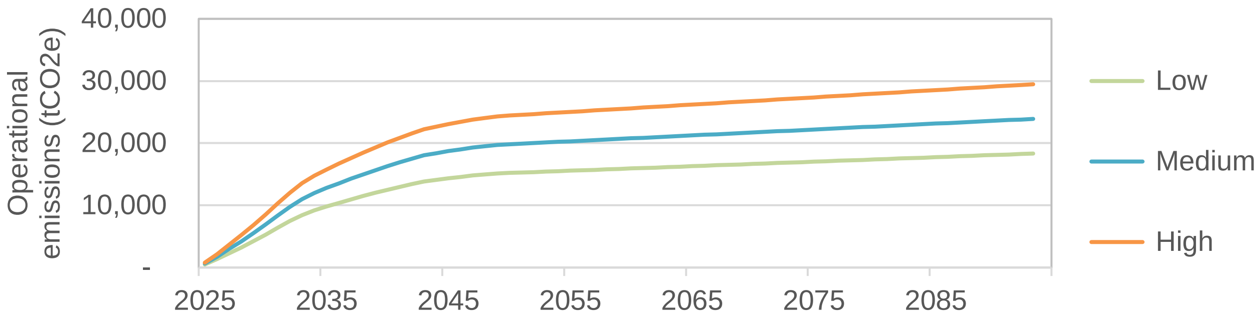
Figure 12.3: Annual GHG emissions associated with operational energy over a 60-year design life. A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied



Note: A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied.

12.3.76 Figure 12.7 shows the cumulative GHG emissions associated with operational energy over the 60-year lifecycle of the Proposed Development. It is predicted that cumulative GHG emissions associated with operational energy will be between 18,330 and 29,480 tCO_2e over the 60-year lifecycle of the Proposed Development.

Figure 12.4: Cumulative operational energy GHG emissions over the 60-year design life of the Proposed Development.



Note: A range of values (i.e., low, medium, and high) have been provided to allow for variations from the benchmarks applied.

12.3.77 The committed embedded mitigation measures for operational energy include buildings being net zero in operation, and the maximisation of renewable energy generation. Therefore, the effects of operational energy (lifecycle stage B6) associated with the Proposed Development are of minor adverse significance. The effects are long term.

Operational Water (Lifecycle B7)

12.3.78 GHG emission attributed to water demands for the Proposed Development over the 60-year lifecycle are summarised in Table 12.7.

Table 12.7: Summary of GHG emissions associated with water consumption for the 60-year design life of the Proposed Development

Use class	Water consumption (m^3)	Carbon factor (kg CO_2e/m^3 of water supplied)	GHG emissions (tCO_2e) of water supplied	Carbon factor (kg CO_2e/m^3 of foul water)	GHG emissions (tCO_2e) of foul water	Total GHG emissions (tCO_2e) of water supplied and foul water
Uses associated with the expansion of Begbroke Science Park Classes B2, B8, E(g), and F1(a)	25,458,750	0.177	4,150	0.201	5,120	9,620
Retail (including the sale of food and drink)E(a), (b), and (c)	178,850	0.177	30	0.201	40	70
Hotel C1	5,475,000	0.177	970	0.201	1,100	2,070
Non-residential and leisure institutions, including nursery, medical or health services, indoor sport or fitness facilities, and creches and/or nurseries E(d), (e), and (f)	147,168,000	0.177	26,050	0.201	29,580	55,630

Use class	Water consumption (m^3)	Carbon factor (kg CO_2e/m^3 of water supplied)	GHG emissions (tCO_2e) of water supplied	Carbon factor (kg CO_2e/m^3 of foul water)	GHG emissions (tCO_2e) of foul water	Total GHG emissions (tCO_2e) of water supplied and foul water
Halls and meeting places F2(b)	315,360	0.177	60	0.201	60	120
Sui generis uses including (but not limited to) public houses, wine bars or drinking establishments	35,770	0.177	10	0.201	10	10
Secondary School F1(a)	481,800	0.177	90	0.201	100	180
Primary Schools (x2) F1(a)	344,925	0.177	60	0.201	70	130
Residential	11,274,120	0.177	2,000	0.201	2,300	4,260
Total	**190,732575**	**n/a**	**33,780**	**n/a**	**38,380**	**72,090**

12.3.79 There are commitments in place to reduce operational water consumption of the residential units in line with the CDC policy requirements, along with the implementation of a circular approach to water, with rainwater capture and reuse. The sensitivity of the receptor is high, the effects are of minor adverse significance, and the effects are long term.

Operational Transport

12.3.80 GHG emissions attributed to the operational transport for the Proposed Development over the 60-year lifecycle are summarised in Table 12.8. Please refer to Appendix 12.1 for detailed information on operational transport GHG emissions.

12.3.81 The figures presented here do take into account the UK Government's target for net zero emissions by 2050, however the electrification of vehicles has not been taken into account up to 2050 to provide an assessment of the worst-case scenario. In reality, with electric vehicles becoming more widespread and the decarbonisation of the grid, it is likely that the numbers here present an overestimation. However, whilst the Government announced the end to sales of new petrol and diesel cars by 2030 on 18 November 2020, existing petrol and diesel cars would still be in circulation until their end of life.

Table 12.8: Summary of GHG emissions associated with operational transport for the 60-year design life of the Proposed Development

Trip type	GHG emissions (tCO_2e) over the 60-year design life of the Proposed Development
Cars	547,200

12.3.82 There are committed mitigations in place to reduce the emissions resulting from operational transport. These include the provision of a Car Club using electric cars, a car sharing scheme and a focus on active travel across the Proposed Development to minimise car use. The sensitivity of the receptor is high, the effects are of major adverse significance, and the effects are long term.

End of Life Stage (lifecycle C1-C4)

12.3.83 GHG emissions associated with the end-of-life stage are estimated to be approximately 1,400 tCO_2e.

12.3.84 There is a commitment to take a circular economy approach to the Proposed Development, therefore the effects associated with end-of-life stage are moderate adverse, effects are long term.

Summary of Effects

12.3.85 Table 12.9 provides a summary of operational effects in relation to GHG emissions. This takes into account GHG emissions associated with operational energy, operational embodied carbon, operational water consumption, operational transport, and GHG emissions associated with the end-of-life stage.

Table 12.9: Summary of Effects during Operational Phase

Receptor	Sensitivity	Description of effect	Effect significance
The global atmosphere	High	Embodied carbon associated with the in-use stage for the Proposed Development (lifecycle stages B1-B5).	Moderate adverse
The global atmosphere	High	GHG emissions associated with operational energy for the Proposed Development (lifecycle stage B6).	Minor adverse
The global atmosphere	High	GHG emissions associated with operational water consumption (lifecycle stage B7)	Minor adverse
The global atmosphere	High	GHG emissions associated with operational transport	Major adverse
The global atmosphere	High	GHG emissions associated with the end-of- life stage (lifecycle stage C1-C4).	Moderate adverse

Whole Life Carbon Summary

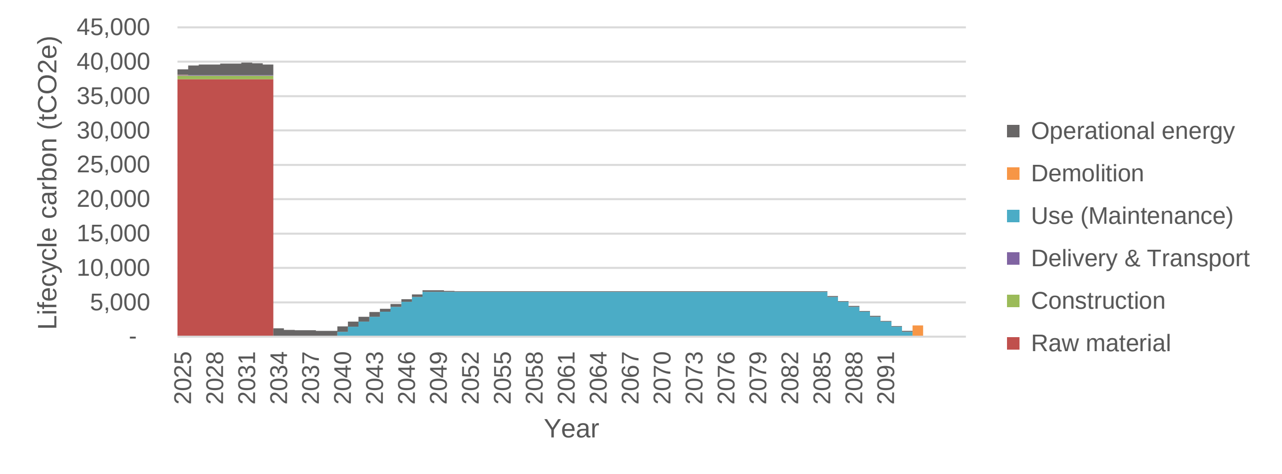
12.3.86 This section of the ES chapter provides a summary of the lifecycle GHG emissions for the Proposed Development in comparison to the future baseline scenario.

12.3.87 Figure 12.8 shows the lifecycle GHG emissions for the sources that were assessed as part of this ES chapter, thereby considering both the construction and operation phases of the Proposed Development. The total GHG emissions for these sources over the 60-year design life of the Proposed Development are between approximately 1,206,440 and 1,295,440 tCO_2e, as outlined in Table 12.10. In comparison, if the Proposed Development were to not go ahead, estimated GHG emissions associated with the future baseline scenario are assumed to remain approximately between 2,210 and 2,930 tCO_2e/year for the current Begbroke Science Park, agricultural fields and operational transport.

Table 12.10: Whole life carbon summary for the Proposed Development

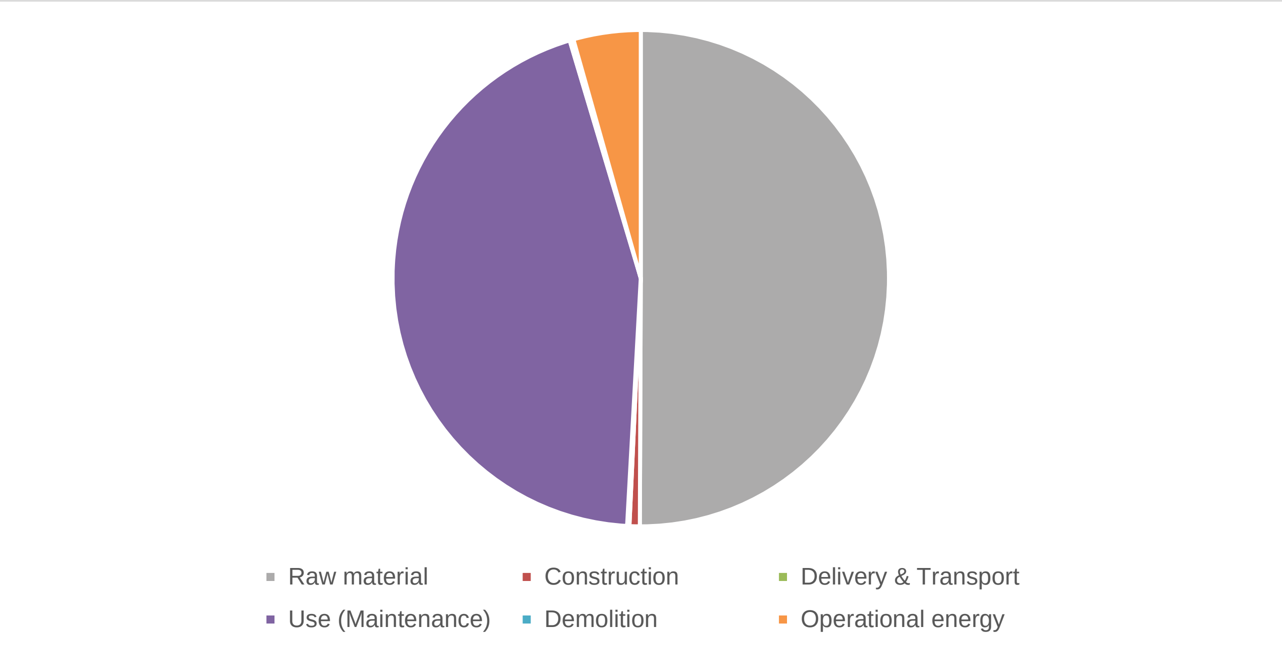
Emissions source	Low scenario tCO_2e	High scenario tCO_2e
Construction (A1-A5)	254,000	343,000
In use stage (B1-B5)	300,000	300,000
Operational energy (B6)	18,330	18,330
Operational water (B7)	72,090	72,090
Operational transport	547,200	547,200
End of life stage (C1-C4)	1,400	1,400
Total	**1,193,020**	**1,282,020**

Figure 12.5: Diagram breaking down GHG emissions associated with the Proposed Development by lifecycle stage



12.3.88 Figure 12.9 breaks down the GHG emissions associated with each lifecycle of the Proposed Development as a proportion of the whole life GHG emissions.

Figure 12.6: Pie chart breaking down the GHG emissions associated with the Proposed Development by lifecycle stage



Wider Context GHG emissions

12.3.89 According to 2005 to 2020 UK local regional greenhouse gas emissions data provided by the Department for BEIS, emissions associated with CDC for 2020 (the most recent available dataset) were 1,131 kt CO_2e. To gain a sense of scale of the GHG emissions associated with the Proposed Development, it may be noted that the Proposed Development represents approximately 0.15% of CDC's emissions at the peak of operational emissions in 2031, and approximately 0.01% during operation post 2050. However, direct comparisons should not be made between these figures because the BEIS GHG emissions figures do not consider 'consumption-based' emissions (i.e. embodied carbon), while the GHG emissions figures for the Proposed Development do. It is likely that a significant proportion of construction materials will be imported; therefore, it is not a like-for-like comparison. Additionally, due to the global nature of GHG emissions, this point of comparison has not been used to determine significance of effects.

Mitigation, Monitoring and Residual Effects

Supplementary Mitigation

12.3.90 Table 12-.11 provides a summary of the supplementary mitigation measures relating to operational GHG emissions associated with the Proposed Development.

Table 12.11: Summary of operational and end-of-life supplementary mitigation measures for Proposed Development

Adverse effect	Mitigation measure	Responsibility / mechanism for implementation	Timing
In use stage (B1-B5) and end of life stage (C1-C4)	Put in place a commitment to reduce lifecycle embodied carbon by 10% compared to the business-as-usual baseline. The business-as-usual baseline is defined as the design of the residential or commercial unit using current standard best practice construction materials and techniques. An appropriate baseline should be defined for the Proposed Development, taking into consideration industry benchmarks set by LETI and RIBA, and reduction secured through further design refinement.	Developer / contractor To be committed to at the reserved matters stage, secured by planning condition	Prior to commencement of development, (other than enabling and associated works), within the relevant phase
In use stage (B1-B5) and end of life stage (C1-C4)	A whole life carbon assessment should be undertaken for each building to identify opportunities to reduce embodied carbon through design, material specification and construction processes. Consideration should be given for embodied carbon associated with the maintenance and replacement cycle.	Developer To be completed at the reserved matters stage, secured by planning condition	
In use stage (B1-B5)	Minimise the use of materials that require more frequent replacement or refurbishment (such as carpets and flood coverings)	Developer / contractor To be reviewed at the reserved matters stage	
In use stage (B1-B5)	Extend the longevity of the materials (e.g., specifying appliances with extended warranty and lifespan).	Developer / contractor	

Adverse effect	Mitigation measure	Responsibility / mechanism for implementation	Timing
		To be reviewed at the reserved matters stage	
Operational energy (B6)	Specify a target year for net zero carbon emissions in operation, well ahead of the UK's trajectory to net zero in 2050.	Developer / contractor To be committed to at the reserved matters stage, secured by planning condition	
Operational water (B7)	Specify water saving devices, such as low flush toilets and showers to reduce water consumption associated with the Proposed Development.	Developer / contractor To be reviewed at the reserved matters stage	
Operational water (B7)	Specify the use of water meters to measure water consumption.	Developer / contractor To be reviewed at the reserved matters stage	
Operational water (B7)	Specify landscaping that does not require irrigation to reduce unregulated water consumption	Developer / contractor To be reviewed at the reserved matters stage	
Operational transport	Provide parking spaces that will benefit from active charging facilities for electric vehicles	Developer / contractor To be reviewed at the reserved matters stage	
Operational transport	Where possible, use green routing to optimise route choices of servicing and delivery trips	Developer / contractor To be reviewed at the reserved matters stage	

12.3.91 With the implementation of the supplementary mitigation measures set out in Table 12.12, the residual effects for operational water (lifecycle stage B7) and operational energy use (lifecycle stage B6) are reduced to negligible, the residual effects for operational embodied carbon (lifecycle stage B1-B5), and end-of-life (lifecycle stage C1-C4) are reduced to minor adverse, and the residual effect for operational transport, is reduced to moderate adverse.

Summary

12.3.92 Table 12.12 provides a summary of construction and operational effects, additional mitigation and residual effects.

Table 12.12: Summary of Residual Effects

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Construction					
Embodied carbon associated with the product stage (lifecycle stages A1-A3)	Global atmosphere – high sensitivity	Global & Long term	Moderate adverse	Put in place a commitment to reduce lifecycle embodied carbon by 10% compared to the business-as-usual baseline. The business-as-usual baseline is defined as the design of the residential or commercial unit using current standard best practice construction materials and techniques. An appropriate baseline should be defined for the Proposed Development, taking into consideration industry benchmarks set by LETI and RIBA, and reduction secured through further design refinement. To be committed at the reserved matters stage, secured by planning condition. Explore the possibility of using cement replacement where possible to reduce embodied carbon. To be reviewed at the reserved matters stage. Review opportunities to minimise internal finishes such as dry lining, ceilings and decorative floor screeds / covering where not technically required (e.g. for acoustics or fire protection), opting for fair faced finishes instead. To be reviewed at the reserved matters stage. A whole life carbon assessment should be undertaken for each building to identify opportunities to reduce embodied carbon through design, material specification and construction processes. To be completed at the reserved matters stage, secured by planning condition.	Minor adverse
Embodied carbon associated with the construction process	Global atmosphere – high sensitivity	Global & Long term	Major adverse	Review opportunities to reduce energy association with construction installation processes. Explore the use of off-site modular construction to consolidate delivery requirements, and for energy efficient assembly and minimising site installation process.	Moderate adverse

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
stage (lifecycle stages A4-A5)					
Completed Development					
Embodied carbon associated with the in-use stage (lifecycle stages B1-B5)	Global atmosphere – high sensitivity	Global & Long term	Moderate adverse	Put in place a commitment to reduce lifecycle embodied carbon by 10% compared to the business-as-usual baseline. The business-as-usual baseline is defined as the design of the residential or commercial unit using current standard best practice construction materials and techniques. An appropriate baseline should be defined for the Proposed Development, taking into consideration industry benchmarks set by LETI and RIBA, and reduction secured through further design refinement. To be committed to at the reserved matters stage, secured by planning condition. A whole life carbon assessment should be undertaken for each building to identify opportunities to reduce embodied carbon through design, material specification and construction processes. To be completed at the reserved matters stage, secured by planning condition. Consideration should be given for embodied carbon associated with the maintenance and replacement cycle. To be reviewed at the reserved matters stage. Minimise the use of materials that require more frequent replacement or refurbishment (such as carpets and flood coverings). To be reviewed at the reserved matters stage.	Minor adverse

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
				Extend the longevity of the materials (e.g., specifying appliances with extended warranty and lifespan). To be reviewed at the reserved matters stage.	
GHG emissions associated with operational energy (lifecycle stage B6)	Global atmosphere – high sensitivity	Global & Long term	Minor adverse	Specify a target year for net zero carbon emissions in operation, well ahead of the UK's trajectory to net zero in 2050. To be committed to at the reserved matters stage, secured by a planning condition.	Negligible
GHG emissions associated with operational water consumption (lifecycle stage B7)	Global atmosphere – high sensitivity	Global & Long term	Minor adverse	Specify water saving devices, such as low flush toilets and showers to reduce water consumption associated with the Proposed Development. Specify the use of water meters to measure water consumption. To be reviewed at the reserved matters stage. Specify landscaping that does not require irrigation to reduce unregulated water consumption. To be reviewed at the reserved matters stage.	Negligible
GHG emissions associated with operational transport	Global atmosphere – high sensitivity	Global & Long term	Major adverse	Provide parking spaces that will benefit from active charging facilities for electric vehicles. To be reviewed at the reserved matters stage. Where possible, use green routing to optimise route choices of servicing and delivery trips. To be reviewed at the reserved matters stage.	Moderate adverse
GHG emissions	Global atmosphere	Global & Long term	Moderate adverse	Put in place a commitment to reduce lifecycle embodied carbon by 10% compared to the business-as-usual baseline. The business-as-usual	Minor adverse

Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
associated with the end-of-life stage (lifecycle stage C1-C4)	– high sensitivity			baseline is defined as the design of the residential or commercial unit using current standard best practice construction materials and techniques. An appropriate baseline should be defined for the Proposed Development, taking into consideration industry benchmarks set by LETI and RIBA, and reduction secured through further design refinement. To be completed at the reserved matters stage, secured by planning condition. A whole life carbon assessment should be undertaken for each building to identify opportunities to reduce embodied carbon through design, material specification and construction processes. To be completed at the reserved matters stage, secured by planning condition. Consideration should be given for embodied carbon associated with the maintenance and replacement cycle. To be reviewed at the reserved matters stage.	

12.4 Part B: Climate Change Resilience Risk Assessment

Introduction

12.4.1 Schedule 4 of the EIA Regulations 2017[54] notes information should be included in the ES on the likely significant effects of a development on the environment resulting from the vulnerability of the project to climate change.

12.4.2 In line with the IEMA EIA Guide to Climate Change Resilience and Adaptation, there are two key strands to assessing climate change resilience and adaptation issues within EIA, as outlined below:

- The risks of changes in the climate to the project (i.e., the resilience or conversely the vulnerability of a project to future climate changes). The IEMA guidance states that this is generally better suited to a risk assessment type process than traditional EIA 'determination of significance'. This climate change resilience risk assessment has therefore been completed for the Proposed Development; and
- The extent to which climate exacerbates or ameliorates the effects of the project on the environment (i.e., 'in-combination' effects). The IEMA guidance states that this is best analysed in the existing chapters of the ES and is suited to using traditional significance criteria from the respective chapters. Therefore, this has been included throughout each of the technical ES chapters and has been completed by each technical specialist.

Climate Change Resilience and Adaptation Workshop

12.4.3 A climate change resilience and adaptation workshop was held on 4th November 2022. The project team in attendance were technical specialists covering a range of environmental topics from Buro Happold, Quod, RCKA, Hydrock, OKR, Tree Frontiers, and BSG Ecology. The project team contributed to this climate change resilience risk assessment through the workshop. The risks and mitigation measures discussed are presented in this risk assessment. This workshop was conducted in order to:

- Summarise guidance relating to climate change resilience and adaptation in EIA;
- Provide details of the Met Office UK Climate Projections 2018 (UKCP18)[55] for the Proposed Development;
- Identify key climate change hazards and risks for the Proposed Development;
- Outline the approach being used for the inclusion of climate change resilience and adaptation in the EIA process; and
- Identify and develop appropriate mitigation measures to increase climate change resilience of the Proposed Development.

Methodology and Assessment Criteria

Risk Assessment

12.4.4 This climate change resilience risk assessment has been undertaken in line with the IEMA guidance. The methodology has been adapted from the C40 Cities Climate Change Risk Assessment Guidance (2018)[17], the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Climate Risk Assessment Methodology

(2015)[56] and the Highways England Design Manual for Roads and Bridges Sustainability & Environmental Appraisal[57]. Risk has been assessed based on the probability of an event occurring and severity of consequences as a result of that event occurring.

12.4.5 A baseline risk assessment has been undertaken that assesses the probability and consequence of climatic risks occurring considering current climatic conditions. A second risk assessment has then been undertaken that assess the change in probability and consequence of climatic risks as a result of future climate change.

Probability

12.4.6 Table 12.13 summarises the criteria utilised to determine the likelihood rating for an effect. The project lifetime includes both the construction and operation stages. The project lifetime for the Proposed Development is considered to be 60 years.

Table 12.13: Criteria used to determine likelihood

Score	Description (probability and frequency of occurrence)
1	The event occurs very rarely during the lifetime of the project (60 years). For example, once every 60 years (1 event).
2	The event occurs limited number of times during the lifetime of the project (60 years). For example, once every 25 years (2-3 events).
3	The event occurs regularly during the lifetime of the project (60 years) For example, once every 2-5 years (12-30 events).
4	The event occurs frequently during lifetime of the project (60 years). For example, once per year (60 events).
5	The event occurs very frequently during the lifetime of the project (60 years). For example, multiple times per year (more than 60 events).

Consequence

12.4.7 Table 12.14 summarises the criteria used to determine the consequence rating for effects relating to a climate risk. Consequence has been determined based on the extent to which the climate risk may impact on the amenity value and function of the Proposed Development. The amenity value is the positive element or elements that contribute to the overall character or enjoyment of the Proposed Development. The function is the extent to which the Proposed Development meets the purpose or purposes that it is designed to fulfil.

Table 12.14: Criteria used to determine consequence

Score	Description
1	Very low but measurable effect on site users and the Proposed Development itself. Slight negative change in amenity value of the Proposed Development and slight negative change in function.
2	Low but measurable effect on site users and the Proposed Development itself. Low negative change in amenity value of the Proposed Development and slight negative change in function.

Score	Description
3	Moderate effect on site users and the Proposed Development itself. Moderate negative change in amenity value of the Proposed Development and slight negative change in function.
4	Moderate effect on site users and the Proposed Development itself. Major negative change in amenity value of the Proposed Development and low negative change in function.
5	Moderate effect on site users and the Proposed Development itself. Major negative change in amenity value of the Proposed Development and moderate negative change in function.
6	Major effect on site users and the Proposed Development itself. Major negative change in amenity value of the Proposed Development and major negative change in function.
7	Extreme effect on site users and the Proposed Development itself. Loss of asset.

Risk Rating

12.4.8 Table 12.15 summarises the matrix used to determine the risk rating, based on probability of the event occurring and the consequences as a result of the event occurring.

Table 12.15: Risk rating determined based on the likelihood and consequence scores

	Probability					
Consequence		**1**	**2**	**3**	**4**	**5**
	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25
	6	6	12	18	24	30
	7	7	14	21	28	35

(yellow)	Low risk
(orange)	Medium risk
(red)	High risk

Limitations and Assumptions

12.4.9 The main uncertainty regarding the climate change resilience assessment surrounds the climate change projections that the scheme is assessed against. Climate change projections (e.g., UKCP18)[55] are presented using a set of scenarios that capture the relationships between human choices, emissions, concentrations, and temperature change. Some scenarios are consistent with continued dependence on fossil fuels, while others are associated with deliberate actions to reduce GHG emissions. Therefore, climate change projections contain inherent uncertainty, reflecting the uncertainty associated with quantifying human activities (including technological change) and their influence on climate.

Current Baseline Conditions

12.4.10 Table 12.16 provides a summary of the current baseline climatic conditions, taken from the Oxford weather station. The data provides average historic climatic conditions for 1991-2020. The monthly mean minimum / maximum temperatures are calculated from the average of the daily maximum and daily minimum temperatures for each month. The warmest month on average was July and the coolest month on average was January. The wettest month on average was October and the driest month on average was March. The sunniest month on average was July and the least sunny month on average was December.

Table 12.16: Summary of historic average climatic conditions for 1991-2020 taken from the Oxford Met Office monitoring station.

Month	Mean daily maximum temperature (°C)	Mean daily minimum temperature (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)
January	7.98	2.38	8.40	63.39	59.57
February	8.63	2.32	7.50	81.90	46.77
March	11.29	3.64	3.80	118.16	43.16
April	14.41	5.29	1.43	165.60	48.65
May	17.68	8.17	0.10	200.27	56.91
June	20.71	11.14	0.00	197.09	49.69
July	23.06	13.09	0.00	211.99	52.50
August	22.50	13.00	0.00	193.28	61.66
September	19.44	10.65	0.00	145.30	51.87
October	15.09	7.95	0.73	110.15	73.18
November	10.88	4.85	3.17	70.75	71.47
December	8.23	2.59	8.60	57.60	66.12
Annual	15.02	7.12	33.73	1615.48	681.55

Identification and Evaluations of Baseline Risks

12.4.11 To provide a baseline, risks relating to the Proposed Development have been assessed against current baseline weather patterns. Table 12.19 provides a list of potential risks, as adapted from the C40 Cities Climate Change Risk Assessment Guidance (C40 Cities, 2017)[17]. The inclusion of certain risks in the assessment is based on availability of data and relevance of the risk to the Proposed Development. Probability and consequence ratings have been given to these risks, thereby generating a risk rating based on Table 12.15. The probability and consequence ratings outlined in Table 12.17 are pre-mitigation.

Table 12.17: Climate change risks based on C40 Cities Climate Change Risk Assessment Guidance

Risk	Is it relevant for the Proposed Development?	Probability rating (1-5)	Likely consequences of climate risk occurring	Consequence rating (1-7)	Risk rating
Rainstorm	Yes	5	Damage and degradation of building materials through wetting and impact from rainfall. Discomfort for users of the Proposed Development.	1	5
Heavy snow	Yes	3	Damage to building materials (e.g., roofs). Discomfort and potential injury to users of the Proposed Development.	2	6
Fog	Yes	5	Increased risk of accidents as a result of impaired vision.	1	5
Hail	Yes	4	Discomfort for users of the Proposed Development.	1	4
Severe wind	Yes	3	Damage to building materials. Discomfort and potential injury to users of the Proposed Development.	4	12
Extra tropical storm	Yes	3	Damage to building materials. Discomfort and potential injury to users of the Proposed Development.	4	12
Lightning	Yes	4	Potential damage to building materials. Injury to users of the Proposed Development unlikely but possible.	2	8
Extreme winter conditions	Yes	4	Damage to building materials (e.g., pipes bursting). Discomfort and potential injury to users of	3	12
Cold wave	Yes	4		3	12

Risk	Is it relevant for the Proposed Development?	Probability rating (1-5)	Likely consequences of climate risk occurring	Consequence rating (1-7)	Risk rating
Extreme cold days	Yes	4	the Proposed Development.	3	12
Heat waves	Yes	3	Damage and degradation to building materials. Extended period of overheating in building affects comfort and health of occupants.	5	15
Extreme hot days	Yes	4	Damage to property and injury to users of the Proposed Development.	4	16
Drought	Yes	3		4	12
Forest fire	Yes	1		5	5
Flash/surface flood	Yes	4	Damage to buildings and contents. Potential injury to users of the Proposed Development.	6	18
River/tidal flood	Yes	2		3	6
Groundwater flood	Yes	2		6	12
Subsidence	Yes	1	Damage to building materials. Potential injury to users of the Proposed Development.	6	6
Water-borne disease	Yes	1	Potential illness to users of the Proposed Development.	3	3
Vector borne disease	Yes	1		4	4
Airborne disease	Yes	1		3	3
Insect infestation	Yes	1		3	3

12.4.12 The following risks were assessed but not deemed relevant to the Proposed Development:

- Monsoon;
- Tornado;
- Hurricane;
- Tropical Storm;
- Storm Surge;
- Land Fire;

- Permanent Inundation;
- Salt Water Intrusion;
- Ocean Acidification;
- Landslide;
- Avalanche; and
- Rock Fall

Likely Effects of Climate Change

12.4.13 The UK Climate Projections 2018 (UKCP18)[55] provide the most up-to-date assessment of how the climate of the UK may change over the 21st century. UKCP18 uses Representative Concentration Pathways (RCPs). These are named according to the concentration of greenhouse gas modelled to occur in the atmosphere in 2100. There are four RCPs available in the UKCP18 climate projections: RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. In line with the IEMA Guidance, RCP 8.5 has been used, which represents the most conservative, highest-impact scenario. Table 12-18 summarises the projected summer and winter mean temperature and precipitation changes up to the 2090s for RCP 8.5.

Table 12.18: UKCP18[55] data for the South-West under RCP 8.5

Season	Variable	Time Period	Projected Change At		
			10th percentile	50th percentile	90th percentile
Winter	Mean temperature (ºC)	2020 - 2039	-1 to 0	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3
		2060 - 2079	0 to 1	2 to 3	3 to 4
		2080 – 2099	1 to 2	3 to 4	5 to 6
	Mean precipitation change (%)	2020 – 2039	-10 to 0	0 to 10	10 to 20
		2040 - 2059	-10 to 0	10 to 20	20 to 30
		2060 - 2079	-10 to 0	10 to 20	40 to 50
		2080 – 2099	0 to 10	20 to 30	50 to 60
	Mean daily maximum temp change compared to 1981-2000	2020 - 2039	0 to 1	1 to 2	2 to 3
		2040 - 2059	0 to 1	2 to 3	3 to 4
		2060 - 2079	1 to 2	3 to 4	6 to 7
		2080 – 2099	2 to 3	5 to 6	8+
	Mean daily minimum temp change compared to 1981-2000	2020 - 2039	-30 to -20	-10 to 0	10 to 20
		2040 - 2059	-50 to -40	-20 to -10	0 to 10
		2060 - 2079	-60 to -50	-30 to -20	0 to 10
		2080 – 2099	-60 to -50	-50 to -40	-10 to 0
Summer	Mean temperature (ºC)	2020 - 2039	-1 to 0	0 to 1	1 to 2
		2040 - 2059	0 to 1	1 to 2	2 to 3

Season	Variable	Time Period	Projected Change At		
			10th percentile	50th percentile	90th percentile
		2060 - 2079	0 to 1	2 to 3	3 to 4
		2080 – 2099	1 to 2	3 to 4	5 to 6
	Mean precipitation change (%)	2020 - 2039	-10 to 0	0 to 10	10 to 20
		2040 - 2059	-10 to 0	10 to 20	20 to 30
		2060 – 2079	-10 to 0	10 to 20	40 to 50
		2080 – 2099	0 to 10	20 to 30	50 to 60
	Mean daily maximum temp change compared to 1981-2000	2020 - 2039	0 to 1	1 to 2	2 to 3
		2040 - 2059	0 to 1	2 to 3	3 to 4
		2060 - 2079	1 to 2	3 to 4	6 to 7
		2080 – 2099	2 to 3	5 to 6	8+
	Mean daily minimum temp change compared to 1981-2000	2020 - 2039	-30 to -20	-10 to 0	10 to 20
		2040 - 2059	-50 to -40	-20 to -10	0 to 10
		2060 - 2079	-60 to -50	-30 to -20	0 to 10
		2080 – 2099	-60 to -50	-50 to -40	-10 to 0

12.4.14 According to UKCP18 data, the projected general trends of climate changes in the 21st century is a move towards warmer, wetter winters and hotter, drier summers. However, natural variations mean that some cold winters, some dry winters, some cool summers and some wet summers will still occur.

Temperature

12.4.15 UKCP18 projections show that there is more warming in the summer than in the winter.

Precipitation

12.4.16 Rainfall patterns across the UK are not uniform and vary on seasonal and regional scales and will continue to vary in the future. While UKCP18 projections show a clear shift to higher probability levels of dry summers, they also suggest that the likelihood of individual wet summers reduces only slightly. The risk of heavy rainfall events is likely to increase.

Snow

12.4.17 According to UKCP18 projections, for the period 2061-2080, under a high emissions scenario (RCP8.5), the regional (12km) and local (2.2km) projections show a decrease in both falling and lying snow across the UK relative to the 1981-2000 baseline.

Wind

12.4.18 There are no compelling trends in storminess, as determined by maximum gust speeds, from the UK wind network over the last four decades. UKCP18 projections over the UK show an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season when more significant effects of wind are experienced. This is accompanied by an increase in frequency of winter storms over the UK. However, the increase in wind speeds is modest compared to interannual variability.

12.4.19 Winds associated with major storm events can be some of the most damaging and disruptive events for the UK with implications for property, power networks, road and rail transport and aviation.

Identification and Evaluation of Risks with Climate Change

12.4.20 Table 12.19 provides a summary of how the identified climate risks are likely to change in the future as a result of climate change. Probability and consequence ratings have been given to these risks, thereby generating a risk rating based on Table 12.15. The probability and consequence ratings outlined in Table 12.19 are pre-mitigation.

Table 12.19: Climate change risks based on C40 Cities Climate Change Risk Assessment Guidance

Risk	Baseline risk rating	Change in probability as a result of climate change	Probability rating (1-5)	Consequence rating (1-7)	Risk rating with climate change	Additional mitigation needed?
Rainstorm	5	The frequency of precipitation is likely to decrease, particularly in the summer. However, the risk of heavy rainfall events is likely to increase.	5	1	5	No
Heavy snow	6	The frequency of heavy snow events is likely to decrease.	2	2	4	No
Fog	5	It is unknown how climate change will affect the frequency of fog.	5	1	5	No
Hail	4	The frequency of hailstorms is likely to increase.	5	1	5	No

Risk	Baseline risk rating	Change in probability as a result of climate change	Probability rating (1-5)	Consequence rating (1-7)	Risk rating with climate change	Additional mitigation needed?
Severe wind	12	The frequency of severe wind and storms is likely to remain similar.	3	4	12	Yes
Extra tropical storm	12		3	4	12	Yes
Forest Fire	5	The frequency of forest fires is likely to increase.	2	5	10	No
Lightning	8	The frequency of lightning storms is likely to remain similar.	4	2	8	No
Extreme winter conditions	12	The frequency of extreme winter conditions is likely to decrease.	3	3	9	No
Cold wave	12	The frequency of cold waves is likely to decrease.	3	3	9	No
Extreme cold days	12	The frequency of extreme cold days is likely to decrease.	3	3	9	No
Heat waves	15	The frequency of heat waves is likely to increase.	4	5	20	Yes
Extreme hot days	16	The frequency of extreme hot days is likely to increase.	5	4	20	Yes
Drought	12	The frequency of drought is likely to increase.	4	4	16	Yes

Risk	Baseline risk rating	Change in probability as a result of climate change	Probability rating (1-5)	Consequence rating (1-7)	Risk rating with climate change	Additional mitigation needed?
Flash/surface flood	18	The frequency of flash/surface flooding is likely to increase.	4	6	24	Yes
River/tidal flood	6	The frequency of river/tidal flooding is likely to increase.	3	3	9	Yes
Groundwater flood	12	The frequency of groundwater flooding is likely to remain at a similar level.	2	6	12	Yes
Subsidence	6	The frequency of subsidence is likely to remain low.	1	6	6	No
Water-borne disease	3	The frequency of water-borne disease is likely to increase but remain low.	1	3	3	No
Vector borne disease	4	The frequency of vector-borne disease is likely to increase but remain low.	1	4	4	Yes
Air-borne disease	3	The frequency of air-borne disease is likely to increase but remain low.	1	3	3	Yes
Insect infestation	3	The frequency of insect infestation is likely to increase but remain low.	1	3	3	Yes

Increasing the Resilience of the Proposed Development to Climate Change

12.4.21 Table 12.20 summarises the mitigation measures that have been put in place for the Proposed Development that will increase resilience to the likely effects resulting from climate change. These particularly focus on the effects that scored highly in the risk assessment Table 12.19.

Table 12.20: Climate change resilience measures

Risk	Mitigation measure
Severe Wind	Wind loading will be taken into account within the structural calculations. This will be taken into account as the design progresses.
Extra tropical storm	The structural design of the buildings to be resilient to high wind. A Drainage Strategy has been developed for the Proposed Development that considers the effects of climate change. This is submitted alongside the planning application (see Appendix 16.1).
Heat waves Extreme hot days	The landscaping strategy includes trees to provide shade during hot periods, thereby improving external comfort. This should be reviewed at the reserved matters stage. The design (e.g. window sizes and location) and orientation of buildings should aim regulate interior temperatures during hot periods. This should be reviewed at the reserved matters stage. Where possible, lighter colours should be used on buildings and hard landscaping to reduce the albedo of surfaces. This should be reviewed at the reserved matters stage. The landscaping strategy will consider a range of native and non-native species, and the climatic range of trees and plants chosen. This should be reviewed at the reserved matters stage.
Drought	The landscaping strategy should aim to include drought resilient planting that isn't reliant on irrigation. This should be reviewed at the reserved matters stage. Buildings should be fitted with low flow sanitaryware to reduce water consumption. This should be reviewed at the reserved matters stage. Where possible, grey and rainwater harvesting should be utilised. This should be reviewed at the reserved matters stage.
Flash/surface flood River/tidal flood Groundwater flood	A Flood Risk Assessment (FRA) and drainage strategy considering climate change have been developed for the Proposed Development and are provided with the ES (see Appendix 16.1). The drainage strategy addresses attenuation measures based on the capacity required for surface runoff. Detailed hydraulic modelling has been carried out to confirm flood extents, and, as set out in the Parameter Plans, this has informed the principle that construction of major built form is outside of these extents. SUDS features should be implemented wherever possible and the landscaping strategy should aim to slow down rainwater runoff. This should be reviewed at the reserved matters stage.

Risk	Mitigation measure
Water-borne disease Vector-borne disease	Consideration of insects and rodents in the waste management strategy is a standard consideration within the design. This should be reviewed at the reserved matters stage.
Airborne disease	Appropriate ventilation strategy should be captured within the design. This should be reviewed at the reserved matters stage.
All risks	Since the effects of climate change are dynamic and constantly changing, an adaptive management approach is recommended. The climate change resilience risk assessment should be periodically revisited by the operator over the lifetime of the Proposed Development in order to re-assess likely effects.

Residual Effects

12.4.22 Table 12.21 provides a summary of the residual effects of climate change on the Proposed Development. Mitigation measures outlined in Table 12.20 have been taken into account.

Table 12.21: Summary of residual risks ratings based on probability and consequence taking into account mitigation measures

Risk	Probability rating (1-5)	Consequence rating (1-7)	Risk rating – based on criteria in Table 12.17
Rainstorm	5	1	5
Heavy snow	2	2	4
Fog	5	1	5
Hail	5	1	5
Severe wind	3	3	9
Extra tropical storm	3	3	9
Forest fire	2	5	10
Lightning	4	2	8
Extreme winter conditions	3	3	9
Cold wave	3	3	9
Extreme cold days	3	3	9
Heat waves	4	4	16
Extreme hot days	5	3	15
Drought	4	3	12
Flash/surface flood	4	5	20
River flood	3	2	6
Groundwater flood	2	5	10
Subsidence	1	6	6
Water-borne disease	1	3	3

Risk	Probability rating (1-5)	Consequence rating (1-7)	Risk rating – based on criteria in Table 12.17
Vector borne disease	1	4	4
Air-borne disease	1	3	3
Insect infestation	1	3	3

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