Fair Isle Harbour Improvement Works

A.9 Climate Change

On behalf of **Shetland Isle Council (SIC)**

Shetland Islands Council

Project Ref: 11168 | Rev: Version 1.0 | Date: April 2023

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: 10 Queen Square, Bristol, BS1 4NT
T: +44 (0)117 332 7840 E: bristol@stantec.com

Fair Isle Harbour Improvement Works

A9.1 Climate Change Policy

On behalf of **Shetland Isle Council (SIC)**

Shetland Islands Council

Project Ref: 11168 | Rev: Version 1.0 | Date: April 2023

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: 10 Queen Square, Bristol, BS1 4NT
T: +44 (0)117 332 7840 E: bristol@stantec.com

Appendix 9.1 Climate Change Policy Context

To satisfy the requirements of the Environmental Impact Assessment (EIA) Directive and the, a Greenhouse Gas (GHG) Emissions Assessment has been undertaken for the Fair Isle Harbour Improvement Works. This Appendix sets out the guidance and standards that have been used to inform the scope, methodology, identification of likely significant effects and potential mitigation measures.

GHG Emissions Assessment

Legislation

Paris Agreement 2015

The 2015 Paris Agreement (UN, 2015) declared a long-term temperature target to strengthen the global response to the threat of climate change. This target is to keep a global temperature rise this *century "well below 2 degrees Celsius above pre-industrial levels and to limit the temperature increase even further to 1.5 degrees Celsius"* (the '1.5 Degrees Target').

In 2015 the UK Government signed the Paris Agreement, and in 2016, ratified it. Ratifying the Paris Agreement formally bound the UK to the "*well below 2 degrees*" target (in 2018 reduced further to the 1.5 Degrees Target) and requires the UK Government to translate that commitment into legislative requirements. Through national legislation, the responsibility to realise the 1.5 Degrees Target disseminates from the UK Government to Local Planning Authorities (LPAs) and, ultimately, developers.

Climate Change (Scotland) Act (CCA) 2009

The Climate Change Act (CCA) (Scotland) established the context for government action on climate change, providing a legal binding framework for Scotland to reduce GHG emissions and Develop Scotland's ability to adapt to Climate Change. Scottish Parliament to set a target for the year 2050, an interim target for the year 2020, and to provide for annual targets. The CCA (Scotland) requires the Government to set annual targets for the maximum amount of net Scottish emissions and ensure that the emissions figure does not exceed this target.

Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

In 2019, the CCA (Scotland) was amended to include a revision of the previous aim of a 50% reduction of GHG emissions compared to 1990 levels by 2050. The CCA (Scotland) 2009 now mandates a net zero target by 2045:

"The Scottish Ministers must ensure that the net Scottish emissions account for the net-zero emissions target year is at least 100% lower than the baseline (the target is known as the "net-zero emissions target").

The "net-zero emissions target year" is 2045."

To reach net zero emissions, the Scottish government has set legally binding carbon budgets, capping the amount of GHG emitted in Scotland each year.

Table A9.1: Climate Change (Emissions Reduction Targets) (Scotland) 2019

Year	Annual target reduction from 1990 baseline
2018	54.0%
2019	55.0%
2020 (interim target)	**56.0%**
2021	57.9%
2022	59.8%
2023	61.7%
2024	63.6%
2025	65.6%
2026	67.4%
2027	69.3%
2028	71.2%
2029	73.1%
2030	75.0%
2040 (interim target)	**90.0%**
2045	100.0% (net-zero emissions)

Scottish Budget 2022 to 2023: carbon assessment

The Scottish budget: carbon assessments are made in accordance with the expenditure data in the 2022-2023 budget and fulfils the statutory requirement under Section 94 of the Climate Change.

"It is estimated that total emissions attributed to the 2022-23 Budget amount to 9.9 million tonnes carbon dioxide equivalent (MtCO2e). Applying the updated model to last year's 2021-22 Budget leads to a downward revision from the published 10.2 MtCO2e to 9.8 MtCO2e. (Scotland) Act 2009 to report upon the emissions impact of expenditure proposals."

The Glasgow Climate Pact 2021 (COP26 Pact)

The UK, along with other Nations, adopted the Glasgow Climate Pact (UNFCCC, 2021) at the COP26 UN climate conference in November 2021. The Pact increases the climate ambition and action from the Paris Agreement in 2015, and sets out new rules to reduce greenhouse gas emissions including phasing down coal and creation of a global carbon market.

Town and Country Planning (EIA) (Scotland) Regulations 2017

Schedule 4 of the 2017 EIA Regulations (Scotland Government, 2017) requires an Environmental Statement to include:

"4. *A description of the factors specified in regulation 4(3) likely to be significantly affected by the development: climate (for example greenhouse gas emissions, impacts relevant to adaptation)*

5. A description of the likely significant effects of the development on the environment resulting from, inter alia:

(f)the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;"

National Policy and UK Government Strategies

National Planning Policy Framework (NPFF) 2021

In terms of planning, addressing climate change is one of the core planning principles which the National Planning Policy Framework (NPPF) (MHCLG, 2021a) expects plan-making and decision-taking to underpin. The NPPF recognises that planning plays a key role in reducing GHG emissions.

Paragraph 152 states:

"*The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure*"

Paragraph 154 states:

"*New development should be planned for in ways that:*

b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards."

Planning Practice Guidance (PPG)

The Planning Practice Guidance (PPG) (MHCLG, 2021b) supports the NPPF. Regarding climate change, the PPG advises how to identify suitable mitigation measures in the planning process to address the impacts of climate change.

Paragraph: 007 Reference ID: 6-007-20140306 discusses how local planning authorities can identify appropriate mitigation measures in plan-making:

"*Every area will have different challenges and opportunities for reducing carbon emissions from new development such as homes, businesses, energy, transport and agricultural related development.*

…The distribution and design of new development and the potential for servicing sites through sustainable transport solutions, are particularly important considerations that affect transport emissions. Sustainability appraisal should be used to test different spatial options in plans on emissions.

Different sectors may have different options for mitigation. For example, measures for reducing emissions in agricultural related development include anaerobic digestion, improved slurry and manure storage and improvements to buildings. In more energy intensive sectors, energy efficiency and generation of renewable energy can make a significant contribution to emissions reduction."

Update to the Climate Change Plan 2018 – 2031: securing a Green Recovering on a Path to net Zero

The Update to the Climate Change Plan 2018 – 2031: Securing a Green Recovery on a Path to net zero, updates the 2018 Climate Change Plan. This plan details Scotland's approach to green recovery and provides clarity on how it will meet its climate change targets. The approach will be iterative and will assist the preparation of the next Statutory Climate Change Plan, which is to be completed by early 2025.

Decarbonising the Scottish Transport Sector

This report assesses what policy outcomes Scotland needs to achieve in order for the transport sector to meet the GHG emissions targets outlined above and make a successful transition to net zero.

The main policy outcomes are in relation to vehicle technology and behavioural change. Efforts must be made to continue innovative technological development and people and businesses must choose more sustainable, active travel options.

Local Planning Policy

The Site is within the administrative council of The Shetland Islands, so the following policy documents have been reviewed:

- Shetland Local Development Plan (2014).

Shetland Local Development Plan 2014

Policy GP1 Sustainable Development

"Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals.

New residential, employment, cultural, educational and community developments should be in or adjacent to existing settlements that have basic services and infrastructure in order to enhance their viability and vitality and facilitate ease of access for all.

This will be achieved through Allocations, Sites with Development Potential and Areas of Best Fit."

Policy GP2 General Requirements for All Development

"Applications for new buildings or for the conversion of existing buildings should meet all of the following General Requirements:

c. Development should be located, constructed and designed so as to minimise the use of energy and to adapt to impacts arising from climate change, such as the increased probability of flooding; water stress, such as water supply; health or community impacts as a result of extreme climatic events; and a change in richness of biodiversity;

e. All new buildings shall avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, through the installation and operation of low and zero-carbon generating technologies (LZCGT). The proportion of such emissions shall be specified in the council's Supplementary Guidance – Design. That guidance will also set out the approach to existing buildings which are being altered or extended, including historic buildings, and the approach to applications where developers are able to demonstrate that there are significant technical constraints to using on-site low and zero carbon generating technologies;

j. Development should not have a significant adverse effect on existing uses;

k. Development should not compromise acceptable health and safety standards or levels;

l. Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance. Development should not have a significant adverse effect on existing uses;"

Standards and Guidance

The following standards and guidance documents have been used to inform the carbon scope, methodology, identify likely significant effects and potential mitigation measures.

Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emission and Significance

IEMA guidance (IEMA, 2022) identifies three underlying principles to inform the assessment of significance:

- *"The GHG emissions from all projects will contribute to climate change, the largest interrelated cumulative environmental effect.*
- *The consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive (e.g. human health, biodiversity, water, land use, air quality).*
- *GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit; as such any GHG emissions or reductions from a project might be considered to be significant."*

World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) Greenhouse Gas Protocol guidance

The Greenhouse Gas Protocol (WBCSD and WRI, 2004) identifies emissions sources as falling under three "scopes", which are defined to enable GHG accounting and reporting. These scopes are defined below:

- **Scope 1: Direct GHG emissions**: direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment. GHG emissions not covered by the Kyoto Protocol, e.g. CFCs, NOx, etc. shall not be included in scope 1 but may be reported separately.
- **Scope 2: Electricity indirect GHG emissions**: Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
- **Scope 3: Other indirect GHG emissions**: Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Publicly Available Standard 2060: Specification for the Demonstration of Carbon Neutrality

PAS 2060 (BSI, 2014) specifies the requirements to demonstrate carbon neutrality. The document sets out key definitions, how to quantify carbon footprint, how to achieve GHG emissions reductions and how offsetting should be implemented for any residual emissions.

Publicly Available Standard 2080: Carbon Management in Infrastructure

PAS 2080 (BSI, 2016) sets out a carbon management process for the delivery of infrastructure. PAS 2080 defines the life cycle stages of an infrastructure project and the primary sources of GHG emissions. The PAS 2080 life cycle stages have been used in this GHG emissions assessment, as shown in Figure A9.1 below.

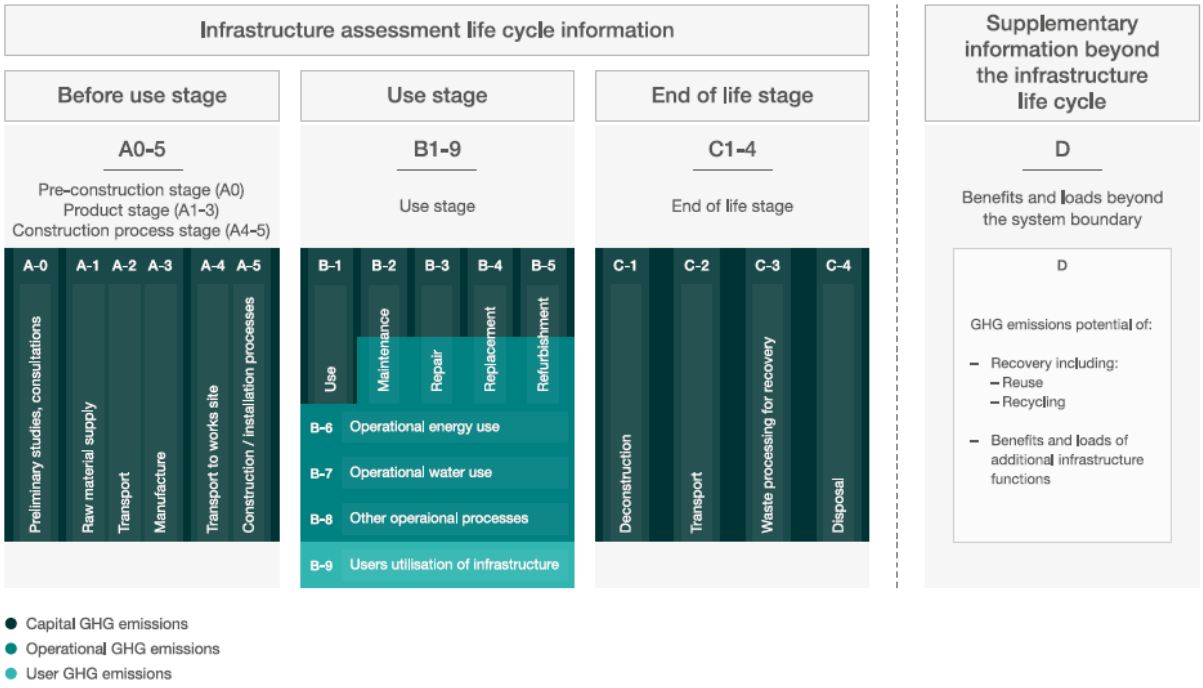

Figure A9.1: Infrastructure life cycle stages. Copy of PAS 2080 Figure 7.

Climate Change Risk Assessment

Legislation

Climate Change (Scotland) Act (CCA) 2009

The Climate Change Act (CCA) (Scotland) established the context for government action on climate change, providing a legal binding framework for Scotland to reduce GHG emissions and Develop Scotland's ability to adapt to Climate Change. Scottish Parliament to set a target for the year 2050, an interim target for the year 2020, and to provide for annual targets. The CCA (Scotland) requires the Government to set annual targets for the maximum amount of net Scottish emissions and ensure that the emissions figure does not exceed this target.

Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

In 2019, the CCA (Scotland) was amended to include a revision of the previous aim of a 50% reduction of GHG emissions compared to 1990 levels by 2050. The CCA (Scotland) 2009 now mandates a net zero target by 2045.

National Adaptation Programme

The second national adaptation programme (2018 to 2023), published by the Department for Environment, Food & Rural Affairs (Defra) in July 2018 (DEFRA, 2018b)., identifies key risks to infrastructure, people and the built environment, and how the government will address climate risks including flood and coastal erosion risk management, water supplies and resources, overheating in buildings, delivery of health and social care services, emergency services, local responders and community resilience.

Climate Change Risk Assessment 2021

The UK CCA 2008 requires Government to prepare a five-yearly assessment of the risks for the UK of the current and predicted impacts of climate change. These reports are prepared by the devolved administrations of Northern Ireland, Scotland and Wales and submitted to the UK Parliament. The UK Climate Risk Independent Assessment (CCRA3) (UK Climate Risk, 2021), published in 2021, sets out the six priority risk areas requiring further action in the UK. These areas are:

- Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazard.
- Risks to soil health from increased flooding and drought.
- Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions.
- Risks to crops, livestock and commercial trees from multiple hazards.
- Risks to supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks.
- Risks to people and the economy from climate-related failure of the power system.
- Risks to human health, wellbeing and productivity from increased exposure to heat in homes and other buildings.
- Multiple risks to the UK from climate change impacts overseas.

Town and Country Planning (EIA) (Scotland) Regulations 2017

Schedule 4 of the 2017 EIA Regulations (Scotland Government, 2017) requires an Environmental Statement to include:

"4. *A description of the factors specified in regulation 4(3) likely to be significantly affected by the development: climate (for example greenhouse gas emissions, impacts relevant to adaptation).*

5. A description of the likely significant effects of the development on the environment resulting from, inter alia:

(f)the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change."

National Policy and UK Government Strategies

National Planning Policy Framework (NPPF) 2021

In terms of planning, addressing climate change is one of the core planning principles which the National Planning Policy Framework (NPPF) (MHCLG, 2021a) expects plan-making and decision-taking to underpin. The NPPF recognises that planning plays a key role in minimising vulnerability, providing resilience and managing the risks associated with climate change.

Paragraph 153 states:

"*Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure*."

Paragraph 154 states that new development should be planned for in ways that:

"*a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure."*

Planning Practice Guidance (PPG)

The Planning Practice Guidance (PPG) (MHCLG, 2021a) supports the NPPF. Regarding climate change, the PPG advises how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change.

Paragraph 004 Reference ID: 6-004-20140612 provides guidance on how adaptation and mitigation approaches should be integrated as follows:

"*When [preparing Local Plans and] taking planning decisions local planning authorities should pay particular attention to integrating adaptation and mitigation approaches and looking for 'win-win' solutions that will support sustainable development. This could be achieved in a variety of ways, for example:*

…through the provision of multi-functional green infrastructure, which can reduce urban heat islands, manage flooding and help species adapt to climate change - as well as contributing to a pleasant environment which encourages people to walk and cycle.

Local planning authorities should be aware of and avoid the risk of maladaptation (adaptation that could become more harmful than helpful)."

Paragraph: 005 Reference ID: 6-005-20140306 provides guidance on dealing with the uncertainty of climate risks when promoting adaptation in particular developments:

"*The impact of climate change needs to be taken into account in a realistic way. In doing so, local planning authorities will want to consider:*

- *identifying no or low cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity;*
- *building in flexibility to allow future adaptation if it is needed, such as setting back new development from rivers so that it does not make it harder to improve flood defences in future; and*
- *the potential vulnerability of a development to climate change risk over its whole lifetime*"

Local Planning Policy

The Site is within the administrative council of The Shetland Islands, so the following policy documents have been reviewed:

- Shetland Local Development Plan (2014).

Shetland Local Development Plan 2014

Policy GP1 Sustainable Development

"Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals.

New residential, employment, cultural, educational and community developments should be in or adjacent to existing settlements that have basic services and infrastructure in order to enhance their viability and vitality and facilitate ease of access for all.

This will be achieved through Allocations, Sites with Development Potential and Areas of Best Fit."

Policy GP2 General Requirements for All Development

"Applications for new buildings or for the conversion of existing buildings should meet all of the following General Requirements:

c. Development should be located, constructed and designed so as to minimise the use of energy and to adapt to impacts arising from climate change, such as the increased probability of flooding; water stress, such as water supply; health or community impacts as a result of extreme climatic events; and a change in richness of biodiversity;

e. All new buildings shall avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, through the installation and operation of low and zero-carbon generating technologies (LZCGT). The proportion of such emissions shall be specified in the council's Supplementary Guidance – Design. That guidance will also set out the approach to existing buildings which are being altered or extended, including historic buildings, and the approach to applications where developers are able to demonstrate that there are significant technical constraints to using on-site low and zero carbon generating technologies;

j. Development should not have a significant adverse effect on existing uses;

k. Development should not compromise acceptable health and safety standards or levels;

l. Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance. Development should not have a significant adverse effect on existing uses;"

Standards and Guidance

The following standards and guidance documents have been used to inform the climate change resilience and adaptation scope, methodology, identify likely significant effects and potential mitigation measures.

Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation

The IEMA guidance (IEMA, 2020) sets out the factors that the assessment should establish the baseline conditions. IEMA guidance states:

"*The current baseline is defined by historic climate conditions and the prevailing conditions at the time of the assessment.* **...** *The practitioner needs to consider a range of factors including:*

- *Extremes in short-term weather events that produce sudden shocks that can have substantial effects on some baseline receptors, such as: heat waves; extreme flooding and freezing conditions; gales and hurricane force windstorms; storm surges along coastlines.*
- *Extremes in longer-term climatic variability including: variations in precipitation over one or more seasons resulting in drought or extremely wet conditions; variations in average temperature which might affect receptors reliant on temperature to, for example, time when breeding cycles commence or end (which may be affected by availability of specific food sources); potential changes in prevailing wind directions as the weather system over central Europe changes.*
- *Changes in average climate norms resulting in: sea level rise; increases in freezing/thawing; changes in seasonal rainfall patterns*."

This guidance has also been used to select the appropriate assessment scenario for defining the future baseline. IEMA guidance states:

"The recommended approach is to use a high emissions scenario, in the UK this would be RCP 8.5"

UKCP18 Guidance: How to use the UKCP18 Land Projections

The UKCP18 Guidance (Met Office, 2018) has been used to determine the correct application of the land projections data and to reference the uncertainty and limitations associated with its use.

"*We recommend that you place any analysis using the global, regional and derived projections in the broader uncertainty context of the probabilistic projections, where the information is available*."

Fair Isle Harbour Improvement Works

A9.2 Climate Projections Data

On behalf of **Shetland Isle Council (SIC)**

Shetland Islands Council

Project Ref: 11168 | Rev: Version 1.0 | Date: April 2023

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: 10 Queen Square, Bristol, BS1 4NT
T: +44 (0)117 332 7840 E: bristol@stantec.com

Appendix 9.2 Figures of Evolving Baseline Climate Projections

This document summarises in figure form the UK Climate Change Projections 2018 (UKCP18), produced by the UK Met Office, under the RCP8.5 probabilistic land projections for the 25 km grid cell within which the Site is located (UKCP18 437500, 1137500) between 2020 and 2099, as this is the last available year with data. This document should be read alongside **Chapter 9 Climate Change**.

Average Climatic Norms

Temperature

Figure A9.2.1 and **Table A9.2.1** show the projections for annual average mean air temperature. The projections show an almost continuous increase in annual average temperature over the next 80 years.

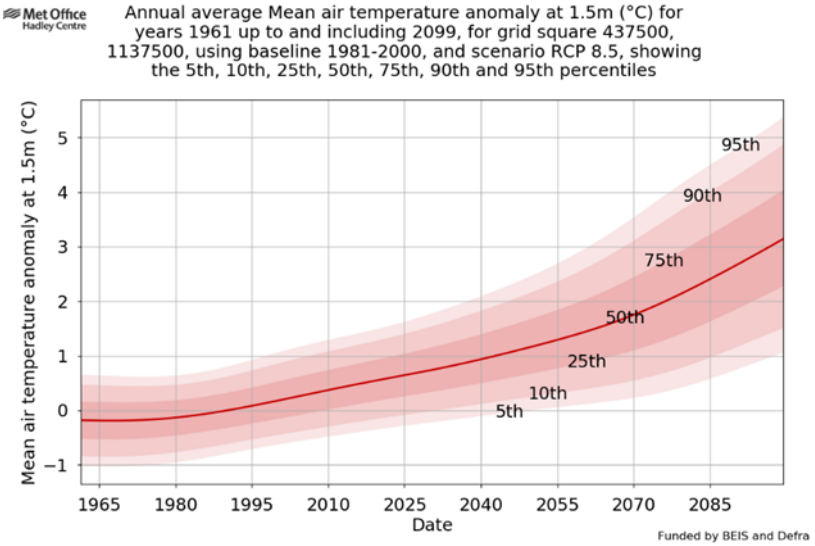

Figure A9.2.1 Annual average mean air temperature anomaly at 1.5m(°C) for years 1965-2099

Table A9.2.1: Annual average mean air temperature anomaly at 1.5m (Â°C)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-0.31365	-0.11738	0.217139	**0.597594**	0.984218	1.339034	1.555942
2024	-0.2889	-0.091	0.247578	**0.632758**	1.024629	1.385579	1.606409
2026	-0.26474	-0.06505	0.277716	**0.667815**	1.066173	1.434391	1.659893
2030	-0.21757	-0.01342	0.338424	**0.740203**	1.153861	1.539148	1.775631
2040	-0.10216	0.121062	0.502566	**0.943752**	1.403985	1.836741	2.104107
2050	0.0075	0.255828	0.681821	**1.175345**	1.691201	2.178018	2.484458
2075	0.324135	0.667534	1.261605	**1.963732**	2.707702	3.431331	3.891262
2099	1.058217	1.509726	2.272792	**3.141181**	4.039889	4.867733	5.371028

Between 2024 and 2026 (the construction period), mean annual air temperature may increase from 0.63°C to 0.66°C above 1981-2000 baseline temperatures. This is a change of 0.03°C for this time period. The 50th percentile shows a 1.18ºC increase by 2050 and a 3.14ºC increase by 2099. The uncertainty around these estimates range from 0.00 to 2.48ºC for 2050 and 1.06 to 5.37ºC for 2099.

Precipitation

Figure A9.2.2 and **Table A9.2.2** shows the projections for the annual average precipitation rate. The projections show that annual precipitation is likely to vary from year to year, with both increases and decreases over the next 80 years.

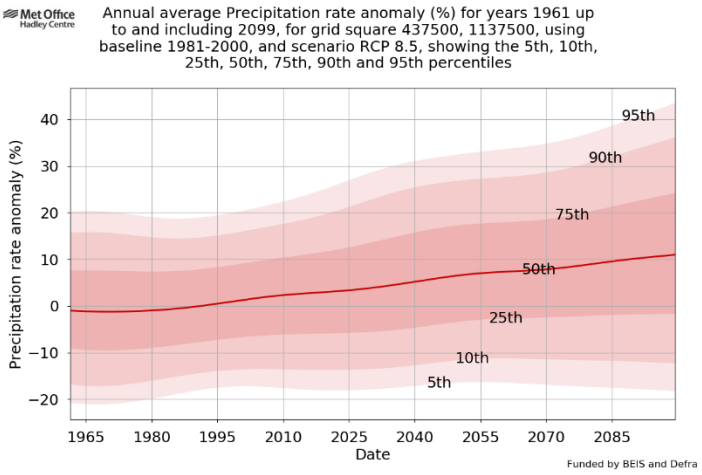

Figure A9.2.2: Annual average precipitation rate anomaly (%) for years 1965-2099..

Table A9.2.2 Annual average precipitation rate anomaly (%)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-18.0946	-13.7087	-5.83754	**3.145755**	12.06557	20.42351	26.02795
2024	-18.077	-13.6854	-5.78573	**3.297005**	12.41998	21.01783	26.71598
2026	-18.0324	-13.6444	05.72053	**3.469287**	12.80444	21.63391	27.29823
2030	-17.8665	-13.498	05.53257	**3.882739**	13.64721	22.87801	28.68898
2040	-17.0974	-12.6713	-4.61301	**5.224814**	15.80866	25.46539	31.08745
2050	-16.3745	-11.5809	-3.35606	**6.573253**	17.29809	26.86726	32.50558
2075	-17.1501	-11.578	-2.30283	**8.353897**	19.33488	29.55731	35.82379
2099	-18.2594	-12.321	1.7339	**10.96293**	24.1803	36.07267	43.42943

Between 2024 and 2026 (the construction period), average annual precipitation may change from 3.30% to 3.47% above 1981-2000 baseline temperatures. This is a change of 0.17% for this time period. The 50th percentile shows a 6.57% increase by 2050 and a 10.96% increase by 2099. The uncertainty around these estimates range from -16.37 to 32.51% for 2050 and -18.26 to 43.43% for 2099.

Seasonal Changes

Summer

Figure A9.2.3 and **Table A9.2.3** show the projections for maximum summer (June, July, August) maximum air temperature. The projections show an overall increase in maximum temperate over the next 80 years.

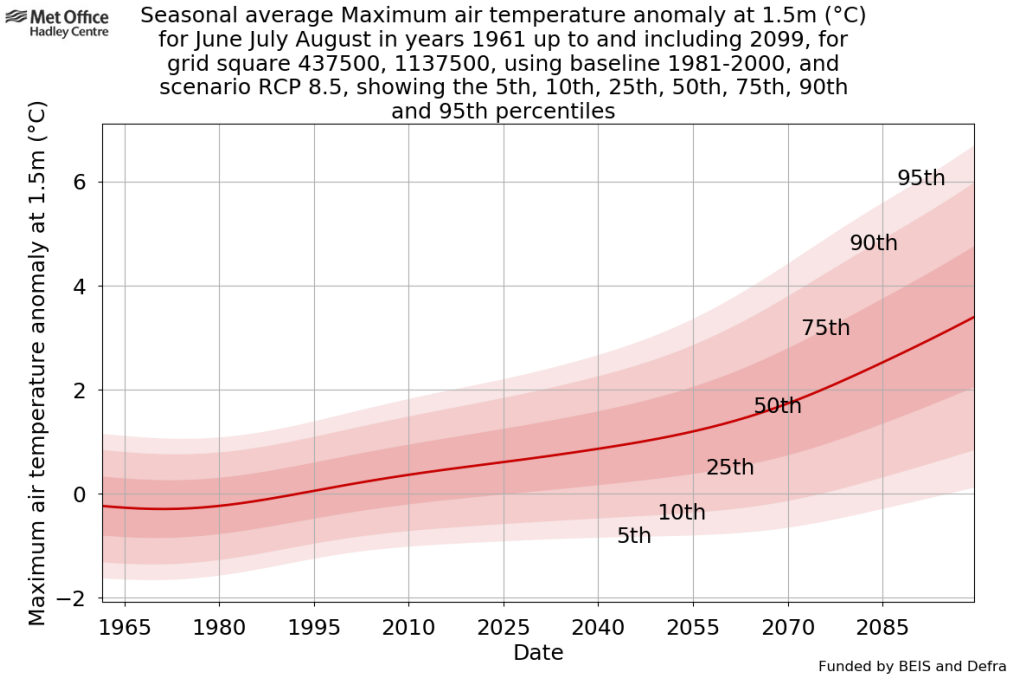

Figure A9.2.3 Summer average maximum air temperature anomaly at 1.5m (A°C) between 1965-2099.

Table A9.2.3 Maximum Summer air temperature anomaly at 1.5m (Â°C)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-0.92702	-0.60123	-0.04244	**0.571156**	1.199006	1.782705	2.137701
2024	-0.91437	-0.58562	-0.01923	**0.602343**	1.23932	1.830744	2.188943
2026	-0.90433	-0.57031	0.002811	**0.633853**	1.280348	1.879992	2.242019
2030	-0.8834	-0.54035	0.050124	**0.698702**	1.365287	1.983215	2.355249
2040	-0.842	-0.46985	0.17088	**0.875002**	1.599116	2.274599	2.68543
2050	-0.81507	-0.40221	0.306959	**1.083658**	1.890516	2.645124	3.114295
2075	-0.53863	0.006596	0.935759	**2.003936**	3.133682	4.199635	4.861878
2099	0.118167	0.838288	2.045741	**3.398593**	4.760821	5.98	6.697012

Between 2024 and 2026 (the construction period), maximum summer air temperature may increase from 0.60°C to 0.63°C above 1981-2000 baseline temperatures. This is a change of 0.03°C for this time period. The 50th percentile shows a 1.08ºC increase by 2050 and a 3.40ºC increase by 2099. The uncertainty around these estimates range from -0.82 to 3.11ºC for 2050 and 0.12 to 6.70ºC for 2099.

Figure A9.2.4 and **Table A9.2.4** show the projections for average summer precipitation rate. The projections show an overall decline in precipitation over the next 80 years.

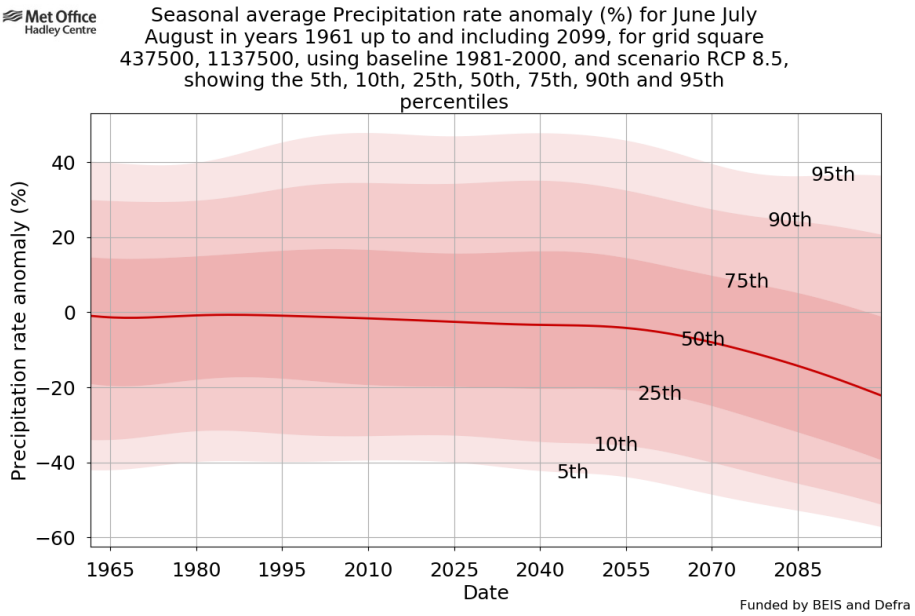

Figure A9.2.4 Summer average precipitation rate anomaly (%) for years 1965-2099.

Table A9.2.4: Average summer precipitation rate anomaly (%)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-39.7809	-32.7603	-19.8468	**-2.38806**	15.70204	34.14004	46.89094
2024	-39.9636	-32.829	-19.8854	**-2.51867**	15.64626	34.18982	46.85398
2026	-40.1952	-32.9527	-19.9358	**-2.65393**	15.6368	34.28326	46.88915
2030	-40.7899	-33.3566	-20.082	**-2.9201**	15.74822	34.51705	47.13414
2040	-42.3413	-34.5793	-20.4259	**-3.37484**	16.24476	35.01971	47.6766
2050	-43.1992	-35.105	-20.4118	**-3.71097**	15.46599	33.64515	46.75084
2075	-50.2763	-42.1418	-27.4449	**-10.1046**	8.08852	25.91857	37.43844
2099	-57.1846	-51.2065	-39.3638	**-22.1469**	-1.13194	20.68814	36.39218

Between 2024 and 2026 (the construction period), average summer precipitation may change from -2.52 % to -2.65% compared to 1981-2000 baseline precipitation. This is a change of 0.13% for this time period. The 50th percentile shows a -3.71 % increase in 2050 and a -22.15% increase in 2099. The uncertainty around these estimates range from -43.20 to 46.75 % in 2050 and -57.18 to36.39% in 2099.

Winter

Figure A9.2.5 and **Table A9.2.5** show the projections for average winter (December, January, February) minimum air temperature. The projections show an overall increase in minimum temperate over the next 80 years.

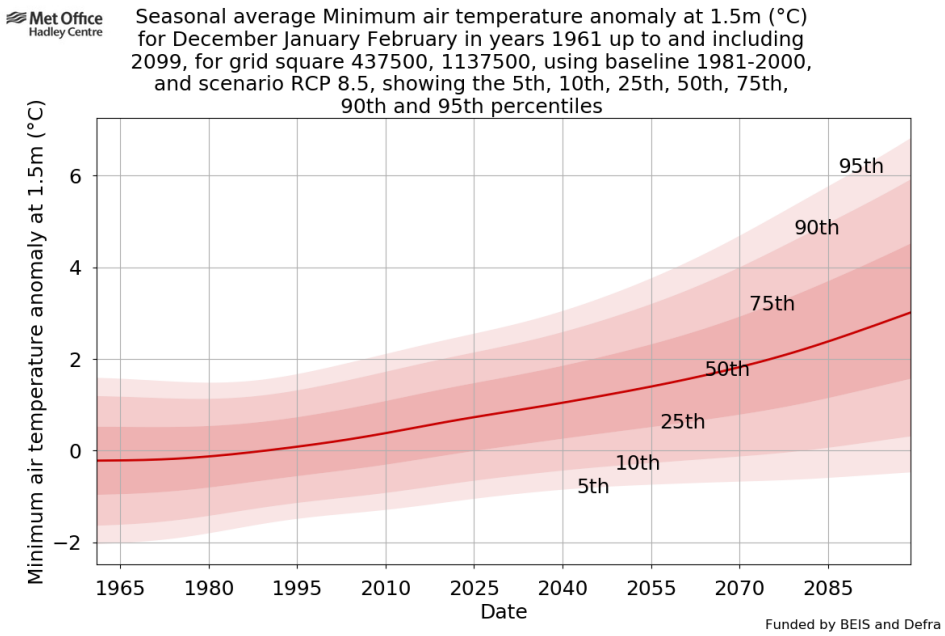

Figure A9.2.5 Winter average minimum air temperature anomaly at 1.5m (A°C) between 1965-2099.

Table A9.2.5: Minimum winter air temperature anomaly at 1.5m (Â°C)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-1.0979	-0.70638	-0.06419	**0.666761**	1.401742	2.064184	2.468093
2024	-1.06506	-0.67152	-0.0255	**0.710639**	1.450801	2.117446	2.524781
2026	-1.03335	-0.637993	0.12124	**0.753132**	1.498834	2.170224	2.581529
2030	-0.97397	-0.57454	0.084816	**0.835536**	1.594085	2.277417	2.698586
2040	-0.85022	-0.43306	0.26173	**1.046901**	1.852789	2.587871	3.047631
2050	-0.76884	-0.31815	0.431846	**1.27705**	2.154026	2.977397	3.49918
2075	-0.65351	-0.07329	0.892494	**1.991908**	3.16605	4.311689	5.041578
2099	-0.4725	0.312663	1.569497	**3.015503**	4.518761	5.917608	6.818497

Between 2024 and 2026 (the construction period), minimum winter air temperature may increase from 0.71°C to 0.75°C above 1981-2000 baseline temperatures. This is a change of 0.04°C for this time period. The 50th percentile shows a 1.28ºC increase by 2050 and a 3.02ºC increase by 2099. The uncertainty around these estimates range from -0.77 to 3.50ºC for 2050 and -0.47 to 6.82ºC for 2099.

Figure A9.2.6 and **Table A9.2.6** shows the projections for average winter precipitation rate. The projections show an overall increase in precipitation over the next 80 years.

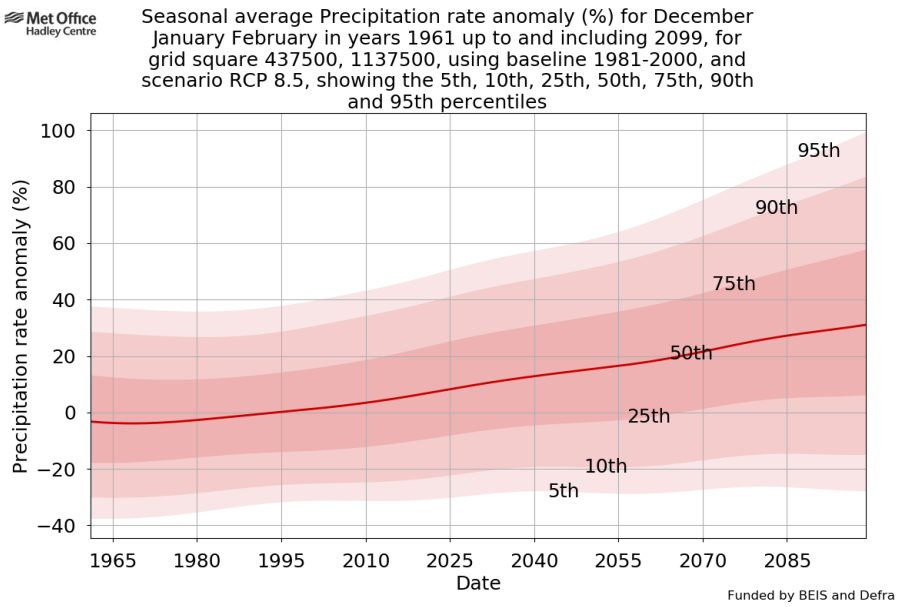

Figure A9.2.6 Winter average precipitation rate anomaly (%) between 1965-2099.

Table A9.2.6: Average winter precipitation rate anomaly (%)

Date	Percentile						
	5th	10th	25th	50th	75th	90th	95th
2022	-30.7562	-23.1033	-9.10239	**7.190216**	23.80325	39.29801	48.84865
2024	-30.4291	-22.6218	-8.49835	**7.888153**	24.73521	40.48759	49.94054
2026	-30.0509	-22.1045	-7.8954	**8.583384**	25.63981	41.47189	51.0286
2030	-29.2279	-21.0503	-6.74012	**9.928871**	27.31467	43.34859	53.09465
2040	-27.9288	-19.3546	-4.6048	**12.84974**	30.76561	47.26406	57.21496
2050	-28.5071	-19.4724	-3.45799	**15.29894**	34.05421	51.0982	61.27424
2075	-26.6436	-15.7523	2.892576	**23.63892**	45.07832	66.20276	79.59649
2099	-27.9478	-15.0393	6.042503	**31.04261**	57.71663	83.51155	99.25871

Between 2024 and 2026 (the construction period), average winter precipitation may change from 7.89% to 8.58% compared to 1981-2000 baseline precipitation. This is a change of 0.69 % for this time period. The 50th percentile shows a 15.3 % increase in 2050 and a 31.04 % increase in 2099. The uncertainty around these estimates range from -28.51 to 61.27 % in 2050 and -27.95 to 99.26 % in 2099.

In the UK, the heaviest snowfalls tend to occur when the air temperature is between zero and 2°C[1]. There is less certainty in the magnitude of change to snow occurrence and amount, although climate models do show a downward trend in both falling and lying snow over time.

Together, the above projections suggest that winters will become milder and wetter. Natural variations may mean that some cold and/or dry winters may still occur.

[1] https://www.metoffice.gov.uk/weather/learn-about/weather/types-of-weather/snow/how-does-snow-form