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London Luton Airport Expansion

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5.01 ENVIRONMENTAL STATEMENT CHAPTER 9: CLIMATE CHANGE RESILIENCE

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9 CLIMATE CHANGE RESILIENCE

9.1 Introduction

9.1.1 This chapter presents the assessment of likely significant effects of climate change impacts on the Proposed Development (the Climate Change Resilience (CCR) assessment) and the combined impacts of climate change and the Proposed Development on receptors in the surrounding environment (the In-combination Climate Change Impacts (ICCI) assessment). An assessment of greenhouse gas (GHG) Emissions (i.e., the impact of the Proposed Development on the climate) is presented in **Chapter 12** Greenhouse Gases of this Environmental Statement (ES) **[TR020001/APP/5.01]**.

9.1.2 The Environmental Impact Assessment (EIA) Scoping Report (**Appendix 1.1 and 1.2** of this ES **[TR020001/APP/5.05])** sets out the proposed scope for the assessment of climate change. In summary, the following have been assessed in this ES:

a. The CCR assessment focuses on the resilience of the Proposed Development to projected future climate change effects. An example of this would be if increased intensity of extreme precipitation events leads to increased volumes of surface water run-off overwhelming the drainage infrastructure and causing disruption to airport operations.

b. The ICCI assessment focuses on those effects of the Proposed Development identified by other environmental assessments in this ES that will be exacerbated by climate change. For example, an increase in duration of dry spells leading to increase in dust production and poor air quality during construction. This may impact communities near the airport if not managed.

9.1.3 The remainder of this chapter consists of:

a. **Section 9.2** Legislation, policy and guidance relevant to the scope and methodology of the assessment;

b. **Section 0** Scope of the assessment;

c. **Section 9.4** Stakeholder engagement undertaken to inform the assessment;

d. **Section 9.5** Methodology applied to the assessment;

e. **Section 9.6** Assumptions and limitations at this stage of work;

f. **Section 9.7** Baseline conditions;

g. **Section 0** Embedded and good practice mitigation;

h. **Section 0** Assessment;

i. **Section 0** Additional mitigation;

j. **Section 9.11** Residual effects;

k. **Section 9.12** Monitoring;

l. **Section 9.13** Assessment summary.

9.2 Legislation, policy and guidance

9.2.1 This section identifies the key legislation, policy and guidance relevant to the scope and methodology for the CCR and ICCI assessments and which may influence the type of mitigation measures that could be incorporated into the Proposed Development during construction and operation.

9.2.2 **Table 9.1** to **Table 9.4** provide a description of the relevant legislation, policy and guidance, and where each of these have been addressed in the ES.

Legislation

Table 9.1: CCR and ICCI legislation

Legislation	How and where addressed in ES
Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref. 9.1) Requires a description of the factors likely to be significantly affected by the development including climate (for example impacts relevant to adaptation) (Schedule 4 (Para 4(4)), and a description of the likely significant effects of the vulnerability of the project to climate change" (Schedule 4 (para 5(f)).	Likely significant effects as a result of the vulnerability of the Proposed Development to climate change, following the inclusion of embedded and good practice mitigation measures, are presented in the **Section 0** and **Table 9.29** and **Table 9.30**.
Climate Change Act 2008 (amended 2019) (Ref. 9.2) Requires infrastructure operators and public bodies to report on how they are addressing the impacts of climate change on their organisation under the Adaptation Reporting Power. London Luton Airport Operations Ltd (LLAOL), the airport operator, published a Climate Change Adaption Report in November 2021(Ref. 9.3) as part of the third round of adaptation reporting.	LLAOL's 2021 Climate Change Adaptation Report has been used to inform the CCR assessment, including the methodology set out in **Section 9.5**.

Policy

Table 9.2: CCR and ICCI policy

Policy	How and where addressed in ES
National Planning Policy Framework (NPPF) (2021) (Ref. 9.4)	The approach required in the NPPF to decrease vulnerability to current and future impacts of climate change and flood risk has been applied using the latest climate

Policy	How and where addressed in ES
The NPPF requires all plans to mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects.	projections data from UKCP18. Embedded and good practice adaptation measures have been identified in **Section 0** and **Table 9.29** and **Table 9.30.**
National Policy Statement for National Networks – December 2014 (NPSNN) (Ref. 9.5) The NPSNN sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects on the national road and rail networks in England. It provides planning guidance for promoters of nationally significant infrastructure projects (NSIP) on the road and rail networks. The provisions of the NPSNN relevant to environmental assessment broadly mirror those as outlined in the ANPS.	There are no elements of the Proposed Development on the national road or rail network that would be classified as a NSIP in their own right. However, the NPSNN remains an important and relevant consideration, particularly as works are proposed on the Strategic Road Network (SRN) at Junction 10 of the M1 as part of the Proposed Development. Where the relevant polices of the NPSNN are consistent with the relevant policies of the ANPS, they have not been repeated here and accordingly the ANPS compliance table (**Table 9.3**) provides the necessary policy response.
National Planning Policy Guidance: Flood Risk and Coastal Change (Ref. 9.6) The Flood Risk and Coastal Change guidance within the National Planning Practice Guidance (NPPG) contains climate change allowances to be included in flood risk assessments.	These allowances have been considered as part of the design as outlined in **Section 0** and **Table 9.30.**
A Green Future: Our 25 Year Plan to Improve the Environment, 2018, updated 2019 (Ref. 9.7) The 25 Year Plan outlines objectives to reduce risk of harm from environmental hazards such as flooding and drought and mitigating and adapting to climate change.	Measures to reduce the vulnerability of the Proposed Development to climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.
Luton Borough Council (LBC) Local Plan 2011-2031(Ref. 9.8) The Local Plan outlines the threats faced as a result of flooding and other climate change risks, and mitigation strategies that need to be considered	Measures to minimise the risk of flooding and other climate change risks are set out in **Section 0** and **Table 9.29** and **Table 9.30**.

Policy	How and where addressed in ES
during the design of new developments.	
LBC Climate Change Action Plan 'My climate action plan. Becoming a carbon neutral borough by 2040' (Ref. 9.9) The Action Plan sets out actions to support climate change adaptation related to flooding and resilience.	Actions to support climate change adaptation related to flooding and resilience outlined in the plan have been incorporated into the measures outlined in **Section 0** and **Table 9.29** and **Table 9.30** to increase the Proposed Development's resilience to climate change.
Central Bedfordshire Council (CBC) Local Plan 2015 – 2035 (Ref. 9.10) The Local Plan includes policies on making developments resilient to the impacts of increased flooding, drought, and overheating, and managing risks through good design.	Measures to increase the Proposed Development's resilience to climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.
North Hertfordshire District Council (NHDC) Local Plan for 2011-2031 (Ref. 9.11) The Local Plan requires consideration to be given to addressing climate change resilience impacts.	Consideration of climate change impacts on the Proposed Development are outlined in **Section 0** and **Table 9.29** and **Table 9.30**. Measures to increase the Proposed Development's resilience to climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.
Dacorum Borough Council (DBC) Dacorum Local Plan (2020-2038) (Ref. 9.12) An objective presented in the Local Plan is to adapt to the impacts of climate change and increase climate resilience. It includes policies to make new developments resilient and contribute to climate change adaptation by: a. using green infrastructure to reduce flood risk, tackle urban heat island effects and provide solar shading; and b. adapting to climate change by ensuring development avoids areas of flood risk and reduces the risk of flooding elsewhere, through the use of measures including sustainable urban drainage systems, green roofs and walls, and permeable surfaces.	Measures to increase the resilience of the Proposed Development to climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.

9.2.3 The Airports National Policy Statement (ANPS) (Ref. 9.13) does not have effect on a development consent order application other than for the Heathrow Northwest Runway. Nevertheless, as set out within paragraph 1.41 of the ANPS, the Secretary of State considers that the contents of the ANPS will be both important and relevant considerations in the determination of such an application, particularly where it relates to London or the south east of England. In particular, the ANPS makes clear that, alongside the provision of a new Northwest Runway at Heathrow, the government supports other airports making best use of their existing runways as set out in Beyond the Horizon: Making best use of existing runways (MBU) (Ref. 9.14), which is the specific policy context for this application.

9.2.4 In addition, whilst the ANPS does not have effect in relation to the Proposed Development, it sets out a number of principles for environmental impact assessment and compliance and these will be an important and relevant consideration in the determination of the application for development consent. A summary of the relevant provisions for the CCR assessment and how these have been addressed in this ES is provided within **Table 9.3**.

Table 9.3: How relevant CCR and ICCI requirements of ANPS are addressed in the ES

ANPS Section	How and where addressed in ES
Paragraph 4.45 "*New airports infrastructure will typically be a long-term investment which will need to remain operational over many decades, in the face of a changing climate. Consequently, the applicant must consider the impacts of climate change when planning design, build and operation*."	The impacts of climate change on the Proposed Development are considered within this ES chapter and have been throughout the sifting and optioneering stages as presented in **Chapter 3** Assessment of Alternatives of this ES **[TR020001/APP/5.01]**. The CCR assessment covered in this chapter covers design, build (construction) and operation.
Paragraph 4.46 "*Detailed consideration must be given to the range of potential impacts of climate change using the latest UK Climate Projections available at the time, and to ensuring any environmental statement that is prepared identifies appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure*"	The assessment methodology outlined in this ES includes identification of climate change impacts using UKCP18 (the latest set of UK climate projections) reflecting a number of time periods, covering the lifetime of the Proposed Development, as described in **Section 9.5** of this chapter. **Section 0** and **Table 9.29** and **Table 9.30** set out how embedded environmental measures will be implemented in relation to climate change.
Paragraph 4.47 "*Where transport infrastructure has safety-critical elements, and the design life of the asset is 60 years or greater, the applicant should apply the latest available UK Climate Projections, considering at least a scenario that reflects a high level of*	The assessment has considered a scenario that reflects a high level of GHG emissions at the 10%, 50% and 90% probability levels to assess the impact of climate change over the lifetime of the Proposed Development. For this reason, Representative Concentration Pathway

ANPS Section	How and where addressed in ES
greenhouse gas emissions at the 10%, 50% and 90% probability levels, to assess the impacts of climate change over the lifetime of the development"	(RCP) 8.5[1], as described in **Section 9.5** has been used. RCP 8.5 is the highest emissions scenario available on UKCP18 representing a global temperature increase of approximately 4.3˚C by 2100, relative to pre-industrial temperatures.
Paragraph 4.48 "*The applicant should demonstrate that there are no critical features of infrastructure design which may be seriously affected by more radical changes to the climate beyond those projected in the latest set of UK Climate Projections. Any potential critical features should be assessed, taking account of the latest credible scientific evidence on, for example, sea level rise, and on the basis that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime through potential further mitigation or adaptation*"	In line with the ANPS, more radical changes to the climate beyond those projected in the latest set of UKCP18 have been considered in the ES (as outlined in **Section 9.7**) using plausible higher and lower end climate change projections from both the H++/L-- scenarios, and the UKCP18 probabilistic projections of climate extremes (PPCE). Within the limitations and uncertainties of the data available on future climate change projections as outlined in **Section 9.6**, critical features of infrastructure have been assessed and no significant impacts have been identified.
Paragraph 4.49 *"Any adaptation measures should be based on the latest set of UK Climate Projections, the most recent UK Climate Change Risk Assessment, consultation with statutory consultation bodies, and any other appropriate climate projection data. Any adaptation measures must themselves also be assessed as part of any Environmental Impact Assessment and included in the environmental statement, which should set out how and where such measures are proposed to be secured."*	The consideration of the UK Climate Change Risk Assessment (Ref. 9.15) in the methodology is described in **Section 9.5** of this chapter. **Section 0** sets out the responses to comments received from Planning Inspectorate via the Scoping Opinion. **Section 9.4** outlines engagement with statutory consultation bodies and other key stakeholders. Mitigation measures have been developed to manage risks. These are described in **Section 0** and the **Mitigation Route Map [TR020001/APP/5.09].**
Paragraph 4.50 *"If any proposed adaptation measures themselves give rise to consequential impacts, the Secretary of State will consider the impact in relation to the application as a whole and the assessment principles set out in the Airports NPS."*	No consequential environmental impacts have been identified as a result of proposed adaptation measures.

[1] UKCP18 uses a range of possible scenarios, classified as RCPs, to inform differing future emission trends. These RCPs specify the concentrations of GHGs that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels.

ANPS Section	How and where addressed in ES
Paragraph 4.51 *"Adaptation measures can be required to be implemented at the time of construction where necessary and appropriate to do so."*	Adaptation measures have been incorporated into the design of the Proposed Development to be constructed. Adaptation/mitigation measures during construction have been identified in **Section 0** and **Table 9.29** and **Table 9.30**.
Paragraph 4.52 *"Where adaptation measures are necessary to deal with the impact of climate change, and that measure would have an adverse effect on other aspects of the project or the surrounding environment, the Secretary of State may consider requiring the applicant to ensure that the adaptation measure could be implemented should the need arise, rather than at the outset of the development."*	Adaptation measures to be incorporated throughout the operational lifetime of the Proposed Development are set out In **Section 0** and **Table 9.29, Table 9.30**.

Guidance

Table 9.4: CCR and ICCI guidance

Guidance	How and where addressed in ES
Institute of Environmental Management and Assessment (IEMA) Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (Ref. 9.16). This provides a framework for the effective consideration of climate change resilience and adaptation in the EIA process.	The IEMA guidance has been used to define the CCR and ICCI assessments, including: a. the identification of Proposed Development assets and receptors potentially vulnerable to climate change set out in **Section 0**; b. the assessment methodology outlined in **Section 9.5**; and c. the existing and future baseline for climate parameters defined in **Section 9.7**.
International Civil Aviation Organisation's (ICAO) Environmental Report 2010 Chapter 6: Adaptation (Ref. 9.17). This provides further context of climate change mitigation and adaptation within the aviation industry.	This report has been used to inform relevant adaptation measures in **Section 0**.
Civil Aviation Authority (CAA) 2015 Climate Change Adaptation Report (Ref. 9.18)	This report has been used to inform the potential risks of climate change on the Proposed Development presented in **Section 0** and in **Table 9.29** and **Table 9.30.**

Guidance	How and where addressed in ES
This highlights the direct impacts of climate change on the aviation sector, reviews performance of adaption across the UK's regulated airports.	
The Committee on Climate Change's (CCC) Technical Report of the Third UK Climate Change Risk Assessment (CCRA3) (Ref. 9.19)	This report has been used to help identify the potential CCR impacts outlined in **Section 0**.
The CCC UK Climate Change Risk Assessment Evidence Report (Ref. 9.20) provides further context of climate risks and opportunities within the aviation industry.	This report has been used to inform the potential risks and impacts of climate change on the Proposed Development presented in **Section 0.**
The Airport Cooperatives Research Programme's (ACRP) Climate Change Adaptation Planning: Risk Assessment for Airports (Ref. 9.21) This provides further context for climate change projections and impacts for airports.	This report has been used to inform the potential risks of climate change on the Proposed Development presented in **Section 0** and in **Table 9.29** and **Table 9.30.**

9.3 Scope of the assessment

9.3.1 This section describes the scope of the CCR and ICCI assessments, including how the assessment has responded to the Scoping Opinion. The temporal and spatial scope, the relevant receptors, and matters scoped in and out are identified. A description of engagement undertaken with relevant technical stakeholders to develop and agree this scope is provided in **Section 9.4**.

Study area

9.3.2 The study area for the CCR assessment is the Proposed Development, i.e. consideration has only been given to future assets for which consent is being sought and any modifications to existing infrastructure.

9.3.3 The study area for the ICCI assessment is defined by the study area boundaries for each of the environmental disciplines.

Scoping Opinion

9.3.4 The EIA Scoping Report sets out the proposed scope and assessment methodologies to be employed in the EIA and is provided in **Appendix 1.1** of this ES **[TR020001/APP/5.05]**.

9.3.5 In response to that Scoping Report, a Scoping Opinion was received from the Planning Inspectorate on 9 May 2019 and is provided in **Appendix 1.3** of this ES **[TR020001/APP/5.05]**.

9.3.6 **Table 9.5** describes the main matters highlighted by the Planning Inspectorate in the Scoping Opinion and how these have been addressed in this ES. Responses to all comments received during Scoping are presented in **Appendix 1.4** of this ES **[TR020001/APP/5.02]**.

Table 9.5: CCR Scoping Opinion comments

Scoping Opinion ID	Scoping Opinion comment	How this is addressed
3.2.17	The ES should include a description and assessment (where relevant) of the likely significant effects the Proposed Development has on climate (for example having regard to the nature and magnitude of GHG emissions) and the vulnerability of the project to climate change. Where relevant, the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development. This may include, for example,	An assessment of the likely significant effects the Proposed Development has on climate (for example having regard to the nature and magnitude of GHG emissions) is covered in **Chapter 12** Greenhouse Gases of this ES **[TR020001/APP/5.01].** An assessment of the vulnerability of the Proposed Development to climate change is included in this ES chapter in **Section 0**. Embedded and good practice mitigation measures including the adaptive

Scoping Opinion ID	Scoping Opinion comment	How this is addressed
	alternative measures such as changes in the use of materials or construction and design techniques that will be more resilient to risks from climate change.	capacity to make the Proposed Development more resilient to risks from climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.
4.3.3	The Applicant should ensure that other consultation bodies with statutory responsibilities for other matters relevant to this aspect assessment (e.g. biodiversity), such as Natural England, are consulted regarding the potential for climate change effects to influence the effectiveness of any proposed mitigation measures.	Consultation with Natural England, and Host Authorities has been undertaken. Where relevant, meetings included discussions about the potential for climate change effects to influence the effectiveness of any proposed mitigation measures, for example biodiversity and landscape, and information gathered considered in habitat and landscape proposals. Consultation on climate change has included meetings with the Environment Agency (EA) and Lead Local Flood Authorities, and the design has accounted for a 40% climate change allowance to account for future impacts of climate change. In addition, engagement has taken place with Thames Water and Affinity Water. Conversations with Affinity Water have considered the future impacts of climate change on water resources in Luton and how mitigation measures embedded in the Drainage Design Statement (such as water reuse and rainwater harvesting, described in **Appendix 20.4** to this ES **[TR020001/APP/5.02]**) will help to minimise the impact of the Proposed Development on local water resource availability.
4.3.4	The ES should set out the assumptions and uncertainties in the projections and explain how these have informed the climate change risk and resilience assessment and influenced the design of the Proposed Development.	The assumptions and uncertainties in this assessment are set out in **Section 9.6,** including how these have informed the CCR assessment and influenced the design of the Proposed Development.

Scoping Opinion ID	Scoping Opinion comment	How this is addressed
4.3.5	The ES should set out how mitigation measures will be secured through the DCO and how the adaptation measures described, and those incorporated into the Climate Change Adaptation Plan, will address the need for on-going review of climate 'hazards' and risks.	Proposed mitigation measures and how they will be secured through the Development Consent Order (DCO) is set out in **Table 9.29** and **Table 9.30** and the **Mitigation Route Map [TR020001/APP/5.09]**. Relevant mitigation measures for the Proposed Development will be incorporated in the next update of the airport operators' Climate Change Adaptation Plan.

9.3.7 Embedded and good practice mitigation measures including the adaptive capacity to make the Proposed Development more resilient to risks from climate change are set out in **Section 0** and **Table 9.29** and **Table 9.30**.

9.3.8 The ICCI assessment considers all identified effects (including those identified by the Cumulative Effects Assessment (CEA) provided as **Chapter 21** of this ES **[TR020001/APP/5.01]**) and whether these are exacerbated by climate change. The Zone of Influence (ZOI) for the ICCI assessment is therefore defined by other environmental topics.

Temporal Scope

9.3.9 The temporal scope for the assessment refers to the timescale over which likely effects may occur and/or be experienced.

9.3.10 As described in **Chapter 4** of this ES **[TR020001/APP/5.01]**, the Proposed Development would be constructed incrementally to deliver capacity in response to forecast demand. For the purposes of assessment, the delivery of the Proposed Development is described in three assessment phases within which construction and operation may take place simultaneously. Assessment phases and anticipated timing are presented in **Table 9.6.**

Table 9.6: Proposed Development Assessment Phases

Assessment Phase	Passenger capacity	Construction start year	Construction completion year	Year predicted passenger capacity reached
Assessment Phase 1	21.5 mppa	2025	2027	2027
Assessment Phase 2a	27 mppa	2033	2036	2039
Assessment Phase 2b	32 mppa	2037	2041	2043

9.3.11 The temporal scope of both the CCR and ICCI assessments is the duration of the construction works and the 60-year project design life (i.e., from the start of operation through to the end of the design life).

9.3.12 Construction works are assessed as commencing in 2025 with activities phased up to 2041. The 2020-2049 time period is used for construction activities, for both the ICCI and CCR assessments, to represent a reasonable worst case approach.

9.3.13 The assessment of effects during operation is divided into two time periods: 2040-2069 and 2070-2099 to understand potential medium-term and long-term impacts. These periods are consistent with available data on probabilistic projections from UKCP18. However, the assessment of climate extremes only considers period up to 2079, which is defined by available UKCP18 regional land projections data.

Receptors

9.3.14 Receptors scoped into the assessment are listed in the **Table 9.7** and **Table 9.8.**

Matters scoped in

Climate change resilience

9.3.15 The scope of the CCR assessment considers the risks of the Proposed Development to the impacts of climate change from construction up to the end of its design life. A scoping exercise was undertaken to determine the key receptors within the construction and operation phases of the Proposed Development and **Table 9.7** sets out the receptors of the Proposed Development scoped into the CCR assessment.

Table 9.7: Receptors scoped into the CCR assessment

Phase	Receptor
Construction	Materials and equipment required for the construction of all built assets
	Structures
	Staff facilities
	Access routes to construction sites
	Workers on construction sites
Operation	Luton Direct Air-Rail Transit (Luton DART) extension to the new terminal
	Additional taxiways and aircraft stands

Phase	Receptor
	Aircraft operations (activities associated with aircraft operations during the landing and take-off cycle i.e. taxi, take off, climb and approach)
	Terminal 1 extension, new Terminal 2, and associated buildings, including airside facilities, and other supporting buildings such as, office buildings, police station, hotels, logistics centre and technical service buildings
	End users such as staff and passengers
	Highway network improvements, including the new Airport Access Road (previously referred to as the Century Park Access Road), car parking facilities, bus, coach and taxi facilities and airside roads
	Drainage and pollution control assets (sewage and effluent treatment plants)
	Fuel storage facility
	Flood attenuation and storage infrastructure i.e. water infiltration (soakaway) and attenuation tanks, fire, water and energy storage assets
	On site electrical facilities and utilities corridors
	De-icing storage facility
	Public open space and amenities
	Energy centre
	Fire training ground
	Cargo and catering facility
	Landform and earthworks
	Landscaping
	Operational workers

In-combination climate change impacts

9.3.16 The ICCI assessment considers the extent to which climate change exacerbates effects on aspect receptors which have already been identified in the other discipline chapters. The scope of and receptors for the ICCI assessment have been identified through the scoping exercise and in liaison with the specialists from other disciplines, these are outlined in **Table 9.8.**

Table 9.8: Receptors scoped into the ICCI assessment

Discipline	Receptors
Agricultural Land Quality and Farm Holdings (**Chapter 6** of this ES **[TR020001/APP/5.01]**)	Soil resources and impact on farming operations.
Air Quality (**Chapter 7** of this ES **[TR020001/APP/5.01])**	Residential and other properties, and designated habitats.
Biodiversity (**Chapter 8** of this ES **[TR020001/APP/5.01])**	Terrestrial and freshwater habitats, including the species present within them.
Cultural Heritage (**Chapter 10** of this ES **[TR020001/APP/5.01])**	Cultural heritage assets, including Someries Castle, archaeological remains and the historic landscape.
Economics and Employment (**Chapter 11** of this ES **[TR020001/APP/5.01])**	Local businesses, local labour force and the broader economy.
GHG (**Chapter 12** of this ES **[TR020001/APP/5.01])**	The global climate.
Health and Community (**Chapter 13** of this ES **[TR020001/APP/5.01])**	Community assets and community and health effects on the people.
Landscape and Visual (**Chapter 14** of this ES **[TR020001/APP/5.01])**	Landscape and townscape characteristics and settings, including residential amenity, viewpoints and recreational routes.
Noise and Vibration (**Chapter 16** 2 of this ES **[TR020001/APP/5.01])**	Residents in terms of individual dwellings and on a wider community basis, including community open areas, and community facilities.
Soils and Geology (**Chapter 17** of this ES **[TR020001/APP/5.01]**)	Surface and ground resources, workers within construction sites, users of the future development or at adjacent land or property, and the built environment.
Water Resources and Flood Risk (**Chapter 20** of this ES **[TR020001/APP/5.01]**)	Groundwater and surface waterbodies, existing water infrastructure as defined by the aspect, flood risk receptors surrounding the Proposed Development.

9.3.17 The ICCI assessment has been deemed as not relevant for following technical disciplines:

a. **Chapter 15** Major Accidents and Disasters of this ES **[TR020001/APP/5.01]**: as consideration of climate change is included as part of the natural hazards assessment. It is noted that although similar risks are considered, both use a different approach to assess these risks.

b. **Chapter 18** Traffic and Transportation of this ES **[TR020001/APP/5.01]**: as the direct impacts of climate change on the transportation networks

infrastructure e.g. connecting roads and the Luton DART, are already considered as part of the CCR assessment and do not require separate ICCI assessment.

c. **Chapter 19** Waste and Resources of this ES **[TR020001/APP/5.01]**: as for the receptors (waste management infrastructure and national and regional material resources demand), it is assumed that impacts arising from climate change on the operation of waste management infrastructure and manufacturing of material resources are considered as part of the planning and permitting process for such facilities.

Matters scoped out

9.3.18 As agreed in the Scoping Opinion, the following aspects of the CCR and ICCI assessments have been scoped out:

a. Impacts of sea level rise have been scoped out of the CCR and ICCI assessments as the Proposed Development is not within the geographical proximity of the coast.

b. Due to the length of the lifetime of the Proposed Development, decommissioning of the airport will not be considered within the scope of the assessment. Any future decommissioning of the airport is likely to require planning consent and a separate assessment.

9.4 Stakeholder engagement and consultation

9.4.1 Engagement and consultation in relation to the vulnerability of the Proposed Development to climate change and ICCIs has been undertaken with a number of prescribed and non-prescribed stakeholders. Engagement and consultation on the CCR and ICCI assessment has been completed through the following:

a. The EIA Scoping Report, provided as **Appendices 1.1** and **1.2** of this ES **[TR020001/APP/5.05]**, collated initial information on the Proposed Development and was submitted to the Planning Inspectorate with a request for the Secretary of State (SoS) to adopt a scoping opinion in relation to the EIA for the Proposed Development. The SoS consulted with the relevant statutory stakeholder bodies and then provided a formal written Scoping Opinion on the information to be included in the ES. The Scoping Opinion is available in **Appendix 1.3** of this ES **[TR020001/APP/5.05]**;

b. non-statutory and statutory consultation, where comments relevant to the climate change assessment were received as part of the joint response issued by WSP on behalf of LBC, CBC, NHDC and Hertfordshire County Council (HCC); and

c. meetings with the Climate Change and GHG stakeholder working group.

9.4.2 The Climate Change and GHG stakeholder working group was established to discuss and inform the CCR, ICCI and GHG assessments for the ES. It comprised representatives from:

a. Buckinghamshire County Council;

b. CBC;

c. DBC;

d. East Herts and Stevenage Council;

e. LBC;

f. Milton Keynes Council; and

g. NHDC.

9.4.3 The invitation to participate in the Climate Change and GHG working group was extended to all host and neighbouring authorities where relevant named contacts were provided, however at present only includes representatives from those listed above.

9.4.4 The **Consultation Report [TR020001/APP/6.01]** and **[TR020001/APP/6.02]** contains a full account of the previous statutory and non-statutory consultation process and issues raised in feedback from the 2019 and 2022 Statutory Consultation. No significant matters were raised regarding the scope, method or mitigation considered as part of the CCR and ICCI assessment.

9.4.5 **Table 9.9** provides a summary of engagement with relevant stakeholders, undertaken to inform the EIA, including the date and time of meetings and a summary of discussions to resolve matters raised.

Table 9.9: Stakeholder engagement relating to CCR and ICCI

Meeting name and date	Attendees (organisation)	Summary of discussion
Climate change and GHG working group – meeting no 1. (18 March 2021)	Buckinghamshire County Council CBC DBC East Herts and Stevenage Council LBC NHDC	Overview of CCR and ICCI methodologies and mitigation/adaptation measures presented. No issues with approach to CCR or ICCI assessments raised. Main focus of the discussion was on the GHG assessment.
Climate change and GHG working group – meeting no 2. (4 November 2021)	Buckinghamshire County Council CBC DBC East Herts and Stevenage Council LBC NHDC	Preliminary findings of 2022 Preliminary Environmental Information Report (PEIR) presented. No issues on CCR or ICCI assessments raised. Main focus of the discussion was on the GHG assessment.
Climate change and GHG working group – meeting no 3. (13 September 2022)	Buckinghamshire County Council CBC LBC NHDC	Updates to assessment since PEIR outlined, including changes to assessment criteria and UKCP18 projection. Detail provided on how consultation responses have been addressed and overview of assessment findings presented. Comments raised about some of the thresholds in the new likelihood and consequence criteria.

9.5 Methodology

Overview

9.5.1 This section outlines the methodology employed for assessing the likely significant effects of climate change on the construction and operation of the Proposed Development and the combined impacts of climate change and the Proposed Development on receptors in the surrounding environment.

Baseline methodology

9.5.2 Baseline data has been collected through desk-based research for the study area as described in **Section 0** in line with relevant legislation (**Table 9.1**), policy (**Table 9.2**) and guidance (**Table 9.4**).

Existing baseline

9.5.3 The existing baseline for the CCR and ICCI assessments is the historic and current climate as defined in terms of temperature, rainfall, and other climatic factors.

9.5.4 Existing baseline data gathered for the CCR and ICCI assessments has been focused on assembling information on historic and current climatic conditions for the location of the Proposed Development.

9.5.5 Data has been sourced from:

a. UK Climate Projections (UKCP18) User Interface (Ref. 9.22);

b. the Met Office observational data for the station nearest to the airport (Ref. 9.23); and

c. LLAOL Climate Change Adaptation Report (Ref. 9.24).

Future baseline

9.5.6 UKCP18 (Ref. 9.25) provides probabilistic climate change projections[2] for annual, seasonal and monthly changes to mean climatic conditions over land areas, i.e. probabilistic changes in future climate based on an assessment of model uncertainties.

9.5.7 For the purpose of this assessment, probabilistic projections for pre-defined 30-year periods for the following average climate variables have been obtained and analysed from UKCP18 for the 25km^2 grid square where the Proposed Development is located (Ref. 9.26):

a. mean annual temperature;

b. mean Summer temperature;

c. mean Winter temperature;

d. maximum Summer temperature;

[2] Probabilistic climate change projections provide information on a given probability to projected changes and uncertainties in future climate changes. Probabilistic projections are available for several alternative future pathways of emissions, including RCP2.6, RCP4.5, RCP6.0 and RCP8.5.

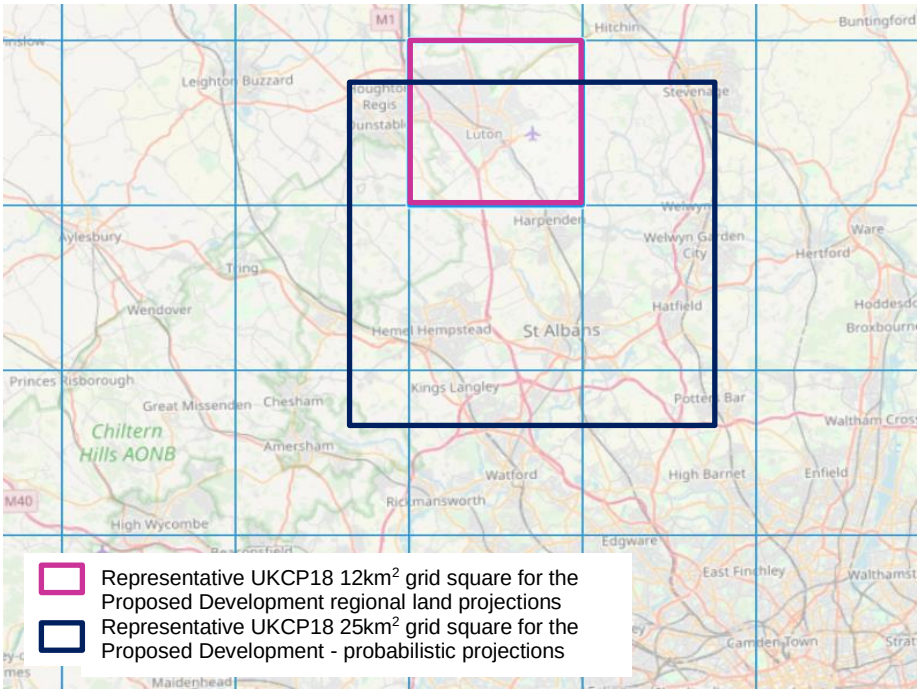
e. minimum Winter temperature;
f. mean annual precipitation;
g. mean Summer precipitation;
h. mean Winter precipitation;
i. annual specific humidity;
j. Summer specific humidity; and
k. Winter specific humidity.

9.5.8 Further data has been obtained from the UKCP18 regional land projections dataset for the 12km^2 grid square where the Proposed Development is located (Ref. 9.27) for other climate variables and extreme weather events, including:

a. annual number of heatwaves (2 days with maximum temperature higher than 29°C and minimum temperature higher than 15°C);
b. annual number of frost days (less than 0°C);
c. annual number of days with 'heavy rain' (precipitation higher than 25mm/day);
d. annual number of dry spells (10 or more consecutive days without precipitation (defined as 0.2mm); and
e. Summer highest daily maximum temperature (ºC).

9.5.9 **Inset 9.1** presents locations of both 12km^2 and 25km^2 grids used.

Inset 9.1: UKCP18 representative 12km^2 and 25km^2 grid squares relevant to the Proposed Development



9.5.10 Future baseline data has been collected for RCP 8.5 which is the highest emissions scenario available for UKCP18 (Ref. 9.28) representing a global temperature increase of approximately 4.3˚C by 2100, relative to pre-industrial temperatures.

9.5.11 The approach to defining future baseline is described in **Section 5.4** of **Chapter 5** of this ES **[TR020001/APP/5.01]**. The future baseline considered for CCR and ICCI is described in **Section 9.7** of this chapter.

Construction and operation assessment methodology

9.5.12 The approach outlined below is aligned with existing guidance as referenced in **Table 9.4** and good practice from similar studies.

9.5.13 The following key terms and definitions relating to the CCR and ICCI assessment are used:

a. **Climate hazard** – a weather or climate related event which has potential to do harm to environmental or community receptors or assets, for example increased Winter precipitation.

b. **Climate change impact** – an impact from a climate hazard which affects the ability of the receptor or asset to maintain its function or purpose.

c. **Consequence** – any effect on the receptor or asset as a result of the climate hazard having an impact.

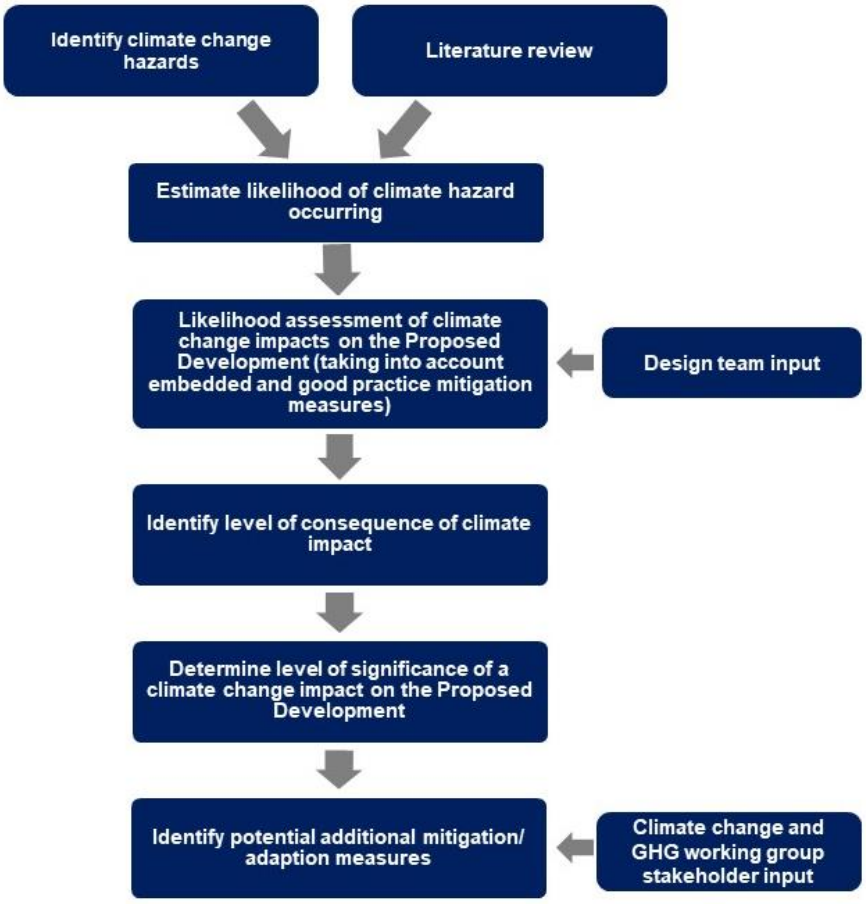
CCR

9.5.14 The methodology applied for the CCR assessment, as outlined in **Inset 9.2** uses a combination of quantitative information on climate change projections and qualitative information related to potential impacts.

9.5.15 The levels and definitions of likelihood and severity (consequence) have been amended since the 2022 PEIR, in agreement with the Climate Change and GHG stakeholder working group, in line with LLAOL's Climate Change Adaptation Report (Ref. 9.29) which was published after completion of the 2022 PEIR.

9.5.16 By using the same definitions and terminology the assessment is consistent with LLAOL's methodology used in the Climate Change Adaptation Report, which outlines how the airport operator (LLAOL) proposes to address the impacts of climate change on their infrastructure; a requirement on infrastructure operators and public bodies under the Adaptation Reporting Power as summarised in **Table 9.1.** The amendments had no material change on the results of the assessment, which remains valid and in compliance with the Scoping Opinion.

Inset 9.2: CCR assessment methodology flow diagram



Identifying climate change hazards

9.5.17 Existing literature on climate change such as the third UK Climate Change Risk Assessment (Ref. 9.30) and LLAOL's Climate Change Adaptation Report (Ref. 9.31) along with UKCP18 data outputs for the location of the Proposed Development have been used to identify potential climate hazards that may affect the geographical location of the Proposed Development.

Likelihood of climate change hazard occurring

9.5.18 Once climate change hazards were identified, the likelihood of the climate change hazard occurring has been assessed. The likelihood of a climate change hazard occurring is defined as the probability of some well-defined outcome occurring in the future.

9.5.19 Likelihood is categorised into five levels, described in **Table 9.10,** depending on the probability of the hazard occurring. This has been taken from LLAOL's 2021 Climate Change Adaptation Report (Ref. 9.30).

Table 9.10: Level of likelihood of the climate hazard occurring

Level of likelihood	Qualitative description	Quantitative Description
Frequent	Likely that the event will occur many times (reoccurs frequently). Evidence/indications strongly suggests a transition from business as usual will occur with the impact anticipated to be substantial.	Climate projection ensemble mean for the percentage of years throughout the considered time period with an event occurrence is 100%.
Occasional	Likely that the event will occur sometimes (reoccurs infrequently). Evidence/indications suggests a transition from business as usual will occur with major impacts.	Climate projection ensemble mean for the percentage of years throughout the considered time period with an event occurrence is 50 - 99%.
Remote	Unlikely that the event will occur, but possible (has occurred rarely). Evidence/indications hint a transition from business as usual will occur although the impacts are anticipated to be minimal.	Climate projection ensemble mean for the percentage of years throughout the considered time period with an event occurrence is 25 - 50%.
Improbable	Very unlikely that the event will occur (not known to have occurred). There is little indication or evidence of a transition occurring.	Climate projection ensemble mean for the percentage of years throughout the considered time period with an event occurrence is < 25%.
Extremely improbable	Almost inconceivable that the event or transition will occur.	Climate projection ensemble mean for the percentage of years throughout the selected time period has an event occurrence of 0%.

Likelihood of climate impact occurring

9.5.20 The likelihood of a climate impact occurring is based on likelihood of the hazard occurring combined with the vulnerability of the Proposed Development, using professional judgement and in discussion with the design team. Embedded mitigation measures have also been taken into account and a likelihood rating assigned as described in **Table 9.11**.

Table 9.11: Likelihood of the climate impact occurring for CCR assessment

Level of likelihood	Definition of likelihood
Frequent	100% probability that the impact will occur during the life of the Proposed Development
Occasional	50-99% probability that the impact will occur during the life of the Proposed Development
Remote	25-50% probability that the impact will occur during the life of the Proposed Development
Improbable	<25% probability that the impact will occur during the life of the Proposed Development
Extremely improbable	0% probability that the impact will occur during the life of the Proposed Development

Consequence of climate impact

9.5.21 Criteria for assessing severity (consequence) for CCR are defined in **Table 9.12.**

Table 9.12: Consequence criteria for CCR assessment

Level	Description of the severity (consequence) criteria
Catastrophic	• Buildings destroyed or lost, requiring replacement • Safety impacts at multiple facilities • Extensive, irreversible environmental damage • International adverse publicity • Loss/mitigation potential: 10% (£15m) or more • Long term security closure, no access to terminal
Hazardous / substantial	• Major building or equipment damage, requiring extensive repairs and temporary closure • Single fatality or multiple serious injury • Extensive, long-term environmental damage • National adverse publicity • Loss/mitigation potential: 5% (£7.5m) or more • Short term security closure, prolonged mass flight cancellations and major delays
Major	• Adverse operating conditions but limited equipment or building damage • Serious injury or illness, inability to work • Localised, long term environmental damage or extensive • short-term damage • Local adverse publicity • Loss/litigation potential: 2.5% (£3.75m) or above • Short term mass flight cancellations and major delays
Minor	• Operating limitations only, no equipment or building damage • Lost time injury with professional treatment required • Localised short-term environmental damage • Multiple negative complaints

Level	Description of the severity (consequence) criteria
	• Loss/litigation potential: 1% (£150k) or above • Missed flights and/or minor delays
Negligible	• Few financial consequences • Minor harm or near miss • Negligible environmental harm • Negligible complaints • Loss/litigation potential: 0.1% (£15k) • Low impact on airport operations
None	• No consequences

9.5.22 The CCR assessment has assumed that the Proposed Development will be designed to be resilient to impacts arising from current weather events and climatic conditions, and designed in accordance with current planning, design and engineering practice and codes.

9.5.23 The assessment has also identified and taken into account the resilience mitigation measures incorporated in the Proposed Development design. These are listed in **Section 0**.

9.5.24 In line with the ANPS (Ref. 9.32), consideration has been given to 'more radical' changes to the climate beyond those projected in the latest set of UKCP18 to demonstrate that there are no critical features of infrastructure design which may be seriously affected.

9.5.25 Plausible higher and lower end climate change projections have been obtained from both the H++/L-- scenarios, and the UKCP18 PPCE (Ref. 9.33).

9.5.26 The H++ and L-- scenarios assess very low probability, high impact risks and use UKCP09 as one of the sources for information. H++ projections have not been updated for UKCP18 data at the time of writing, therefore the UK Committee on Climate Change Adaptation Sub-Committee Report Developing H++ Climate Change Scenarios (Ref. 9.34) has been used here.

9.5.27 The PPCE (Ref. 9.35) provide information on 21st Century temperature and precipitation extremes across the UK. They have been analysed for the 25km grid square where the Proposed Development is located. These daily figures have been expressed as absolute values in relation to the 1981-2000 baseline, for the Winter season (Dec, Jan, Feb), RCP8.5 scenario, and 1 in 100 return period. The highest percentile value available has been selected to represent the reasonable worst case scenario.

Significance criteria

9.5.28 While there are no specific significance criteria for the assessment of CCR, a framework has been developed by combining the outcomes from the likelihood of impact with the consequence to determine the level of effect, as shown in **Table 9.13**. This is based on the approach from the LLAOL Climate Change Adaptation Report (Ref. 9.36). Where a risk is determined as Major or Severe this has been deemed significant. There is no explicit guidance on setting

criteria or boundaries for likelihood or consequence for climate change resilience. Therefore, based on professional judgement, Minor and Moderate have been classed as not significant and Major and Severe as significant.

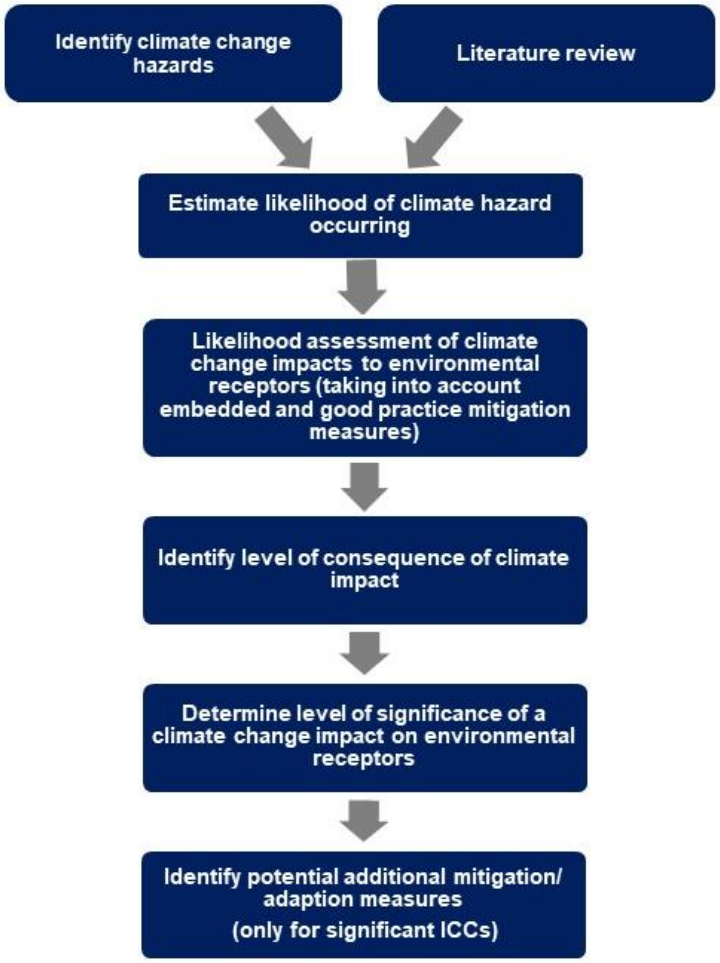
Table 9.13: Level of effect criteria for CCR impacts

		Severity (consequence)				
		Negligible	Minor	Major	Hazardous	Catastrophic
Likelihood	Frequent	Moderate	Major	Major	Severe	Severe
	Occasional	Moderate	Moderate	Major	Major	Severe
	Remote	Minor	Moderate	Moderate	Major	Major
	Improbable	Minor	Moderate	Moderate	Moderate	Major
	Extremely Improbable	Minor	Minor	Minor	Moderate	Moderate

In-combination climate change impacts

9.5.29 The ICCI assessment as outlined in **Inset 9.3** qualitatively assesses how the effects identified by other environmental disciplines are affected by future climate change within the design life of the Proposed Development.

Inset 9.3: ICCI assessment methodology flow diagram



9.5.30 The sections below outline the method shown in the diagram in more detail and provide details on assessment criteria. Climate change specialists worked with the other environmental disciplines throughout this process.

Identifying climate change hazards

9.5.31 The process used to identify hazards for the CCR assessment has been followed to identify hazards for the ICCI assessment.

Likelihood of climate hazard occurring

9.5.32 The likelihood of a climate hazard occurring has been based on the approach outlined above for the CCR assessment. A likelihood rating has been assigned as described in **Table 9.10**.

Likelihood of a climate change impact occurring

9.5.33 In defining likelihood of an impact occurring (**Table 9.11**), embedded and good practice mitigation measures have been accounted for.

9.5.34 The likelihood of an impact occurring has been based on the likelihood of the climate hazard occurring combined with the sensitivity of the receptors as

defined in relevant environmental disciplines, using professional judgement. Definitions of likelihood are set out in **Table 9.14**.

Table 9.14: Level of Likelihood of the climate change impact occurring

Level of likelihood	Definition of likelihood
Occasional	>50% probability that the impact will occur during the life of the Proposed Development
Remote	25-50% probability that the impact will occur during the life of the Proposed Development
Improbable	<25% probability that the impact will occur during the life of the Proposed Development

9.5.35 **Table 9.14** has been then used to determine the overall likelihood of the ICCI; embedded and good practice mitigation measures have been accounted for.

Consequence

9.5.36 Criteria for assessing the consequence of in-combination impacts are defined in **Table 9.15** and have been based on the change to the significance of the effect of the Proposed Development on the resource or receptor for each relevant environmental discipline.

Table 9.15: Consequence criteria for ICCI assessment

Consequence	Consequence criteria
High	The climate change parameter in-combination with the effect of the Proposed Development causes the significance of the impact of the Proposed Development on the resource/receptor, as defined by the topic, to increase from moderate to major.
Medium	The climate change parameter in-combination with the effect of the Proposed Development causes the significance of the impact of the Proposed Development on the resource/receptor, as defined by the topic, to increase from low to moderate.
Low	The climate change parameter in-combination with the effect of the Proposed Development causes the significance of the impact of the Proposed Development on the resource/receptor, as defined by the topic, to increase from negligible to low.
Very low	The climate change parameter in-combination with the effect of the Proposed Development does not impact the significance of the impact of the Proposed Development on the resource/receptor, as defined by the topic.

Significance criteria

9.5.37 The significance of effects has been determined using the matrix in **Table 9.16.** Where an impact has been identified as moderate and major, this has been deemed significant. This is different to the CCR significance threshold to align with the other discipline assessments.

Table 9.16: ICCI scale of impact criteria to establish significance

		Likelihood		
		Improbable	**Remote**	**Occasional**
Consequence	**Very Low**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

9.5.38 A summary of the potential ICCIs identified by each discipline is summarised in the respective discipline chapters. The complete findings of the ICCI assessment have been presented in **Section 0** and **Table 9.31** of this chapter.

9.6 Assumptions and limitations

9.6.1 This section provides a description of the assumptions and limitations to the CCR and ICCI assessments.

9.6.2 The probabilistic projections from UKCP18 are presented to include the 60-year project design life (the temporal scope for the assessment), i.e. from the start of construction through to end of design life. These time periods include: 2020-2049, 2040-2069, 2070-2099.

9.6.3 Data for the regional 12km projections, which provide information on local climate effects within a defined 12km square location is only available up to 2079. This data has been used to generate the projections in **Table 9.21** and **Table 9.22**; meaning that these extremes cannot be explored beyond 2079 up to the end of the project design life.

9.6.4 All simulations of the future are conditioned on both a limited number of scenarios of future GHG emissions and the particular methodologies employed in UKCP18. For instance, while the global projections provide a range of climate futures, they cannot cover all potential future climate outcomes (Ref. 9.37).

9.6.5 All climate change projections are subject to uncertainties, due to the complexity of the climate system, natural climate variability, uncertainty over future GHG emission levels and modelling uncertainties. For example, there is uncertainty in climate models and regarding how global climatic trends will be reflected at the regional scale. Leading climate change data from the UKCP18 programme has been used to explore trends and magnitude of change at the regional scale. UKCP18 is the result of over seven years work by the Met Office's Hadley Centre Climate Programme and over thirty years of work from other contributing organisations. UKCP18 builds upon UKCP09 to provide the most up-to-date assessment of how the climate of the UK may change over the 21st century. Additionally, to account for this uncertainty climate projections at the 10%, 50% and 90% probability levels have been considered.

9.6.6 Information on climate change effects on lightning and fog is not available in UKCP18 for the 12km regional nor 25km probabilistic data and therefore a qualitative assessment has been provided based on professional judgement. Lightning flash rate data has more recently been released as part of the higher resolution UKCP local 2.2km data, however it is not currently available via the UKCP18 User Interface, instead the headline findings have been used in the accompanying Update to the UKCP Local (2.2km) Projections report (Ref. 9.38).

9.6.7 Assessments made in relation to 'consequence' and 'likelihood' have relied on professional judgement and evidence gathered through other environmental topic assessments, such as biodiversity, air quality, noise, and the Proposed Development design team.

9.6.8 All existing assets that are not being modified as part of the Proposed Development are assumed to be maintained in line with LLAOL's existing Climate Change Adaptation Report (Ref. 9.39) or any subsequent equivalent document that may supersede it and therefore are not assessed here.

Reasonable Worst Case

9.6.9 **Chapter 5** Approach to the Assessment of this ES **[TR020001/APP/5.01]** describes the general approach adopted to ensure that a reasonable worst case is assumed in this assessment including the use of parameters, accounting for uncertainty, and incorporating flexibility in design and demand forecasts.

9.6.10 Further relevant assumptions on reasonable worst case specific to this assessment include:

a. This assessment represents a reasonable worst case scenario of how climate change could impact the Proposed Development as the climate projections used in the assessment are for the highest emissions scenario available representing a global temperature increase of approximately 4.3˚C by 2100, relative to pre-industrial temperatures (RCP 8.5).

b. As mentioned above, in line with the ANPS (Ref. 9.40), consideration has been given to 'more radical' changes to the climate beyond those projected in the latest set of UKCP18 in line with the ANPS (Ref. 9.41) to demonstrate that there are no critical features of infrastructure design which may be seriously affected by climate change. Consideration has been given to plausible higher and lower end climate change projections from both the H++/L-- scenarios, and the PPCE released in 2020 (Ref. 9.42).

9.7 Baseline conditions

9.7.1 This section provides a description of the existing conditions in the study areas as described in **Section 9.3**.

Existing conditions for CCR and ICCI assessments

9.7.2 Historic climate data obtained from the Met Office website (Ref. 9.43) recorded by the meteorological station closest to the Proposed Development (Rothamsted No.2) for the periods 1981-2010 and 1991-2020 is presented **Table 9.17**. The period 1991-2020 is not yet available as a baseline within future projections from UKCP18. Therefore, both time periods have been presented.

9.7.3 Baseline conditions described in the other discipline chapters are also relevant to the ICCI assessment.

Table 9.17: Historic climate data

Climate variable	1981-2010	1991 – 2020
Average annual maximum daily temperature	13.7 °C	14.1°C
Warmest month on average	July (mean maximum daily temperature of 21.8°C)	July (mean maximum daily temperature of 22.1°C)
Coldest month on average	February (mean minimum daily temperature of 1°C)	February (mean minimum daily temperature of 1.52°C)
Average total annual rainfall levels	712.3 mm	714.5 mm
Wettest month on average	October (81.1 mm of rainfall on average for the month)	October (78.2 mm of rainfall on average for the month)
Driest month on average	March (47.7 mm of rainfall on average for the month)	March (47.7 mm of rainfall on average for the month)

9.7.4 Baseline data for the climate extremes obtained from the observational gridded dataset released as part of UKCP18 are recorded in **Table 9.21** for the period 1980-2010**.**

9.7.5 On 19th July 2022, for the first time, the record temperature in the UK exceeded 40°C. The new highest daily maximum temperature has been recorded in the UK by the Met Office of 40.3°C in Coningsby (Lincolnshire). This figure exceeds the previous record of 38.7°C recorded in Cambridge Botanic Garden on Thursday 25 July 2019, by 1.6°C (Ref. 9.44).

Future baseline

9.7.6 Regardless of whether or not the Proposed Development goes ahead, there is likely to be a change to the future baseline conditions as a result of climate change.

9.7.7 Projected changes in temperature, precipitation, and specific humidity are presented in **Table 9.18** and **Table 9.19** and **Table 9.20** respectively. These

tables include the UKCP18 probabilistic projections (Ref. 9.45) for the 25km^2 grid square where the Proposed Development is located. These figures are expressed as anomalies in relation to the 1981-2010 baseline[3] and have been presented to include the 60-year design life of the Proposed Development (the temporal scope for the assessment), at the 10%, 50% and 90% probability levels for RCP8.5. The 50% probability levels are shown in bold and the 10% and 90% probability levels are shown in brackets.

9.7.8 Further data has been obtained for other climate variables and extreme weather events, using land projections at a 12km^2 resolution from UKCP18 and are presented in **Table 9.21** and **Table 9.22**).

Table 9.18: Projected changes to temperature parameters (°C)

Climate parameter	Time period		
	2020-2049	2040-2069[4]	2070-2099
Mean annual air temperature anomaly at 1.5m (°C)	**+1.1** (+0.5 to +1.7)	**+2.0** (+1.0 to +3.0)	**+3.8** (+2.2 to +5.5)
Mean Summer air temperature anomaly at 1.5m (°C)	**+1.4** (+0.5 to +2.3)	**+2.6** (+1.1 to +4.0)	+**5.1** (+2.6 to +7.7)
Mean Winter air temperature anomaly at 1.5m (°C)	**+0.9** (+0.1 to +1.7)	**+1.7** (+0.5 to +2.9)	**+3.0** (+1.2 to +5.0)
Maximum Summer air temperature anomaly at 1.5m (°C)	**+1.6** (+0.3 to +2.8)	**+2.9** (+1.0 to +4.8)	**+5.8** (+2.5 to 9.1)
Minimum Winter air temperature anomaly at 1.5m (°C)	**+0.9** (+0.1 to +1.9)	**+1.8** (+0.4 to +3.2)	**+3.2** (+1.1 to +5.7)

** Note: 1.5m from sea level*

Table 9.19: Projected changes to precipitation parameters (%)

Climate parameter	Time period		
	2020-2049	2040-2069	2070-2099
Annual precipitation rate anomaly (%)	**+0.3** (-5.7 to +6.5)	**-2.8** (-10.7 to +5.2)	**-2.3** (-13.3 to +8.8)
Summer precipitation rate anomaly (%)	**-7.0** (-27.9 to +13.1)	**-16.3** (-43.0 to +10.1)	**-35.5** (-64.4 to +0.5)
Winter precipitation rate anomaly (%)	**+6.3** (-3.4 to +17.0)	**+9.1** (-4.3 to +24.8)	**+20.2** (-1.4 to +46.6)

[3] While historic data is available for period 1991-2020, Met Office projections data are expressed in relation to the 1981-2010 baseline.
[4] Data available from UKCP18 is for pre-determined 30-year periods. To allow projections to be presented up to the end of the century there is an overlap of 10 years for the first and second time periods presented.

Table 9.20: Projected changes in humidity parameters (%)

Climate parameter	Time period		
	2020-2049	2040-2069	2070-2099
Annual specific humidity anomaly at 1.5m (%)	**+5.6** (+0.8 to +10.7)	**+10.3** (+3.6 to +17.8)	**+20.9** (+10.5 to +32.2)
Summer specific humidity anomaly at 1.5m (%)	**+5.7** (-1.5 to +12.7)	**+10.4** (+0.5 to +20.7)	**+19.4** (+4.6 to +34.7)
Winter specific humidity anomaly at 1.5m (%)	**+5.7** (-0.8 to +12.5)	**+11.1** (+1.1 to +21.5)	**+22.7** (+6.6 to +39.4)

9.7.9 Further data has been obtained for other climate variables and extreme weather events. These have been assessed using land projections at a 12km resolution from UKCP18 and are presented in **Table 9.21** (Ref. 9.46) and **Table 9.22** (Ref. 9.47). Wind data from the 12km data has not been included due to lower confidence in the modelling.

9.7.10 The baseline values in **Table 9.21** are from UKCP18 climate models or "projected baseline" (mean of 12 models for period 1981-2010).

9.7.11 In **Table 9.21** and **Table 9.22**:

a. Min = minimum of the 12 climate models (RCP 8.5);

b. Mean = mean value of the 12 climate models (RCP 8.5); and

c. Max = maximum value of the 12 climate models (RCP 8.5).

9.7.12 **Table 9.21** presents the absolute climate projections for each time period. **Table 9.22** presents the anomalies (i.e. the change in the climate parameter relative to the baseline period).

Table 9.21: Projected changes extremes (absolute)

Climate parameter	Baseline (1981-2010)		2020-2049			2040-2069			2050-2079		
	Observed	Projected	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Annual number of frost days (daily minimum temperature equal or lower than 0°C)	49.2	37.6	24.9	33.0	46.0	19.7	24.7	35.0	16.8	20.9	27.7
Annual number of heatwaves (2 days with maximum temperature higher than 29°C and minimum temperature higher than 15°C)	0.3	0.5	0.3	2.1	5.3	1.8	5.7	11.9	3.9	9.0	16.1
Number of hot days (daily maximum temperature higher than 25°C)	14.5	11.0	21.6	35.5	59.7	35.0	55.5	79.4	41.2	67.8	90.5
Summer highest daily maximum temperature (ºC)	28.5	26.4	29.4	31.7	34.3	31.3	33.7	36.3	32.6	34.8	37.4
Annual number of dry spells (10 or more consecutive days without precipitation (defined as 0.2mm)	4.3	1.3	4.0	34.7	5.6	4.4	5.3	6.1	4.5	5.6	6.7
Annual number of days per year when precipitation is greater than 25mm per day (Met Office definition of 'heavy rain')	1.2	1.3	0.8	1.5	2.4	0.9	1.5	2.2	1.1	1.6	2.3

Table 9.22: Projected changes extremes (anomalies)

Climate parameter	2020-2049			2040-2069			2050-2079		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Annual number of frost days (daily minimum temperature equal or lower than 0°C)	-24.3	-16.2	-3.2	-29.5	-24.5	-14.2	-32.4	-28.3	-21.5
Annual number of heatwaves (2 days with maximum temperature higher than 29°C and minimum temperature higher than 15°C)	0.0	1.8	5.0	1.5	5.4	11.6	3.6	8.7	15.8
Number of hot days (daily maximum temperature higher than 25°C)	7.1	21.0	45.2	20.5	41.0	64.9	26.7	53.3	76.0
Summer highest daily maximum temperature (ºC)	0.9	3.2	5.8	2.8	5.2	7.8	4.1	6.3	8.9
Annual number of dry spells (10 or more consecutive days without precipitation (defined as 0.2mm)	-0.3	0.4	1.3	0.1	1.0	1.8	0.2	1.3	2.4
Annual number of days per year when precipitation is greater than 25mm per day (Met Office definition of 'heavy rain')	-0.4	0.3	1.2	-0.3	0.3	1.0	-0.1	0.4	1.1

9.7.13 Compared to the current baseline, UKCP18 projections (mean and RCP 8.5) highlight that by the end of the century:

a. mean Summer temperatures are expected to increase by 4.9°C;
b. mean Winter temperatures are expected to increase by 3.1°C;
c. Summer precipitation is expected to decrease by 36%; and
d. Winter precipitation is expected to increase by 20%.

9.7.14 Compared to the current baseline, UKCP18 projections (mean and RCP 8.5) highlight that by 2079 as shown in **Table 9.22**:

a. the annual number of heatwaves is expected to increase by 8.7;
b. the annual number of frost days is expected to decrease by 28.3;
c. the number of dry spells (10 or more consecutive days without precipitation (defined as 0.2mm) is expected to increase by 1.3; and
d. the number of days with heavy rain (precipitation higher than 25mm/day is expected to increase by 0.4.

9.7.15 There is a future increase in spatially averaged lightning frequency over the UK domain in Summer and to a lesser extent in Spring, little change in Winter, and a decrease in Autumn (Ref. 9.48).

9.7.16 **Table 9.23** presents the plausible high-end projections of the climate change projections (i.e. a reasonable worst case scenario for climate extremes). Information is presented from both the H++/L-- scenarios (Ref. 9.49), and the UKCP18 PPCE released in 2020 (Ref. 9.50). Note that baseline reference periods vary for the different climate events based on the data availability for extremes.

Table 9.23: Plausible high-end climate change scenarios (absolute)

Climate event	H++ / L-- scenarios	UKCP18 PPCE
High temperature	Hottest Summer days could exceed 48°C (H++)	Maximum air temperature at 1.5m: 37°C
Low temperature	Minimum Winter temperature (L--)[5]: 2020s: -7°C 2080s: -11°C	N/A
High precipitation	The H++ scenario for high precipitation projects a 70-100% increase in Winter rainfall (December to February), from a 1961-1990 baseline. Increased frequency (up to 5x) and daily/sub-daily depth of high precipitation events in both Summer and Winter (H++)	1-day total precipitation: 64mm 5-day total precipitation: 107mm

[5] This L - - scenario is considered extremely unlikely, and there is low confidence in the evidence that supports this future trend. However, extreme cold weather events have been considered as part of the climate change assessments to ensure that potential future climate impacts are adequately assessed.

Climate event	H++ / L-- scenarios	UKCP18 PPCE
Low precipitation	Significant increases in 6-month Summer droughts (a precipitation deficit up to 60% less than the long-term average 1900-1999), with no notable change in Winter droughts. However, longer and drier periods (a precipitation deficit of up to 20% less than the long-term 1900-1999 average) lasting 3 to 5 years are possible (H++)	N/A
Wind	Increased number of days per year with strong winds to increase between 50 – 80% greater than a 1975-2005 baseline (strong winds defined here as UK-averaged daily mean wind speeds over the 99th percentile of historical simulations, at 850 hectopascals (hPa)) (H++)	N/A

9.8 Embedded and good practice mitigation measures

CCR

Construction

9.8.1 All construction mitigation measures outlined below are included in the Code of Construction Practice (CoCP) provided as **Appendix 4.2** of this ES **[TR020001/APP/5.02]**. The adoption and implementation of the CoCP by appointed contractors is to be secured as a requirement of the DCO.

9.8.2 A high-level risk assessment of severe weather impacts on the construction process will be produced by the lead contractor to inform any required mitigation. Any receptors and/or construction-related operations and activities potentially sensitive to severe weather events will be considered in the assessment. Climate change projections will also be considered in the risk assessments.

9.8.3 **Table 9.24** describes the embedded and good practice mitigation for CCR during construction of the Proposed Development, which have been incorporated into the Proposed Development design or would be secured as a requirement of the DCO via the CoCP.

Table 9.24: Summary of embedded and good practice mitigation measures for construction

Receptor	Summary of embedded and good practice mitigation measures
Materials and equipment required for the construction of all built assets	Use of construction materials with superior properties that offer increased tolerance to fluctuating temperatures, heavy precipitation and other extreme weather events such as storms, where reasonably practical. The lead contractor will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The lead contractors' EMS will consider all measures deemed necessary and appropriate to manage severe weather events and should as a minimum cover training of personnel and prevention and monitoring arrangements. As appropriate, construction method statements should also consider severe weather events where risks have been identified.
Structures	Vulnerable aspects of earthworks will not be done during the Winter months to avoid placing and compacting soil which is too wet, resulting in long-term settlement issues. Transportation of earthworks sensitive to moisture will be also avoided in winter months. Requirements for consideration of climate change impacts on groundwater levels, soil moisture content and precipitation are included in the construction and design of earthworks and structures in-line with

Receptor	Summary of embedded and good practice mitigation measures
	BS EN1997-1 (Ref. 9.51) and BS6031 Code of Practice for Earthworks (Ref. 9.52). Construction works will be carried out in accordance with the Outline Soil Management Plan (SMP) provided as **Appendix 6.6** of this ES **[TR020001/APP/5.02]**.
Staff facilities	A high-level risk assessment of severe weather impacts on the construction process will be produced by the lead contractor to inform mitigations.
Access routes to construction sites	The lead contractor will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The lead contractor's EMS will consider all measures deemed necessary and appropriate to manage severe weather events and will register with the EA's flood warning service in areas of flood risk.
Workers on construction sites	The lead contractor will consider climate change impacts to construction workers and will develop health and safety plans to prevent worker exhaustion due to heat. Supportive measures for working in high temperatures might include the provision of sunblock, sun hats and lightweight clothing, refreshment breaks and cooled water supply. Use of a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The lead contractor's EMS will consider all measures deemed necessary and appropriate to manage severe weather events and should as a minimum cover training of personnel and prevention and monitoring arrangements. As appropriate, construction method statements should also consider severe weather events where risks have been identified. In addition, temporary buildings will be designed with measures to control summertime overheating. Construction works will be carried out in accordance with airport requirements of working airside, e.g. airside construction works will be paused if there is low visibility or increased dust being blown across airfield.

Operation

9.8.4 CCR has been taken into account in the sift/optioneering stages of the Proposed Development that influenced the 'future airport layout' and has also influenced the design to date. Multiple workshops and meetings were conducted with the design teams to discuss climate projections, potential

impacts of climate change and to understand and influence the level of embedded mitigation incorporated into the design to increase the resilience of the Proposed Development to climate change effects.

9.8.5 Assets will be maintained regularly to detect deterioration and damage caused by extreme weather events such as storms through maintenance and monitoring in contracts.

9.8.6 **Table 9.25** presents the embedded and good practice mitigation for CCR during operation of the Proposed Development, which have been incorporated into the Proposed Development design or would be secured as a requirement of the DCO. Certain mitigation measures can only be fully defined at an appropriate point in the future, for example, during detailed design. Where this is the case, such measures have been included in the **Design Principles** document **[TR020001/APP/7.09]** submitted as part of the application for development consent and secured by Requirement in the draft DCO **[TR020001/APP/2.01]**.

Table 9.25: Summary of embedded and good practice mitigation measures for operation

Receptor	Summary of embedded and good practice mitigation measures
Luton DART extension	The proposed asset will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) for the Proposed Development accounts for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change aligned with EA guidance (Ref. 9.53). The Luton DART extension design includes a covered station (i.e. protected from the elements) and the chosen system design has previous use cases in colder climates than the UK. Asset would be located within the tunnel therefore would be protected from high wind speeds that may create or distribute debris to track disrupting service. Adequate heating, ventilation and air-conditioning (HVAC) systems provided on trains to minimise impacts associated with increased Summer temperatures and hot days. The Luton DART extension will be designed to the EA's guidance on Flood risk assessments: climate change

Receptor	Summary of embedded and good practice mitigation measures
	allowances (Ref. 9.54) and the principles of the Luton Local Transport Plan (Ref. 9.55).
Additional taxiways and aircraft stands	Assets will either be designed for the climatic conditions projected or the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) for the Proposed Development accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change. The Construction Industry Research and Information Association (CIRIA)'s Sustainable Drainage Systems (SuDS) Manual (C753) (Ref. 9.56) will be used for design of all SuDS assets and Water UK's Sewers for Adoption design guide (Ref. 9.57) for other drainage assets. Government projections for climate change allowance have been followed (Ref. 9.58). Use of construction materials (as far as practicable) with superior properties which offer increased tolerance to high temperatures. Taxiway surfaces, based on design standards are intended to withstand far higher temperatures to be able to cope with aircraft braking. New de-icing facilities are incorporated into the Proposed Development to mitigate any impacts associated with increased extreme cold weather events. Regular maintenance of snow, de-icing and anti-icing equipment.
Aircraft operations (activities associated with aircraft operations during the landing and take-off cycle i.e. taxi, take off, climb and approach)	On-site rescue and firefighting service are the first-responders for any incident within the airport boundary. Sensitive telecoms equipment fitted with lightning protection as per latest design standards. New de-icing facilities are incorporated into the Proposed Development to mitigate any impacts associated with increased extreme cold weather events. Regular maintenance of snow, de-icing and anti-icing equipment.

Receptor	Summary of embedded and good practice mitigation measures
	Measures relating to allowances in maximum take-off weight and maximum plane operating temperature are managed by standard flight operation procedures. During times of high winds airline operators will follow precautions due to strong wind operating procedures. Low visibility procedures will be in operation to deal with periods of fog and cloud cover.
Terminals and associated buildings, including airside facilities, and other supporting buildings such as, office buildings, police station, hotels, logistics centre and technical service buildings.	All new buildings and assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) of the Proposed Development can accommodate for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change. Adequate HVAC systems provided to mitigate any impacts on thermal comfort of staff and passengers in airport buildings as a result of increased average and Summer temperatures and the frequency of heatwaves. New de-icing facilities are incorporated into the Proposed Development. Terminal 2 buildings will be designed to at least 'BREEAM Excellent' standard, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' status except where the building typology dictates that it is not practical. Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). Rainwater harvesting from the roofs will allow greywater storage and re-use where practicable and appropriate to increase resilience against increased frequency of dry spells.

Receptor	Summary of embedded and good practice mitigation measures
End users such as staff and passengers	Adequate HVAC systems provided. Terminal 2 buildings will be designed to at least 'BREEAM Excellent' standard, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' status except where the building typology dictates that it is not practical.
Cargo and catering facility	Assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) for the Proposed Development accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.
Highway network improvements, car parking facilities, bus, coach and taxi facilities and airside roads	All surface access transport infrastructure will be designed to EA guidance on flood risk assessments: climate change allowances (Ref. 9.59) and the principles set out in the Luton Local Transport Plan (Ref. 9.60). Where applicable, the highway design has been developed to the standards set within the Design Manual for Roads and Bridges (DMRB). Shaded areas across surface access areas will be included in the design e.g., car parks, bus stops to mitigate impacts of future extreme heat events. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) for the Proposed Development accommodated for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change. Pavement will be designed to accommodate future climate change conditions. Design mitigation measures for temperature increases may include: a. Use of construction materials with superior properties which offer increased tolerance to high temperatures.

Receptor	Summary of embedded and good practice mitigation measures
	b. Suitable drainage to maintain dry foundation, and better slopes to drain surface water and prevent ponding. c. Modification to the asphalt mix design to accommodate deformation in hotter weather under slow moving heavy aircraft. d. Smaller bays or thicker slabs will be considered to accommodate additional thermal stresses due to hot temperatures. e. Dowel bars and edge thickening will be considered to accommodate additional wrapping stress due to hot temperatures. f. Appropriate transition details for asphalt/concrete interface will be considered to accommodate larger movements. g. Reduction of the subgrade design strength to account for higher water table and moisture content.
Drainage and pollution control assets (sewage and effluent treatment plants)	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) for the Proposed Development reports that the proposed drainage design can accommodate surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change aligned with EA guidance (Ref. 9.61). Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.**4 of this ES **[TR020001/APP/5.02]).** These include reduction of demand and foul water discharge, reduction in use of potable water in applications where non-potable water can be used, use of water efficient appliances and equipment within the terminal. The CIRIA's SuDS Manual (C753) (Ref. 9.62) will be used for design of all SuDS assets and Water UK's Sewers for Adoption design guide for other drainage assets. Government projections for climate change allowance have been followed (Ref. 9.63). The requirements for consideration of climate change impacts on groundwater levels, soil moisture content and precipitation are included in the construction and design of earthworks and structures in-line with BS EN1997-1 (Ref.

Receptor	Summary of embedded and good practice mitigation measures
	9.64) and BS6031 Code of Practice for Earthworks (Ref. 9.65).
Fuel farm	This proposed asset will either be designed for the climatic conditions projected or the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. On-site rescue and firefighting service are the first-responders for any incident within the airport boundary. Incidents associated with increased fire risk of combustible materials, may occur as a result of increased Summer temperatures and the number of hot days, especially if accompanied by periods of drought or low precipitation.
Flood attenuation and storage infrastructure i.e. water infiltration (soakaway) and attenuation tanks, fire, water and energy storage assets	Consideration of climate change in all drainage infrastructure and flood retention infrastructure are stated in the Drainage Design Statement of the Proposed Development (**Appendix 20.4** of this ES **[TR020001/APP/5.02]).** The Drainage Design Statement of the Proposed Development (**Appendix 20.4** of this ES **[TR020001/APP/5.02])** describes the design that can accommodate for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.
On site electrical facilities and utilities corridors	To reduce potential impacts associated with storms and high winds, the design of electrical facilities and utilities corridors does not include any overhead lines or cables. Design of buried services will include flexible conduits at least where we are building over the landfill where some degree of settlement is expected. New underground utilities are not laid at shallow depths to avoid damage due to temperature extremes during excavations. Energy centre and new sub-stations will be above the ground level in enclosed structures which will offer protection from high winds and provide the opportunity for climate/temperature control. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02])** of the Proposed Development can accommodate for surface water flows during 1 in 100 years

Receptor	Summary of embedded and good practice mitigation measures
	storm event, accounting for an increase in precipitation of 40% due to climate change.
De-icing storage facility	Asset will either be designed for the climatic conditions projected or the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02])** of the Proposed Development can accommodate for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.
Public open space, amenities and landscaping	Shading (of public open spaces and buildings within the Order limits) suitable for extreme heat events in the future. SuDS and permeable surfacing suitable for extreme rainfall events. Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). Rainwater harvesting from the roofs will allow greywater storage and re-use where practicable and appropriate. No specific design standards have been used for landscaping, but the proposals seek to deliver multi-functional green infrastructure and have been developed with consideration to the Landscape Institute's Position Statement on Climate Change (Ref. 9.66). The Outline Landscape and Biodiversity Management Plan (LBMP) (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**) details measures that will be implemented to create and manage these habitats for a period of at least 50 years. Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species planting and habitat creation, e.g. drought tolerant species and provide adequate monitoring post-planting, as presented in the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).
Energy centre	Asset will either be designed for the climatic conditions projected or the end of their design life, using appropriate

Receptor	Summary of embedded and good practice mitigation measures
	design guidance where available or adaptive capacity will be built into the designs.
Fire training ground	Asset will either be designed for the climatic conditions projected or the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02])** for the Proposed Development accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.
Landform and earthworks	Suitable drainage to maintain dry foundation, and better slopes to drain surface water and prevent ponding.
Operational workers	The new terminal building will utilise efficient building design, including electric reverse heat pumps for heating and cooling supported with ground source heat pump technology; and storage of heat using water storage facilities. Adequate HVAC systems provided to mitigate any impacts on thermal comfort of staff and passengers in airport buildings as a result of increased average and Summer temperatures and the frequency of heatwaves. Terminal 2 buildings will be designed to at least 'BREEAM Excellent' standard, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' Status except where the building typology dictates that it is not practical. Shaded areas across surface access areas will be included in the design e.g. car parks, bus stops to mitigate impacts of future extreme heat and cold weather events.

9.8.7 A further breakdown of embedded and good practices mitigation measures assigned to each asset scoped into the assessment against potential climate change impacts is presented in **Table 9.29** and **Table 9.30.** A definition of these classifications of mitigation and how they are considered in the EIA is provided in **Chapter 5** Approach to the Assessment of this ES **[TR020001/APP/5.01]**.

Good Practice

9.8.8 Using appropriate design guidance where available, all buildings, surface access routes, taxiways, aprons and other airside and airfield assets will be designed for the climatic conditions projected for the end of their design life. Due to the different timescales of aspects of the Proposed Development being constructed the most up to date and relevant guidance will be reviewed at the time of detailed design of each aspect.

In-combination Climate Change Impacts

9.8.9 **Table 9.26** and **Table 9.27** summarise the embedded and good practice mitigation measures identified by the other disciplines and how these influence the ICCI assessment.

Construction

Table 9.26: ICCI embedded and good practice mitigation measures - construction

Receptor	Changes and effects	Embedded and good practice mitigation measure
Air quality (**Chapter 7 [TR020001/APP/5.01]**) and soils and geology receptors (**Chapter 17 [TR020001/APP/5.01]**)	Increased dusts and airborne contamination to soils during construction due to extended dry spells.	Minimised as far as reasonably practicable, through the measures required by the CoCP (e.g. reduce dust emissions through the effective transportation and storage of materials such as dampening down of dusts particularly where material is stockpiled), and the proposed monitoring regime.
Agricultural land quality and farm holdings (**Chapter 6 [TR020001/APP/5.01]**)	Increase Winter precipitation in increases risk of structural damage to soil resources if handled when too wet.	Increase of Winter participation will put soil resources with low resilience are at risk of structural damage if handled in too wet conditions. This will be mitigated by the sustainable use of soil resources on site would and maintenance as described in the Outline SMP (**Appendix 6.6** of this ES **[TR020001/APP/5.02]**).

Table 9.27: ICCI embedded and good practice mitigation measures - operation

Receptor	Changes and effects	Embedded and good practice mitigation measure
Air quality (**Chapter 7 [TR020001/APP/5.01]**)	Sunnier and drier / drought conditions could change concentrations of certain air pollutants such as NOx, $PM_{2.5}$	It is unlikely that sunnier and drier/drought conditions will exacerbate concentrations of NOx, $PM_{2.5}$ and PM_{10} because aircraft engines and ground transportation, such as cars, are expected to be cleaner in the future. This is because aircraft engines will

Receptor	Changes and effects	Embedded and good practice mitigation measure
	PM_{10} and ozone (O_3).	comply with emission standards set by the Committee on Aviation Environmental Protection (CAEP) (Ref. 7.67) and there will be improvements in road vehicle technology and changes in fleet composition with higher proportion of low emission vehicles, as predicted by Defra. O_3 is likely to increase and consequently affect NO_2 concentrations. O_3 is a trans-boundary pollutant which is formed in the atmosphere from reactions involving other pollutants. It is not directly emitted from processes that can be regulated, therefore there are limited mitigation measures available to the Applicant in relation to O_3. The change in surface O_3 concentrations is likely to be small in comparison to the important precursor pollutants to O_3 formation (NOx, methane, and non-methane volatile organic compounds).
	Sunnier/hotter conditions could increase aircraft emissions due to the steeper climb angles taken.	It is unlikely that conditions will exacerbate emissions because aircraft engines are expected to be cleaner in the future.
	Changes in wind speed and direction could influence local pollutant levels.	There is considerable uncertainty in projections for changes in wind speed and wind direction, and studies show statistically insignificant variation in wind speed. Monitoring measures are already in place. If there is increased channelling due to changes in wind direction this would increase annual average levels at some receptors and decrease them at others. However, Defra predicts that background concentrations are likely to decrease.
	Degradation of ecosystem services	The proposed habitat creation/enhancement has been

Receptor	Changes and effects	Embedded and good practice mitigation measure
Biodiversity (**Chapter 8 [TR020001/APP/5.01]**)	and reduced food availability as a result of increased annual temperatures.	designed to link existing habitats and provide a larger expanse of biodiverse semi-natural habitat. This will provide a variety of fauna with a varied and increased food source, that will help boost their resilience to the impacts of future temperature change. Further details of how these habitats will be created and managed can be found within the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).
	Impacts to retained sensitive habitats and reduced success of new planting as a result of decrease in annual precipitate.	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) would ensure that there is no significant change to water availability within retained habitats and areas of new open space, planting and habitat creation and has accounted for future climate changes, including reduced water availability.
	Reduced success of establishment of new planting due to hotter drier conditions	Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species planting and habitat creation and adequate monitoring post-planting occurs in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02])**.
	Reduced success of establishment of new planting due to wetter conditions	Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species planting and habitat creation and adequate monitoring post-planting occurs in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02])**.
Health and community (**Chapter 13 [TR020001/APP/5.01])**	Climate change exacerbates the effect the Proposed Development has on health and community, particularly in relation to increased Summer temperatures and flooding.	New trees and planting in replacement open space to provide areas of shade and cooling. This is secured through the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).

Receptor	Changes and effects	Embedded and good practice mitigation measure
Landscape and visual (**Chapter 14 [TR020001/APP/5.01]**)	The increased occurrence of heatwaves and droughts and their potential to reduce the growth rates of plant material and/or increase the likelihood of plant failure.	Landscape species to be selected and maintained in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]** and the detail specification for the soil growing medium to be in accordance with the Outline SMP (**Appendix 6.6** of this ES **[TR020001/APP/5.02]**. Planting areas to be regularly monitored and maintained in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).
Noise and vibration (**Chapter 16 [TR020001/APP/5.01]**)	Potential to exacerbate noise effects on communities in terms of individual dwellings and on a wider community, due to windows being open more often due to an increase in high temperatures.	The noise assessment criteria assume windows are open when internal noise levels are considered. Consequently, there is no further impact on noise effects arising from the ICCI. However, the effectiveness of noise insulation could be reduced, and noise insulation packages may need to provide a greater emphasis on ventilation.
	Increases in temperature and humidity of the air reducing the atmospheric attenuation of noise.	Over distances of a few hundred metres, atmospheric effects can be ignored for sound with low frequency prominence, such as aircraft noise. Consequently, increases in temperature and humidity is unlikely to affect ground-based noise sources such as ground noise, construction noise and surface access noise. Due to the longer distances that aircraft noise travels, the effect of increases in temperature and humidity can affect aircraft noise levels. However, the change in atmospheric absorption will only have a significant effect on high frequencies. Given the prominence of low frequencies in aircraft noise, it would take a substantial change in climate to result in a perceptible change in air noise. Consequently, it is expected that

Receptor	Changes and effects	Embedded and good practice mitigation measure
		changes in temperature will not result in additional impacts. Increased temperature and humidity could impact aircraft take-off performance, requiring a longer take-off run, slower climb, more thrust and potentially higher noise levels on the ground. However, this would be the case for the Do Something and Do Minimum scenarios so the identified effects would not be changed.
Soils and geology **(Chapter 17 [TR020001/APP/5.01])**	Decreased precipitation and increased temperatures causing dry exposed Made Ground and landfill waste could lead to increase production of dusts and airborne contaminated soils.	The consequence of this ICCI is minimised as far as reasonably practicable using good construction practice measures set out in the CoCP for example, dampening down of dusts particularly where material is stockpiled.
	Decreased precipitation and increased temperatures resulting in differential settlement of ground caused by decreases in moisture content can be sufficient to damage property, roads, and infrastructure.	The design of the Proposed Development takes into account ground conditions, and how this may be affected by future climate change. Mitigation such as surcharging/ground improvement techniques, flexible pavements and modified service connections will be used.
Water resources and flood risk (**Chapter 20 [TR020001/APP/5.01]**)	Water shortages due to increasing Summer air temperatures and decreasing Summer precipitation.	A Water Cycle Strategy (**Appendix 20.5** of the ES **[TR020001/APP/5.02]**) has been prepared to inform the ES to assess how potential water use associated with the Proposed Development will affect water resources and infrastructure considering potential impacts of climate change.

Receptor	Changes and effects	Embedded and good practice mitigation measure
		The Drainage Design Statement (**Appendix 20.4** of the ES **[TR020001/APP/5.02]**) includes a description of measures to minimise water use and maximum water reuse. The use of such measures have been considered in the Water Cycle Strategy.
	Less snow and ice, potentially resulting in increased surface water runoff in Winter periods Flooding may have an impact on leachate generation.	The design has been developed to accommodate the volume and rate of water generated by a 1 in 100-year return period storm event, including a 40% uplift to allow for potential increases in rainfall due to climate change as set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). A capping layer including drainage management systems would be in place across the whole of the landfill and hence infiltration would not interact with the waste to generate leachate once constructed.
	Decrease in precipitation volumes could result in increased sensitivity of waterbodies to pollution discharge	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02])** outlines commitments to treat water to prevent pollution of the principal aquifer and associated receptors. Real-time monitoring of concentrations of contaminants will be in place across the Main Application Site (as defined in **Chapter 2** of this ES **[TR020001/APP/5.01])**, and if trigger levels are exceeded at any time then contaminated runoff will be diverted to a storage tank and into a facility for treatment at a controlled rate.

9.9 Assessment

9.9.1 This section presents the results of the assessment of likely significant effects with the embedded and good practice mitigation measures, described in the previous section, in place.

9.9.2 A summary of the assessment of effects is provided on **Table 9.29** in **Section 9.13**. The likelihood of significant effects is discussed in further detail in this section.

CCR

Construction

9.9.3 The effects of climate change may result in a range of short-term climate risks during the construction of the Proposed Development through the potential increase in the occurrence and/or magnitude of extreme weather events, including:

a. extreme weather events such as heatwaves, heavy precipitation and increased snowfall/freezing disrupting construction timescales;
b. health risk to construction workers from heatwaves and other extreme weather;
c. water availability causing disruption and delays during construction;
d. flooding may cause disruption to soil structures and increase rate of runoff; and
e. weather conditions can negatively impact the use of construction materials e.g. water evaporation can occur in hot weather, changing the water to cement ratio and decreasing compressive strength.

9.9.4 The assessment as provided in **Table 9.29** and **Table 9.30** shows that, with the incorporation of embedded and best practice mitigation measures, no significant effects during construction have been identified.

Operation

9.9.5 A summary of the potential climate change impacts identified in the CCR assessment includes:

a. damage to assets and infrastructure due to flooding;
b. damage to assets as a result of extreme weather such as storms and high wind speeds creating or distributing debris disrupting train services and airfield operations;
c. reduced reliability of the Luton DART as a result of track damage or train failure caused by extreme weather events;
d. increased heat stress for passengers, staff, and outdoor maintenance workers;
e. lightning striking the airport resulting in an aircraft accident or loss of telecommunications;

f. increasing Summer temperatures would require airlines to burn more fuel to get the aircraft off runway;

g. because water levels can be variable in chalky soils, periods of high rainfall in Winter could cause groundwater levels to rise to higher than predicted;

h. potential issue with groundwater levels as variable in chalk and respond quickly to rainwater;

i. increased Summer temperature and increased Winter temperature variability has the potential to cause damage to the asphalt and affect operations;

j. prolonged periods of dry spells leading to drought and reducing the potable water availability required for the operation of both terminals;

k. increase in fire risk during hot days, and increased risk in damage to fuel operations due to lightning strikes;

l. flood water management infrastructure can be stressed by exacerbation of flood events under future climates; and

m. potential to damage the open space and habitats if planting is not resilient to climate change.

9.9.6 The assessment as provided in **Table 9.29** and **Table 9.30** shows that, with the incorporation of embedded and best practice mitigation measures, no significant effects during operation have been identified.

In-combination Climate Change Impacts

9.9.7 **Table 9.31** summarises the findings from the ICCI assessment and shows that, with the incorporation of embedded and best practice mitigation measures, no significant in-combination effects have been identified.

Sensitivity Analysis

9.9.8 There are certain known scenarios or risks that may occur that could influence the conclusions of the Core Planning Case assessment. These scenarios and the general approach to considering them in this assessment are described in **Section 5.4** of **Chapter 5** Approach to the Assessment **[TR020001/APP/5.01]**.

9.9.9 **Table 9.28** provides a qualitative assessment of any likely changes to the conclusions of the assessment reported in this chapter, in the event that that scenario or risk is realised.

Table 9.28: Qualitative Sensitivity Analysis

Sensitivity scenario	Potential impact and change	Likely effect
19 mppa Application	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant

Sensitivity scenario	Potential impact and change	Likely effect
Faster growth	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant
Slower growth	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant
Next generation aircraft	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant
J10 without National Highways Smart Motorway upgrade (hard shoulder running scheme)	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant
Changes to airspace	Not likely to impact the resilience of the Proposed Development to climate change or ICCIs or change assessment outcome.	No change to effect and to remain not significant

9.10 Additional mitigation

9.10.1 For both the CCR and ICCI assessments, no mitigation measures during construction and operational phase, in addition to those identified in **Section 0** are proposed, as no likely significant effects during construction or operation have been identified.

9.11 Residual effects

Construction effects

9.11.1 No additional construction phase mitigation is required with respect to the CCR assessment. As such the effects would be as reported in **Section 0**.

9.11.2 No additional mitigation with respect to construction ICCI effects is required. As such the effects would be as reported in **Section 0.**

Operational effects

9.11.3 No additional operational phase mitigation is required with respect to the CCR assessment. As such the effects would be as reported in **Section 0.**

9.11.4 No additional mitigation is required with respect to operational ICCI effects. As such the effects would be as reported in **Section 0.**

9.12 Monitoring

Construction monitoring

CCR

9.12.1 As outlined in the CoCP (**Appendix 4.2** of this ES **[TR020001/APP/5.02]**), the lead contractors' EMS would consider all measures deemed necessary and appropriate to manage severe weather events and should, as a minimum, cover training of personnel and prevention and monitoring arrangements.

Operational monitoring

CCR

9.12.2 When the Proposed Development becomes operational, dedicated personnel within the airport operator's organisation would be responsible for reporting and monitoring of the operational measures and risks. The Operator would also need to consider the Proposed Development assets within the next adaptation reporting cycle under the Adaptation Reporting Power as described in **Table 9.1**.

9.12.3 All assets would be maintained regularly to detect deterioration and damage caused by extreme weather events such as storms through maintenance and monitoring in contracts.

9.12.4 Landscape planting would take into consideration climate change in the selection of appropriate woodland tree and shrub species and provide adequate monitoring post-planting and, if necessary, replacement.

9.12.5 A list of extreme weather-related incidents (for example, road surface deformations from extreme heat, storms, snow and ice etc.) would be maintained to assist in identifying thresholds which, when exceeded, require maintenance.

9.13 Assessment summary

9.13.1 **Table 9.29** and **Table 9.30** provide a summary of the identified construction phase and operational phase impacts, mitigation and likely effects of climate change on the Proposed Development.

9.13.2 **Table 9.31** provides a summary of the identified ICCI impacts, mitigation and likely effects on the external receptors.

Table 9.29: CCR assessment summary: construction phase (2020-2049)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring	Climate change impact	Embedded/good practice mitigation measures	Likelihood of climate change impact occurring	Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)
Materials and equipment required for the construction of all built assets, structures, staff facilities	Extreme weather events (such as storms)	Occasional	Damage to materials and construction equipment resulting in delays to construction programme and associated costs and/or unacceptable safety risks, as well as high winds increasing dust (and other construction debris).	A high-level risk assessment of severe weather impacts on the construction process will be produced by the lead contractor to inform mitigations. Any receptors and/or construction-related operations and activities potentially sensitive to severe weather events should be considered in the assessment. Climate change projections should be considered in the risk assessments. Use of construction materials with superior properties that offer increased tolerance to fluctuating temperatures, heavy precipitation and other extreme weather events such as storms, where practical. The lead contractors' EMS should consider all measures deemed necessary and appropriate to manage severe weather events and should as a minimum cover training of personnel and prevention and monitoring arrangements. As appropriate, construction method statements should also consider severe weather events where risks have been identified. The lead contractor will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures.	Improbable	Minor	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring	Climate change impact	Embedded/good practice mitigation measures	Likelihood of climate change impact occurring	Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)
Structures	Increased frequency and intensity of heavy precipitation	Occasional	Flooding may cause disruption to soil structures and increase rate of runoff.	The CoCP (**Appendix 4.2 [TR020001/APP/5.02]**) states that vulnerable aspects of earthworks will not be done during the Winter months. Requirements for consideration of climate change impacts on groundwater levels, soil moisture content and precipitation are included in the construction and design of earthworks and structures in-line with BS EN1997-1 (Ref. 9.68) and BS6031 Code of Practice for Earthworks (Ref. 9.69). Construction works will be carried out in accordance with the Outline SMP provided as **Appendix 6.6** of this ES **[TR020001/APP/5.02]**.	Remote	Minor	Moderate (Not significant)
Staff facilities	Extreme weather events (such as storms)	Occasional	Damage to staff facilities, resulting in delays to construction programme and associated costs and/or unacceptable safety risks, as well as high winds increasing dust (and other construction debris).	A high-level risk assessment of severe weather impacts on the construction process will be produced by the lead contractor to inform mitigations.	Improbable	Minor	Moderate (Not significant)
Access routes to construction sites	Increased frequency and intensity of heavy precipitation	Occasional	Viability of and access to construction sites (such as heavy rain resulting in	The lead contractor will use a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term	Remote	Minor	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring	Climate change impact	Embedded/good practice mitigation measures	Likelihood of climate change impact occurring	Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)
			surface water flooding of local roads, sources of power supply or inundation of construction sites).	programme management, environmental control and impact mitigation measures. The lead contractor will register with the EA's flood warning service in areas of flood risk. The lead contractors' EMS will consider all measures deemed necessary and appropriate to manage severe weather events and will register with the EA's flood warning service in areas of flood risk.			
Workers on construction sites	Increased average Summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Occasional	Increased heat stress/heat exhaustion for workers.	The CoCP (**Appendix 4.2 [TR020001/APP/5.02]**) states that lead contractor will consider climate change impacts to construction workers and will develop health and safety plans to prevent worker exhaustion due to heat. Supportive measures for working in high temperatures might include the provision of sunblock, sun hats and lightweight clothing, refreshment breaks and cooled water supply. Use of a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures. The lead contractor's EMS will consider all measures deemed necessary and appropriate to manage severe weather events and should as a minimum cover training of personnel and prevention and monitoring arrangements. As appropriate, construction method statements should	Improbable	Minor	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring	Climate change impact	Embedded/good practice mitigation measures	Likelihood of climate change impact occurring	Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)
				also consider severe weather events where risks have been identified. In addition, temporary buildings would be designed with measures to control summertime overheating. Construction works will be carried out in accordance with airport requirements of working airside e.g. airside construction works will be paused if there is low visibility or increased dust being blown across airfield.			
	More extreme cold weather events	Improbable	Possible negative health implications for workers on construction site.	The CoCP (**Appendix 4.2 [TR020001/APP/5.02]**) states that lead contractor will consider climate change impacts to construction workers and will develop health and safety plans. Use of a short to medium range weather forecasting service from the Met Office, or other approved meteorological data and weather forecast provider, to inform short to medium term programme management, environmental control and impact mitigation measures.	Improbable	Minor	Moderate (Not significant)

Table 9.30: CCR assessment summary: operation phase

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
Luton DART extension to the new terminal	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Damage to track due to flooding and water ingress to critical equipment, including traction power distribution sites, leading to signalling or other electronic equipment failures, requiring switch off or, possibly causing damage.	The proposed asset will be designed to EA's guidance on Flood risk assessments: climate change allowances (Ref. 9.70) and the principles of the Luton Local Transport Plan (Ref. 9.71). The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change. The proposed asset will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
	Increased average and Summer high temperatures and increasing	Frequent	Frequent	Rail buckling and/or associated misalignment problems. Increased heat stress for passengers and	All assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
	frequency of hot days and heatwaves			staff on trains, as well as outdoor maintenance workers.	Adequate HVAC systems provided on trains.					
	More extreme cold weather events	Improbable	Remote	Possible negative health implications for passengers and staff.	The Luton DART extension design includes as covered station (i.e. is protected from the elements) and the chosen system design has previous use cases in colder climates than the UK.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
	More extreme cold weather events	Improbable	Remote	Reliability of trains may reduce at low temperatures due to: failure of train horns due to ice/snow accretion; failure of sliding doors, couplers, pneumatic devices and reduced effectiveness of brakes due to ice/snow accretion; traction motor failures due to snow and/or water ingress, and damage from snow and/or ice accretions	The Luton DART extension design includes a covered station, and the chosen system design has previous use cases in colder climates than the UK.	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				dislodged at speed.						
	Extreme weather events (including storms)	Occasional	Occasional	Damage to assets and high wind speeds may create or distribute debris to track disrupting services.	Asset located within the tunnel.	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)
Additional taxiways and aircraft stands	Extreme weather events (including storms) and increased frequency and intensity of heavy precipitation	Occasional	Frequent	Potential to result in hazardous conditions for operation of vehicles and aircraft, slowing the system and causing delays. Increased intensity of wind events also has the potential to cause disruption to taxiway utilisation and schedules, resulting in flight delays. Risk of water damage affecting taxiways, underground foundations, structures or services.	Assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change. The CIRIA's SuDS Manual (C753) (Ref. 9.72) used for design of all SuDS assets and Sewers for Adoption for other drainage assets and the government projections for climate change allowance have been followed (Ref. 9.73).	Improbable	Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
	Increased temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Increased Summer temperature has the potential infrastructure damage to the tarmac and asphalt affecting the structural integrity of airfield structures and sub-surfaces such as runway and aprons.	Taxiway surfaces, based on design standards are intended to withstand far higher temperatures to be able to cope with aircraft braking. Use of construction materials (as far as practicable) with superior properties which offer increased tolerance to high temperatures.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	More extreme cold weather events and snow fall	Improbable	Remote	Increased risk of surfaces freezing	New de-icing facilities are incorporated into the Proposed Development. Regular maintenance of snow, de-icing and anti-icing equipment.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
Aircraft operations	Increased Summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Frequent	Frequent	Increased Summer temperature can increase the frequency of lightning strikes. Lightning striking the airport could result in an aircraft accident or loss of telecommunications. Increased temperatures have an	On-site rescue and firefighting service are the first-responders for any incident within the airport boundary. Sensitive telecoms equipment fitted with lightning protection as per latest design standards.	Improbable	Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				associated increased fire risk of combustible materials, especially if accompanied by period of drought or low precipitation.						
	Increased temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Maximum temperatures influence surface air density and thus lift produced affecting maximum take-off weight capacity. This can result in increase in occurrence of days outside the acceptable range of temperatures affecting aircraft and their utilisation schedule.	Measures relating to allowances in maximum take-off weight and maximum plane operating temperature are managed by standard flight operation procedures.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Increased temperatures and increasing frequency of hot days and heatwaves	Occasional	Frequent	Delays in re-fuelling procedures as result of flashpoint of aviation fuel exceeded on hot days.	On-site rescue and firefighting service are the first-responders for any incident within the airport boundary.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
	Extreme weather events (including storms)	Remote	Remote	Runway and/or facilities closure leading to aircrafts not permitted to land or take off, causing delays and flight disruptions.	New de-icing facilities are incorporated into the Proposed Development. Regular maintenance of snow, de-icing and anti-icing equipment.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	More extreme cold weather events and snowfall	Improbable	Improbable	Low temperatures will reduce the runway friction impacting take-off procedures as directed by the airline procedures. Increased pressure on critical de-icing equipment for aircraft resulting in reduced efficiency in operational procedures due to increased time to de-ice planes.	New de-icing facilities are incorporated into the Proposed Development. Regular maintenance of snow, de-icing and anti-icing equipment	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Extreme winds	Frequent	Frequent	High wind speeds or gusts impacting take off procedures.	During times of high winds airline operators will follow precautions due to strong wind operating procedures.	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)
	Fog	Remote	Remote	Poor visibility can reduce the capacity of an airport having	Low visibility procedures will be in operation to deal with periods of fog and cloud cover.	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				implications for take-off and landing operations.						
New terminal, and associated buildings, including airside facilities, and other supporting buildings such as, police station, hotels. logistics centre and technical.	Extreme weather events (including storms, high winds)	Occasional	Frequent	Potential damage to the building and structure fabric.	All new buildings and assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events could lead to flooding of assets and infrastructure.	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency of dry spells	Occasional	Frequent	Prolonged periods of dry spells could lead to drought and may reduce the potable water availability required for building operations.	Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). Rainwater harvesting from the roofs will allow greywater storage and re-use where practicable and appropriate.	Improbable	Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)
	More extreme	Remote	Remote	Reliability of journeys may	New de-icing facilities are incorporated into the	Improbable	Improbable	Minor	Moderate	Moderate

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
	cold weather events			reduce at low temperatures due to cracking of pavement surfaces and snow/ice accretion on aircraft and runways/airfield pavements causing delays.	Proposed Development. The new terminal building will utilise efficient building design, including electric reverse heat pumps for heating and cooling supported with ground source heat pump technology; and storage of heat using water storage facilities. Terminal 2 buildings will be designed to at least 'BREEAM Excellent' standards, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' status' except where the building typology dictates that it is not practical.				(Not significant)	(Not significant)
End users such as staff and passengers	Increased average and Summer temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Impacts thermal comfort of staff and passengers on trains, in terminal buildings and aircraft on stands, can lead to overheating from increased	Adequate HVAC systems provided. Terminal 2 buildings will be designed to at least 'BREEAM Excellent' standard, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				Summer temperature.	with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' status' except where the building typology dictates that it is not practical.					
Cargo and catering facility	Extreme weather events (including storms, high winds)	Occasional	Frequent	Potential damage to the building and structure fabric.	All assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events could lead to flooding of the logistics centre and technical service buildings and the ancillary infrastructure.	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
Highway network improvements, car parking facilities, bus, coach and taxi facilities and airside roads	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Damage to roads and car parks because of flooding and cause disruption to users.	All surface access assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs. The Drainage Design Statement (**Appendix 20.4**	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
					of this ES **[TR020001/APP/5.02])** accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.					
	Extreme weather events (including storms)	Occasional	Frequent	Damage to assets and high wind speeds may create or distribute debris to these areas and cause disruption to users.	Where applicable, the highway design of the Proposed Development has been developed to the standards set within the DMRB. Shaded areas across surface access areas will be included in the design e.g., the car park, bus stops.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
	Increased Summer temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Increased risk of thermal expansion and movement of paved surfaces, and material deterioration and cause disruption to users.	Use of construction materials with superior properties which offer increased tolerance to high temperature. Shaded areas across surface access areas will be included in the design e.g., the car park, bus stops. Suitable drainage to maintain dry foundation, and better slopes to drain surface water and prevent ponding.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
					Modification to the asphalt mix design to accommodate deformation in hotter weather under slow moving heavy aircraft. Smaller bays or thicker slabs will be considered to accommodate additional thermal stresses due to hot temperatures. Dowel bars and edge thickening will be considered to accommodate additional wrapping stress due to hot temperatures. Appropriate transition details for asphalt/concrete interface will be considered to accommodate larger movements. Reduction of the subgrade design strength to account for higher water table and moisture contents.					
Drainage and pollution control assets (sewage and effluent treatment plants)	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events could lead to flooding and could exacerbate acute and chronic impacts on foul, non-potable and	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) reports that the proposed drainage design can accommodate surface water flows during 1 in 100 years storm event, accounting for an increase	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				surface water infrastructure.	in precipitation of 40% due to climate change. Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). These include reduction of demand and foul water discharge, reduction in use of potable water in applications where non-potable water can be used, use of water efficient appliances and equipment within the terminals. CIRIA's SuDS Manual (C753) (Ref. 9. 74) will be used for design of all SuDS assets and Water UK's Sewers for Adoption design guide for other drainage assets. Government projections for climate change allowance have been followed (Ref. 9.75). The requirements for consideration of climate change impacts on groundwater levels, soil moisture content and precipitation are included in the construction and					

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
					design of earthworks and structures in-line with BS EN1997-1 (Ref. 9.76) and BS6031 Code of Practice for Earthworks (Ref. 9. 77).					
Fuel farm	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events can exacerbate acute and chronic impacts on fuel and transfer assets due to an increase of flood risk.	The proposed asset will be designed for the climatic conditions experienced at the end of their operational life cycle, using appropriate design guidance. The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Increasing Summer temperatures, increased humidity and increasing frequency of hot days and heatwaves	Frequent	Frequent	Increase in fire risk during hot days, and increased risk in damage to fuel operations due to lightning strikes.	On-site rescue and firefighting service are the first-responders for any incident within the airport boundary.	Improbable	Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)
Flood attenuation and storage infrastructure i.e. water	Increased frequency and intensity of heavy	Occasional	Frequent	Flood water management infrastructure can be stressed by exacerbation	Consideration of climate change in all drainage infrastructure and flood retention infrastructure are stated in the Drainage	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
infiltration (soakaway) and attenuation tanks, fire, water and energy storage assets.	precipitation			of flood events under future climates.	Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**). The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.					
On site electrical facilities and utilities corridors.	Extreme weather events (including storms), increased frequency and intensity of heavy precipitation, increased Summer temperatures and number of hot days	Occasional	Frequent	Potential to damage the over and underground electricity network either through direct contact (for example, flooding or wind damage), or through damage to structures or buildings supporting this network (for example, heat buckling of HV cables, subsidence). Multiple events over a short timescale are likely to have	Design does not include any overhead lines or cables. Design of buried services will include flexible conduits at least where we are building over the landfill where some degree of settlement is expected. New underground utilities are not laid at shallow depths to avoid damage due to temperature extremes during excavations. Energy centre and new sub-stations will be above the ground level and in enclosed structures which will offer protection from high winds.	Extremely Improbable	Extremely Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				the greatest impact as these will inhibit any maintenance activities.	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.					
	Increasing average and Summer temperatures	Occasional	Frequent	Sensitive electronic equipment and mechanical operating mechanisms may fail to operate correctly due to high temperatures.	Above ground installations will be in enclosed structures which will provide the opportunity for climate/temperature control.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
De-icing storage facility	Extreme weather events (including storms)	Occasional	Frequent	Extreme weather, such as storms and high winds have the potential to cause damage to the building and structure fabric.	All assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events could lead to flooding of the storage facility.	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) accommodates for surface water flows during 1 in 100 years storm event, accounting for an increase	Improbable	Improbable	Major	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
					in precipitation of 40% due to climate change.					
Public open space, amenities and landscaping	Extreme weather events (including storms)	Occasional	Frequent	Potential to damage the open space and habitats if planting is not resilient to climate change.	Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species for planting and habitat creation e.g. drought tolerant species and provide adequate monitoring post-planting as presented in the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Potential to damage the open space and habitats if planting is not resilient to climate change.	SuDS and permeable surfacing suitable for extreme rainfall events.	Remote	Remote	Minor	Moderate (Not significant)	Moderate (Not significant)
	Increased frequency of dry spells	Occasional	Frequent	Potential to damage the open space and habitats if planting is not resilient to climate change.	Landscape planting will select species that are resistant to warm and dry weather e.g. drought tolerant species. Water efficiencies are built into the Proposed Development through the design and principles set out in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02])**. Rainwater harvesting from	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
					the roofs will allow greywater storage and re-use where practicable and appropriate. SuDS and permeable surfacing suitable for drought events					
	Increasing average and Summer temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Potential to damage the open space and habitats if planting is not resilient to climate change.	Shading (of public spaces and buildings) suitable for extreme hot events in the future. Landscape planting will select species that are resistant to warm and dry weather e.g. drought tolerant species. Maintenance of connectivity for enabling migration of species under increased temperatures.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
Energy centre	Extreme weather events (including storms)	Occasional	Frequent	Damage and disruption to power supply to airport.	Asset will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available or adaptive capacity will be built into the designs.	Improbable	Improbable	Hazardous	Moderate (Not significant)	Moderate (Not significant)
Fire training ground	Extreme weather events (including storms)	Occasional	Frequent	Extreme weather, such as storms and high winds have the potential to cause damage	Assets will either be designed for the climatic conditions projected for the end of their design life, using appropriate design guidance where available	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
				to the building and structure fabric.	or adaptive capacity will be built into the designs.					
	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Extreme precipitation events could lead to flooding of the facility and damage to training equipment.	The drainage proposals described in the Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) can accommodate for surface water flows during 1 in 100 years storm event, accounting for an increase in precipitation of 40% due to climate change.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
Landform and earthworks	Increased frequency and intensity of heavy precipitation	Occasional	Frequent	Water scour causing structural damage and landslides.	Suitable drainage to maintain dry foundation, and better slopes to drain surface water and prevent ponding.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
Operational workers	Increasing average and Summer temperatures and increasing frequency of hot days and heatwaves	Frequent	Frequent	Increased heat stress and impacts on thermal comfort of staff in terminal buildings, aircraft on stands, well as outdoor workers can lead to overheating from increased Summer temperature.	Adequate HVAC systems provided. Shaded areas across surface access areas will be included in the design e.g., car parks, bus stops to mitigate impacts of future extreme heat events.	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)
	More extreme cold	Remote	Remote	Health risk to staff extreme cold weather.	Terminal 2 buildings will be designed to at least BREEAM 'Excellent'	Improbable	Improbable	Minor	Moderate (Not significant)	Moderate (Not significant)

Proposed Development asset(s) (receptor)	Climate change hazard	Likelihood of climate change hazard occurring		Climate change impact	Embedded/ good practice mitigation measures	Likelihood of climate change impact occurring		Severity (Consequence)	Description of effect and significance (including embedded and good practice mitigation)	
		2040 - 2069	2070 - 2099			2040 - 2069	2070 - 2099		2040 - 2069	2070 - 2099
	weather events				Status, or equivalent at the time of detailed design, to be energy efficient with appropriate installations and equipment together with thermally efficient materials and shading. Other new buildings will be designed to 'BREEAM Excellent' status' except where the building typology dictates that it is not practical. Shaded areas across surface access areas will be included in the design e.g., car parks, bus stops to mitigate impacts of future extreme cold events.					

Table 9.31: ICCI assessment summary

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
Agricultural and land use (**Chapter 6 [TR020001/APP/5.01]**)	Increase in Winter precipitation rate	Frequent	Soil resources of high sensitivity (low resilience) are at risk of structural damage if handled when too wet, particularly during the late Autumn and Winter.	Increase of Winter participation will put soil resources with low resilience are at risk of structural damage if handled in too wet conditions. This will be mitigated by the sustainable use of soil resources on site and maintenance as described in the Outline SMP (**Appendix 6.6** of this ES **[TR020001/APP/5.02]**).	Remote	Low	Minor (Not significant)
Air quality **(Chapter 7 [TR020001/APP/5.01])**	Increased number of hot days; increase of droughts	Remote	Increased dust production during construction due to extended dry spells.	During the construction phase, extended dry spells may cause increased dust production. This consequence would be minimised as far as reasonably practicable, through the measures required by the CoCP (**Appendix 4.2 [TR020001/APP/5.02]**) (e.g. reduce dust emissions through the effective transportation and storage of materials), including the proposed monitoring regime.	Improbable	Very low	Negligible (Not significant)
	Increased number of hot days	Frequent	Sunnier and drier / drought conditions could change concentrations of certain air pollutants such as NO_x, $PM_{2.5}$ PM_{10} and ozone (O_3).	It is unlikely that sunnier and drier/drought conditions will exacerbate concentrations of NOx, $PM_{2.5}$ and PM_{10} because aircraft engines and ground transportation, such as cars, are expected to be cleaner in the future. This is because aircraft engines will comply with emission standards set by the Committee on Aviation Environmental Protection	Remote	Very low	Negligible (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				(CAEP) and there will be improvements in road vehicle technology and changes in fleet composition with higher proportion of low emission vehicles, as predicted by Defra. O_3 is likely to increase and consequently affect NO_2 concentrations. O_3 is a trans-boundary pollutant which is formed in the atmosphere from reactions involving other pollutants. It is not directly emitted from processes that can be regulated, therefore there are limited mitigation measures available to the Applicant in relation to O_3. The change in surface O_3 concentrations is likely to be small in comparison to the important precursor pollutants to O_3 formation (NOx, methane, and non-methane volatile organic compounds).			
	Increased number of hot days	Frequent	Sunnier/hotter conditions could increase aircraft emissions due to the steeper climb angles taken.	It is unlikely that conditions will exacerbate emissions because aircraft engines are expected to be cleaner in the future.	Remote	Very low	Negligible (Not significant)
	Changes to wind speed	Remote	Changes in wind speed and direction could influence local pollutant levels.	There is considerable uncertainty in projections for changes in wind speed and wind direction, and studies show statistically insignificant variation in wind speed. Monitoring measures are already in place. If there is increased channelling due to changes in wind direction this would	Improbable	Very low	Negligible (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				increase annual average levels at some receptors and decrease them at others. However, Defra predicts that background concentrations are likely to decrease.			
Biodiversity **(Chapter 8 [TR020001/APP/5.01])**	Increase in mean annual air temperature	Frequent	Degradation of ecosystem services and reduced food availability.	The proposed habitat creation/enhancement has been designed to link existing habitats and provide a larger expanse of biodiverse semi-natural habitat. This will provide a variety of fauna with a varied and increased food source, that will help boost their resilience to the impacts of future temperature change. Further details of how these habitats will be created and managed can be found within the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).	Remote	Very low	Negligible (Not significant)
	Decrease in annual precipitation rate	Frequent	Further impacts to retained sensitive habitats and reduced success of new planting	The Drainage Design Statement (**Appendix 20.4** of this ES **[TR020001/APP/5.02]**) would ensure that there is no significant change to water availability within retained habitats and has accounted for future climate changes, including reduced water availability. Resilience of landscaping to climate change would be ensured by the habitat creation/enhancement requirements provided within the ES to ensure that climate change is taken into consideration in the choice of species and adequate	Remote	Very low	Negligible (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				monitoring post-planting occurs in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02**).			
	Increased number and frequency of hot days; increase of droughts	Frequent	Reduced success of establishment of new planting due to hotter drier conditions	Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species planting and habitat creation e.g. drought tolerant species and adequate monitoring post-planting occurs in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).	Remote	Very low	Negligible (Not significant)
	Increased frequency and intensity of heavy precipitation	Frequent	Reduced success of establishment of new planting due to wetter conditions	Landscape planting will take into consideration climate change in the selection of appropriate woodland tree and shrub species planting and habitat creation and adequate monitoring post-planting occurs in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).	Remote	Very low	Negligible (Not significant)
GHG (**Chapter 12 [TR020001/APP/5.01]**)	Increased Summer air temperatures	Frequent	Increased energy required for cooling in buildings. Increased ambient temperatures with lowers air density and requires higher fuel consumption to increase thrust.	Possible increases of GHG emissions would be mitigated through measures within the Outline Greenhouse Gas Action Plan (**Appendix 12.1** of this ES **[TR020001/APP/5.02]**)	Remote	Very low	Negligible (Not significant)
	Extreme weather events (including high winds)	Frequent	Stronger winds and changing wind patterns might lead to modifications of flight lengths and routings, resulting in increase in the fuel consumption.	Possible increases of GHG emissions will be mitigated through measures within the Outline Greenhouse Gas Action Plan (**Appendix 12.1** of this ES **[TR020001/APP/5.02]**).	Remote	Very low	Negligible (Not significant)
Health and community (**Chapter 13**	Increased occurrence of high	Frequent	Potential increase in heat risk for vulnerable members of population due to partial loss	The replacement open space will provide a greater area of open green space, but it will	Improbable	Low	Negligible (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
[TR020001/APP/5.01])	Summer temperatures, humidity and heatwaves		of Wigmore Valley Park, and the consequent decrease in shade provision and cooling effect from the existing mature trees and vegetation.	take time for the new trees and planting to mature and provide comparable levels of shade and cooling to the existing area of open space.			
Landscape and visual (**Chapter 14 [TR020001/APP/5.01]**)	Increased occurrence of heatwaves and droughts	Frequent	Reduction in the growth rates of plant material	Landscape species to be selected and maintained in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**) and the detail specification for the soil growing medium to be in accordance with the Outline SMP (**Appendix 6.6** of this ES **[TR020001/APP/5.02]).**	Remote	Low	Minor (Not significant)
		Frequent	Increase to the likelihood of plant failure.	Planting areas to be regularly monitored and maintained in accordance with the Outline LBMP (**Appendix 8.2** of this ES **[TR020001/APP/5.02]**).	Remote	Low	Minor (Not significant)
Noise and vibration (**Chapter 16 [TR020001/APP/5.01]**)	Increase in occurrence of heatwaves	Frequent	Potential to exacerbate noise effects on communities in terms of individual dwellings and on a wider community, due to windows being open more often due to an increase in high temperatures.	The noise assessment criteria (**Chapter 16 [TR020001/APP/5.01]**) assume windows are open when internal noise levels are considered. Consequently, there is no further impact on noise effects arising from the ICCI. However, the effectiveness of noise insulation could be reduced, and noise insulation packages may need to provide a greater emphasis on ventilation.	Remote	Very Low	Negligible (Not significant)
	Increase in mean temperature and humidity	Frequent	Increases in temperature and humidity of the air reducing the atmospheric attenuation of noise.	Over distances of a few hundred metres, atmospheric effects can be ignored for sound with low frequency prominence, such as aircraft	Remote	Very Low	Negligible (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				noise. Consequently, increases in temperature and humidity is unlikely to affect ground-based noise sources such as ground noise, construction noise and surface access noise. Due to the longer distances that aircraft noise travels, the effect of increases in temperature and humidity can affect aircraft noise levels. However, the change in atmospheric absorption will only have a significant effect on high frequencies. Given the prominence of low frequencies in aircraft noise, it is expected that changes in noise will not result in additional impacts.			
Soils and geology **(Chapter 17 [TR020001/APP/5.01])**	Decreased Summer precipitation; increased Summer temperatures	Frequent	Dry exposed Made Ground and landfill waste could lead to increased production of dusts and airborne contamination soils.	The consequence of this ICCI is minimised as far as reasonably practicable using good construction practice measures set out in the CoCP (**Appendix 4.2** of this ES **[TR020001/APP/5.02])** for example, dampening down of dusts particularly where material is stockpiled.	Remote	Low	Minor (Not significant)
		Frequent	Differential settlement of ground caused by decreases in moisture content can be sufficient to damage property, roads, and infrastructure.	The design of the Proposed Development takes into account ground conditions, and how this may be affected by future climate change. Mitigation such as surcharging/ground improvement techniques, flexible pavements and modified service connections.	Remote	Low	Minor (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
		Frequent	Creation of gas pathways due to drying/cracking of soils and capping layer caused by decreases in moisture content.	Gas management measures detailed in **Section 17.8** would prevent gas migration into the buildings on site. The perimeter gas protection measures would prevent gas migration off-site.	Remote	Very low	Negligible (Not Significant)
	Increase in maximum/mean Summer air temperature	Frequent	Increase in soil temperature due to hotter conditions. Increased soil temperatures may increase rate emission of volatile contaminants and gases in soils.	Gas management measures detailed in **Section 17.8** would prevent gas migration into the buildings on site. The perimeter gas protection measures would prevent gas migration off-site.	Remote	Very low	Negligible (Not significant)
		Frequent	Decrease in heavy metal mobility due to hotter conditions. Heavy metals are less likely to be leached in drier condition, leading to increased persistence in soils.	Hardstanding/engineered landscaping and the proposed capping means there is unlikely to be any direct contact with underlying soils.	Remote	Very low	Negligible (Not significant)
	Increase in Winter precipitation rate	Frequent	Changing precipitation patterns, increased flood risk could lead to increased soil erosion.	Mitigation measures used during construction to prevent erosion such as compaction of soils, phased excavation, use of temporary capping and geotextile layers. During operational period the design includes hardstanding and an engineered cover system for hardstanding and soft landscapes which makes soil erosion unlikely.	Remote	Very Low	Negligible (Not significant)
Water resources and flood risk (**Chapter 20 [TR020001/APP/5.01]**)	Increase in mean annual air temperature Increase in mean Summer air temperature	Frequent	Increase in air temperature potentially affecting groundwater recharge and availability for abstraction	Though increased air temperatures have the potential to effect groundwater recharge and availability, overall impacts are likely to be minor compared with the annual seasonal variations and the increased variability anticipated in rainfall.	Remote	Low	Minor (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				A Water Cycle Strategy (**Appendix 20.5** of the ES **[TR020001/APP/5.02]**) has been prepared to inform the ES to assess how potential water use associated with the Proposed Development would affect water resources and infrastructure considering potential impacts of climate change. The Drainage Design Statement (**Appendix 20.4** of the ES **[TR020001/APP/5.02])** includes a description of measures to minimise water use and maximum water reuse. The use of such measures has been considered in the Water Cycle Strategy (**Appendix 20.5** of the ES **[TR020001/APP/5.02]**) prepared to inform the ES.			
	Increase in mean Winter air temperature Increase in minimum air temperature	Frequent	Less snow and ice, potentially resulting in increased surface water runoff in Winter periods	The design has been developed to accommodate the volume and rate of water generated by a 1 in 100-year return period storm event, including a 40% uplift to allow for potential increases in rainfall due to climate change.	Remote	Very low	Negligible (Not significant)
	Decrease in annual precipitation rate Decrease in Summer precipitation rate	Frequent	Changing precipitation patterns and water shortage (potentially drought and indirect impacts on local water supply and aquifer recharge)	A Water Cycle Strategy (**Appendix 20.5** of the ES **[TR020001/APP/5.02]**) has been prepared to inform the ES to assess how potential water use associated with the Proposed Development would affect water resources and infrastructure considering	Remote	Low	Minor (Not significant)

Discipline	Climate hazard	Likelihood of climate hazard occurring	Likely ICCIs identified	**Description of ICCI considering** embedded environmental measures/good practice	Likelihood of ICCI occurring	Consequence	Significance of ICCI effects
				potential impacts of climate change. The Drainage Design Statement (**Appendix 20.4** of the ES **[TR020001/APP/5.02])** includes a description of measures to minimise water use and maximum water reuse. The use of such measures have been considered in the Water Cycle Strategy (**Appendix 20.5** of the ES **[TR020001/APP/5.02]**) prepared to inform the ES.			
	Increase in annual specific humidity Increase in Summer specific humidity Increase in Winter specific humidity	Frequent	Increase in heavier precipitation events and risk of flooding and impact on leachate generation	The design has been developed to accommodate the volume and rate of water generated by a 1 in 100-year return period storm event, including a 40% uplift to allow for potential increases in rainfall due to climate change. A decrease in annual precipitation would lead to a reduction in leachate generation. However, the increased intensity of rainfall events may cause the generation of large quantities of leachate. A capping layer including drainage management systems will be in place across the extent of the historic landfill affected by the Proposed Development to ensure that infiltration would not interact with the waste to reduce the potential for leachate generation.	Remote	Very low	Negligible (Not significant)

COMPETENT EXPERTS

Topic	Role	Company	Qualifications/competencies/experience of author
Climate Change	Author	AECOM	MSc International Marketing Management with Sustainability, BSc Economics, MIEMA, CEnv, 8 years' experience working in the sustainability sector.
Climate Change	Author	AECOM	MSc Carbon Management, MA(Hons) Geography, MIEMA, CEnv, 6 years' experience working in the field of climate change and sustainability.
Climate Change	Checker	Arup	MSc Climate Change, BSc (Hons) Geography, 16 years of experience working in the field of climate change impacts, adaptation and resilience.
Climate change	Technical Review	AECOM	BA Hons Environmental Studies, MIEMA, CEnv, 20 years' experience on climate change assessment.

GLOSSARY AND ABBREVIATIONS

Term	Definition
ANPS	Airports National Policy Statement
ACRP	Airport Cooperatives Research Programme
CAA	Civil Aviation Authority
CBC	Central Bedfordshire Council
CCC	Committee on Climate Change
CCR	Climate Change Resilience
CCRA	Climate Change Risk Assessment
CIRIA	Construction Industry Research and Information Association
DBC	Dacorum Borough Council
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EIA	Environmental Impact Assessment
EQS	Environmental Quality Standards
ES	Environmental Statement
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organisation
ICCI	In-combination Climate Change Impacts
IEMA	Institute of Environmental Management and Assessment
LBC	Luton Borough Council
LLAOL	London Luton Airport Operations Limited
LBMP	Landscape and Biodiversity Management Plan
MBU	Beyond the Horizon: Making best use of existing runways
NHDC	North Hertfordshire District Council
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
PEIR	Preliminary Environmental Information Report
PPCE	Probabilistic Projections of Climate Extremes
RCP	Representative Concentration Pathway
SuDS	Sustainable Drainage Systems
UKCP18	UK Climate Projections 2018

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