HyNet North West

ENVIRONMENTAL STATEMENT (VOLUME II)

Chapter 7 – Climate Resilience

HyNet Carbon Dioxide Pipeline DCO

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulations 5(2)(a)

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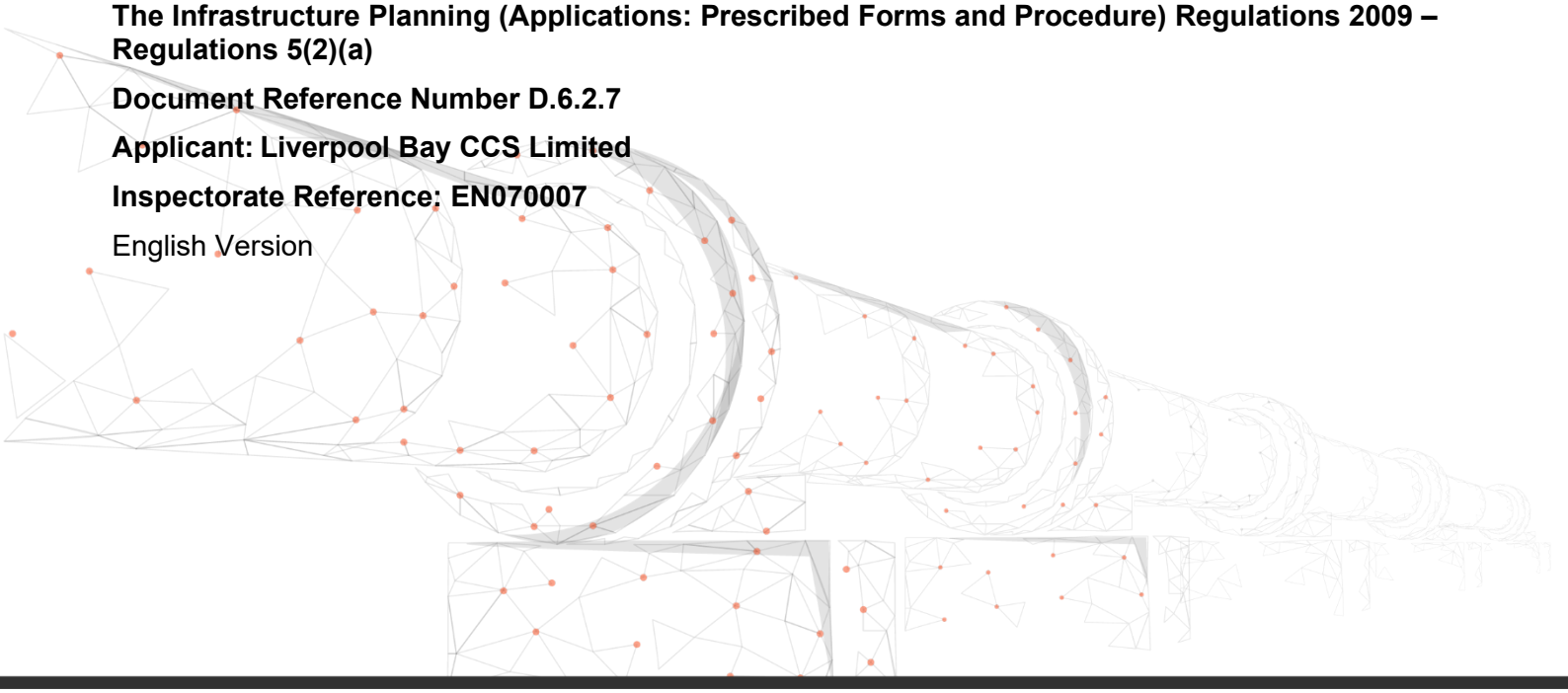

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7. CLIMATE RESILIENCE

7.1. INTRODUCTION

7.1.1. This Chapter determines the vulnerability of the Development Consent Order (DCO) Proposed Development to climate change and reports on the assessment and the DCO Proposed Development's resilience to the likely significant effects from climate change. It describes:

- Relevant legislation, policy and guidance;
- Consultation undertaken;
- Assessment methodology;
- Baseline conditions
- Potential effects of the Operation and Decommissioning Stages of the DCO Proposed Development;
- Potential design, mitigation and enhancement measures;
- Residual effects;
- Monitoring; and
- Next steps.

7.1.2. This Chapter (and its associated appendices) is intended to be read as part of the wider ES, with particular reference to **Chapter 18 - Water Resources and Flood Risk** and the **Register of Environmental Actions and Commitments (REAC)** (**Document reference: D.6.5.1**.

7.1.3. This Chapter has been prepared by competent experts with relevant and appropriate experience, as outlined in **Appendix 5.1 – Relevant Expertise and Competency (Volume III).**

7.2. LEGISLATIVE AND POLICY FRAMEWORK

7.2.1. A summary of the international, national, and local legislation, planning policy and guidance relevant to the climate resilience assessment for the DCO Proposed Development is set out below.

LEGISLATIVE FRAMEWORK

International

United Nations Framework Convention on Climate Change **(Ref. 7.1)**

7.2.2. The UK is a member of the United Nations Framework Convention on Climate Change ('UNFCCC') which drives international action on climate change. The UK has pledged to reduce emissions under the 'Paris Agreement' in 2015, as a part of a joint pledge by members of the EU. This provides an overarching commitment by the UK in the form of the Climate Change Act 2008 established a legal requirement for an 80% reduction in the GHG emissions of the UK economy by 2050 in comparison to the 1990 baseline. In June 2019, the government laid the draft Climate Change Act 2008 (2050 Target Amendment) Order 2019 to introduce a net zero target - for at least 100% reduction of GHG emissions (compared to 1990 levels) in the UK by 2050.

Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 **(Ref. 7.2)**

7.2.3. The Infrastructure Planning Environmental Impact Assessment (EIA) Regulations 2017 (the DCO EIA Regulations) set out the requirements for EIA for Nationally Significant Infrastructure Projects (NSIP). The DCO EIA Regulations require the developer to assess the environmental impacts of a project or scheme. The DCO EIA Regulations state that the EIA must include a description of the likely significant effects of the development on the environment including the vulnerability of the project to climate change.

Directive 2014/52/EU of the European Parliament and of the Council of the European Union **(Ref. 7.3)**

7.2.4. The requirement to consider a project's impact on, and vulnerability to climate change results from the 2014 amendment to the EIA Directive (2014/52) (Directive 2014/52/EU of the European Parliament and of the Council 16 April 2014 amending Directive 2011/92/EU on the assessment of the effect of certain public and private projects on the environment, 2014). The Directive has been fully transposed into UK law in the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (the 'TCPA EIA Regulations') and came into force in the UK on the 16 May 2017. The Directive requires:

> "*A description of the likely significant effects 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

UK Climate Change Act 2008 **(Ref. 7.4)**

7.2.5. The Climate Change Act (CCA) established a legal requirement for an 80% reduction in the GHG emissions of the UK economy by 2050 in comparison to the 1990 baseline. In June 2019, the UK government made the draft Climate Change Act 2008 (2050 Target Amendment) Order 2019 to introduce a statutory net zero target - for at least 100% reduction of GHG emissions (compared to 1990 levels) in the UK by 2050.

National Adaptation Programme **(Ref. 7.5)**

7.2.6. The National Adaptation Programme (NAP) was submitted to the UNFCCC to describe how a country intends to adapt to climate change. The UK second NAP (2018 – 2023) sets out what the government will do to over the next 5 years in line with the five yearly requirements laid down by the CCA 2008. The NAP includes measures on climate change risks, planning, water erosion and water resources, delivery of health and social care and community resilience.

POLICY

National

Overarching National Policy Statement for Energy (EN-1) (Department of Energy and Climate Change, 2021) **(Ref. 7.7)**

7.2.7. The Draft EN1 policy outlines the policy context for nationally significant energy infrastructure. The policy has been updated to reflect the amendment to the CCA, including the ratification of the Paris Agreement.

7.2.8. The National Policy Statement for Energy (EN-1) outlines the planning policy for the energy sector. It discusses:

- The transition to a low carbon economy, and the energy sector's role in achieving that end;
- The challenge of meeting energy security and carbon reduction objectives (set out in the Climate Change Act (2008), and Energy Act (2013));
- The aim of reducing demand through energy efficiency; and
- The role of smart technologies to balance supply and demand and therefore result in carbon savings.

7.2.9. Section 4.9 of the draft policy sets out how applicants and the Secretary of State should take the effects of climate change into account when developing and consenting infrastructure. The policy states under paragraph 4.9.2:

> "*Climate change is likely to mean that the UK will experience hotter, drier summers and warmer, wetter winters. There is a likelihood of increased flooding, drought, heatwaves, and intense rainfall events, as well as rising sea levels and coastal change. Adaptation is therefore necessary to deal with the potential impacts of these changes that are already happening. Renewable and low carbon development is an adaptive measure to address climate change*".

7.2.10. Section 4.9.7 also states:

> "*The Secretary of State should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections and associated research and expert guidance (such as the EA's Climate Change Allowances for Flood Risk Assessments) available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures*".

National Planning Policy Framework (2021) **(Ref. 7.6**

7.2.11. The National Planning Policy Framework explains that achieving sustainable development requires the planning system to have three overarching objectives, which are interdependent and need to be pursued in mutually supporting ways (so that opportunities can be taken to secure net gains across each of the different objectives). One of the three objectives is environmental (with the other two being economic and social), which includes the objective of 'mitigating and adapting to climate change, including moving to a low carbon economy' (paragraph 8).

7.2.12. Paragraph 152 provides that:

> "*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*".

7.2.13. Paragraph 154 – 158 provide 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; and

b) *can help to reduce greenhouse gas emissions, such as through its location, orientation and design*".

Future Wales: The National Plan 2040 **(Ref. 7.9)**

7.2.14. The National Plan sets the direction for development in Wales up to 2040. A key target includes achieving decarbonisation and climate resilience. Future Wales National Plan sits with the Natural Resources Policy, Welsh National Marine Plan, Wales Transport Strategy and the Economic Action Plan. The Plan identifies key climate change projections for Wales and highlights:

> '*Changes to our climate and weather patterns will have a significant impact on well-being on both current and future generations. Increasing temperatures and extreme weather events caused by climate change are putting pressure on ecosystems, infrastructure, built environment and our unique landscape and cultural heritage, which all contribute to social, economic and ecological resilience'*.

Planning Policy Wales **(Ref. 7.10)**

7.2.15. Planning Policy Wales sets out the land use planning policies, to ensure the planning system contributes towards the delivery of sustainable development and improves the social, economic and environmental and cultural well-being of Wales.

7.2.16. In 2019 the Welsh Government declared a climate emergency to co-ordinate action nationally and locally to help combat the threats of climate change.

GUIDANCE

European Commission Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient (European Commission, 2016) (Ref. 7.11)

7.2.17. The guidelines are designed to provide support to developers of physical assets and infrastructure and help project developers understand the steps they can take to make investment projects resilient to climate variability and change. The Guidelines provide information on the steps that can be undertaken to integrate climate resilience within a familiar project lifecycle appraisal practiced by project developers.

European Commission (2016) Climate change and major projects (European Commission, 2016) (Ref. 7.12)

7.2.18. The Climate change and major projects guidance aims to ensure the resilience to the adverse impacts of climate change, acknowledging that Europe will see a strong increase in overall climate hazards leading to economic losses. The

guidance looks to integrate climate resilience through feasibility, design procure / build and the operation stages of projects to enhance the resilience to adverse impacts of climate change.

IEMA Environmental Impact Assessment guide to Climate Change Resilience and Adaptation (Environmental Impact Assessment guide to Climate Change Resilience and Adaptation, 2020) (Ref. 7.13)

7.2.19. The IEMA guidance is the reference point for integrating climate change resilience and adaptation in EIA in line with the TCPA EIA Regulations.

Design Manual for Roads and Bridges (DMRB) LA 114 Climate (2019) (Ref. 7.14)

7.2.20. The LA114 guidance sets out the requirements for assessing and reporting the effects of climate on highways (climate change resilience and adaptation), and the effect on climate of greenhouse gas from construction, operation and maintenance projects. The methodology can be applied to non-highways projects as its sets out how relevant climate events and impacts can be assessed. The guidance includes how to assess the likelihood and consequence of the impact occurring to each defined sensitive receptor, leading to evaluation of the significance of the effect.

7.3. SCOPING OPINION AND CONSULTATION

RESPONSE TO THE SCOPING OPINION

7.3.1. An EIA Scoping Opinion (**Appendix 1.2 – EIA Scoping Opinion, Volume III**) was received by the Applicant from the Planning Inspectorate ('The Inspectorate') on 14 July 2021, including formal responses from Statutory Consultees. A full list of the responses from The Inspectorate and how these requirements have been addressed by the Applicant are set out in **Appendix 1.3 –Scoping Opinion Responses (Volume III)**.

CONSULTATION UNDERTAKEN TO DATE

7.4. No further consultation has been undertaken to inform the assessment of the vulnerability of the DCO Proposed Development to climate change.

7.5. SCOPE OF THE ASSESSMENT

7.5.1. The scope of this assessment has been established through an ongoing scoping process. Further information can be found in **Chapter 5 - EIA Methodology (Volume II)** of this ES.

7.5.2. This section provides an update to the scope of the assessment and re-iterates the evidence base for scoping out elements following further iterative assessment.

ELEMENTS SCOPED OUT OF THE ASSESSMENT

7.5.3. The full descriptions of the components within the DCO Proposed Development are provided in **Chapter 3 - Description of the DCO Proposed Development (Volume II)** but include:

- Carbon Dioxide Pipeline
- Above Ground Installations (AGIs)
- Block Valve Stations (BVSs)

Construction Stage

7.5.4. None of the elements are considered to have a high vulnerability to climate change at the scoping stage, therefore all construction elements; construction site and construction workers, have been scoped out of the assessment.

7.5.5. The elements shown in **Table 7.1** are not considered to give rise to likely significant effects as a result of the DCO Proposed Development and have therefore not been considered within this assessment.

Table 7.1 - Elements Scoped Out of the Assessment

Stage	Element	Climate variable	Justification
Construction	Construction site and workers	Change in annual average precipitation and temperature	Low vulnerability due to impacts being limited and controlled by the inclusion of measures within the **REAC** (**Document reference: D.6.5.1** to avoid or reduce potential impacts during the Construction Stage. In addition, the Construction Stage is approximately 16 months and will therefore be less vulnerable to the effects of climate change.
		Extreme precipitation events	
		Extreme temperature events	
		Drought	
		Wind	
		Humidity	
		Storm surge and storm tide	
Operation	Carbon Dioxide Pipeline (Newbuild Carbon Dioxide Pipeline and existing Flint Connection to PoA Terminal Pipeline)	Change in annual average precipitation and temperature	Showing low vulnerability to climate effects during the scoping stage
		Drought	
		Wind	
		Humidity	
		Storm surge and storm tide	
Operation	AGIs and BVS	Drought	Showing low vulnerability to climate effects during the scoping stage
		Humidity	
		Storm tide	

ELEMENTS SCOPED INTO THE ASSESSMENT

Operation Stage

7.5.6. The following elements are considered to have a medium or high vulnerability to climate change at the scoping stage and therefore have been scoped into the assessment for the operation of the DCO Proposed Development.

Table 7.2 Elements scoped into the Assessment

Stage	Element	Climate variable	Justification
Operation	Carbon Dioxide Pipeline (Newbuild Carbon Dioxide Pipeline and existing Flint Connection to PoA Terminal Pipeline)	Extreme precipitation events	These elements were determined to have medium or high vulnerability in the Scoping Report due to the design life of the element.
		Extreme temperature events	
		Sea level rise	
Operation	AGIs and BVSs	Change in annual average precipitation and temperature	These elements were determined to have medium or high vulnerability in the Scoping Report due to the design life of the element.
		Extreme precipitation events	
		Extreme temperature events	
		Gales and high winds	
		Storms	
		Sea level rise	

End of Life Stage

7.5.7. The decommissioning works include the removal of the AGIs and BVSs while the Newbuild Carbon Dioxide Pipeline and existing Flint Connection to PoA Terminal are likely to be kept in situ. Whilst the Construction Stage has been scoped out of the assessment due to its short time frame and low vulnerability to climate change, the decommissioning has been assumed to take place after 2050, where climate change projection may be more extreme. Therefore, the elements identified in **Table 7.3** have been scoped into the assessment.

Table 7.3 Elements Scoped into the End of Life Stage

Stage	Element	Climate variable	Justification
End of Life	Decommissioning site of the Newbuild Carbon Dioxide Pipeline, existing Flint Connection to	Change in annual average precipitation	These elements are determined to have medium or high vulnerability in line with future climate projections
		Extreme precipitation events	
		Drought	
		Wind and lightning	

Stage	Element	Climate variable	Justification
	PoA Terminal Pipeline and AGIs/BVS		
	Decommissioning workers	Change in annual average temperature	
		Wind and lightning	

7.5.8. Decommissioning design and works will be undertaken in compliance with all necessary legislation, permits and best practice at that time, expected to take place at the end of the useful life of the DCO Proposed Development.

7.6. ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

STUDY AREA

7.6.1. The vulnerability assessment refers to the impact of climate change on the DCO Proposed Development (rather than the impact of the DCO Proposed Development on the environment). As such, the Study Area of the DCO Proposed Development are the 25km grid squares shown in Insert 7.1 below.

METHOD OF BASELINE DATA COLLATION

Desk Study

7.6.2. All baseline data collection has been completed through desk study using publicly available data and guidance, as outlined in the **Impact Assessment Methodology** section.

7.6.3. The climate vulnerability assessment is compliant with EN-1 Section 4.8 'climate change adaptation' **(Ref. 7.15)** specifically 4.8.5 which outlines that

> *'New energy infrastructure will need to remain operational over many decades, in the face of a changing climate. Consequently, applicants must consider the impacts of climate change when planning the location, design, build, operation and, where appropriate, decommissioning of new energy infrastructure.'*

7.6.4. The climate vulnerability assessment is compliant with EN-4 **(Ref. 7.16)** section 2.2 'climate change adaptation', specifically 2.2.2 which identifies risks to infrastructure as a result of climate change.

7.6.5. The ES has utilised the latest UKCP18 climate projections, and has included embedded mitigation determined by the design team within the vulnerability assessment of the DCO Proposed Development. The UKCP18 Guidance: Caveats and Limitations **(Ref. 7.17)** highlights the need to demonstrate UK Climate Projections, following the 10%, 50% and 90% estimate ranges and highlights these results should be considered alongside relevant research based on the climate projections.

Site Visit and Surveys

7.6.6. No site visits or surveys were required to complete this assessment.

IMPACT ASSESSMENT METHODOLOGY

7.6.7. The significance of effects has been determined by considering the likelihood and the consequence from potential changes in climate variables on the DCO Proposed Development elements.

7.6.8. Despite the DCO Proposed Development not containing any road elements, the Design Manual for Roads and Bridges (DMRB) offers an industry-recognised approach for determining the significance of effects from climate change.

7.6.9. Likelihood and consequence have been qualitatively assessed using the descriptions in **Table 7.4** and **Table 7.5,** and informed by the existing and projected baselines, as well as the lifetime of the DCO Proposed Development's elements.

7.6.10. In this Chapter, the significance of effects from climate change has, in accordance with the DMRB LA114 (**Ref. 7.14**), been determined by considering the likelihood and the consequence of potential climate elements on the DCO Proposed Development. **Table 7.4** and **Table 7.5** have been adapted from the DMRB LA114. **Table 7.4** describes the likelihood of occurrence for the climate change event on the DCO Proposed Development. **Table 7.5** describes the consequence of the climate change event on the DCO Proposed Development.

7.6.11. The Operation Stage of the DCO Proposed Development is expected to have an operational life of 25 years (2025 - 2050) with the Carbon Dioxide Pipeline designed for 40 years, but being left in situ during the End of Life Stage:

- The Carbon Dioxide Pipeline is designed to have a life span of 40 years (2025 – 2065); and
- the BVSs / AGIs are designed to have a lifespan of 25 years (2025 – 2050).

7.6.12. At the end of life, the Newbuild Carbon Dioxide Pipeline and the Flint Connection to PoA Terminal Pipeline will be decommissioned safely, filled with nitrogen and left in-situ. AGIs and BVSs will be dismantled, cleared and the ground conditions restored to their previous condition. The Decommissioning Stage is expected to take place after the Operation Stage (post 2050).

7.6.13. The climate projections in the assessment include 2020s and 2050s timescales to cover the construction and operation of the scheme. The 2070s have also been assessed to cover the full design life of the Newbuild Pipeline components and the potential decommissioning stage.

Table 7.4 Likelihood of climate change event

Measure of likelihood	Description
Very high	The event occurs multiple times during the lifetime of the DCO Proposed Development. For example, approximately annually.
High	The event occurs several times during the lifetime of the DCO Proposed Development. For example, approximately once every 10 years.
Medium	The event occurs limited times during the lifetime of the DCO Proposed Development. For example, approximately once every 30 years.
Low	The event occurs occasionally during the lifetime of the DCO Proposed Development. For example, once in 40 years.
Very low	The event may occur once during the lifetime of the DCO Proposed Development.

Table 7.5 Consequence of climate change event

Consequence of event	Description
Very large adverse	Permanent damage. Disruption lasting more than ten days. Early renewal of infrastructure >90%. Severe health effects and/or fatalities. Significant repair costs.
Large adverse	Extensive infrastructure damage. Disruption lasting more than three but less than ten days. Early renewal of 50-90% of infrastructure. Severe health effects and/or fatalities. Significant effect on the environment, requiring remediation. Significant repair costs.
Moderate adverse	Limited infrastructure damage with damage recoverable by maintenance or minor repair. Disruption lasting more than one but less than three days. Adverse effects on health and/or the environment. Moderate repair costs.
Minor adverse	Localised infrastructure disruption. No permanent damage, minor restoration work required: Disruption lasting less than one day. Slight adverse health or environmental effects. Minor repair costs.
Negligible	No infrastructure damage, minimal adverse effects on health, safety, and the environment. No disruption to infrastructure. No financial loss.

SIGNIFICANCE CRITERIA

7.6.14. The likelihood and consequence have been combined to assess the significance of the climate events on the affected elements, as shown in **Table 7.6.**

Table 7.6 Significance rating matrix

Measure of significance of climate event	Measure of likelihood				
	Very Low	**Low**	**Medium**	**High**	**Very High**
Very Large	Not Significant	Significant	Significant	Significant	Significant
Large	Not Significant	Not Significant	Significant	Significant	Significant
Moderate	Not Significant	Not Significant	Significant	Significant	Significant
Minor	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Negligible	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

ASSUMPTIONS AND LIMITATIONS

7.6.15. To ensure transparency within the EIA process, the following limitations and assumptions have been identified:

- The UK Climate Projections 2018 (UKCP18) **(Ref. 7.18)** have been used to infer future changes in a range of climate variables that may affect the resilience of the DCO Proposed Development to climate change. At the time of writing, these represent the most up-to-date representation of future climate in the UK. However, the UKCP18 data currently available does not provide data for drought, snow and ice or wind.
- There are inherent uncertainties associated with climate projections and they are not predictions of the future. It is possible that future climate will differ from the future baseline climate against which the resilience of the DCO Proposed Development has been assessed, depending on global emissions over the next century. A ‘high’ emissions scenario (RCP 8.5) using the 2080s time slice (2070 – 2099 - the longest temporal scale available through UKCP18) has been used to develop the baseline against which resilience has been assessed. This is consistent with the precautionary principle (i.e. ‘worst case’ scenario).
- Any further research, analysis or decision-making should take account of the accuracies and uncertainties associated with climate projections. It is important to note that the analysis is based on selected observational data, the results of climate model ensembles and a selected range of existing climate change research and literature available at the time of the assessment.

- The significance of the effects determined in this Chapter is based upon the Preliminary Design that forms the basis of the DCO Proposed Development and therefore the basis of assessment for this Chapter.

7.7. BASELINE CONDITIONS

7.7.1. The DMRB LA 114 **(Ref. 7.14)** and IEMA EIA Guide to Climate Change Resilience and Adaptation **(Ref. 7.13)** identify the need for the baseline assessment of climate change on the DCO Proposed Development to consider:

- The current climate baseline (defined by historic climate conditions) to provide an indication of past vulnerability; and
- The future climate baseline (short term extremes and long-term variation) to assess the DCO Proposed Development's vulnerability to climate change.

7.7.2. Historic climate data has been extracted for the region in which the DCO Proposed Development is to be constructed, using Met Office Regional climate profiles and weather station data. Future projected climate data has been interpreted from UKCP18 data.

EXISTING BASELINE

7.7.3. The DCO Proposed Development is located within the Met Office climate profiles of both North West England and Wales **(Ref. 7.19** and **Ref. 7.20)**. The climate profile of North West England includes the Hawarden weather station (the closest weather station to the DCO Proposed Development), which has been detailed here as representative for the DCO Proposed Development as a whole.

7.7.4. North West England ('the region') (**Ref. 7.19**), is characterised as having a climate of great variety from a 30-year averaging period of 1981-2010. The region includes both the coldest place in England (Cross Fell in the Pennines) and the wettest place in England (the Lakeland fells around Seathwaite in Cumbria). The closest weather station to the DCO Proposed Development is Hawarden (approximately 15km from the Stanlow Manufacturing Complex).

7.7.5. Wales ('the region') (**Ref. 7.20**) is characterised as being a maritime climate, characterised by weather that is often cloudy, wet and windy but also mild.

Precipitation

7.7.6. The region has some of the wettest places in the UK[1], with the higher parts of the Lake District averaging over 3,200mm of rainfall per year and the more

[1] Data is representative of north west England, as the 'Hawarden' weather station is located in this region. Whilst the DCO Proposed Development spans both north west England and Wales, as the current baseline aims to provide a general representation of the weather in the vicinity of the DCO Proposed Development.

sheltered areas of Cheshire and the Eden valley in Cumbria drier with less than 800mm per year **(Ref. 7.21)**.

7.7.7. Average monthly rainfall data at Hawarden weather station, the region, and for the UK for the period 1981–2010 is presented in **Table 7.7.** It shows that the area covered by Hawarden weather station is drier than the UK average even though the regions (North West of England and England North West and Wales) are wetter.

Table 7.7 Long-term Average Monthly Rainfall (1981-2010) for Hawarden Weather Station, the region, and the UK Average

Season	Precipitation (mm)			
	Hawarden	NW of England	England NW & Wales	UK Average
Summer	173	284	275	238
Winter	179	430	375	328
Annual	726	1446	1304	1142

Extreme Precipitation

7.7.8. The region is wetter than the UK average and experiences extreme rainfall events. Extreme rainfall is classified by the Met Office as where rainfall exceeds 10mm per day **(Ref. 7.22)**.

7.7.9. Periods of prolonged rainfall are often associated with Atlantic depressions or with convection **(Ref. 7.23)**. The Atlantic lows are more vigorous in autumn and winter. In summer, convection caused by solar surface heating sometimes forms shower clouds and a large proportion of rain falls from showers and thunderstorms. Rainfall caused this way is normally more intense than winter rainfall which tends to be more frontal with falls occurring over longer periods.

7.7.10. Some noteworthy extreme rainfall and storm events include:

- Storm Christoph January 2021: brought exceptionally wet weather to North Wales and northern England. Approximately 100mm of rain fell across upland areas of Cheshire. For North West England and North Wales this was one of the wettest 3-day periods on record.
- Heavy rainfall July 2019: Thunderstorms from an area of low pressure caused flooding across parts of northern England due to intense downpours. Parts of South Manchester and East Cheshire were badly affected by flash-flooding with widespread flooding of properties and road closures across the region **(Ref. 7.24).**
- November 2012: A sequence of heavy rainfall events resulted in one of the wettest weeks in England in the last 50 years **(Ref. 7.25)**.

Snow and Ice

7.7.11. Snowfall is closely linked with temperature, with falls rarely occurring if the temperature is higher than 4°C. For snow to lie for any length of time, the temperature must normally be lower than this. Over most of the region, snowfall is normally confined to the months from November to April, but upland areas may have falls in October and May. Snow rarely lies outside the period from November to March but over higher ground lying snow can also occur in October and as late as May. The region has experienced snow events in:

- February to March 2018: the most significant spell of snow and low temperatures for the UK overall since December 2010 **(Ref. 7.26)**.
- December 2009 to January 2010: the UK experienced a spell of very low temperatures and significant snowfalls which affected almost the whole country **(Ref. 7.27)**.
- December 2010: two spells of snowfall lasting around a month **(Ref. 7.28)**.

Temperature

7.7.12. The temperature in the region depends very much on altitude and proximity to the coast. Over the lower-lying areas inland the average varies from around 10.5°C in Cheshire to 9°C in the Solway Plain and there is an approximate decrease of 0.5°C for each 100m increase in altitude. Temperature at ground level depends on seasonal fluctuations, local heat flow and thermal conductivity of the ground. Temperature increases with depth. The average increase, referred to as the geothermal gradient, for the UK is 2.6°C per 100m depth **(Ref. 7.29).**

7.7.13. **Table 7.8** shows the long-term average mean monthly temperature for Hawarden Weather station, the region and for the UK between 1981 and 2010. It shows that the area around the DCO Proposed Development is slightly warmer by comparison with the region and the rest of the UK.

Table 7.8 Long-term Average Mean Monthly Temperature for Hawarden Weather Station and the region, by comparison with the rest of the UK

Season	Temperature (ºC)		
	Hawarden	Region	UK Average
Summer	15.7	14.4	14.4
Winter	4.8	3.8	3.7
Annual	10.3	8.9	8.9

Extreme Temperature

7.7.14. The region has experienced extreme temperatures. Some noteworthy extreme temperature events include:

- The hottest day in the UK on record was experienced during record heatwave conditions in July 2022 with temperatures exceeding 40°C and reaching a record 40.3°C at Coningsby in Lincoln. This led to national disruption to transport infrastructure with temperatures causing restriction to all public transport **(Ref. 7.30).**
- July 2020: the UK experienced a short but exceptional heatwave in late July. Temperatures exceeded 30°C widely across much central and southern England on 23 July, and across the south and east on 24 July, but 25 July was by far the hottest day with 30°C recorded through much of northern England **(Ref. 7.31)**.
- Summer 2018: warm, dry, sunny weather with the UK under the influence of high pressure, particularly during June and July. This was the UK's warmest summer since 2006, the driest since 2003 and the sunniest since 1995 **(Ref. 7.32)**.
- December 2010: the coldest December in over 100 years as a result of persistent easterly or north-easterly winds bringing bitterly cold air from northern Europe and Siberia, accompanied by snow. Temperatures struggled to rise above freezing during the day and there were very severe frosts at night. Temperatures widely fell below -10°C on several nights **(Ref. 7.33)**.

Wind and Storms

7.7.15. The region is among the more exposed parts of the UK, being relatively close to the Atlantic and containing large upland areas. The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter half of the year, especially from December to February, and this is when mean speeds and gusts are strongest. As Atlantic depressions pass the UK the wind typically starts to blow from the south or south west, but later comes from the west or north-west as the depression moves away. The range of directions between south and north-west accounts for the majority of occasions and the strongest winds nearly always blow from this range of directions.

7.7.16. A day of gale is defined as a day on which the wind speed attains a mean value of 34 knots or more over any period of ten minutes. Notable gales affecting the region include:

7.7.17. In 2022 alone, the UK has seen three storms with two rare red warnings issued:

- Storm Dudley (16 – 17 February)
- Storm Eunice (18 February)
- Storm Franklin (20 - 21 February)

7.7.18. Storm Eunice was the most severe and damaging storm to affect England and Wales since February 2014[2]. Winds gusted at over 81mph in exposed coastal locations and a gust of 122mph was recorded at the Isle of Wight. Storms Dudley and Franklin also brought significant weather impacts **(Ref. 7.34)**.

7.7.19. The UK experienced a turbulent week of weather from 10 to 16 March 2019 as a succession of Atlantic low-pressure systems brought strong winds and heavy rain, driven by a powerful jet stream. This spell included Storm Gareth on 12 to 13 March, the seventh named storm of the 2018-2019 winter **(Ref. 7.35)**.

Sea Level

7.7.20. The Stanlow AGI is located approximately 1.7km from the tidal mouth of River Mersey, bounded to the Irish Sea. The Flint AGI is also located on the north coast of Wales approximately 1km from the estuary of River Dee, bounded to the Irish Sea. The coastline is naturally vulnerable to sea level rise. Sea level around the UK rose by about 1mm/year in the 20th century, corrected for land movement **(Ref. 7.36)**.

7.7.21. Flood Mapping of the UK and Wales indicates that a number of water bodies have a high likelihood of flooding throughout the DCO Proposed Development. However, the flood map also indicates that the DCO Proposed Development is in an area that benefits from tidal flood defences along some extents of the DCO Proposed Development **(Ref. 7.37)** and **(Ref. 7.38)**.

FUTURE BASELINE

7.7.22. The UK Climate Projections 2018 (UKCP18) **(Ref. 7.18)** provide data on projected change in climate variables for the UK.

7.7.23. The UKCP18 datasets are the most up-to-date projections of climate change for the UK, providing projections until the end of the twenty-first century. UKCP18 includes probabilistic projections of a range of climate variables for different emissions scenarios, termed representative concentration pathways (RCP) and for a range of time slices to the end of the century. The central estimate projections (50th percentile) are presented against baseline levels of 1981-2010s.

7.7.24. RCP8.5 is a high emissions' scenario which combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements.

7.7.25. The future baseline has been presented for the 2020s (2010-2039), the 2050s (2040-2069) and 2070s (2060-2089), based on the UKCP18 projections, to

[2] Met Office (2022) Storms Dudley, Eunice and Franklin, February 2022 Microsoft Word - 2022_02_storms_dudley_eunice_franklin.docx (metoffice.gov.uk)

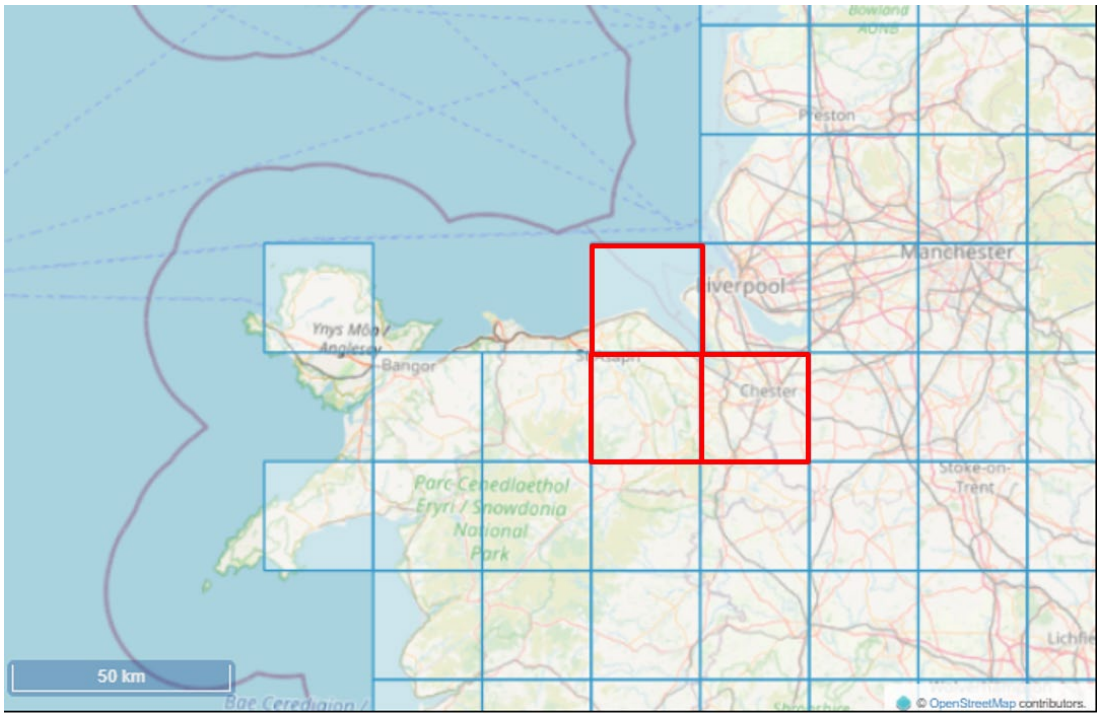
identify the anticipated climate conditions over the life of the DCO Proposed Development's key components:

- The Newbuild Carbon Dioxide Pipeline and existing Flint Connection to PoA Terminal Pipeline are designed to have a life span of 40 years; and
- The BVSs / AGIs are designed to have a lifespan of 25 years

7.7.26. The DCO Proposed Development spans across three 25 km grid squares from the UK border into Wales; these are shown in **Insert 7.1**.

7.7.27. The climate projections in the future baseline have been assessed in line with 2050s and 2070s timescales to cover the full design life of the operational components and the potential decommissioning phase.

Insert 7.1 25km Grid Squares used for Probabilistic Projections



Precipitation

7.7.28. Climate change is projected to lead to wetter winters and drier summers although natural variation, including extreme events such as storms and heatwaves, will continue to punctuate these trends.

7.7.29. The projected changes to average summer and winter rainfall for the 2020s, 2050s and 2070s are summarised in **Table 7.9**.

Table 7.9 Projected Change in Mean Summer and Winter Precipitation for the 2020s, 2050s and 2070s, RCP8.5

Season	Time slice, precipitation change (%)		
	2020s	**2050s**	**2070s**
Summer	-5.5 to -4.3	-18.7	-28.8 to -27.2
Winter	+0.1 to +0.8	+5.0	+6.0 to +9.0

The central estimate (50th percentile) predicts that there will be a decrease in summer rainfall for all of the time slices, with a decrease of up to 28% by the 2070s. In contrast, winter precipitation is predicted to increase by 5.0% for the 2050s and up to 9.0% for the 2070s.

Extreme Precipitation

7.7.30. The future projections for a 1-in-20-year return period[3,4] (i.e. the 5% probability of occurrence) of total rainfall over a 1-day period is greatest in the northern and western regions of the UK compared to the south and south east of the UK as a result the influence of Atlantic depressions losing power as it travels eastwards across the UK. 1-day total rainfall reaches over 90 mm in the region of the DCO Proposed Development.

7.7.31. Extreme rainfall in winter months indicates large spatial variability and summer extreme rainfall shows less spatial variability across the UK.

Snow and Ice

7.7.32. With regards to future changes, rising winter temperatures are likely to reduce the amount of precipitation that falls as snow in winter. UKCP18 does not have data on snowfall, although UKCP09 (the climate projections preceding UKCP18) projects a reduction of mean snowfall, the number of days when snow falls and heavy snow events by the end of the twenty-first century. UKCP09 projections indicate substantial reductions in snowfall days for all regions in winter (**Ref. 7.39**).

Temperature

7.7.33. In general, UKCP18 predicts that climate change is projected to lead to hotter summers and warmer winters; however natural variation means some cold

[3] Return period: The return period is equal to the inverse of probability of the event occurring in the next time period, that is, T = 1/P, where T is the return period, in number of time intervals, and P is the probability of the next event's occurrence in a given time interval.

[4] A 1 in 20-year return period can be expressed as a probability of occurring being 1/20, or 5% in any one year. This does not mean that if an event with such a time-period occurs one year then the next event will happen again in 20 years' time. Instead, it means that in any given year there is a 5% chance that the event will happen, regardless of when the last similar event occurred.

winters and cool summers will still occur[5]. **Table 7.10** summarises the UKCP18 projections for changes in mean temperature for the 25km grid square where the DCO Proposed Development is located in the 2020s, 2050s and 2070s under RCP 8.5.

Table 7.10 Projected Change in Mean Summer and Winter Temperature for the 2020s, 2050s and 2070s RCP8.5

Season	Time slice, temperature change (°C)		
	2020s	2050s	2070s
Summer	+0.8	+2.0	+3.2 to +3.3
Winter	+0.6 to 0.7	+1.6	+2.4 to +2.5

7.7.34. The central estimate (50th Percentile) predicts that there will be an increase in summer temperature of approximately 0.8°C for the 2020s, 2.0°C for the 2050s and 3.3°C for the 2070s. Winter temperature is also predicted to increase by 0.7°C for the 2020s, 1.6°C for the 2050s and 2.5°C for the 2070s.

Extreme Temperature

7.7.35. Extreme temperature projections are calculated using the UK Climate Risk Indicators (CRI) data. This tool is based on UKCP18 data.

7.7.36. The Met Office defines heatwaves as daily maximum temperatures reaching >25^{o}C for three consecutive days[6]. Using a baseline of 1981 – 2010, the range number of heatwave events for Flintshire and Cheshire West and Chester was 0.6 to 0.8 days per year, with projections increasing the number of heatwave days per year to 1.4 - 1.6 for the 2020s, 3.6 - 4.3 for the 2050s and 5.3 to 5.7 for the 2070s.

7.7.37. UKCP18 defines 'frost days' as days where the temperature falls below 0oc. Using a baseline of 1981 – 2010, the number of frost days is expected to half by the 2070s.

7.7.38. **Table 7.11** provides a summary of the 1 in 20-year return periods [1] for maximum air temperature (°C) within the above 25 km grid squares shown in **Insert 7.1**. Results are expressed in absolute future values for RCP8.5 and are bias corrected to the reference period 1981-2000. The results are given for the average summer and winter temperature extremes for short term and long-term events.

[5] Met Office ukcp18-fact-sheet-temperature.pdf (metoffice.gov.uk)

[1] A 1 in 20-year return period can be expressed as a probability of occurring being 1/20, or 5% in any one year. This does not mean that if an event with such a time-period occurs one year then the next event will happen again in 20 years' time. Instead it means that in any given year there is a 5% chance that the event will happen, regardless of when the last similar event occurred.

[6] Met Office What is a heatwave [online] Available at: What is a heatwave? [online] Available at: What is a heatwave? - Met Office

7.7.39. There is a 5% probability that in any given year there will be an increase in the extreme temperatures for both summer and winter months. It is worth noting that the values represent average maximum temperature extremes, therefore individual days may exceed these values.

7.7.40. For RCP8.5, summer extremes in the 2050s are likely to reach 36.4°C to 37.1°C and winter extremes of 17.5°C to 17.7°C under the 90th percentile.

Table 7.11 Projected maximum air temperature (°C) ranges for summer and winter (2020s, 2050s and 2070s) under RCP8.5

Season		RCP8.5		
	Percentile	2020	2050	2070
Winter	10th	15.0 – 15.4	15.7 – 16.0	16.2 – 16.6
	50th	15.6 – 15.9	16.5 – 16.8	17.4 – 17.7
	90th	16.2 – 16.5	17.5 – 17.7	18.7 – 19.0
Summer	10th	31.0 – 31.9	31.4 – 32.2	31.8 – 32.6
	50th	32.1 – 32.9	33.7 – 34.4	35.2 – 35.9
	90th	33.3 – 34.0	36.4 – 37.1	39.2 – 40.0

Wind

7.7.41. UKCP18 depicts a wide spread of future changes in mean surface wind speed; however, there is large uncertainty in projected changes in circulation over the UK and natural climate variability contributes much of this uncertainty. It is therefore difficult to represent regional wind extreme winds and gusts within regional climate models **(Ref. 7.39)**.

7.7.42. Central estimates of change in mean wind speed for the 2050s are small in all ensemble runs (<0.2m/s). A wind speed of 0.2m/s (approximately 0.4 knots) is small compared with the typical magnitude of summer mean wind speed of about 3.6–5.1m/s (7 – 10 knots) over much of England **(Ref. 7.40)**. Seasonal changes at individual locations across the UK lie within the range of –15% to +10%.

7.7.43. In terms of storms, the analysis presented here is a summary of expected changes in storm patterns under changing climate. A storm is defined by the Met Office as a wind event measuring 10 or higher on the Beaufort scale (equivalent to a wind speed of 24.5m/s or 55mph) **(Ref. 7.41)**.

7.7.44. Studies **(Ref. 7.42** and **Ref. 7.43)** relating to future projections of storms suggest that climate-driven storm changes are less distinct in the northern than southern hemisphere. However, such is the wide range of inter-model variation, robust projections of changes in storm track are not yet possible and there is

low confidence in the direction of future changes in the frequency, duration or intensity of storms affecting the UK.

Sea Level

7.7.45. Projections for sea level rise have been ascertained using UKCP18 marine projections for the closest location to the DCO Proposed Development area as presented in **Insert 7.2**. Projected changes in sea level rise for the 2020s, 2050s and 2070s are presented in **Table 7.12**. By 2050, the area could experience sea level rise in the region of 24cm.

Insert 7.2 - Grid Square used for Marine Projections (Met Office, 2022)

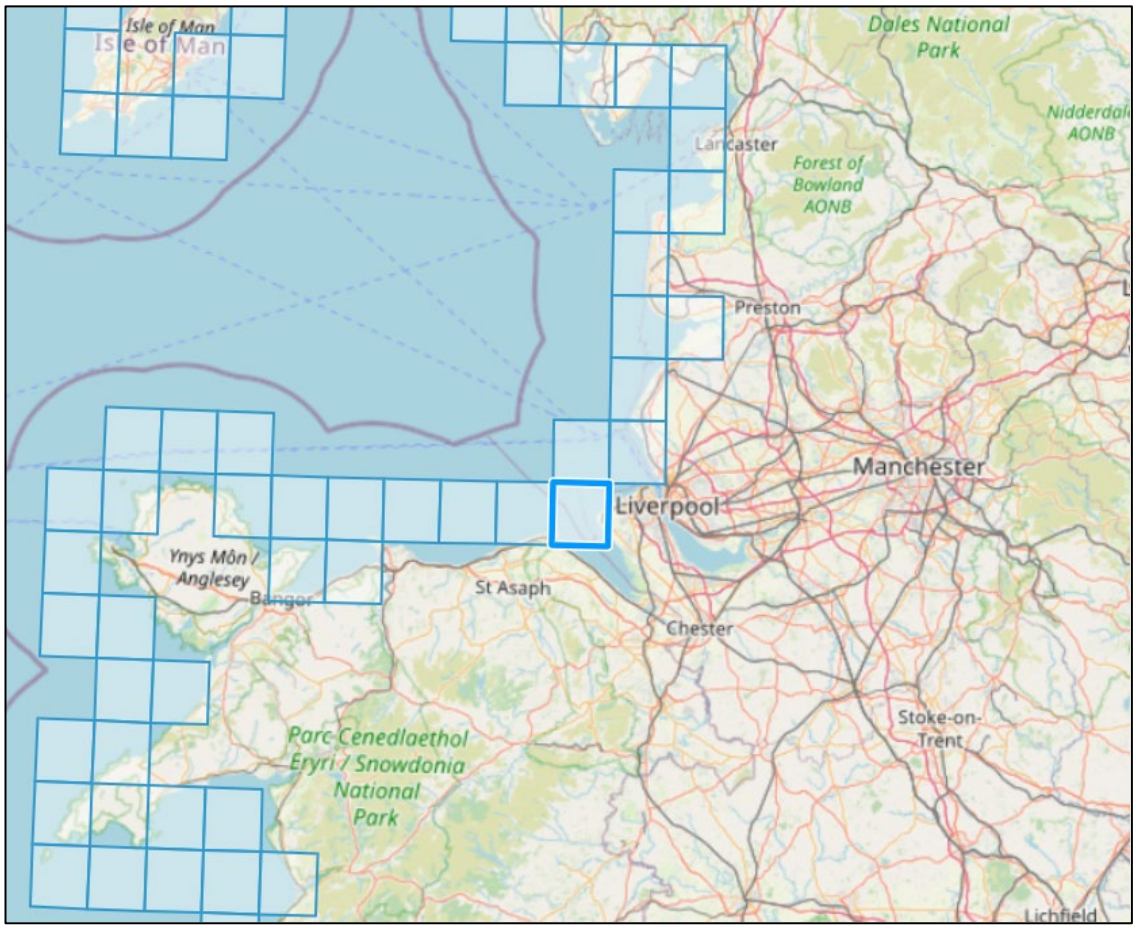


Table 7.12 Projected Change in Sea Level Rise (m) for the 2020s, 2050s and 2070s RCP8.5

Sea level increase (m)	Time slice		
	2020s	**2050s**	**2070s**
	+0.08m	+0.24m	+0.39m

7.8. SENSITIVE RECEPTORS

7.8.1. The following sensitive receptors have been deemed as vulnerable during scoping and assessed:

- **Newbuild Carbon Dioxide Pipeline and existing Flint Connection to PoA Terminal Pipeline** - the Newbuild and existing Carbon Dioxide Pipeline (including the cathodic protection cables) will be buried underground along its entire length, except for short sections of pipeline within the AGIs, and above-ground valve stems within the BVSs; and
- **AGIs** (four in total) and **BVSs** (six in total).

7.9. DESIGN DEVELOPMENT, IMPACT AVOIDANCE, AND EMBEDDED MITIGATION

7.9.1. The assessment of effects takes into account mitigation embedded in the Preliminary Design of the DCO Proposed Development that has been agreed with the Applicant's design team.

7.9.2. **Table 7.13** sets out the embedded mitigation measures in the Preliminary Design which consider climate risk during the operation of the DCO Proposed Development.

Table 7.13 Embedded mitigation in the DCO Proposed Development's Preliminary Design

Climate Hazard	Associated Hazard	Receptor Affected	Potential Impact	Embedded Mitigation	Evidence of Commitment
Precipitation **2050s** projections for decreases in summer precipitation are -18.7% **2050s** projections for increase of winter precipitation are +5.0%	Changes in annual average	Carbon Dioxide Pipeline AGIs and BVSs	Flooding of AGI and BVS components. Damage to the Carbon Dioxide Pipeline, AGIs and BVSs from increased run off. Existing drainage infrastructure overwhelmed leading to surface water flooding and siltation. Damage to AGIs and BVSs from increased run off, resulting in loss of supply.	This will not have an impact on the design. The AGI/BVS are facilities housing electrical components in a metal building with the valves below ground. Power and telecoms will be via underground cable therefore it's unlikely the facility and its operation would be impacted by precipitation. An **Outline Surface Water Drainage Strategy Report (Document Ref: D.6.5.13)** has been prepared for permanent features of the DCO Proposed Development, including the AGIs and BVSs. The facility and its operation would not be impacted by dry conditions. Above ground equipment are specified with a high quality external coating to protect from all credible external corrosive mechanisms, regardless of rainfall volume. Likewise, outdoor electrical equipment are rated to a suitable ingress protection rating (IP56, IP65). The facilities are predominantly gravelled (limited paved areas) so will be more resilient to increased rainfall levels due to their drainage potential. The design intent for the AGIs and BVSs is to be located above projected potential flood levels (**REAC D-CR-005**) (**Document Ref: D.6.5.1**).	Drawing 1025H0BXST08014 – Specification for Anticorrosion Coating of Equipment and Structures Drawing 102100BEPU40000 – Electrical Design Criteria Drawing 1025H0BISH50001 – General Specification for Instrumentation AGI and BVS Civil Works Drawings **Chapter 18 - Water Resources and Flood Risk (Volume II)** **Outline Surface Water Drainage Strategy Report (Document reference: D.6.5.13)**
	Extreme precipitation events	AGIs and BVSs			

Climate Hazard	Associated Hazard	Receptor Affected	Potential Impact	Embedded Mitigation	Evidence of Commitment
				SuDS features are proposed such as infiltration trench, filter drain, vortex separator and detention basin. Runoff from the surface will be picked up by various components, it is then conveyed to the attenuation pond via underground drainage network and discharge at a restricted outfall rate of 2 l/s at the following locations: Ince AGI, Stanlow AGI, Rock Bank BVS, Mollington BVS, Aston Hill BVS. Attenuation volume has been designed for the 1 in 100 years plus 40% climate change event. It is considered that with the surface water drainage design in place, the DCO Proposed Development will not increase the risk of surface water flooding on or off site or have any adverse impacts on existing watercourses and network. The E&I kiosks will be weather-sealed, and the outdoor electrical and instrumentation equipment will be IP-rated The electrical equipment in the AGIs/BVSs will be raised off the ground by approximately 1m. All other main critical infrastructure will be buried and/or built of suitable resistant material to impacts (i.e. stainless steel pipes) to minimise loss of supply from precipitation.	

Climate Hazard	Associated Hazard	Receptor Affected	Potential Impact	Embedded Mitigation	Evidence of Commitment
Temperature **2050s** projections for extreme summer temperature are +36.4°c – +37.1 °c under the 90th percentile. **2050s** projections for extreme winter temperature are +17.5 °c – 17.7 °c under the 90th percentile.	Extreme temperature events Change in annual average	Carbon Dioxide Pipeline AGIs and BVSs	Overheating of AGIs and BVSs. Faster rate of deterioration of materials from increase in UV radiation (for example, brittleness and fading) Increase in thermal expansion of structure joints compromising structural integrity leading to increased maintenance. Shrinking and cracking of soils leading to ground destabilisation. Risk of fire.	All the outdoor equipment at the AGIs and BVSs is designed to a temperature of 60degC or more. Each E&I Kiosk within the AGIs and BVSs will have an HVAC system to ensure the electrical equipment within does not overheat. The Newbuild Carbon Dioxide Pipeline is predominantly installed below ground and is designed to a maximum design temperature of 65°C. The maximum temperature of the CO2 in the system is controlled by the upstream emitters, so no impact is foreseen from increased air temperatures (**REAC D-CR-006**). There will be an Operations and Maintenance Procedure for routine maintenance and inspection visits on the AGIs and BVSs (**REAC D-CR-001**). Emergency shut down valves will be located at the AGIs, with an Emergency Response Plan and Major Accident Prevention Document implemented to prevent the risk of fire and increased maintenance (**REAC D-CR-003**). Ground investigations have been implemented across the site to provide geotechnical and geo-environmental baselines. Following a review of the data available, geotechnical and ground stability surveys (including sampling of groundwater) indicate few ground stability risks, mainly associated with changing peat conditions near Ince AGI and the river Gowy (**REAC D-CR-002**).	Drawing 1025H0BGRB09001 – Basis of Design for Onshore Pipelines **Appendix 11.6 – Ground Investigation Report (Volume III)**

Climate Hazard	Associated Hazard	Receptor Affected	Potential Impact	Embedded Mitigation	Evidence of Commitment
Wind Seasonal changes at individual locations across the UK for wind speeds lie within the range of –15% to +10%.	Gales and high winds	AGIs and BVSs	Damage from high winds and rain infiltration into components	The structures in the AGIs and BVSs are designed considering wind loading in accordance with EN 1991-1-4 "Eurocode 1: Actions on structures". There are no permanent structures foreseen over 5 meters' height . The AGIs and BVSs have few above ground features, all of which will be bolted to concrete foundations (**REAC D-CR-007**). The E&I kiosks will be weather-sealed, and the outdoor electrical and instrumentation equipment will be IP-rated. There will be a Lightning Protection Study assigned during Detailed Design to monitor and protect components against lightning events (**REAC D-CR-004**).	Drawing 1025H0BARB10000 – Civil and Structural Design Criteria Lightning Protection Study (REAC D-CR-004)
Storms	Hail and lightning	AGIs and BVSs	Lighting strikes causing fires		
Sea level **2050s** projections for sea level rise for this area are in the region of 24cm.	Sea level rise	Carbon Dioxide Pipeline AGIs and BVSs	Drainage infrastructure overwhelmed. Reduction of earthwork stability due to sea level rise and flooding. Increase in deterioration of structures.	The Carbon Dioxide Pipeline is inland of the coast. The AGIs and BVSs are all located inland, at elevations above that projected to be impacted by rising sea levels, as follows: • Ince AGI +5.20m • Stanlow AGI +9.50m • Rock Bank BVS +18.70m • Mollington BVS +29.69m • Aston Hill BVS +37.13m • Northop Hall AGI +119.04m	Drawing 1025HXBLDG80017 – 20'' and 36'' Field Layout Drawing 1025HXBLDG80596 – P852 Pipeline Field Layout

Climate Hazard	Associated Hazard	Receptor Affected	Potential Impact	Embedded Mitigation	Evidence of Commitment
				• Flint AGI +58.47m • Cornist Lane BVS +143.5m • Pentre Halkyn BVS +213.5m • Babell BVS +172m	

7.10. ASSESSMENT OF LIKELY IMPACTS AND EFFECTS

7.10.1. This section describes the likely impacts and effects for the DCO Proposed Development during the Operational and Decommissioning Stage. This Section considers the impact of climate change on the DCO Proposed Development following the implementation of embedded mitigation and identifies impacts which may be deemed significant at this stage.

7.10.2. A full assessment of potential preliminary effects from climate change during the Operational and Decommissioning Stages has been undertaken in **Appendix 7.1 – Climate Resilience Assessment of Effects (Volume III).**

CONSTRUCTION STAGE

7.10.3. This has been scoped out as per **Section 7.5 'Scope of the assessment'**.

OPERATIONAL STAGE

7.10.4. The likely significant effects from climate change associated with the Operational Stage are set out in **Table 7.14** and are based on the incorporation of the embedded mitigation measures in the Preliminary Design. The significance of effects has been determined using the likelihood and consequence methodology included in **Section 7.6**.

DECOMMISSIONING STAGE

7.10.5. It is likely that decommissioning impacts will be limited and controlled given the short timescales; however, the following climate events set out in **Table 7.15** have the potential to cause significant effects based on future climate projections.

Operational Stage

Table 7.14 Effects on receptors during the Operational Stage of the DCO Proposed Development

Receptor	Potential Impact	Likelihood	Consequence	Significance
Carbon Dioxide Pipeline	Shrinking and cracking of soils leading to ground destabilisation	High	***Moderate adverse***	***Significant***

Decommissioning Stage

Table 7.15 Effects on AGIs and BVSs during the Decommissioning Stage of the DCO Proposed Development

Receptor	Potential Impact	Likelihood	Consequence	Significance
Decommissioning site	Flooding of sites and components.	Medium	***Moderate Adverse***	***Significant***
	Existing drainage infrastructure overwhelmed leading to surface water flooding and siltation.	Medium	***Moderate Adverse***	***Significant***
Decommissioning workers	Overheating of equipment and fire	Medium	***Moderate Adverse***	***Significant***
	Health and safety risks from heatstroke and UV radiation	Medium	***Moderate Adverse***	***Significant***
	Health and safety risks from extreme temperatures and winds	Medium	***Moderate Adverse***	***Significant***

7.11. MITIGATION AND ENHANCEMENT MEASURES

This section sets out the avoidance, mitigation and compensation measures which are required to address the significant effects as identified in **Section 7.10.**

Construction

7.11.1. This has been scoped out as per **Section 7.5 'Scope of the assessment'**.

Operation

7.11.2. Additional Ground Investigations will be undertaken as required to help inform the geotechnical and geo-environmental baseline. Geotechnical and ground stability surveys (including sampling of groundwater) will be undertaken as required pre-construction to determine and address any ground stability risks.

Decommissioning

7.11.3. A Decommissioning Environmental Management Plan (DEMP) is included as a Requirement of the **Draft DCO** (**Document Reference: D.3.1**), and will be prepared at the End of Life Stage to protect workers from climate change effects as identified in **Table 7.15** during the Decommissioning Stage.

7.12. RESIDUAL EFFECTS

OPERATION

7.12.1. Following consideration of the embedded mitigation measures identified in **Table 7.13** and the additional mitigation recommendations; including the ground investigation works, it is anticipated there will be no residual effects during operation.

END OF LIFE

7.12.2. Following the commitment to prepare and implement a DEMP at the End Of Life Stage, there should be no significant residual effects.

7.12.3. **Table 7.16** summarises the residual effects associated with the DCO Proposed Development during operation and decommissioning stages.

Table 7.16 Summary of Residual Effects

Receptor	Description of the effect	Pre-mitigation significance of effects	Mitigation measure	Residual effect
Operation				
Carbon Dioxide Pipeline	Shrinking and cracking of soils	***Significant***	Additional Ground Investigations will be undertaken as required to help inform the geotechnical and geo-environmental baseline. Geotechnical and ground stability surveys (including sampling of groundwater) will be undertaken as required pre-construction to determine and address any ground stability risks.	*Not Significant*
Decommissioning				
Decommissioning site Decommissioning works	Flooding of sites and components. Existing drainage infrastructure overwhelmed leading to surface water flooding and siltation. Overheating of equipment and fire Health and safety risks from heatstroke and UV radiation Health and safety risks from extreme temperatures and winds.	***Significant***	A Decommissioning Environmental Management Plan will be produced at the End Of Life Stage (as included as a Requirement of the **Draft DCO (Document Reference: D.3.1)** to protect workers from climate change effects.	*Not Significant*

7.13. IN-COMBINATION CLIMATE CHANGE IMPACTS

7.13.1. Climate change in combination with other topic receptors is considered in relevant topic chapters and therefore no further consideration is required here.

- The **Chapter 9 - Biodiversity (Volume II**) addresses effects of future climate projections on habitats.
- The **Chapter 11 - Land and Soils (Volume II)** considers climate impacts and highlights the maintenance measures proposed which work to combat future climate projections.
- The **Chapter 12 - Landscape and Visual (Volume II)** considers the future projections of climate change on species for proposed planting and the management of proposed planting.
- The **Chapter 13 - Major Accidents and Disasters (Volume II**) highlights the embedded mitigation identified in relevant chapters will mitigate against potential climate impacts and will not exacerbate the MAD assessment.
- The **Chapter 14 - Materials and Waste (Volume II**) highlights the potential climate impacts on stockpiling of materials and stored waste during construction, however as construction has been scoped out of the climate resilience assessment it is not anticipated these affects will be significant.
- The **Chapter 16 - Population and Health (Volume II)** takes into account the potential for climate projections to have an impact on human health.
- The **Chapter 18 – Water Resources and Flood Risk (Volume II)** addresses the future baseline of an increase in precipitation effects causing flooding on the tidal and surface water bodies surrounding the DCO Proposed Development.

7.14. MONITORING

7.14.1. A list of extreme weather-related incidents (for example, rainfall, heatwaves, snow and ice etc.) will be maintained by the Applicant to assist in identifying thresholds which, when exceeded, require maintenance or alteration. Inspections will be carried out following an intense rainfall event or heatwave to monitor any damage and implement appropriate mitigation as necessary (**REAC D-CR-008**).

7.14.2. A schedule of general inspections and principal inspections of each structure will be carried out to determine condition of the AGIs / BVSs and identify any potential maintenance requirements. Inspections will be undertaken following an intense rainfall event or heatwave to monitor any damage and implement appropriate mitigation as necessary as stated within the DMRB BD 63/17 (**REAC D-CR-009**).

7.14.3. The DCO Proposed Development will have an Operations and Maintenance Environmental Management Plan (OMEMP) (as included as a Requirement of the **Draft DCO (Document Reference: D.3.1)**) to be followed for routine maintenance and inspection visits of the Carbon Dioxide Pipeline and the AGIs and BVSs to ensure their protection against potential climate impacts identified (**REAC D-CR-001**).

7.14.4. Monitoring and management of the surface water drainage features post planning will be undertaken to obtain long term ground water data, in accordance with the **Outline Surface Water Drainage Strategy Report (Document Ref: D.6.5.13)**.

7.15. REFERENCES

- **Ref. 7.1** - United Nations Framework Convention on Climate Change
- **Ref. 7.2** - Infrastructure Planning (Environmental Impact Assessment) Regulations (2017)
- **Ref. 7.3** - Directive 2014/52/EU of the European Parliament and of the Council of the European Union
- **Ref. 7.4** - UK Climate Change Act 2008 (2050 Target Amendment) Order 2019
- **Ref. 7.5** - National Adaptation Programme
- **Ref. 7.6** - National Planning Policy Framework 2021 (National Planning Policy Framework, 2021)
- **Ref. 7.7** - Overarching National Policy Statement for Energy (EN-1) (2011) (Department of Energy and Climate Change, 2011)
- **Ref. 7.8** - National Planning Policy Guidance on Climate Change
- **Ref. 7.9** - Future Wales: The National Plan 2040
- **Ref. 7.10** - Planning Policy Wales
- **Ref. 7.11** - European Commission Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient (European Commission, 2016)
- **Ref. 7.12 -** European Commission (2016) Climate change and major projects (European Commission, 2016)
- **Ref. 7.13** - IEMA Environmental Impact Assessment guide to Climate Change Resilience and Adaptation (Environmental Impact Assessment guide to Climate Change Resilience and Adaptation, 2020)
- **Ref. 7.14** - Design manual for Roads and Bridges LA114 Climate (2019)
- **Ref. 7.15** - Overarching National Policy Statement for Energy (EN-1)

- **Ref. 7.16** - National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Department of Energy and Climate Change, 2011)
- **Ref. 7.17** – Met Office UKCP data caveats and limitations - Met Office
- **Ref. 7.18** - UK Climate Projections 2018 (UKCP18)
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