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Rhomco | Fusion, 10-12 Whitworth Street

Climate Change Adaptation Report

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Author:	Alex Thompson	Review:	Ben Sidebottom
Job Title:	Senior Sustainability Consultant	Job Title:	Associate Director

Distribution List	
Name	Association / Company Name
Alex Haddow	Rhomco
Julian Gauregui	Rhomco

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Climate Change Background Information

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1.0 CLIMATE CHANGE BACKGROUND INFORMATION

1.1 Responsible Individual

This climate change adaptation report was completed by Alex Thompson, who is a Senior Sustainability Consultant at Mainer Associates, with 4.5 years' experience in the industry. A copy of Alex's professional CV can be seen in Appendix B.

1.2 Building Information

The development consists of the construction of a 39-storey multi-residential tower block development, along with associated amenity and plant areas. The site is located on a brownfield site on Whitworth Street, in the centre of Manchester. The immediate surroundings of the development are existing buildings directly to the east and west, Whitworth Street to the north, with one of Manchester's Metrolink Tram lines beyond. The southern façade of the building is situated immediately adjacent to the stretch of railway line between Deansgate and Manchester Oxford Road train stations.

The building will have an assumed design life of circa 60 years. On this basis, the building will be assessed against the risks associated with the future changes to climate in the 2020's, 2040's, 2060's, and 2080's.

1.3 Historic Climate Data

Like the rest of the United Kingdom, Manchester's climate is generally temperate. According to Met Office records[1] for Rochdale (which represents the closest climate station to Manchester), between 1991 and 2020:

- There was an average of 1,197.22 millimetres (mm) of rain per year
- December was typically the wettest month with an average of 138.88 mm of rain
- May was typically the driest month with an average of 65.67 mm of rain
- The average daily maximum temperature was 13.13°C
- The average daily minimum temperature was 6.09°C
- July was typically the hottest month with an average maximum temperature of 20.01°C
- February was typically the coldest month with an average minimum temperature of 1.41°C.

1.4 Predicted Climate Change

There is broad agreement that human-induced greenhouses gas emissions are causing unavoidable changes to the earth's climate. Recent studies by the intergovernmental Panel on Climate Change (IPCC) indicate that global temperatures could increase by 3.7 to 4.8°C by the year 2100 (on a business-as-usual case). If all man-made greenhouse gas emissions ceased immediately, the influence of historical gas emissions already in the atmosphere would still result in climate changes.

The UK climate is changing to reflect global patterns – average temperatures have been rising, winter precipitation rates have increased, and sea levels have been rising by 1 mm per year during the last century. A broad trend of hotter, drier summers and warmer, wetter winters across the whole UK has been identified.

The most accurate UK focused climate change projection is the UK Climate Projection 2018 (UKCP18) data[2]. UK Climate Projections is a climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme, which is supported by the Department of Business, Energy, and Industrial Strategy (BEIS) and the Department for Environment, Food and Rural Affairs (Defra).

UKCP18 uses cutting-edge climate science to provide updated observations and climate change projections out to 2100 in the UK and globally. The project builds upon UKCP09 to provide the most up-to date assessment of how the climate of the UK may change over the 21st century.

UKCP18 provides climate information designed to help design teams plan how they will adapt to a changing climate. The climate change projections are split into four scenarios based on varying greenhouse gas (GHG) emissions- RCP2.6, RCP4.5, RCP6.0 and RCP8.5.

All projections are based on Met Office methodology and reflects scientists' best understanding of how the climate system operates, how it might change in the future, and allows a measure of the uncertainty in future climate projections to be included.

UKCP18 have produced a series of maps to display projected changes in the UK climate at a national and regional level. They use the four emission scenarios as detailed above, four 20-year time periods (2020-2039, 2040-2059, 2060-2079 and 2080-2099) and three different levels of confidence (10th, 50th and 90th percentiles).

The following table provides predictions for 2020-2039, 2040-2059, 2060-2079, and 2080-2099 for key changes to the climate in each of the emissions scenarios for North-West England. These figures are relative to a 1981-2000 baseline and represent the central estimate (50th percentile) probability level.

	2020-2039 Emissions				2040-2059 Emissions				2060-2079 Emissions				2080-2099 Emissions			
	RCP2.6	RCP4.5	RCP6.0	RCP8.5	RCP2.6	RCP4.5	RCP6.0	RCP8.5	RCP2.6	RCP4.5	RCP6.0	RCP8.5	RCP2.6	RCP4.5	RCP4.5	RCP6.0
Mean Summer Temperate (°C)	+1 to+2	0 to +1	0 to +1	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+3 to +4	+1 to+2	+2 to+3	+3 to+4	+4 to+5
Summer Precipitation (%)	0 to -10	0 to -10	0 to -10	0 to -10	-10 to -20	-10 to -20	-10 to -20	-10 to -20	-10 to -20	-10 to -20	-10 to -20	-20 to -30	-10 to -20	-20 to -30	-20 to -30	-30 to -40
Mean Summer Daily Maximum Temperature (°C)	+1 to+2	0 to +1	0 to +1	+1 to+2	+1 to+2	+1 to+2	+1 to +2	+2 to +3	+1 to +2	+2 to+3	+2 to+3	+3 to+4	+1 to +2	+3 to+4	+3 to+4	+5 to +6
Mean Summer Daily Minimum Temperature (°C)	+1 to+2	0 to +1	0 to +1	0 to +1	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+1 to+2	+2 to+3	+1 to+2	+2 to+3	+3 to+4	+4 to+5
Mean Winter Temperate (°C)	0 to +1	0 to +1	0 to +1	0 to +1	0 to +1	+1 to+2	0 to +1	+1 to+2	0 to +1	+1 to+2	+1 to+2	+2 to+3	+1 to+2	+1 to+2	+2 to+3	+3 to+4
Winter Precipitation (%)	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	+10 to +20	0 to +10	+10 to +20	+10 to +20	+10 to +20
Mean Winter Daily Maximum Temperature (°C)	0 to +1	0 to +1	0 to +1	0 to +1	0 to +1	+1 to+2	+1 to+2	+1 to+2	0 to +1	+1 to+2	+1 to+2	+2 to+3	+1 to+2	+1 to+2	**+2 to+3**	**+3 to+4**
Mean Winter Daily Minimum Temperature (°C)	0 to +1	0 to +1	0 to +1	0 to +1	0 to +1	+1 to+2	+1 to+2	+1 to+2	0 to +1	+1 to+2	+1 to+2	+2 to+3	+1 to+2	+2 to+3	+2 to+3	+3 to+4

The above shows that likely changes to average weather conditions are likely to be experienced in the future. Note: not all years will fit a clear trend of change leading to a variable and unpredictable climate. Therefore, projections enable identification of the likely effects of climate change (to a degree of certainty) and inform appropriate recommendations for changes to design, construction and maintenance policies, standards, and practice.

Legislative Background

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2.0 LEGISLATIVE BACKGROUND

2.1 Legal and Policy Drivers for Climate Change

Since the manufacturing transition of the industrial revolution, the acceleration of climate change has been well-documented, with anthropogenic greenhouse gas emissions increasing owing to fossil fuel consumption, globalisation, and rapid societal development. The economic growth associated with globalisation has accelerated unsustainable practices; atmospheric carbon dioxide levels have hit record highs intensifying the greenhouse gas effect and causing unnatural increases to Earth's temperature, threatening all life on Earth.

Recognising that current efforts are falling short to solve the climate emergency, rapid decarbonisation solutions are becoming increasingly necessary and there is an emerging consensus on the seriousness of climate change. Governments and organisations have consequently developed responses to limit global warming; in 2015 a legally binding international treaty on climate change called the 'Paris agreement' was adopted by 196 countries committed to limiting global warming. It was established with the primary objective to limit the increase of global warming well below 2 ˚C above pre-industrial levels, with efforts to limit the temperature increase to 1.5 ˚C. This however was officially sur-passed in February 2024; Earth experienced its first full 12-month period with global temperatures exceeding 1.5 ˚C above pre-industrial levels.

Climate change poses both risks and opportunities and the potential to adapt to them are relevant to the design, construction, maintenance, operation, and end of life phases of buildings. Rising international and national aspirations on climate change adaptation and mitigation has led to the strengthening of planning policies and building control processes to support sustainable and resilient development.

What COP 28 Means For Climate Change



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3.0 WHAT COP28 MEANS FOR CLIMATE CHANGE

The United Nations held the 28th annual climate conference (COP28) in Dubai throughout December 2023 which hosted 85,000 participants, including more than 150 world leaders and government representatives, businesses, scientists, and citizens to address the targets of the Paris Agreement and the climate crisis. At COP28, several key agreements and initiatives were reached, such as keeping 1.5 ˚C within reach. These specifically included:

- The conclusion of the first 'global stocktake', stating that progress has been insufficient and calling for tripling renewable energy capacity and doubling energy efficiency by 2030, marking 'the beginning of the end' of the fossil fuel era.
- Operationalising new funding for loss and damage – a new dedicated fund established under the UNFCC to support vulnerable countries and communities already experiencing the adverse impacts of climate change. To date, this has totalled US$661m.
- Strengthening the development of nature-based solutions for climate resilience, biodiversity gains, and carbon storage within countries' national climate action plans, due by early 2025.
- Halting and reversing deforestation and forest degradation by 2030.
- Green climate fund: pledges by 6 new countries to boost the green climate fund. This now stands at a record contribution from 31 countries, totalling US$12.8bn.

IPPC Sixth Assessment Report



4.0 IPCC SIXTH ASSESSMENT REPORT

The IPCC Sixth Assessment Report addresses the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science. As an intergovernmental body of the United Nations responsible for advancing knowledge on human-induced climate change the resources provided by the IPCC are the most reliable, unbiased and scientific available.

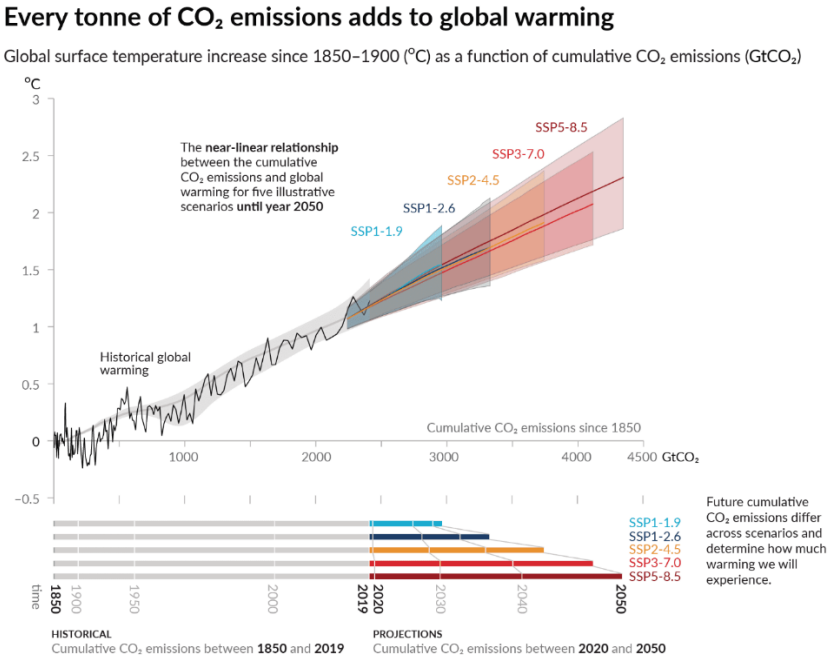


Figure 2: IPCC graph showing the correlation between CO_2 increase and temperature increase

- Figure 2, taken from the IPCC report shows how the increased CO_2 emissions associated with human interference has significantly altered the average temperature of the planet. With the trends already visible in the data the need to reduce and limit the amount of CO_2 we put into the atmosphere is paramount if irreversible climate damage is to be prevented. With a shrinking carbon budget (cumulative amount of carbon dioxide emissions permitted) limiting pollution of CO_2 and other harmful greenhouse gases is an issue that needs addressing now.
- Covered within the report are the wider impacts that climate change will have on our planet including ecosystem damage, increased natural disasters, rising sea levels, poor air quality and many more climate hazards which will cause irreversible damage to the environment, economy and health.

The Climate Change Act 2008 sets up a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions by 34% over the 1990 baseline by 2020 and by 80% by 2050 and to ensure steps are taken towards adapting to the impact of climate change. The Act introduced a system of carbon budgeting which constrains the total amount of emissions in a given time period and sets out a procedure for assessing the risks of the impact of climate change for the UK, and a requirement on the Government to develop an adaptation programme.

The Climate Change Act introduced new powers and duties on climate change adaptation and mitigation. Through amendment of the Climate Change Act, the UK committed to achieving net-zero emissions by 2050. For adaptation it established a:

- UK-wide Climate Change Risk Assessment that must take place every five years
- National Adaptation Programme which must be put in place and reviewed every five years to address the most pressing climate change risks
- Government power to require 'bodies with functions of a public nature' and 'statutory undertakers' - for example, water and energy utilities - to report on how they have assessed the risks of climate change to their work, and their response
- Adaptation Sub-Committee of the independent Committee on Climate Change (CCC) in order to oversee progress on the national programme and advise on the risk assessment. The CCC provides independent advice on setting and meeting the country's carbon budget ratchetting down the total amount of greenhouse gas emissions over future 5-year periods to zero by 2050.

The Government published the UK Climate Change Risk Assessment (CCRA) on 25 January 2012, the first assessment of its kind for the UK and the first in a five-year cycle. The CCRA has reviewed the evidence for over 700 potential impacts of climate change in a UK context. Detailed analysis was undertaken for over 100 of these impacts across 11 key sectors, on the basis of their likelihood, the scale of their potential consequences and the urgency with which action may be needed to address them.

The CCRA sets out key climate change risks for each sector and measures for responding to and mitigating against these risks. For the UK's construction sector, the key risks identified are:

- Damage to property from flooding and coastal erosion
- Overheating in buildings
- Increasing impact from the 'urban heat island' effect
- Buildings affected by subsidence.

The National Planning Policy Framework (NPPF) 2024 describes ways in which the challenge of climate change can be met. Chapter 14 of the NPPF highlights that planning plays a key role in mitigation against climate change. The policy also states that local planning authorities should:

- Take a proactive approach to mitigating and adapting to climate change, and account for long-term climate impacts, including flood risk, coastal change, water supply, biodiversity and landscapes, and overheating and drought risks.
- Plan for new development in ways that:
    - Avoid increased vulnerability to the range of impacts arising from climate change, or manage risks through suitable adaptation measures.
    - Help reduce greenhouse gas emissions, through location, orientation, or design.
- Avoid inappropriate development in areas at risk of flooding, or where development is necessary, making it safe for its lifetime without increasing flood risk elsewhere.
- Support the move to a low carbon future, by supporting energy efficient improvements to existing buildings.

- Help to increase the use and supply of renewable and low carbon energy.

4.1 Local Context and Response

UK Projections

The UK Climate Projections (UKCP) is a climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme and provides the most up-to-date assessment of how the UK climate may change in the future. All projections are based on Met Office methodology and reflects scientific understanding of how the climate system operates, future changes and allows a measure of the uncertainty in future climate projections. Climate change scenarios are then produced under different emissions scenarios called Representative Concentration Pathways (RCP's) which were defined by the Intergovernmental Panel on Climate Change (IPCC) and are a representation of the latest information available on climate change. The following are the defined RCPs:

- RCP 4.5 (low/medium emission scenario)
- RCP 6.0 (medium emission scenario)
- RCP 8.5 (high emission scenario)

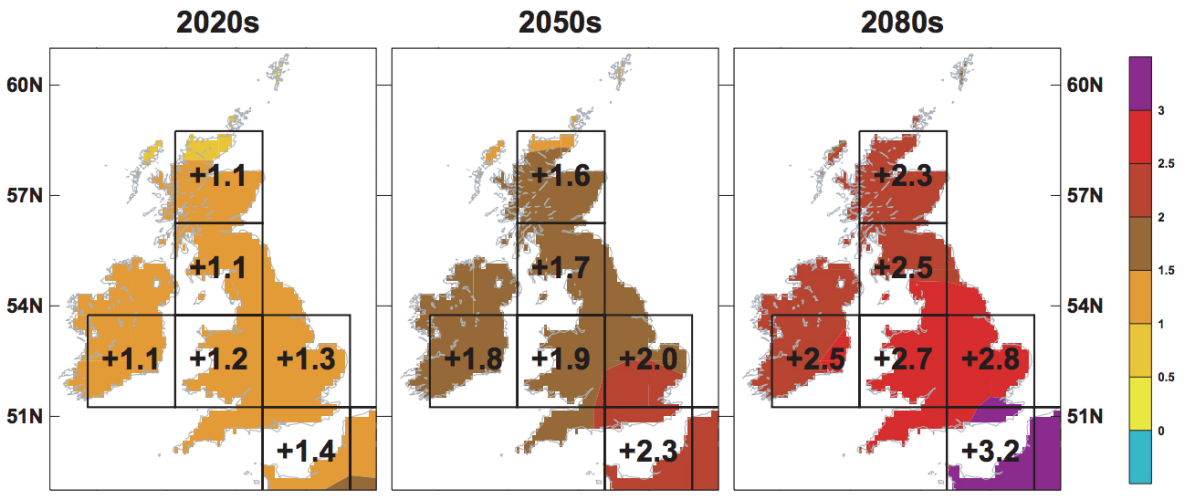


Figure 3: UKCIP98 projections of change in average annual temperature (in degrees C, relative to a 1961-90 baseline) for a medium-high emissions scenario[1]

The UK government released its net zero strategy[2] in October 2021 with the key priority to be to 'build back greener' and increase awareness of net zero and empower businesses to make green choices limiting the impact on the environment. The expectation and responsibility for everyone is to limit environmental impact as much as possible to avoid life threatening temperature increases such as those displayed in figure 3 as well as other severe climate related disasters.

UK Impact and Response

The UK has already begun to see the effects of climate change and scientists anticipate weather extremes will become more frequent and severe unless dramatic change is made. All of the top ten warmest years for the UK in records back to 1884 have occurred since 2002 in addition to increases in annual rainfall (see figure 4).

[1] https://ora.ox.ac.uk/objects/uuid:ffe1394e-cfea-4e55-a561-2b707325fd1b/download_file?file_format=pdf&safe_filename=98_summary.pdf&type_of_work=Report
[2]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf

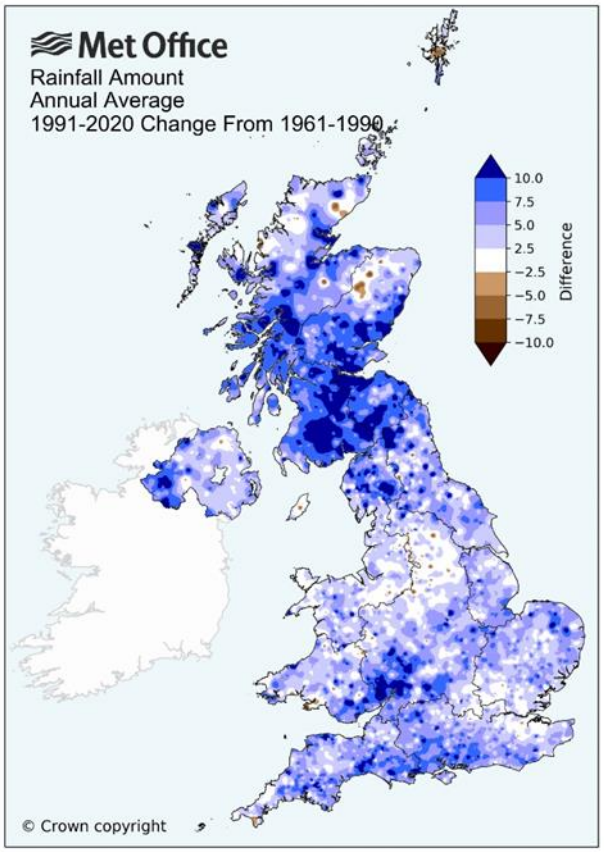


Figure 4: UK average annual rainfall change from 1961-1990

Climate change is a massive threat to the UK and even if the most significant measures are taken to limit the impact we have on the environment the UK see people and property exposed to climatic danger. The UK will see sea level rises between 30cm and 34 cm by 2050 with low lying and coastal cities at particular risk from the impacts. Correspondingly flooding will become more frequent and more severe to areas across the UK causing damage to buildings, disrupting

transport and affecting health. Buildings and infrastructure need to understand how to cope with the new climatic conditions and both mitigation and adaption strategies are essential in ensuring the longevity of new developments.

4.2 Local Context and Response

Manchester City Council

Like many councils across the UK, Manchester has declared a climate emergency acknowledging the need for mitigation and adaption to the climate emergency. The Council resolved not only to declare a climate emergency, but to launch a collective climate action plan, and committed to halve carbon emissions within 5 years from July 2019. To further this, Manchester has set a target to become a zero-carbon city by 2038, to be achieved by setting a science-based target for carbon reduction.

Manchester City Council updated the 2019 climate action plan in 2023, which sets out workstreams to target sustainable practices, as follows:

- Workstream 1 – Buildings & Energy
- Workstream 2 – Transport & Travel
- Workstream 3 – Reducing consumption-based emissions and influencing suppliers
- Workstream 4 – Climate adaption, carbon storage & carbon sequestration
- Workstream 5 – Influencing behaviour change and being a catalyst for change

Climate Change in Manchester and Responses

10-12 Whitworth Street is a 39-storey high building situated in the city centre of Manchester and aims to achieve high sustainability standards. As a development with high sustainability aspirations, it will be aiming to limit its individual impact towards the climate crisis. Being located in a busy urban centre there are various climate change impacts likely to impact the building and the requirements for its ability to adapt to and mitigate against climate change

across best- and worst-case scenarios. Below Mainer has identified and analysed the potential climate change impacts that are likely to impact 10-12 Whitworth Street.

Extreme heat

As a city centre development, the 'urban heat island' effect will result in hotter than average temperatures, particularly during prolonged spells of warm weather. With rising average temperatures and prolonged spells of extreme heat consideration towards the management of temperature for the building and its occupants is essential.

Figure 5 demonstrates the maximum summer air temperatures since 1961, to a predicted 2099 scenario, for the RCP 6.0 scenario within a 25km grid area in which the site is located, from the Met Office's UK climate projections. These climate projections for the site indicate significant temperature rises in the decades ahead for summers. If temperatures such as this become more frequent and intense then the impact to people could be fatal. It is therefore paramount that approaches to heating, cooling and comfort are considered at this development.

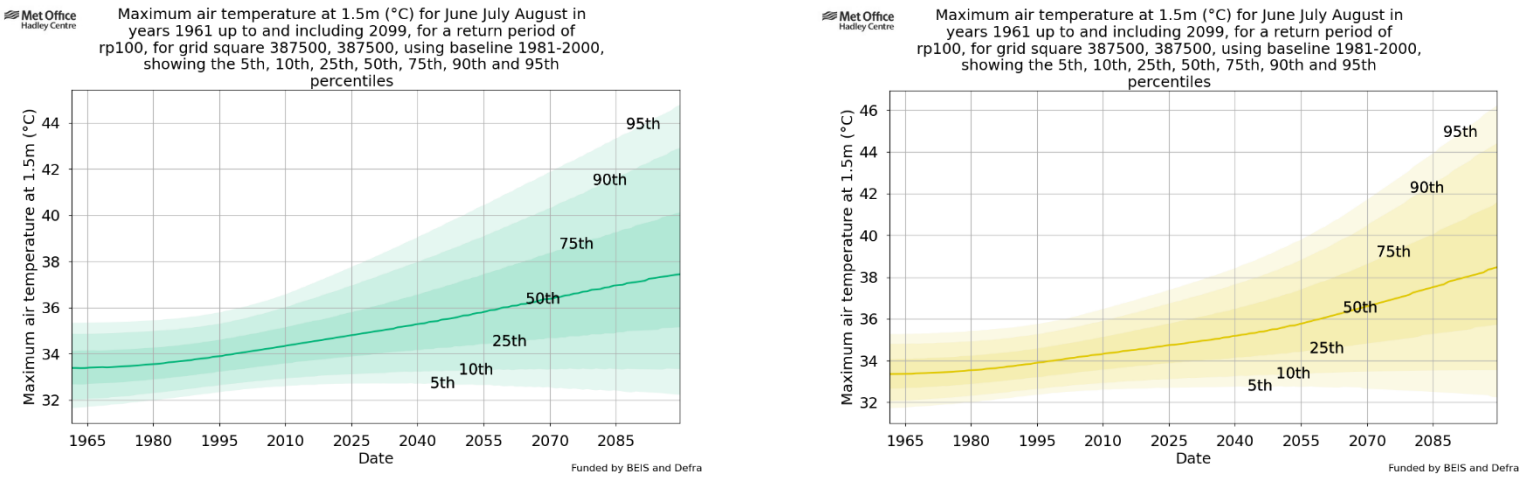


Figure 5: Maximum summer air temperature, 1961-2099 (projected), RCP 4.5 (left) and RCP6.0 (right)[3]

PRECIPITATION

As detailed above the intensity of heat will be one of the main results of climate change scenarios therefore frequency of rain will remain roughly the same however the impacts of days with intense heat and less rain could have wider impacts. Regarding rainfall the intensity of the wettest days is likely to increase significantly.

[3] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

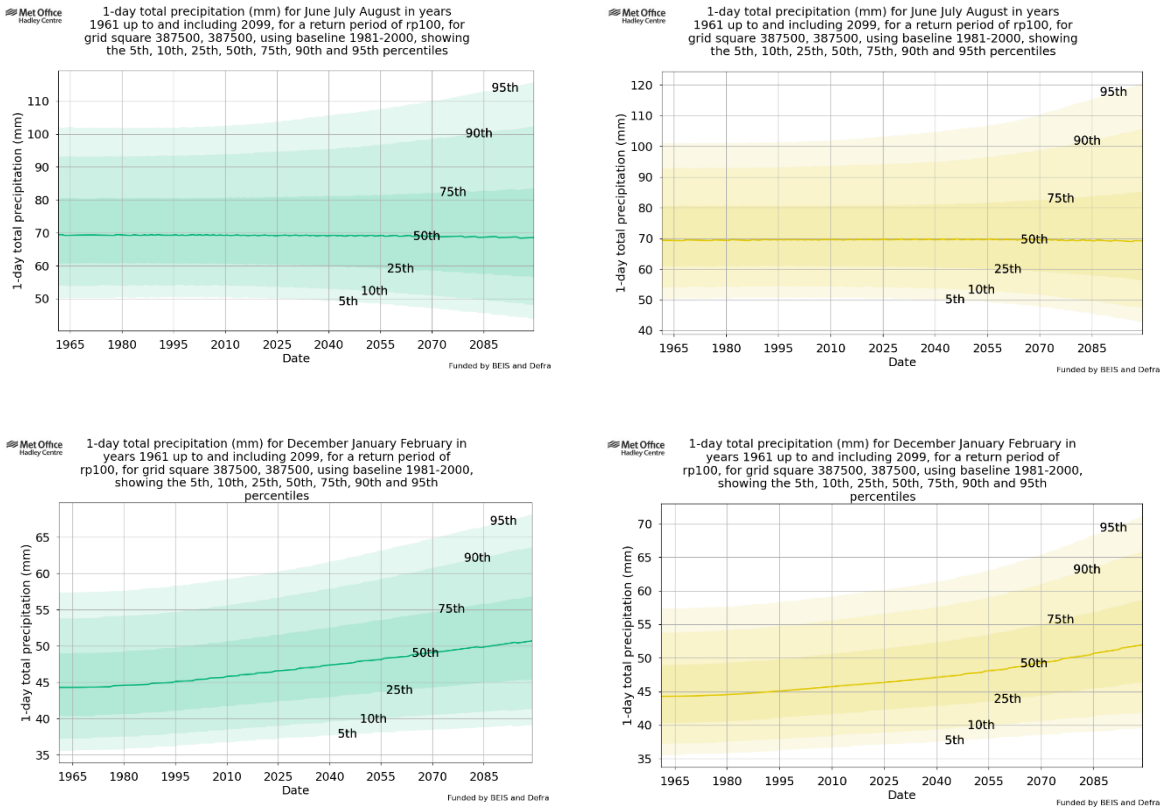


Figure 6: Wettest days 1961-2099 (projected), Summer (top) and Winter (bottom); RCP 4.5 (left) and RCP 6.0 (right)

Figure 6 shows the intensity of rain on individual days which means heavier and prolonged spells of rainfall often resulting in issues such as flooding. Whilst peak rainfall summer day scenarios are projected to remain at similar levels, winter could see a peak rainfall day increase of 4mm (from 2025-2085) (50th percentile; RCP 6.0), rising up to 52mm of rainfall in one day.

FLOODING

A result of the increased rainfall discussed previously the likelihood and intensity of flood events is likely to increase. Using the Government's and Environment Agency Flood Risk Assessment tool, Mainer have produced a Flood Zone map (Figure 7).

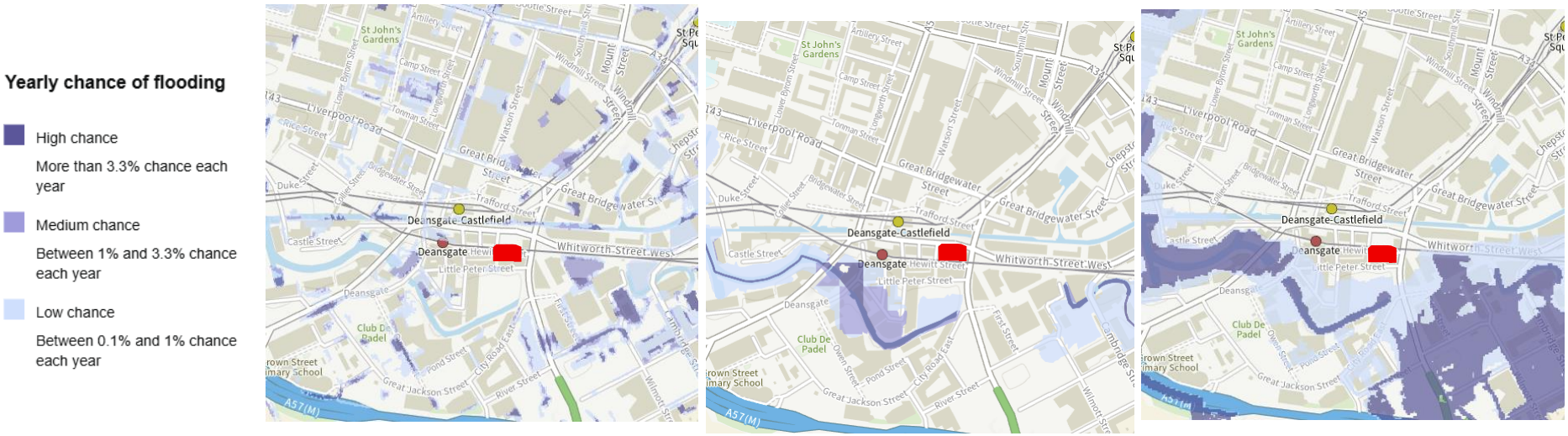


Figure 7: 10-12 Whitworth Street Flood Report – Surface Water Flooding (left); River/Tidal Flooding (middle); Reservoir Flooding (right)

Marked on Figure 7 with the 'selected point' is the location of Fusion, 10-12 Whitworth Street, showing that the development falls narrowly outside areas at risk of flooding, from all three assessed sources of flooding as above. It is therefore located within Flood Zone 1. However, it is worth noting that areas at risk of all three sources of pollution lie nearby to the site and affect neighbouring properties. Therefore, it is recommended that a full Flood Risk Assessment is performed by an appropriate consultant with qualifications and experience, to truly determine the flood risk of the site, and any potential protection measures which may need to be implemented.

OTHER RISKS

Above are the most likely impacts that will result from climate change and also have the potential to cause the most significant damage. Warmer summers and wetter winters have the potential to disrupt transport systems and limit people's capacity to work in an office environment with droughts and temperature variations also proposing potential issues to building users in a wider context.

4.3 Climate Change and BREEAM

BREEAM New Construction v6.1 includes the Wst 05 – Adaptation to Climate Change credits. The standard credit assesses the potential effects of climate change on the building structure, fabric, building services and renewable systems.

The exemplary credit is available where a holistic approach on adaptation to climate change has been covered, this is demonstrated by achieving other credits/criteria which are impacted by climate change:

- Hea 05 – Thermal Comfort
- Ene 01 – Energy and Carbon Performance for Regulated Energy Uses
- Wat 01 – Water Consumption
- Mat 04 – Durability and Resilience
- Pol 03 – Flood and Surface water management – Flood Resilience **and** Surface Water Run-off

This report addresses the standard credit **only**.

Hazard Identification and Assessment

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5.0 HAZARD IDENTIFICATION AND ASSESSMENT

UK Climate Projections (UKCP09) indicate that the main nation-wide trends of climate change are:

- Wetter winters
- Drier summers
- Increased temperatures across all seasons

This information, as well as information from other identified sources, has informed the identification of hazards that are likely to occur resulting from climate change. The hazard identification section of the following table outlines the climate change related hazards identified.

The hazard assessment section of the following table assesses a list of identified hazards to determine the likelihood of the hazard occurring the likely consequences of that hazard. A range of data and mapping information have been consulted to inform the table, links to these sources are outlined in the reference list at the end of this document.

Hazard Identification		Hazard Assessment	
		Likelihood	Consequences
A	Flooding	Climate Central Sea level rise modelling[5] shows that for the most severe emissions scenario (corresponding to 4°C) the site is not at risk of coastal flooding. Environment Agency maps[9] show that the site is in Flood Zone 1, meaning that the risk of surface water and river flooding each year is less than 0.1%. The site is outside the maximum extent of reservoir flooding zone.	The consequences of sea level rise include increased coastal flooding, coastal flooding, increased coastal erosion. The likely consequences from flooding are damage to land, property, infrastructure and building services (potentially leading to electrocution). Flooding can potentially cause injury or loss of life for building users. Overwhelming of sewers with flood water may lead to

			flood water contamination, increasing the risk of disease transmittance.
B	Storms (including wind-driven rain)	UKCP18 data[3] predicts a 0-10% increase in winter precipitation and a 0-10% reduction in summer precipitation from 2020-2039. By the 2040-2059 a 0-10% increase in winter precipitation and a 10-20% decrease in summer precipitation is predicted. During the 2060-2079 period, a 0-20% increase in winter precipitation and a 10-30% decrease in summer precipitation is expected. Ranges depend on emissions scenarios. Data for the North-West England region. According to mapping from the BRE[11], the site is in a moderate area with 33-56.5 litres/m^2 per spell of wind driven rain.	Consequences of increased heavy storm events include superficial and structural building damage, such as overwhelming of roofs causing water to leak into the building / increased penetration of building fabric. This can cause further damage to the building and lead to potential injury or loss of life. There is also increased risk of outage of emergency services, damage to infrastructure and disruption of transportation services.
C	Cold events	UKCP18 modelling[2] data predicts a 0-1˚C winter mean temperature increase during 2020-2039, a 0-2˚C winter mean temperature increase by 2040-2059, and a 0-3˚C winter mean temperature increase by 2060-2079. This will likely lead to a decrease in extreme cold events.	Cold events can impact building systems and, such as freezing up pipes, and increased heating demand. Further risks to external site areas are ice, which can lead to slip hazards / cause injuries to building occupants.
D	Heat waves	UKCP18 modelling data[2] predicts a 0-2˚C summer mean temperature increase by 2020-2039, a 1-2˚C summer mean temperature increase by 2040-2059, and a 1-4 ˚C summer mean temperature increase by 2060-2079. Ranges depend on emissions scenarios. Data for the North-West England region. This will likely lead to an increased risk of heat waves in summer. UKCP18 maps (figure 5) predict a maximum annual air temperature of 37°C by 2085 (50th percentile). Data is specific to a 25km catchment around the site.	Heat waves will cause building overheating, therefore increasing pressure on cooling demand, and causing a reduction of the thermal comfort of building users. Extreme heat can also lead to a loss of biodiversity, which cannot withstand extreme weather conditions, and can cause fires, which are likely to cause superficial and structural damage to the building and could potentially cause injury or loss of life.
E	Drought	The UKCP18 models[2] predict an increase in summer temperatures coupled with a decrease in summer precipitation. This will likely lead to an increased risk of droughts.	Increased risk of drought could lead to water shortages and increased likelihood of drought orders and water rationing. This can also impact on biodiversity.

		Information from the Environment Agency[7] states that areas supplied by United Utilities are currently under moderate stress. Under various climate change scenarios, they predict that water stress will remain moderate, and they designate the final stress as 'not serious'.	
F	Milder winters	UKCP18 modelling[2] data predicts a 0-1˚C winter mean temperature increase during 2020-2039, a 0-2˚C winter mean temperature increase by 2040-2059, and a 0-3˚C winter mean temperature increase by 2060-2079. This will likely lead to milder winters.	Milder winters should reduce demand on building heating systems and consequently improve occupant thermal comfort.
G	Wetter winters	UKCP18 data[2] predicts a 0-10% increase in winter precipitation by 2020-2039. By 2040-2059 a 0-10% increase, and by 2060-2079 a 0-20% increase in winter precipitation is predicted. UKCP18 maps (figure 6) predict a 1-day winter precipitation risk scenario increase to 51-52mm by 2085, up from a 47mm 1-day event in 2024.	Wetter winters might lead to increased flood risk, and demand on drainage systems. See Hazard A for details on flood impacts.
H	Warmer summers and increased solar radiation	The UKCP18 models[2] predict an increase in summer temperatures coupled with a decrease in summer precipitation. This will likely lead to increased summer UV radiation. UKCP18 data as per hazard D.	Warmer summers are likely to reduce the thermal comfort of employees and increase reliance on cooling systems (e.g. air conditioning). However, it is also likely to reduce reliance on heating systems. Overheating is likely to be a greater issue in urban areas due to the 'urban heat island' effect. Increased levels of UV rays are likely to lead to increased corrosion and damage to the exterior of the building. Higher levels of UV rays are also linked to higher rates of skin cancer and damage to the human eye.

I	Temperature variation	According to Met Office records[1] for Rochdale, July was typically the hottest month with an average maximum temperature of 20.01°C, and February was typically the coldest month with an average minimum temperature of 1.41°C. UKCP18 data[2] predicts a rise in both winter and summer average temperatures, but maps (figure 5) predict a maximum summer air temperature of 37°C by 2085 (50th percentile).	A wider range of temperatures will create increased demand on building heating and cooling systems, which will need to operate across higher temperature ranges to maintain occupant thermal comfort. This will also likely lead to a loss in biodiversity, as species emigrate to milder climates.
J	Precipitation, e.g. rain and snow	UKCP18 data[2] predicts a 0-10% increase in winter precipitation and a 0-10% reduction in summer precipitation from 2020-2039. By the 2040-2059 a 0-10% increase in winter precipitation and a 10-20% decrease in summer precipitation is predicted. During the 2060-2079 period, a 0-20% increase in winter precipitation and a 10-30% decrease in summer precipitation is expected. Ranges depend on emissions scenarios. Data for the North-West England region.	See Hazards A, G for impacts of increased precipitation. Decrease in precipitation could lead to droughts, and increased strain on water supply systems. See Hazard E for impacts resulting from this.
K	Subsidence or ground movement	British Geological Survey mapping[10] shows that the site has low-to-nil potential for landslides. Climate change projection data shows a likely increase in winter precipitation; therefore, the risk may potentially increase in the future. British Geological Survey mapping[6] shows that the site has a low level of soils subject to clay shrinkage.	Shrinkage of dry soils increases the risk of subsidence, which can lead to landslides. This has the potential to cause superficial and structural damage to the building and can potentially lead to injury or loss of life.
L	Air Quality	Defra air quality mapping[4] show that in 2023 there were 3.94 days where background ozone was greater than 120 µg m^{-3}. The number of ozone particles is likely to increase in the future due to rising temperatures predicted by UKCP18 modelling[2]. UKCP18 temperature as per hazard number 1.	Increased ozone particles can have short term health effects (e.g. irritation of the airways, throat and eyes). It can also have long term health consequences for building users (e.g. increased levels of asthma).

Risk Estimation and Evaluation



6.0 RISK ESTIMATION AND EVALUATION

6.1 Risk Assessment

This risk assessment is based on the information outlined in the hazard identification and assessment section of this report. For each hazard a likelihood and consequence score has been estimated. These estimations have considered structural stability, structural robustness, weather proofing and detailing, material durability, health and safety of building occupants and others and impacts on building contents and business continuity. A risk level has been awarded to each risk, with green being the lowest risk and red being the highest. Risk levels are calculated using the following scoring matrix:

Figure 8 presents a risk assessment graph, detailing the relative impacts of hazards A-L as identified in Section 5.0. Each hazard has been appraised against the combined product of their likelihood and severity; both measured on a scale of 1-5 based on the RCP scenarios described in Section 3.1 and maps analysed earlier in Section 4:

Risk Likelihood

1. Very low likelihood
2. Low likelihood
3. Potentially dangerous / likely
4. Very dangerous / likely
5. High / fatal danger / very likely

Severity of Hazard

1. Very low risk
2. Low risk
3. Potentially likely
4. Likely
5. Very likely

Severity of hazard has been assessed against the following aspects:

- Structural stability
- Structural robustness
- Weather proofing and detailing
- Material durability
- Health and safety of building occupants and others
- Impacts on building contents and business continuity.

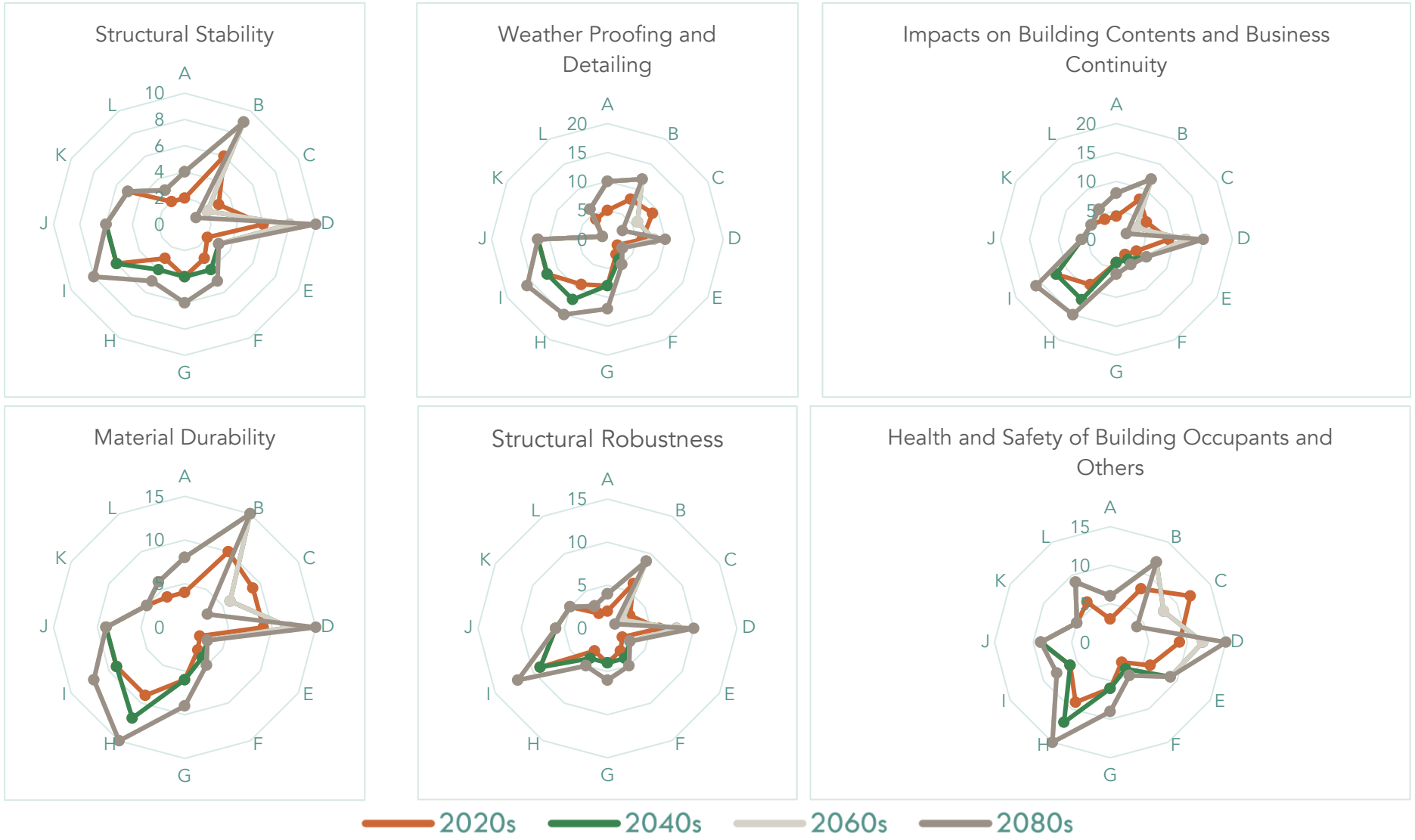


Figure 8: Risk Assessment Impact charts

6.2 Risk Management

The aim of this section is to provide potential design mitigation measures for the climate change hazards whose risk has been deemed significant. Significant risks have been determined using the table in the Risk Assessment section, with high-risk items considered in need of mitigation measures.

Risk ID	Issue	Potential Design Mitigation Measures
A	Flooding	- A Flood Risk Assessment has been undertaken to ensure full Flood Risk is considered. - Drainage has been designed to ensure an allowance is included to combat future changes in runoff (allow +30%). - Drainage design is in line with SUDS requirements - Building services should be situated higher up to reduce likelihood of damage from flooding
B	Storms (including high winds)	- The building fabric is designed to prevent water ingress. - Where flat roofs are present, they incorporate suitable drainage. - A material durability report is completed, to ensure the building is designed to protect from material damage / degradation from extreme weather. - Exposed areas of the building are sheltered from strong wind and rain - Planting is also sheltered from strong wind and rain.
C	Cold events	- A building occupant safety plan will be put in place for cold / freezing weather scenarios (e.g. external areas to be salted to reduce slip hazard). - A Thermal comfort assessment of the building has been undertaken and confirms that the building's heating strategy is capable of achieving occupant thermal comfort throughout winter months. - The building can structurally withstand pressure from heavy snowfall
D	Heat waves	- Thermal assessment of the building has been undertaken, and this has been extended to consider future climate changes in the 2020's and 2050's - Ensure that solar controls are provided on buildings - Integrate passive measures into the design (e.g. shape and orientation) - Use reflective building materials on the roof/facades to reduce thermal absorption of the fabric. - Allow for future provision of solar shading if needed - Maximise the thermal insulation in the building if possible - Specify efficient appliances and lighting that reduce internal heat gains. - Ensure mechanical air handling units do not discharge into frequented external spaces

		- Use natural ventilation where possible.
E	Drought	- Consider Rainwater or Greywater Recycling – or allowing for future fitting of such a system - Ensure low consumption sanitaryware is fitted - Ensure future maintenance regimes manage water consumption (e.g. review of data to identify leakages) - Review demand for water and identify means by which demand can be reduced (e.g. more efficient equipment) - Do not irrigate landscaping – ensure that drought tolerant native species are planted
F	Milder winters	- Despite the building heating demand being lessened during milder winters, ensure the building is still designed to withstand extreme events
G	Wetter winters	- As per Hazard A, a Flood Risk Assessment is completed, and includes further analysis of surface water flood risk. - Drainage has been designed to withstand prolonged periods of wet weather (including an allowance for climate change). - Drainage design is in line with SUDS requirements.
H	Warmer summers and increased solar radiation	- See Hazard D - Health and safety procedures should be put into place for people working outside on days with a high UV Index. - External building materials should be specified that are highly resilient to corrosion from UV. - Measures should be put into place to minimise glare for building users e.g. blinds or brise soleil.
I	Temperature variation	- A Thermal Comfort Assessment is completed to ensure heating and cooling demand can be met for winter and summer operative ranges. This includes extreme warm / cold weather scenario, and has been extended to consider future climate changes in the 2020's and 2050's. - Install passive design measures into the design. - Maximise the thermal insulation in the building if possible
J	Precipitation, e.g. rain and snow	- See Hazard G. - The building can structurally withstand pressure from heavy snowfall
K	Subsidence or ground movement	- Ensure Ground Investigation looks at soil types to further confirm the likelihood of this - Locate the building in a flat area where possible, away from sloped ground. - Ensure the building is designed to avoid any potential soil shrinkage/subsidence/swelling issues - Ensure the building is designed to withstand ground movement.
L	Air Quality	- Increased vegetation planting on and around the site. - Encouraging staff and visitors to reduce the use of private vehicles. - Choose surface materials that reduce dirt particles in the air. - Design of the building to increase separation distances from sources of air pollution

Conclusion

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7.0 CONCLUSION

Mainer have performed an adaption and mitigation to climate change study for Fusion, 10-12 Whitworth Street in Manchester with the purpose of identifying hazards and risks that are likely to result from a range of climate change scenarios. A systematic risk assessment to identify the impact of expected extreme weather conditions arising from climate change on the building over its projected life cycle has been performed with resulting recommendations being listed below. Implementation from the design team of the recommendations must be adhered to and detailed. Where not possible the design team can discuss omissions with the assessor of this report and justification/compromises can be arranged. Alongside an update produced during the Technical Design stage of the project, the BREEAM credits associated with WST 05 can be awarded.

7.1 Recommendations

- Remain in line with the commitment made by Manchester City Council to becoming carbon neutral by 2038
- Perform a Low Zero Carbon (LZC) technology study to see what sustainable energy sources can be utilised on the development
- Perform a thermal comfort study considering climate change scenarios to ensure the building can maintain the health and well-being of its occupants
- Completion of the Flood Risk Assessment and Surface Water-run Off strategy detailing risk of flooding and the appropriate allowances for future climate change. It is advised that detailed consideration is given to the longevity of the drainage systems and their capacity to deal with future climate change
- Specification of leak detection systems
- Specification of low consumption sanitaryware to mitigate against potential reduction in availability of potable water because of drier summer

- External envelope and structure to be designed to withstand the effects of driving rain and increased wind velocity and any associated subsidence variance.
- Roof to be designed to withstand the effects of potential overwhelming and increased structural damage
- Consider incorporating ecological features into the development to improve flood defences and reduce carbon

Appendices

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APPENDIX A: REFERENCES

1. Met Office historic weather information: https://www.metoffice.gov.uk/public/weather/climate/
2. UKCP18 climate change projection maps and data: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/summaries/climate-change-projections-over-land
3. UKCP Met Office projected maximum air temperature & 1-day precipitation maps: https://ukclimateprojections-ui.metoffice.gov.uk/products
4. Defra air quality mapping: https://uk-air.defra.gov.uk/data/gis-mapping
5. Modelled climate change sea level rise mapping: https://coastal.climatecentral.org/map/
6. British Geological Survey soil shrinkage mapping: https://www.bgs.ac.uk/products/geosure/shrink_swell.html
7. Environment Agency UK water stress report: https://www.gov.uk/government/publications/water-stressed-areas-2021-classification; https://www.gov.uk/government/publications/water-stressed-areas-2013-classification
8. Environment Agency River catchment map outlining water quality: http://environment.data.gov.uk/catchment-planning/
9. Environment Agency long-term flood risk mapping: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map
10. British Geological Survey land slide potential mapping: https://www.bgs.ac.uk/products/geosure/landslides.html
11. BRE driven rain map: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975999/wic-appendix-a.pdf

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APPENDIX B: ASSESSOR CV



Alex Thompson
Senior Sustainability Consultant

Alex has joined Mainer, from BDP, as a Senior Sustainability Consultant.

Alex's background in architecture has helped him gain an extensive understanding of building strategies and functions, which he has incorporated into his work in Embodied and WLCA, and LCC, including creating client-friendly strategies / processes to undertake these.

He has worked closely with clients and certified numerous projects across BREEAM UK new construction, delivering both assessments and strategies to projects.

Qualifications

- BREEAM Assessor (UK New Construction)
- BA Architecture (Hons)

07496 221026
LinkedIn/Alex Thompson
alex.thompson@mainer.co.uk