Whitestown Way LRD, Tallaght - Climate Risk and Vulnerability Assessment

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AWN Consulting Ltd, The Tecpro Building, IDA Business & Technology Park, Clonshaugh, Dublin 17, D17 XD90

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Details	Written by	Approved by
Signature	Mobin.	SBerry
Name	Mobin Ud Din	Sarah Berry
Title	Senior Climate Consultant	Principal Climate Consultant
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EXECUTIVE SUMMARY

This report presents a semi-quantitative climate risk and vulnerability assessment for a Large-scale Residential Development at Whitestown Way, Tallaght, Dublin 24. The assessment methodology aligns with national and international best practice, including EU Technical guidance on the climate proofing of infrastructure in the period 2021-2027[1].

The analysis uses the latest EPA Climate Ireland CMIP5 projections at a 1.5 km² resolution, providing site-specific future climate scenarios and a tailored assessment of potential impacts on plant operations.

The results of the assessment, along with recommendations to enhance climate resilience, are detailed in Sections 5 and 6. A summary of key findings is provided below.

Climate Risk

The results of the initial Climate Screening (Section 5) highlighted extreme temperatures, extreme wind and flooding as priority vulnerabilities. These hazards were taken forward for detailed analysis and evaluated to determine a future risk rating for all relevant hazards in relation to the Proposed Development across two climate scenarios (RCP4.5 and RCP8.5) (Representative Concentration Pathways, see Section 2.1 for more detail) for mid-century (2041-2070) and late century (2071-2100) conditions, as set out in Table 1 below:

Table 1: Future risk rating of climate hazards across the medium and long term modelled at RCP4.5 and RCP8.5

Description of physical hazard	Baseline Baseline Risk Rating	Chosen Climate Scenario	Medium Term Risk	Long Term Risk	Future Risk Rating Note1
Extreme Heat	Medium	RCP4.5	Medium	High	High
		RCP8.5	High	High	
Extreme Cold	Medium	RCP4.5	Medium	Low	Low
		RCP8.5	Medium	Extremely low	
Flooding (pluvial & fluvial)	Medium	RCP4.5	Medium	Medium	High
		RCP8.5	Medium	High	
Extreme Wind	Medium	RCP4.5	Medium	Medium	High
		RCP8.5	Medium	High	
Note 1 The Future Risk Rating takes the maximum rating across medium and long-term scenarios. Full results tables are presented in Section 6.					

The assessment identified extreme heat, flooding (fluvial and pluvial flooding), and extreme wind as the most significant climate risks to the Proposed Development. Extreme cold was not a significant risk in the long term and has been omitted from Table 2 for the purposes of this summary. Table 2 provides a high-

[1] European Commissions (2021) EU Technical guidance on the climate proofing of infrastructure in the period 2021-2027

level summary of the top risks to the Proposed Development and the recommended adaptation measures to mitigate residual impacts and enhance resilience.

Table 2 Key climate risks and highlighted adaptation opportunities.

Climate hazard	Risk Description	Adaptation Measures
Extreme heat	▶ **Health, Safety & Wellbeing:** Increased frequency and intensity of extreme heat events may result in overheating and thermal discomfort within buildings, particularly affecting Creche users and other sensitive receptors, with potential adverse implications for occupant health, wellbeing and internal environmental quality. ▶ **Communal Gardens:** Prolonged periods of high temperatures and drought may lead to vegetation stress, reduced soil moisture and loss of planting vitality, alongside overheating of hard surfaces, reducing comfort, usability and amenity value and contributing to urban heat island effects. ▶ **Critical Systems:** High ambient temperatures may adversely affect the efficiency, reliability and lifespan of building services and electrical systems, increasing the risk of overheating, reduced performance or premature equipment failure, if not designed for future climate conditions.	**Health, Safety & Wellbeing:** An overheating assessment has been undertaken by the M&E consultant, with openable windows for purge ventilation. **Communal gardens:** Communal areas incorporate tree canopy cover, light-coloured paving, native and drought-tolerant planting, woodland edge planting and SuDS features to reduce heat absorption, support evaporative cooling and maintain amenity. **Drainage**: The watermains will be well below the surface to avoid fluctuations to temperature as per Uisce Eireann Code of Practice. **Critical Systems:** The proposed heat pump is well built to operate in the increased temperature scenarios.
Flooding (pluvial and fluvial)	▶ **Drainage:** Intense rainfall events may surcharge drainage systems, increasing the risk of exceedance and localised pluvial flooding where system capacity is exceeded. ▶ **Roads:** The main access road, located within Flood Zones A and B, is susceptible to fluvial and pluvial flooding, with increased impermeable area potentially exacerbating surface water accumulation if insufficiently mitigated. ▶ **Communal Gardens**: Flooding may cause soil erosion, nutrient leaching, contamination and damage to landscape features, reducing ecological value and the functionality of open spaces if unmanaged.	**Drainage:** Surface water runoff is attenuated to greenfield runoff rates (Qbar) via a detention basin designed for the 1-in-100-year storm event with a 20% climate change allowance, in accordance with the GDSDS. **Buildings and Structure:** All buildings are located within Flood Zone C, with finished floor levels set a minimum of 300 mm above the 1-in-1,000-year flood level, providing appropriate flood resilience. **Roads:** Overland exceedance flow routes are incorporated along development roads to safely convey flows during events exceeding design capacity. Development within Flood Zones A and B is limited to "Less Vulnerable" uses, with alternative pedestrian, cyclist and emergency access provided during temporary flooding of the primary access.

Climate hazard	Risk Description	Adaptation Measures
		Communal Gardens: A site-wide SuDS strategy, including swales, permeable paving and green roofs, manages surface water quantity and quality, with discharge restricted to greenfield rates.
Extreme wind	► **Buildings & Structure:** Intensified storm events may cause damage to buildings and building elements, particularly from wind loading and flying debris, with implications for structural integrity and durability. ► **Communal Gardens:** Strong winds may reduce comfort and usability of outdoor spaces and increase the risk of damage to landscape features, presenting potential safety risks to residents and garden users.	**Buildings & Structure:** Buildings and foundations are designed in accordance with the relevant Eurocodes and National Annexes to safely transfer wind loads to the ground and ensure structural stability. Robust materials, fixings and detailing are specified to reduce susceptibility to wind damage and flying debris. **Communal Gardens:** Landscape design incorporates tree and woodland planting as windbreaks, with structured planting layouts creating sheltered microclimates within communal spaces. All trees will be securely staked until established to minimise wind throw risk during storm events.

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1. INTRODUCTION

1.1 Outline of requirements

This Climate Risk and Vulnerability Assessment (CRVA) has been prepared by AWN Consulting on behalf of Ardstone for a Large-scale Residential Development at Whitestown Way, Tallaght, Dublin 24 (hereafter referred to as the 'Project' or 'Proposed Development'). This report assesses the risk of the effects future climate change hazards may have on the Proposed Development.

This CRVA investigates the vulnerability of the proposed design to physical climate change hazards. The assessment will identify hazards and analyse climate resilience while commenting on recommendations for adaptation. The assessment supports the long-term resilience of the proposed design.

1.2 Proposed Development and Site description

The Proposed Development is located at Whitestown Way, Tallaght, Dublin 24. The 1.32 ha site is bound to the east by Whitestown Way; to the south by Riverside Business Park; to the west by Whitestown Road /Whitestown Industrial Estate and the Vita Actives premises; and to the north by Whitestown Road, the Vita Actives premises and undeveloped land.

The Proposed Development will consist of the construction of a mixed-use development in 2 No. blocks (Block A & Block B) and including 169 No. residential units s (80 No. 1-bed and 89 No. 2-bed); 2 No. commercial units (totalling 356.5 sq m); and a crèche (164.6 sq m) with external play area.

The development also comprises: junction with Whitestown Way and new street at the site's southern side; 78 No. car parking space, with 63 No. within the undercroft car parking area and 15 No. on-street; 1 No. set-down bay; cycle parking; hard and soft landscaping, including public open space, communal amenity space and incidental spaces; private amenity spaces (as balconies and terraces facing all directions); boundary treatments; sub-station; plant/operational rooms; bin stores; public lighting; green roofs; rooftop plant, PV arrays, lift overruns, telecommunications infrastructure and automatic opening vents; and all associated works above and below ground.

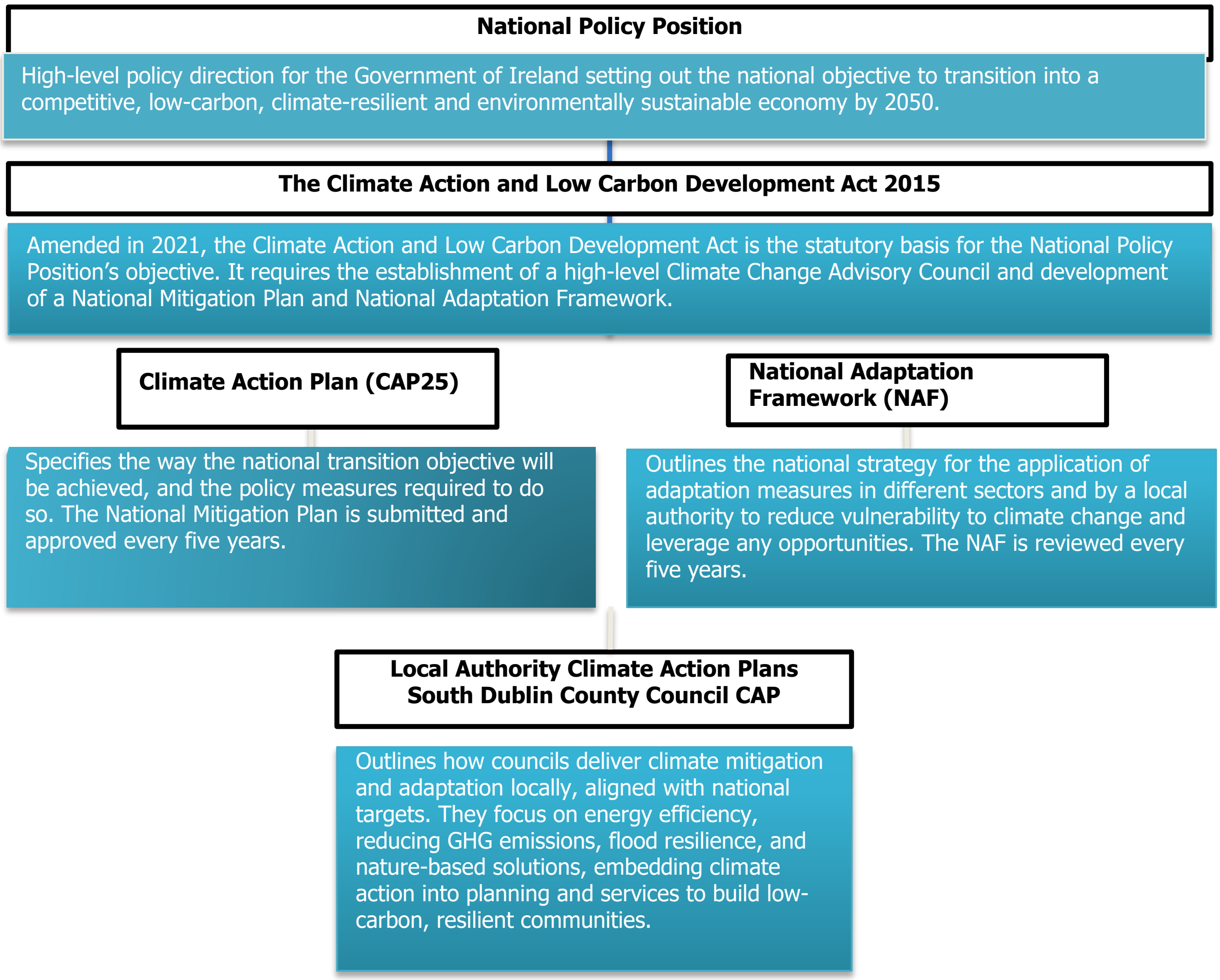
The topography of the site generally falls from southwest to northeast. Site levels range from between 95.5m and 98m. A localised depression was observed in the northeast corner of the site. As can be seen in Figure 1.1 the area surrounding the site is urban fabric with a public open space to the East. Whitestown Stream (also called Tallaght Stream) runs 60m to the South of the development.

Figure 1.1: Satellite Image of the site

1.3 Policy and Legislative Context

This section provides an overview of the statutory requirements for CRVA's in Ireland, summaries of national and regional contexts and an overview of relevant strategy and policy guiding the risk assessment and its purpose.

Figure 1.2: Statutory context for climate change adaptation in Ireland.



1.3.1 National climate policy and regulation

1.3.1.1 Climate Action and Low Carbon Development Act[2]

The Climate Action and Low Carbon Development Act 2015, as amended (hereafter referred to as 'the 2015 Act') set Ireland's National Transition Objective: to achieve a low-carbon, climate-resilient, and environmentally sustainable economy by 2050. It required the development of a National Mitigation Plan and a National Adaptation Framework and established the Climate Change Advisory Council to advise on these plans and ensure compliance with climate obligations. The act can be seen as Irelands primary legislation an umbrella under which climate risk assessment, action, and future legislative and policy arrangements are built under.

Section 15 of the 2015 Act places a duty on public bodies to perform their functions in line with:

- The most recent Climate Action Plan (CAP): Document setting out climate action for Ireland.
- The national long-term climate strategy

[2] Government of Ireland (2015) Climate Action and Low Carbon Development Act 2015, as amended (the 2015 Act)

- The National Adaptation Framework and sectoral adaptation plans
- The national climate objective
- Goals for reducing greenhouse gas emissions and adapting to climate impacts.

This means consenting authorities (e.g., An Coimisiún Pleanála, local councils) must ensure developments align with adaptation frameworks and consider future climate risks.

1.3.1.2 Climate Action Plans – (CAP25)

Ireland declared a climate and biodiversity emergency in May 2019, and the EU followed with a similar resolution in November 2019, the Government introduced the Climate Action and Low Carbon Development (Amendment) Act 2021 (hereafter referred to as 'the 2021 Act'). The 2021 Act was signed into law on 23 July 2021; it gave statutory effect to the objectives of the first Climate Action Plan.

The 2021 Act commits Ireland to a climate-resilient, biodiversity-rich, and climate-neutral economy by 2050, introduces carbon budgets, and sets sectoral decarbonisation targets. A carbon budget is defined as the total greenhouse gas emissions permitted within a given period.

In April 2025, the latest Climate Action Plan (CAP25) was published. Building on CAP24, it operationalises carbon budgets and sectoral ceilings to achieve a 50% reduction in carbon emissions by 2050 while also directing reform of planning to further drive a sustainable transition economy in key areas of renewables, EV, transport and buildings.

Ireland's annual Climate Action Plans are cornerstones for directing policy and legislation at the actionable upstream level and the measures laid out by these plans, alongside international frameworks such as COP agreements, EU Fit for 55, and the EU Taxonomy, aim to keep emissions on a trajectory that mitigates severe climate impacts while also considering adaptation for climate resilience.

1.3.1.3 National Adaptation Framework

The National Adaptation Framework (NAF), first established in 2018 and updated in June 2024 under the Climate Action and Low Carbon Development Act 2015, sets Ireland's strategy for building a climate-resilient, biodiversity-rich society. It works alongside the Climate Action Plan to guide national and local responses to climate risks such as extreme weather, flooding, drought, biodiversity loss, sea-level rise, and rising temperatures. The Second *National Adaptation Framework* (NAF) (Government of Ireland, 2024c), published in June 2024, outlines a comprehensive, whole-of-government and whole-of-society approach to climate adaptation. Its core objective is to enhance Ireland's resilience to a wide range of climate risks, including extreme weather events, flooding, drought, biodiversity loss, sea level rise, and rising temperatures.

Building on the principles of a "Just Transition", the NAF introduces the concept of "Just Resilience", envisioning a climate-resilient Ireland that ensures fairness, equity, and inclusivity in adaptation planning and implementation. It promotes reduced reliance on fossil fuels, the expansion of electrified and accessible public transport, and the integration of sustainability and climate resilience across all sectors. These include energy, water, wastewater, agriculture, transport, health, built environment, and biodiversity, with a strong emphasis on mainstreaming adaptation practices into policy, planning, and operations.

1.3.1.4 National Climate Change Risk Assessment[3]

The National Climate Change Risk Assessment (NCCRA) is a comprehensive suite of reporting and technical guidance documents developed by the Environmental Protection Agency (EPA) of Ireland, spanning 2024

[3] EPA (2025) National Climate Change Risk Assessment Main Report

and 2025, with the main report published in June 2025. It can serve as the foundational framework for climate risk assessment, adaptation planning, and implementation across Irish society, and aligns with international best practices, ISO standards, and IPCC methodologies. This assessment has selected to follow EU Technical Guidance methodology as an alternative (see Section 2.1.4).

1.3.2 Local Policy and Action

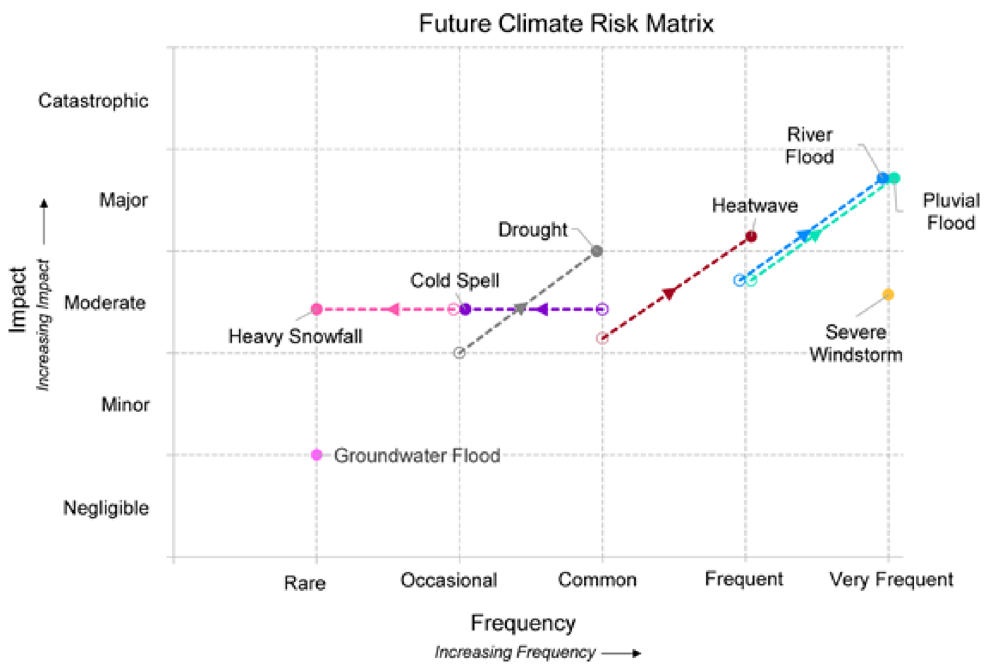
1.3.2.1 South Dublin County Council's Climate Change Risk Assessment[4]

A County Council Climate Change Risk Assessment (CCRA) was carried out by KPMG for South Dublin County Council. The assessment identified severe windstorms, river flooding and pluvial flooding as posing the highest levels of risk for South Dublin in the current period.

Current projections indicate that the level of risk associated with some climate hazards will increase, some will decrease, and for others the level of risk will remain the same. The risk matrix in Figure 1.3 below is taken from KPMG's CCRA and shows the future change in risk with the hollow marker showing the current risk and the solid marker the future risk. The dotted line shows the change between the current and future risk. The report highlights:

- River (fluvial) and pluvial flooding are projected to increase due to increased precipitation and areas and assets exposed to these hazards;
- Heatwaves and droughts are expected to occur more frequently with the impact exacerbated by increased vulnerable populations (65 years+);
- Windstorms are not expected to increase however they will remain a risk; and
- Snowfall and cold spells will still occur at the same intensity but less frequently.

Figure 1.3 Future Climate Risk Matrix



[4] SDCC (2024) South Dublin County Council's Climate Change Risk Assessment

1.3.2.2 South Dublin County Development Plan 2022- 2028[5]

The Development Plan lists Climate Resilience as one of its five themes (Biodiversity, Sustainable Water Management, Climate Resilience, Recreation and Amenity, Landscape, Natural, Cultural and Built Heritage). It sets eight objectives regarding climate resilience including:

- Enhance biodiversity and ecosystems to absorb floodwater, buffer extreme weather, sequester carbon and filter pollution;
- Water course protection to reduce flood risk;
- Compliance with tree strategies to increase canopy cover and recognise mature trees for carbon sequestration over saplings;
- Require qualifying developments to meet a minimum Green Space Factor score, ensuring green surfaces, planting, SuDS features and biodiversity supporting elements;
- Promote soil protection to support water absorption and carbon storage;
- Increase native Irish species of flora;
- Require green roofs and walls in apartment, commercial, leisure and educational buildings where possible;
- Complete flood risk assessment to restore and protect biodiversity, ecosystems and drainage systems.

[5] SDCC (2022) South Dublin County Council Development Plan 2022-2028

2. METHODOLOGY

This CRVA is designed to align with international and national guidance and best practice for climate risk assessment and to integrate key national and international approaches, such as those from the following guidance documents:

- EU Technical Guidance on The Climate Proofing of Infrastructure in the Period 2021-2027[6]
- Transport Infrastructure Ireland (TII) PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document[7]
- Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation[8]
- Risk Assessments International Standards Organisation (ISO): ISO 14091:2021 Adaptation to climate change – Vulnerability, impacts and risk assessment[9]
- National Climate Change Risk Assessment: Technical Guidance for Sectoral Risk Assessments[10]
- UK Green Building Council: Measuring and Reporting Physical Risk[11]

Although the PE-ENV-01104 is national guidance for roads and rail projects, it is applicable to other infrastructure projects as it sets out a robust methodology for climate change risk assessments, based on the EU Technical Guidance set out above. Further, it is Irish guidance and therefore addresses climate hazards relevant to Ireland.

A full glossary of terms used in this assessment can be found in Appendix A.

2.1 Climate Risk and Vulnerability Assessment Approach

The following steps outline the approach for the assessment.

2.1.1 Step 1- Review of the site and Dublin's historical baseline climate & initial screening of climate hazards.

- **Initial climate hazard screening** (Section 3): High level qualitative assessment is undertaken to screen out any hazards which are not relevant to the Proposed Development for example coastal flooding is only relevant if the Proposed Development is in close proximity to the coast. The selected list of climate hazards is taken from TII's guidance document PE-ENV-01104.

- **Baseline Climatology Analysis (Section 4.1):** Review of observed weather data taken from Dublin Airport for the period 1991-2020 and records of extreme weather events. This baseline data is derived from the ECMWF ECMWF[12] ERA5 data reanalysis and includes observational data from meteorological weather stations across Ireland from 1950-2023. This data is processed and bias corrected to provide a complete monthly and annual baseline climatology for County Dublin. This method has been chosen to ensure data can be analysed at the daily and monthly level to provide a robust depiction of weather variation across the year.

[6] European Commission (2021) Technical Guidance on climate proofing of infrastructure in the period 2021-2027. CIPR - EC Technical Guidance on Climate Proofing of Infrastructure
[7] Transport Infrastructure Ireland (TII) (2022) PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document.
[8] ISEP (2020) Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation
[9] ISO (2021) ISO 14091:2021 Adaptation to climate change – Vulnerability, impacts and risk assessment.
[10] EPA (2024) Technical Guidance for Sectoral Risk Assessments. EPA_NCCRA_Sectoral_Technical_Guidance_FINAL_2024_10_02.docx
[11] UKGBC (2022) A Framework for Measuring and Reporting of Climate-related Physical Risks to Built Assets.
[12] European Centre for Medium-Range Weather Forecasts (ECMWF) (2023) ERA5 Fifth Generation Atmospheric Reanalysis: Copernicus Climate Change Service - Complete ERA5 global atmospheric reanalysis.

2.1.2 Step 2 - An analysis of future climate projections

- **Future Climatology Analysis** (Section 4.2): this assessment will provide a site-specific analysis of future climate change using the latest EPA Climate Ireland 'Translate' projections[13] using the latest CIMP5[14] climate data modelling. Two climate scenarios will be assessed (RCP4.5[15] and RCP8.5). The 1.5km^2 resolution of the climate projections allow for a site-specific analysis of future climate change projections.

Aligning with best practice and national guidance this assessment will review two-time periods 'Epochs'; the 2050s (2041-2070) and 2100s (2071-2100). There is limited variance between RCPs scenarios and current climate conditions before the 2040 period and any existing development or new developments or alterations to the Project are likely to have lifespans which fit within the extended range. Using both a medium and long-term analysis across both epochs allows for a better understanding of future climate change hazards, potential impacts, and implementation of appropriate mitigation measures to accommodate climate change.

Aligned with international best practice and the NCCRA, two contrasting climate change scenarios 'RCPs' have been selected for this assessment:

- **RCP4.5** is a medium emissions scenario where radiative forcing reaches about 4.5 W/m² by 2100. It assumes moderate mitigation efforts, with emissions peaking mid-century and then declining. This pathway is projected to limit global warming to roughly 2.4–3 °C by 2100.
- **RCP8.5**, in contrast, is a high greenhouse gas concentration scenario often considered a "business-as-usual" or worst-case pathway, leading to radiative forcing of about 8.5 W/m² by 2100 and significantly higher projected global warming.

2.1.3 Step 3 - Climate Screening

- **Sensitivity Analysis** (Section 5.1) This assessment determines which climate hazards are relevant to the Proposed Development, irrespective of its location. Asset categories specific to the Proposed Development are selected and reviewed against individual climate hazards. To undertake the sensitivity analysis, a sensitivity score should be given for each asset category against each climate hazard. The following definitions should be used when assessing sensitivity:

  - **High Sensitivity:** The climate hazard will or is likely to have a major impact on the asset category.
  - **Medium Sensitivity:** It is possible or likely the climate hazard will have a moderate impact on the asset category.
  - **Low Sensitivity:** It is possible the climate hazard will have a low or negligible impact on the asset category.

  The sensitivity is scored on a scale of 3 (high), 2 (medium) or 1 (low).

- **Exposure Analysis** (Section 5.2): This section focuses on the Proposed Development's exposure to current climate hazards. The following definitions should be used when assessing exposure:

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[13] EPA (2025) Climate Ireland: Future climate change Projections. Available at: [EPA Climate Ireland | Climate Change Projection Maps]

[14] Coupled Model Inter-comparison Projects (CMIPs), overseen by the [World Climate Research Program]. Data presented is CIMP5, derived from the fifth phase of the CMIPs. The CMIPs form the data foundation of the IPCC Assessment Reports.

[15] RCP (Representation Concentration Pathways): Representation Concentration Pathways (RCPs) are greenhouse gas concentration trajectories developed by the IPCC for climate modelling and scenario analysis.

- **High Exposure:** It is almost certain or likely this climate hazard will occur at the project location i.e. might arise once to several times per year.
- **Medium Exposure:** It is possible this climate hazard will occur at the project location i.e. might arise a number of times in a decade.
- **Low Exposure:** It is unlikely or rare this climate hazard will occur at the project location i.e. might arise a number of times in a generation or in a lifetime.

The sensitivity is scored on a scale of 3 (high), 2 (medium) or 1 (low).

► **Vulnerability Analysis (Section 5.3):** In accordance with best practice described in the EU Technical Guidance, a vulnerability analysis is then undertaken and combines the outcomes of the sensitivity and exposure analysis, with the aim to identify the key vulnerabilities and the potentially significant climate hazards associated with the project.

Vulnerability= Sensitivity X Exposure

The results of the Vulnerability Analysis will determine the priority hazards to be assessed within the detailed CRVA.

Vulnerability is assessed using the matrix in Figure 2.1 below:

Figure 2.1 Vulnerability Matrix

		Exposure		
		Low (1)	Medium (2)	High (3)
Sensitivity	Low (1)	1	2	3
	Medium (2)	2	4	6
	High (3)	3	6	9

2.1.4 Step 4 – Detailed Climate Risk and Vulnerability Assessment

A detailed Climate Risk and Vulnerability Assessment will then be carried out on any risks which are deemed medium or high from the results of the Vulnerability Assessment. In accordance with the EPA National Climate Change Risk Assessment (2025), the assessment will, at a minimum, consider temperature-related, wind-related and water-related climate hazards, recognising these as the principal drivers of physical climate risk across the receiving environment.[16]. The risk assessment uses the UKGBC template[17] as it provides a clear structure but the nomenclature has been adapted to align with the TII's PE-ENV-01104. This is to ensure continuity across all sections of this report. Risks to the built asset will be described in detail and the level of risk across the baseline, medium term and long term will be quantified across RCP4.5 and RCP8.5 scenarios. An overall future risk rating will then be calculated, highlighting climate hazards which require adaptation measures to be considered.

2.1.5 Step 5 – Adaptation

This report will then provide recommendations for design and operations to improve adaptation and embed climate resilience across the Proposed Development. These adaptation measures are considered opportunities for resilience and should not be taken as direct design or operational changes instructed without due diligence but rather, further considerations to support climate resilience and risk mitigation.

[16] EPA (2024) Technical Guidance for Sectoral Risk Assessments. EPA_NCCRA_Sectoral_Technical_Guidance_FINAL_2024_10_02.docx

[17] UKGBC (2022) A Framework for Measuring and Reporting of Climate-related Physical Risks to Built Assets.

3. INITIAL CLIMATE HAZARD SCREENING

Table 3.1 sets out a qualitative assessment of climate hazards relevant to the Proposed Development. This high-level screening ensures focus is given to relevant climate hazards throughout the remainder of the assessment. Rationale is only provided for hazards which have been screened out, detailed analysis of screened in hazards can be found in Section 6. The initial climate hazard list is taken from TII PE-ENV-01104.

Table 3.1 Physical climate hazards screening

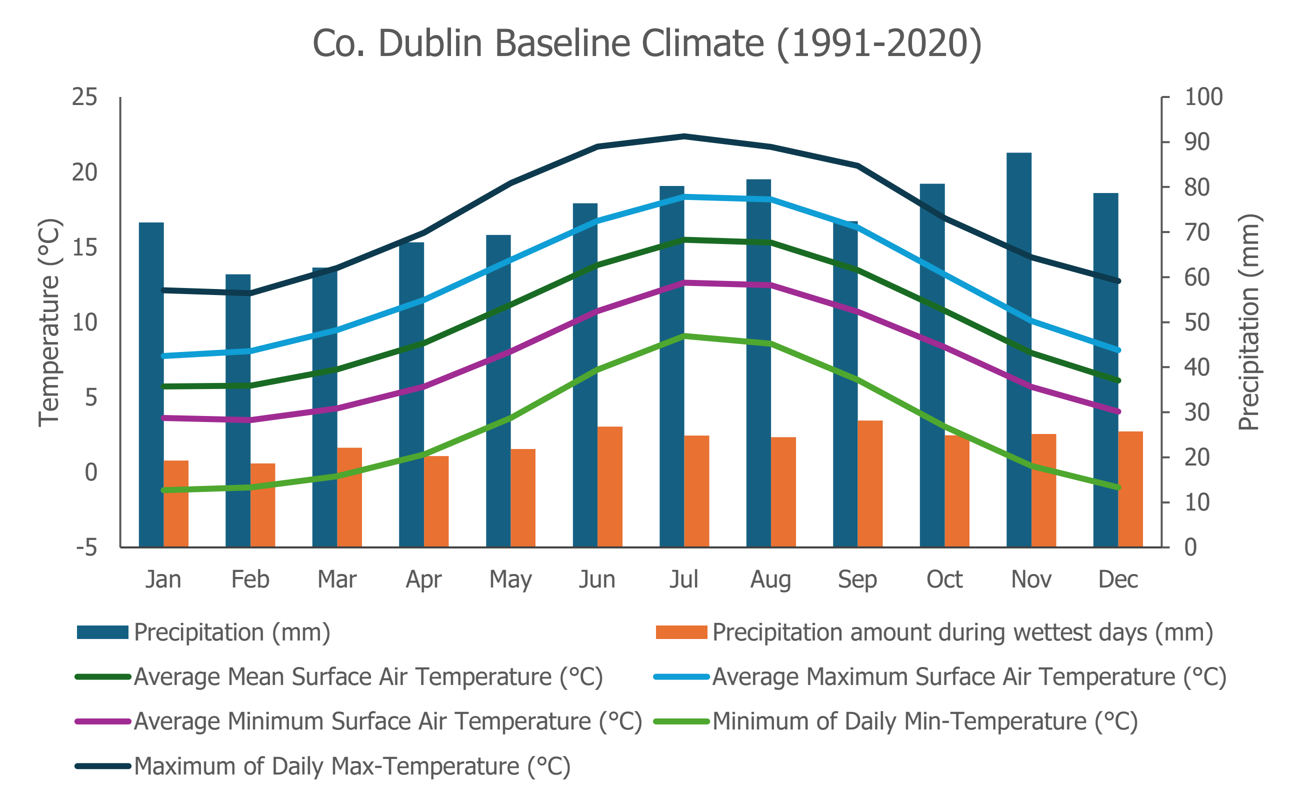
Climate-related Hazard	Screening	Screen out rationale
Extreme heat (including extreme heat events and increasing temperatures overtime)	Screen in	
Extreme cold (including frost and snow)	Screen in	
Flooding (pluvial)	Screen in	
Flooding (fluvial)	Screen in	
Flooding (coastal)	Screen out	Proposed Development approximately 12km from the coast.
Drought	Screen out	Drought is more likely to occur in the future but it is not considered a fundamental issue for the operation of a residential development.
Wildfire	Screen out	The area surrounding the Proposed Development is largely developed and in close proximity to urban centres.
Extreme wind	Screen in	
Fog	Screen out	Fog is not considered a significant hazard for the Proposed Development, as it does not involve transport, aviation, or activities requiring high visibility.
Lightning and hail	Screen out	Proposed Development not at an elevated location and is surrounded by other tall buildings.
Landslides	Screen out	Geological Society of Ireland (GSI) landslide susceptibility mapping database categorized location as low for landslide susceptibility.

4. CLIMATE CONTEXT

4.1 Baseline Climatology

The baseline climate data (Figure 4.1) is taken from a historical observation across Dublin from 1991 – 2020. A summary of notable events that have impacted the area around the site and surrounding region is provided in Table 4.1 with further detailed provided.

Figure 4.1 Monthly average climatology across the observed baseline period (1991-2020)



4.1.1 Temperature

July and August are the warmest months with average mean temperatures of 15°C and maximum mean daily temperatures above 21°C. There has been an increasing trend in maximum and mean temperatures across Ireland and Dublin during the observed baseline period, with the top twenty hottest days occurring in the last twenty years from 2003-2023.

The maximum daily air temperature was recorded in July 2022 reaching 33°C, which coincided with the 2022 heatwave and Ireland's hottest year on record.[18] There have been three notable high temperature events that have impacted Dublin across the observed baseline period, including a Yellow High Temperature warning issued by Met Éireann for July 2022 and a heatwave event in August 2022 and August 2025.[19] Moreover, July 2025 was the warmest month of 2025 and the hottest July since 2021 (which had a mean temperature of 16.83 °C).[20]

[18] Met Éireann (2022) 2022: Provisionally Ireland's Warmest Year on Record - Met Éireann - The Irish Meteorological Service
[19] RTE New (2025) High temperature warning issued for Ireland tomorrow
[20] Met Éireann (2025) Climate Statement for July 2025 - Met Éireann - The Irish Meteorological Service

January and February are the coldest months with mean temperatures of 7.8°C and 8.1°C respectively. The minimum mean daily temperatures have been -1°C in each of the aforementioned months. The annual average number of frost days (days <0°C) across the baseline are 36 days with several years having notable cold spells and low temperature with snow recorded across the observed baseline period most notable in 2018 during the 'Beast from the East'.

4.1.2 Precipitation

The Dublin region receives a lower-than-average volume of rainfall annually across the baseline (average ~800mm) when compared with other regions in Ireland. November is the wettest month on average with 87.6mm of rainfall across the baseline (Figure 4.1). The remaining months are also notably high with average precipitation ranging from 80mm in July to 82mm in August. Large winter rainfall often coincides with large low pressure Atlantic systems moving eastwards over the Irish coast across the winter period.

Across the baseline February is the driest month with 61mm and spring (March-May) the driest season with monthly averages ranging from 62-69mm (Figure 4.1). Summer (June-August), while it has the warmest months, is also markedly wet with monthly average precipitation ranging from 76-82mm. These high averages also correspond with high daily averages received during the summer months ranging from 25-27mm.

4.1.3 Wind and Storms

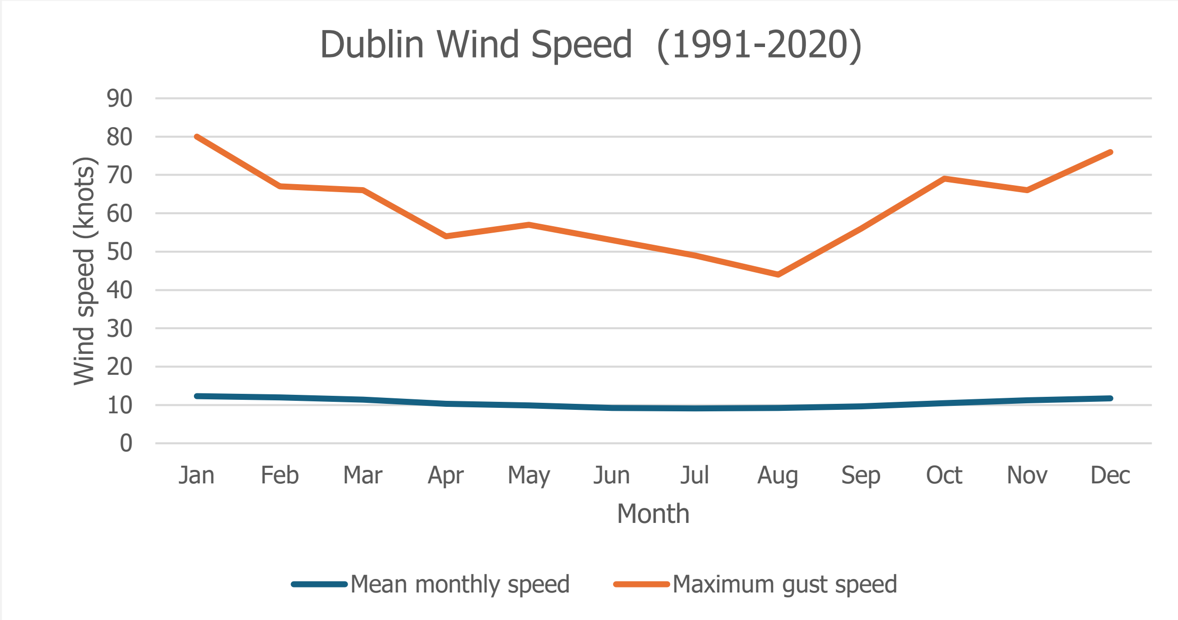
Winter is markedly the windiest season (Figure 4.2), with an average monthly wind speed of 12 knots (22 km/hr). January is the windiest month with an average wind speed of 12.3 knots (22.8 km/hr). During the winter and late autumn season (November-February) increases in average windspeed coincide with increased likelihood of storms aligning with historical records of storm activity across the North Atlantic and Irish Coast.

Across the observed baseline the maximum daily gust speeds across the 90th percentile is 39 knots (72km/hr), with the highest ever recorded daily gust was 80 knots (148 km/hr). This was recorded in January 2007 and coincided with the Cyclone Kyrill[21].

There have been seven notable storm and high wind events that have occurred during the observed baseline period including Storm Isha (21st January 2024) and Storm Ophelia (16th October 2017) during which Red Wind Warnings[22] were issued by Met Éireann.

[21] Met Éireann (2018) Violent storm Eleanor.
[22] Issued when widespread mean speeds exceed 80km/hr and widespread gusts exceed 130km/hr.

Figure 4.2 Mean Monthly Windspeed across the observed baseline taken from Dublin Airport[23]



4.1.4 Historical Events (1991-present)

Since 1991, Dublin and the proposed site area have been exposed to several significant hazards most notably storms which have combined high winds and large volumes of precipitation leading to flooding. Most recently, extreme temperatures are occurring increasing the risk of water scarcity as referenced in Ireland's *National Climate Change Risk Assessment* (2025)[24].

Table 4.1 Notable Historical Climate Events[25]

Year	Hazard type	Period	Description
2018	Cold Snap and Storms *('Beast from the East' & Storm Emma)*	Early 2018 (Feb-March)	Severe cold snap with significant snowfall and freezing temperatures
2018	Drought	Summer 2018	Dry summer in the region led to water scarcity across reservoirs[26]
2018	Heatwave	May – July	Extended periods of temperatures exceeding 25°C and maximum of 32°C recorded in
2022	Heatwave	July	The highest temperature ever recorded in Dublin was 33°C. The heatwave lasted 5-6 days. [27]

[23] Met Éireann (2025) Dublin Airport – 30-year averages (1991-2020)
[24] EPA (2025) National Climate Change Risk Assessment. Available at: EPA Climate Ireland | National Climate Change Risk Assessment
[25] World Bank Climate Data (2025) Historical Events Record. Available at: IrelandIRL - Historical Natural Disasters | Climate Change Knowledge Portal
[26] O'Halloran, T et al. (2023) 'Compound climate events in Ireland: The Beast from the East and the summer drought of 2018', *Weather*, 78(1), pp. 2–8. Available at: https://rmets.onlinelibrary.wiley.com/doi/am-pdf/10.1002/wea.4586.
[27] Met Éireann (2022) - Annual Climate Statement for 2022 - Met Éireann - The Irish Meteorological Service

Year	Hazard type	Period	Description
2025	Storm Éowyn	January	Large violent storm which significantly impacted all of Ireland including Dublin. Red weather warnings were issued across several regions in Ireland and Orange for the Dublin region[28].

4.2 Future Climate Change

This chapter begins the analysis and review of future climate projections identified as 'Step 2' and detailed under the methodology (See Section 2.1.2).

Ireland is already experiencing increased annual rainfall in the north and west, with more variable patterns in the south and east including the area of the Proposed Development. Key risks identified by the EPA relevant to Ireland include:

- Increased likelihood of more frequent and intense North Atlantic low-pressure systems bringing high rainfall and high winds.
- More intense rainfall periods which may lead to pluvial flooding and elevated fluvial levels.
- Longer dry spells and increased temperatures, increasing the risk to operations and workers and drought while reducing the likelihood of cold and ice.

4.2.1 Climate Change Projections and Approach taken

International best practice and national policy such as the IPCC[29], NCCRA[30], and Transport Infrastructure Ireland[31] recommends using two emission scenarios to project future climate change. This includes a medium emission and high emission scenarios (RCP4.5 and RCP8.5) for future planning. This climate change assessment uses the latest climate change projections standardised and bias corrected for Ireland available through the EPA and the TRANSLATE project[32]. The approach followed for this assessment is further explained in Section 2.1.2 of the Methodology.

4.2.2 Data Caveats and Uncertainty Across Projections:

This assessment uses the latest Ireland CIMP5 climate projections downscaled and bias corrected for Ireland. Providing site specific projections within a 1.5km^2. Whilst there is clear evidence indicating rising temperatures, changes to precipitation and flood risk, there is uncertainty regarding the pace of change due to both the implementation of greenhouse gas emission reduction targets and the response of the climate system.

This uncertainty is reduced by assessing future climate change under two future climate change pathways (scenarios) as has been the approach of this assessment. However, it is important to recognise that projection data cannot be taken as an exact representation of the future and rather should be interpreted as an indication of trends in the area.

[28] Irish Time (2024) Storm Éowyn Dublin update: Extensive damage in the capital as shops, transport and services begin to return – The Irish Times
[29] Intergovernmental Panel on Climate Change (IPCC) (2023) 6th Synthesis report. Available at: AR6 Synthesis Report: Climate Change 2023 — IPCC
[30] EPA (2024) NCCRA, Technical Guidance on Sectorial Risk Assessment: EPA Climate Ireland | Sectoral adaptation guidance
[31] Transport Infrastructure Ireland (TII) (2022) PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document.
[32] Environmental Protection Agency (2025) Climate Ireland Data Explorer. O'Brien, E. and Nolan, P., 2023. TRANSLATE: standardized climate projections for Ireland.

4.2.3 Temperature (Hot and Cold) and extremes

	Annual and monthly mean temperatures are projected to increase although lengthy heat-waves remain unlikely, hot spells lasting several days to over a week are likely with the number of summer days (>25°C) increasing by almost 4 days (+210%) across the century. Temperature extremes are projected to increase in RCP4.5 compared to the baseline suggesting hotter summers.
	Annual mean and daily minimum temperatures are projected to increase across both RCPs throughout the century. The number of frost days per year is projected to decrease 45% under RCP4.5 by mid-century. Suggesting more mild winters and less exposure to significant cold snaps.

For the Proposed Development, overall temperatures are projected to increase across the century compared to the baseline period (1976-2005). Average annual mean temperatures are projected to increase 1.1°C and 1.6°C by mid-century under RCP4.5 and RCP8.5 respectively. By late century (2070-2100) temperature increases under RCP4.5 stabilise however under RCP8.5 these increase significantly (+2.8°C) compared to the baseline (See Table 4.2).

The greatest increase in temperature across the year is projected for the summer months which could experience 1.4°C and 1.6°C increase on the baseline under RCP4.5 and RCP8.5 respectively by mid-century (2041-2070).

The average maximum temperatures in the long term (2071-2100) is projected to increase by 2.2°C and 4.1°C under RCP4.5 and RCP8.5 respectively. This increase compared to the baseline shows that the Proposed Development could be under stress of high temperatures.

Table 4.2 Complete annual temperature variables for RCP4.5 & RCP8.5 scenarios up to 2100 compared to the Baseline

Variable	Baseline	RCP4.5		RCP8.5	
	1976-2005	2041-2070	2071-2100	2041-2070	2071-2100
Mean Values (°C)					
Mean Temperature	9.6	10.7	11.1	11.2	12.4
Mean Maximum	13.2	14.3	14.7	14.8	15.9
Mean Minimum	6	7.2	7.6	7.6	8.9
Daily Extremes (°C)					
Daily Maximum	25.2	27.2	27.4	27.8	29.3
90^{th} Percentile Extreme[33]	-	27.9	28.2	28.6	30.3
Daily Minimum	-5.6	-3.5	-2.9	-3.1	-1.6
10^{th} Percentile Extreme	-	-4.5	-3.7	-4.0	-2.9
Occurrence (Annually)					
No. of Heatwaves[34]	-	0.08	0.08	0.2	0.5
No. Summer Days[35]	2	6	7	8	17

[33] The 90^{th} and 10^{th} percentile ranges represent the more extreme ranges of the projection but not anomalies. This ranges provide insight into less frequent events.
[34] Number of periods of more than 5 consecutive days with maximum temperature >25˚C.
[35] Number of days with maximum temperature >25°C.

Variable	Baseline	RCP4.5		RCP8.5	
	1976-2005	2041-2070	2071-2100	2041-2070	2071-2100
No. Frost Days [36]	36	20	15	15	6
No. Icing Days [37]	0.2	0.06	0.04	0.03	0.004

The warming projected across both scenarios can be reflected in the significant reduction in the number of frost days annually accounting for a 45% reduction under RCP4.5 and 59% reduction under RCP8.5 by mid-century. Additionally, the occurrence of severe cold snaps reflected in number of icing days (max daily temperatures <0°C) are projected to dramatically decrease suggesting more mild winter and less likelihood of snowfall or disruptive winter conditions.

4.2.4 Precipitation and Flooding

Annual mean rainfall is projected to increase by approximately 42 mm under both RCP scenarios by mid-century and beyond. While the number of rainfall days remains relatively unchanged, overall increases are driven by higher rainfall intensity and greater winter volumes. Maximum one-day rainfall is expected to rise by around 10 mm by 2050 under both RCPs, increasing the risk of pluvial flooding and pressure on drainage systems.

Projections indicate an overall increase in annual rainfall under both scenarios, primarily driven by higher winter totals and more intense short-duration events (1-day and 5-day volumes; see Table 4.3). Winter and autumn (October–February) remain the wettest periods, while summers may become notably drier.

By mid-century (2041–2070), the number of wet days is expected to marginally reduce compared to current patterns; however, rainfall intensity will increase. Days exceeding 20 mm and 30 mm become marginally more frequent under both scenarios, placing a relatively greater strain on stormwater drainage systems due to higher runoff volumes and flow rates. Without mitigation, these events increase the likelihood of pluvial flooding across the site. Therefore, different operational aspects of Proposed Development could be impacted by the flooding.

Table 4.3: Complete annual precipitation projection across both RCPs

Variable	Baseline	RCP4.5		RCP8.5	
	1976-2005	2041-2070	2071-2100	2041-2070	2071-2100
Precipitation (mm)					
Annual Precipitation	829	861	878	881	909
Max 1 Day	38	48	48	50	53
Max 5 Day	70	75	77	77	80
Occurrence (Annually)					
No. Wet Days[38]	153	150	151	150	148
No. Days ≥20mm	4	4	4	4	5
No. Very Wet Days (≥30mm)	1	1.5	1.5	1.6	1.8

[36] Number of days when minimum temperatures are <0°C.
[37] Number of days when maximum temperatures are <0°C.
[38] Number of days with daily precipitation amount ≥1 mm

4.2.5 Storms and high winds

	Mean 10m wind speeds are projected to decrease marginally. Maximum gust speeds are to remain consistent with historical data while more frequent Atlantic storm events may elevate exposure to such high winds. Summer wind speeds are projected to decrease on average but with more variability due to storm events.

There is a high degree of uncertainty associated with projections for wind speed due to the complex nature of underlying dynamics such as temperature, pressure and local topography that make it difficult to capture small-scale wind events. At the time of writing this assessment, wind projections for Ireland and from the EPA translate project - Climate Ireland - remain in development[39].

Climate Ireland and the EPA do identify several key points regarding projected future wind speed which this report has used in its analysis.

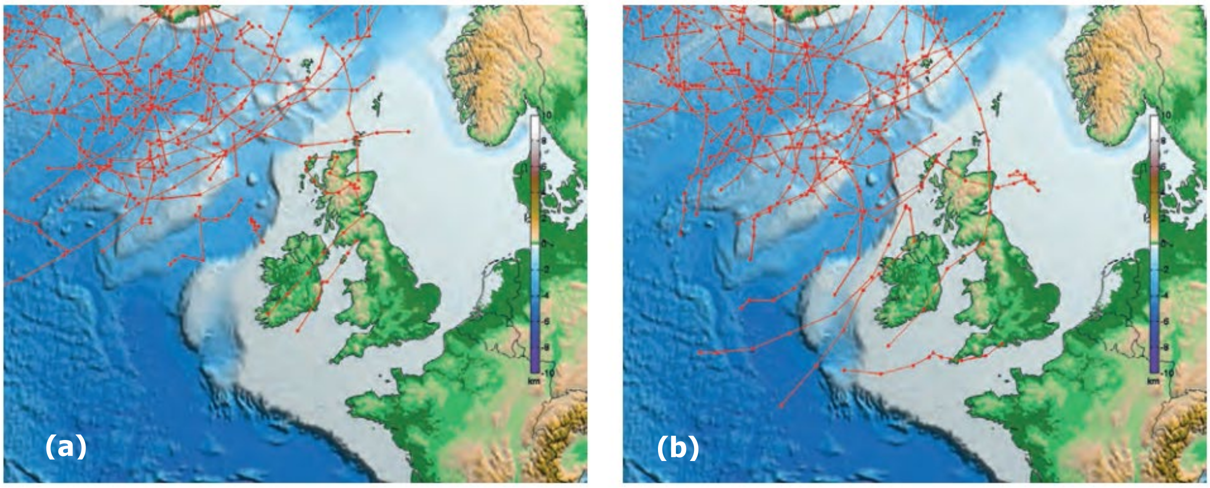
- Projections at a European scale suggest a reduction in mean wind speed over Ireland but an increase in variability.
- Clustering of windstorms will increase in many areas of Europe over coming decades.
- Projections indicate a decrease in the number of less intense storms for Ireland with an increase in more intense storms which are rare events. However, due to a limited number of studies, these projections should be considered with a high level of caution.[40]

Figure 4.3(a) below presents historical storm paths across Ireland from 1981-2000 while comparing to future projected storm tracks for 2041-2060 under RCP8.5 (Figure 4.3(b)).

There is a clear pattern of large low pressure storm systems extending further south over Ireland potentially impacting the Proposed Development in the future. Extreme storm events comparable to Storm Éowyn are identified to occur predominately over winter which aligns with the projected increases in mean winter wind speeds discussed above. Increases in sea surface temperature and wind patterns across the Atlantic may increase the intensity of such storms, increasing the likelihood of violent storms (≥100km/h) in the future however these are expected to remain rare events. On average Ireland experiences 8 named storms annually[41], an alteration of the storm tracks due to climate change will increase this number and ultimately lead to increased exposure to high winds and storm force gusts. Consequently, the Proposed Development could be subject to storm events and associated high wind conditions over its operational lifetime.

[39] Copernicus (2019) Copernicus Interactive Climate Atlas.
[40] Climate Ireland (2025) EPA Climate Ireland | Future Climate of Ireland
[41] Data from combined Met Éireann, UK Met Office and Dutch Meteorological services

Figure 4.3 Tracks of storms with a core mean sea level pressure of <940hPA and with a lifetime of at least 12 hours. (a) Past regional climate model (RCM) 18km simulations (1981-2000) and (b) RCP8.5 RCM 18km simulations (2041-2060). Source: Nolan (2015). [42]



4.3 Climate Change Projections Summary

Table 4.4: Climate projections summary table for medium emissions pathway RCP4.5

Climate Hazard	Indicator	Baseline (1976-2005)	RCP4.5 (2041-2070)	RCP4.5 (2071-2100)
Temperature	*Mean temp (°C)*	9.6	10.7 (+1.1)	11.1 (+1.5)
	Mean Max temp (°C)	13.2	14.3 (+1.1)	14.7 (+1.5)
	Mean Min temp (°C)	6.0	7.2 (+1.1)	7.6 (+1.6)
	Mean Daily Max temp (°C)	25.2	27.2 (+2.0)	27.4 (+2.2)
	Daily Max Temp 90th percentile (°C)	-	28.0	28.2
	Frost Days annually (no. of days)	36	20 (-16)	15 (-21)
Precipitation and Flooding	*Annual precipitation (mm)*	829	861 (+32)	878 (+49)
	Max 1-day (mm)	38	48 (+10)	48 (+10)
	No. Days >20mm	4	4	4
Storms and high winds	*Number of Storms Qualitative (Description)*	On Average 8 named storms annually with speeds exceeding 100km/hr (N.1)	Winter storm frequency is projected to increase, with a possible extension of the storm season. While the intensity of individual storms cannot be accurately projected, storm wind speeds are likely to remain above 100 km/hr.	
	Max Gust Speed 1991-2020 (Knots)	80 (N.2)		
Note-1: Data from combined Met Éireann, UK Met Office and Dutch Meteorological services.				
Note-2: Data from Dublin Airport approximately 19km from the site. Met Éireann Dataset (2025)				

Table 4.5 Climate projections summary table for high emissions pathway RCP8.5

Climate Hazard	Indicator	Baseline (1976-2005)	RCP8.5 (2041-2070)	RCP8.5 (2041-2070)
Temperature	*Mean temp (°C)*	9.6	11.2 (+1.6)	12.4 (+2.8)

[42] Nolan, P. (2015) Ensemble of regional climate model projections for Ireland.

Climate Hazard	Indicator	Baseline (1976-2005)	RCP8.5 (2041-2070)	RCP8.5 (2041-2070)
	Mean Max temp (°C)	13.2	14.8 (+1.5)	15.9 (+2.7)
	Mean Min temp (°C)	6.0	7.6 (+1.6)	8.9 (+2.9)
	Mean Daily Max temp (°C)	25.2	27.8 (+2.6)	29.3 (+4.1)
	Daily Max Temp 90^{th} percentile (°C)	-	28.6	30.3
	Frost Days annually (no. of days)	36	15 (-21)	6 (-30)
Precipitation and Flooding	*Annual precipitation (mm)*	829	881 (+53)	909 (+80)
	Max 1-day (mm)	38	50 (12)	53 (14)
	No. Days ≥20mm	4	4	5 (+1)
Storms and high winds	*Number of Storms Qualitative (Description)*	On Average 8 named storms annually with speeds exceeding 100km/hr *(N.1)*	Winter storm frequency is projected to increase, with a possible extension of the storm season. While the intensity of individual storms cannot be accurately projected, storm wind speeds are likely to remain above 100 km/hr.	
	Max Gust Speed 1991-2020 (Knots)	80 *(N.2)*		
Note-1: Data from combined Met Éireann, UK Met Office and Dutch Meteorological services.				
Note-2: Data from Dublin Airport approximately 19km from the site. Met Éireann Dataset (2025)				

Overall, the comparison of RCP4.5 and RCP8.5 demonstrates that while both emissions pathways indicate a clear intensification of climate hazards relative to the 1976–2005 baseline, the magnitude of change is consistently greater under the high-emissions RCP8.5 scenario. By the late century, mean temperatures under RCP8.5 are projected to be higher than under RCP4.5, with a corresponding increase in extreme heat metrics, including daily maximum temperatures exceeding 29°C and a substantial reduction in frost days to around 6 per annum. Precipitation is also projected to increase more markedly under RCP8.5, with annual totals approximately 80 mm above baseline and higher short-duration rainfall extremes, indicating an elevated risk of surface water flooding. In contrast, RCP4.5 presents a more moderate warming trajectory, with smaller increases in temperature and rainfall and only marginal changes in drought and lightning risk. As such, RCP8.5 represents a significantly more severe climate future, with implications for thermal stress, water management and resilience measures that are notably greater than those anticipated under RCP4.5.

5. CLIMATE SCREENING

5.1 Sensitivity Analysis

The aim of the sensitivity analysis is to identify which climate hazards are relevant to the specific type of project, irrespective of its location. Individual components within the Proposed Development are assessed against each climate hazard.

Table 5.1 Receptors and their sensitivity to climate hazards

Sensitive Receptors	Sensitivity to Climate Hazards (No consideration of site location)				
	Extreme Heat	Extreme Cold	Flood (Pluvial)	Flood (Fluvial)	Extreme Wind
Building & structures	1	1	2	2	1
Drainage	1	1	2	2	1
Health and wellbeing	2	1	2	2	2
Roads	2	1	2	2	1
Communal gardens	2	2	1	1	2
Critical systems	2	1	2	2	2
1= Low, 2= Medium, 3= High					

Table 5.1 shows low sensitivity and medium sensitivity for relevant climate hazards when assessed against sensitivity receptors. High sensitivity was not proposed for any of the sensitivity receptors. The majority of the medium risks are to the health and wellbeing of the residents and to critical systems. By the EU Technical guidance definition, a high risk is "the climate hazard will or is likely to have a major impact on the asset category". Due to the nature of the Proposed Development and strict building regulations ensuring buildings in Ireland are constructed to a high quality and with some resilience to climate hazards, the risks to the receptors are not considered high.

5.2 Exposure Analysis

The exposure of the Proposed Development to climate risks is highly dependent on the project location. The aim of the exposure analysis is to identify which climate hazards are relevant to the planned project location. This assessment is based on current climate described in Section 4.1.

Table 5.2 Exposure of Proposed Development to the climate hazards

Climate Exposure	Exposure Risk to Climate Hazards (Consider the site location)				
	Extreme Heat	Extreme Cold	Flood (Pluvial)	Flood (Fluvial)	Extreme Wind
Exposure at project location	2	1	2	2	2
1= Low, 2= Medium, 3= High					

Table 5.2 shows the locality of the Proposed Development is at medium exposure to most climate hazards, defined as "this climate hazard occurs at the project location a number of times in a decade". The assessment has been based on information in Section 4.1 for example extreme wind is evidenced by the number of named storms discussed in Table 4.1. Exposure of the Proposed Development to pluvial and fluvial flooding was determined to be 'Possible' by DBFL in the Site-Specific Flood Risk Assessment and has been reflected here for consistency.

5.3 Vulnerability Analysis

This assessment combines the outcomes of the sensitivity and exposure analysis to determine which climate hazards pose a risk to the Proposed Development. The vulnerability of the Proposed Development to climate risks is determined based on the sensitivity and the exposure as follows:

Vulnerability = Sensitivity x Exposure

The vulnerability of the Proposed Development to the risks of Climate Change impacts is shown in Table 5.3 below:

Table 5.3 Vulnerability of the Proposed Development to the risks of climate change impacts

Receptors	Vulnerability Analysis				
	Extreme Heat	Extreme Cold	Flood (Pluvial)	Flood (Fluvial)	Extreme Wind
Buildings & Struc-tures	2	1	4	4	2
Drainage	2	1	4	4	2
Health, safety & wellbeing	4	1	4	4	4
Roads	4	1	4	4	2
Communal gar-dens	4	2	2	2	4
Critical systems	4	1	4	4	4
1, 2 = Low; 3, 4 = Medium; 6,9 = High					

Table 5.3 shows a collective rating of each receptor's vulnerability to the hazards that were screened in Section 3 (Table 3.1). Health and wellbeing of the users of the Proposed Development are the most vulnerable to the physical hazards except extreme cold due to the increasing temperatures in the long term. Similarly, the critical systems are also vulnerable to extreme heat, flooding (pluvial and fluvial), and extreme winds. Due to the necessity of its functions, like air-conditioning and power supply, it can have a cascading effect on the health and wellbeing of the users of the Proposed Development.

Elevated temperatures, pose risks to health and wellbeing, roads, communal gardens, and critical systems. These risks are illustrated in detail in Table 6.1. In addition, pluvial flooding presents as a medium risk to the Proposed Development due to the nature and extent of its potential impacts. As confirmed in the Site Specific Flood Risk Assessment by DBFL, the site is also vulnerable to fluvial flooding, as a small section of the proposed road in the south-eastern area lies within Flood Zone A and Flood Zone B, associated with flooding from Whitestown Stream. Therefore to mitigate that, the buildings and the uses of them have been kept out of the Flood Zone A and B.

Although not as impactful as extreme heat and flooding, extreme wind poses a medium risk to the critical systems, communal gardens, and health, safety & wellbeing of the users of the Proposed Development. As mentioned in Table 4.4, winter storm frequency is projected to increase, with a possible extension of the storm season. Therefore, external electrical systems and open-space amenities could be impacted adversely.

6. DETAILED ANALYSIS

This detailed part of the assessment is based on the results of Climate Screening. It assesses the potential risks and consequences of climate hazards to the Proposed Development across different climate scenarios (RCP4.5 & RCP8.5) and timespans. The future time periods are mid-century (2041-2070) and late century (2071-2100). Both should be assessed due to the anticipated lifespan of the Proposed Development (60 years) spanning both timeframes.

The Climate Change Risk Assessment in Section 5 shows the primary risks are extreme hot temperatures, flooding (pluvial and fluvial) and extreme wind. Although the frequency of extreme cold temperature is predicted to decrease, the intensity will likely remain, therefore it has been included in the below risk assessment for completeness.

A detailed description of the climate hazards relevant to each sensitivity receptor is stated (Table 6.1) followed by a detailed comparison of baseline versus future risk to the Proposed Development with respect to the mentioned physical climate hazards (Table 6.2). The potential cost impact of the risk is then determined to provide an 'Overall Risk Rating' (Table 6.3).

The adaptation measures which are embedded into the design are detailed in Table 6.4. Integrated and proposed design mitigation and measures addressed via management and maintenance strategies will further reduce the consequence of these risks. Following adaptation measures, residual risk and associated cost are assessed.

Table 6.1 Description of climate hazards to the Proposed Development

Description of physical hazard	Description of the risks to the built asset
Extreme Heat	**Buildings and structure:** Prolonged or abrupt periods of high temperatures may result in thermal expansion and moisture loss in underlying soils, potentially leading to minor settlement, cracking or long-term structural stress if not appropriately designed for changing climatic conditions. Extreme temperatures may accelerate material degradation, thermal movement and sealant failure in façade systems, increasing the risk of reduced durability, air leakage and higher maintenance requirements over the operational life of the development. **Roofs**: High temperatures may lead to deterioration of green roof and put the vegetation under stress. **Drainage**: Extreme heat and prolonged dry conditions may cause shrinkage of soils around buried drainage infrastructure and thermal stress in pipework, increasing the risk of misalignment, cracking or reduced system performance during subsequent rainfall events. **Health, safety & wellbeing**: Extreme temperatures may increase the risk of thermal discomfort and heat stress, particularly for Creche users, with potential implications for health, wellbeing and internal living conditions. **Roads**: Sustained high temperatures may result in softening and deformation of road surfaces, including rutting or cracking, particularly during peak summer periods, potentially affecting road condition, safety and maintenance frequency. **Communal gardens**: Periods of extreme heat may cause vegetation stress, reduced soil moisture and loss of planting vitality. Increased temperatures may also lead to overheating of hard surfaces, reduced comfort in open spaces, and urban heat island effects, impacting usability of the public realm. **Critical systems**: High ambient temperatures may adversely affect the efficiency and reliability of building services like heating and cooling systems, and electrical systems, increasing the risk of overheating, reduced performance or premature equipment failure if not adequately ventilated or climate-resilient.
Extreme Cold	**Buildings and structure:** Prolonged periods of extreme cold may result in frost penetration and freeze–thaw action within soils, potentially leading to ground heave, minor movement or long-term stress on foundations where ground conditions are susceptible.

Description of physical hazard	Description of the risks to the built asset
	Extreme cold conditions may increase the risk of freeze–thaw damage, material contraction and sealant embrittlement within façade systems, potentially reducing durability, weather tightness and increasing maintenance requirements over time. **Roofs**: Periods of extreme cold may lead to freeze–thaw damage to roofing materials and stress to green roof systems, potentially affecting drainage performance, vegetation survival and long-term roof integrity. **Drainage**: Low temperatures may cause freezing of surface and shallow drainage infrastructure, increasing the risk of blockages, reduced capacity or pipe damage, particularly during thaw events and subsequent rainfall. **Health, safety & wellbeing**: Extreme cold conditions may increase the risk of thermal discomfort particularly for sensitive users like creche attendees. **Roads**: Prolonged cold conditions may result in freeze–thaw deterioration of road surfaces, leading to cracking, pothole formation and reduced surface integrity, with potential implications for safety and maintenance. **Communal gardens**: Extreme cold and frost events may damage planting and landscaped areas. Moreover, colder conditions may reduce usability of open spaces and increase risks associated with frost and icy surfaces. **Critical systems**: Extreme cold may adversely affect the operation and reliability of building services and external electrical systems, increasing the risk of frozen pipework, reduced heating efficiency or service disruption if not adequately protected or insulated.
Flooding (pluvial & fluvial)	**Buildings & Structure:** Increasing and intensified rainfall can accelerate deterioration of structures and some materials. Flooding is unlikely to undermine foundations, however, may increase rates of deterioration. The development will increase the impermeable area and run-off volume relative to the existing conditions. All buildings are within flood zone C which has a low risk of flooding. Water ingress behind render can cause cracking or discolouration. It can lead to permeating damp internal to the property. **Drainage:** Surcharges of water through drainage systems can overwhelm systems leading to pluvial flooding. **Roads**: The SSFRA shows that the main access road is within Flood Zones A & B so is susceptible to flooding. the development will increase the impermeable area and run-off volume relative to the existing conditions. This can lead to flooding of roads where mitigation such as attenuation and drainage is insufficient. **Health, safety & wellbeing:** Flood events can cause damage to, or loss of possessions. Flood risk can cause stress to residents. **Communal gardens**: Flood water can lead to soil erosion, leaching the ground of nutrients, vital for plant survival. Floods can also damage structural elements such as raised beds. Contamination brought by flood water can also damage ecosystems. It can reduce the functionality of open spaces if not properly managed. **Critical Systems:** If transformers are flooded power cuts could occur. Post flood, any silt left behind can cause corrosion or blockages within the system.
Extreme Wind	**Buildings & Structure:** Intensified storms may cause significant damage to structures particularly vulnerable to flying debris. **Roads**: Flying debris may block roads preventing access. **Communal gardens**: Exposure to strong winds may reduce comfort levels in open spaces and increase risk of damage to landscape elements. It will also put the residents and garden users at risk. **Critical Systems:** Roof mounted systems such as solar photovoltaics are at risk of damage due to high exposure during storms and high winds.

Table 6.2 Baseline versus Future risk of the Proposed Development to different hazards

Description of physical hazard	Baseline			Future										
	Probability of risk occurring	Consequence of risk occurring	Baseline Risk Rating	Chosen Climate Scenario	Probability of risk occurring	Consequence of risk occurring	Medium Term Risk	Medium Term Risk Rating	Probability of risk occurring	Consequence of risk occurring	Long Term Risk	Long Term Risk Rating	Future Risk Rating Number	Future Risk Rating
Extreme Heat	Moderate	Minor	Medium	RCP4.5	Moderate	Minor	Medium	2	Likely	Minor	High	3	3	High
				RCP8.5	Likely	Minor	High	3	Likely	Moderate	High	3		
Extreme Cold	Moderate	Minor	Medium	RCP4.5	Moderate	Minor	Medium	2	Unlikely	Minor	Low	2	2	Low
				RCP8.5	Moderate	Minor	Medium	2	Unlikely	Insignificant	Extremely low	1		
Flooding (pluvial & fluvial)	Moderate	Minor	Medium	RCP4.5	Moderate	Minor	Medium	2	Moderate	Minor	Medium	2	3	High
				RCP8.5	Moderate	Minor	Medium	2	Likely	Moderate	High	3		
Extreme Wind	Moderate	Minor	Medium	RCP4.5	Moderate	Minor	Medium	2	Moderate	Minor	Medium	2	3	High
				RCP8.5	Moderate	Minor	Medium	2	Likely	Moderate	High	3		

Table 6.3 Overall risk of the Proposed Development to different hazards

Description of physical hazard	Overall Risk		
	Interdependencies of risks	Cost Impact	Overall Risk Rating
Extreme heat	The deterioration of the façade could hinder the insulation of the buildings and hence impact the residents and users of the proposed development. Moreover, any impact on the drainage might hinder its ability to withstand the extremities of flooding.	**Minor**	Medium
Extreme cold	The adverse effect of extreme cold on heating services may impact the residents and their comfort.	**Minor**	Low
Flooding (fluvial & pluvial)	Flood-related impacts may interact across systems, with urban drainage overload increasing pressure on emergency response services, disrupting transport and energy infrastructure, and elevating the risk of contamination of water supplies.	**Minor**	Medium
Extreme wind	Damage to power lines and transport networks may have cascading effects on emergency services.	**Minor**	Medium

6.1.1 Adaptation

Table 6.4 Adaptation measures for the Proposed Development

Description of physical hazard	Adaptation Measures		Residual Risk & Cost	
	What adaptation measures are already incorporated into the design work?	**What adaptation measures are to be addressed via management and maintenance strategy?**	**Residual risk, if any, following adaptation measures?**	**Cost of residual risk, if any?**
Extreme heat	**Buildings and structure:** Foundations will be reinforced concrete construction, which has inherently good resistance to temperature fluctuations. Increased concrete cover used in foundations to protect reinforcement from corrosion etc. also acts as a mitigation to any potential cycles of expansion and contraction. **Roofs:** Green roofs will be provided with a bib tap and designed with fire breaks in line with best practice. **Drainage**: The watermains will be well below the surface to avoid fluctuations to temperature as per Uisce Eireann Code of Practice. **Health, safety & wellbeing**: Overheating analysis carried out by M&E consultant, openable windows for purge ventilation provided. Tree planting and green infrastructure to provide shading, green roofs to reduce ambient temperatures, native and drought tolerant planting, and SuDS features contributing to cooling and improved microclimate. **Roads:** Road pavements have been designed as asphalt which have adequate flexibility for temperature fluctuations. **Communal gardens**: Tree canopy provision across streets and open space to provide shading and cooling, use of light-coloured paving materials to reduce heat absorption, integration of green roofs, native and drought tolerant planting, woodland edge planting for microclimate buffering, and SuDS features contributing to evaporative cooling. **Critical systems:** The safe operational temperature range of the proposed air-to-water heat pump is within RCP8.5 extreme scenarios for temperature in the long term. Based on the specifications of the Joule Modul-Air All-E heat pump, it rather	**Roofs**: The risk of extreme heat for green roofing still exists due to lack of mitigations. **Communal gardens**: The health of the gardens and vegetation should be closely monitored in times of increased temperature.	Low	**Minor**

Description of physical hazard	Adaptation Measures		Residual Risk & Cost	
	What adaptation measures are already incorporated into the design work?	**What adaptation measures are to be addressed via management and maintenance strategy?**	**Residual risk, if any, following adaptation measures?**	**Cost of residual risk, if any?**
	performs marginally better in increased temperatures (based on RCP8.5 scenario).			
Extreme cold	**Buildings and structure**: Foundations will be reinforced concrete construction, which has inherently good resistance to temperature fluctuations. Increased concrete cover used in foundations to protect reinforcement from corrosion etc also acts as a mitigation to any potential cycles of expansion and contraction. **Roofs**: Green roofs are not generally susceptible to frost damage.	**Health, safety & wellbeing**: During predicted icing or sub-zero temperatures, the pavements and roads should be gritted to avoid and slipping hazards for pedestrians and vehicles.	Extremely low	**Negligible-**

Description of physical hazard	Adaptation Measures		Residual Risk & Cost	
	What adaptation measures are already incorporated into the design work?	What adaptation measures are to be addressed via management and maintenance strategy?	Residual risk, if any, following adaptation measures?	Cost of residual risk, if any?
	Drainage: Watermains are designed to be buried below the frost zone as per Uisce Eireann Code of Practice. Rainwater pipes and waste pipes are brought through the building internally to avoid and environmental issues. **Health, safety & wellbeing**: Planting structure and courtyard layout to provide shelter, woodland edge planting to buffer exposure, and well drained surfaces to maintain safe and usable spaces. **Roads**: Road pavements have been designed to ensure no frost susceptible material is within the frost zone below the road surface. **Communal gardens**: Use of durable, SDCC compliant materials, well drained surfaces to prevent standing water, integration of landscape with drainage to reduce surface water issues, and planting structure to provide shelter and improve microclimate conditions. **Critical systems**: The safe operational temperature range of the proposed air-to-water heat pump is within RCP4.5 and RCP8.5 extreme scenarios for temperature in the long term. Since the mean minimum temperatures are expected to rise, the operational efficiency rather improves in the long run. The temperature at the Proposed Development site has never dropped below the operational limit of -10°C therefore the heat pump is a feasible option for the long-term climate.			
Flooding (pluvial and fluvial)	**Buildings and structure**: A detention basin is proposed to attenuate runoff from the development to the greenfield runoff rate (Qbar) and has been designed to accommodate the 100-year storm event. The design rainfall intensities were increased by a factor of 20% to take account of climate change, as required by the GDSDS for attenuation storage design. All portions of the site where buildings are proposed are within Flood Zone C. The building FFLs are set 300mm above the 1000-year water level.	**Drainage**: Proposed drainage system to be maintained on a regular basis to reduce the risk of a blockage. **Roads**: In the event of a fluvial flood event, the overland flow paths should remain clear to ensure the conveyance of flood water. Maintain Access and Egress routes via Whitestown Road and the proposed shared surface to ensure emergency access to the	Low	**Minor**

Description of physical hazard	Adaptation Measures		Residual Risk & Cost	
	What adaptation measures are already incorporated into the design work?	**What adaptation measures are to be addressed via management and maintenance strategy?**	**Residual risk, if any, following adaptation measures?**	**Cost of residual risk, if any?**
	For storms in excess of the 100-year, the development has been designed to provide overland flood routes along the development roads towards the surface water outfall and adjoining roads. **Drainage:** The pipe network is designed to accommodate the 2-year storm event. SuDS measures, such as swales, permeable paving and green roofs, are proposed to attenuate runoff and reduce the pollution impact. Discharged flows are reduced to equivalent green-field run-off rates in accordance with the GDSDS. Proposed road levels are designed to fall towards the gullies, SuDS features and grass areas and directing surface water runoff into the drainage system. This will ensure that the proposed residential units are protected from flooding when the drainage network may be exceeded. **Roads:** The access road within Flood Zone A and B is at risk of fluvial flood flooding from the Whitestown Stream. The proposed works within Flood Zone A and B are classified in the Planning System and Flood Risk Management - Guidelines for Planning Authorities 2009 as "Less Vulnerable" development. Alternative access and egress points to the proposed development via the shared surface in the north of the site are available for pedestrian, cyclist and emergency vehicle access during any temporary blockage of the vehicular entrance by flooding. **Health, safety & wellbeing**: All portions of the site where buildings are proposed are within Flood Zone C. The building FFLs are set 300mm above the 1000-year water level. A specialist is engaged at construction stage to size the rainwater goods in line with future expectation	development can be facilitated during flood events.		

Description of physical hazard	Adaptation Measures What adaptation measures are already incorporated into the design work?	What adaptation measures are to be addressed via management and maintenance strategy?	Residual Risk & Cost Residual risk, if any, following adaptation measures?	Cost of residual risk, if any?
	Communal gardens: Fully integrated SuDS strategy forming part of the Green Infrastructure network, central detention basin designed for exceedance events, inclusion of a low flow channel, use of permeable surfaces and planting beds to promote infiltration, and distributed SuDS elements forming a management train.			
Extreme wind	**Building & Structure**: Foundations are designed to transfer load from high winds experienced by buildings directly to ground in accordance with the relevant Eurocodes and National Annex. Materials and fixing details are robust **Communal gardens**: Tree and woodland planting used as windbreaks, structured planting to create sheltered microclimates, and landscape layout designed to reduce exposure. All trees are staked until well established.	**Building and Structures**: Within building management plans, scheduled inspections should be included by a building surveyor to confirm no issues or damage related to wind or storms within the building structures including the roof. Where maintenance is deemed required, it must be promptly completed to ensure the building is resilient to future storm events. **Communal Gardens**: Landscaping maintenance will review vulnerable planting annually. Removing planting that has the potential to cause damage during a storm due to previous weakening or removal of leaves which have fallen and may result in blocked drains.	Low	**Negligible**

6.2 Summary of Detailed Analysis

The detailed analysis was carried out for the following elements of the Proposed Development:

1. Buildings and structure
2. Drainage
3. Health, safety & wellbeing
4. Roads
5. Communal gardens
6. Critical systems.

For each physical climate hazard (extreme heat, extreme cold, flooding (pluvial & fluvial), and extreme wind), risks pertaining to the relevant element were assessed. Prior to the consideration of adaptation and cost impact, the future risk is considered as high for all hazards, excluding extreme cold. In terms of comparative scenarios (RCP4.5 and RCP 8.5), the long-term risk is high for the hazard of extreme heat in both scenarios. For flooding and extreme wind hazard, the long-term risk is assessed to be medium and high for RCP4.5 and RCP8.5 respectively. It is useful to note that the range of risk is Extreme, High, Medium, Low, and Extremely low.

Once the cost impact of the risk is incorporated, the overall risk prior to adaptation measures is medium for extreme heat, flooding, and extreme wind hazards.

To calculate the residual risk of the hazard on the Proposed Development, adaptation measures were incorporated into the assessment. These measures are embedded to future proof the impacts of the risks, should they materialise. Therefore, the residual risk for all hazards is resultantly low. The only exception is extreme cold which has a residual risk of very low. The cost of residual risk for high heat and flooding is minor.

Conclusively, the Proposed Development is at low risk from climate change hazards, in the medium and long-term scenarios once adaptation measures are embedded.

7. CONCLUSION

This Climate Risk and Vulnerability Assessment (CRVA) has assessed the projected change in climate for the Large-scale Residential Development at Whitestown Way and identified key climate hazards and risks it may face under both a medium emissions scenario (RCP4.5) and 'worst case' high emission scenario (RCP8.5). The climate risk assessment has identified that the components of the Proposed Development will be under low and very low risk from four climate hazards over the expected lifetime of the existing design (2041-2070) once the adaptation measures listed in Table 6.1 are embedded:

- Extreme heat;
- Extreme cold;
- Flooding (pluvial and fluvial); and
- Extreme wind.

Adaptation opportunities have been identified to support climate resilience for the Proposed Development and individual components. It is expected that engineers, operators and administrative teams consider the risks identified, alongside recommended adaptations, and consider how to incorporate further resilience into the construction and operation. Key areas for further action include:

- Critical Systems:
  - The Proposed Development should further ensure that the critical infrastructure (heat pumps, electricity, solar PV, etc.) are future proofed against extreme heat, flooding, and extreme winds.
- Drainage:
  - In the event of a fluvial flood event, the overland flow paths should remain clear to ensure the conveyance of flood water.
  - Proposed drainage system is to be maintained on a regular basis to reduce the risk of a blockage.
- Communal gardens
  - Landscaping maintenance to review vulnerable planting annually. Removing planting that has the potential to cause damage during a storm due to previous weakening or removal of leaves which have fallen and may result in blocked drains.
- Roads:
  - In the event of a fluvial flood event, maintain access and egress routes via Whitestown Road and the proposed shared surface to ensure emergency access to the development can be facilitated during flood events.
- Buildings and structure:
  - Within building management plans, scheduled inspections should be included by a building surveyor to confirm no issues or damage related to wind or storms within the building structures including the roof. Where maintenance is deemed required, it must be promptly completed to ensure the building is resilient to future storm events.
- Health, safety & wellbeing:
  - The interest, in terms of health, safety and wellbeing, of the users of the Proposed Development should be central to the plan. Since they are one of the key stakeholders, the point of interaction between the elements of the development and the users should be closely monitored, particularly during periods when physical climate hazards are elevated.

The finding of this report is that the Large-scale Residential Development at Whitestown Way under the existing design and plan, inclusive of all adaptation measures, is resilient to climate change. However, changes to climate outside of the predictions set out in this report may pose a risk to the Proposed Development's operation and safety and therefore this CRVA should be regularly reviewed and updated in line with national predictions.

APPENDIX A

Glossary of Terms & Definitions

- **Hazard:** The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
- **Exposure:** The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
- **Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
- **Risk:** The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change, as well as human responses to climate change.
- **Sensitivity:** The degree to which people, ecosystems and species, economic, social and cultural assets, and services are affected, either negatively or positively, by climate variability or change.
- **Adaptive Capacity:** The ability of an organization or system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
- **CIMP5 (Coupled Model Intercomparison Project Phase 5):** This phase was a major international effort to improve understanding of past, present, and future climate change through coordinated climate model experiments. CMIP5 data informed the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report and remain a key source for regional climate projections, including those used in this assessment.
- **Confidence:** The robustness of a finding based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgement) and on the degree of agreement across multiple lines of evidence. In this report, confidence is expressed qualitatively.

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