Cottam Parkway Railway Station

Environmental Statement

Volume 2: Main Statement

Chapter: Climate Change

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12 Climate Change

ES Chapter Number	Environmental Topic	Relevant Appendices
12	Climate Change	Appendix 12.1: Carbon Calculation Values

12.1 Introduction

12.1.1 Climate change refers to a large-scale long-term shift in the planet's weather patterns and average temperatures[1]. Global warming describes the current rise in the average temperature of Earth's air and oceans and is often described as the most recent example of climate change.

12.1.2 When greenhouse gases (GHGs) such as carbon dioxide (CO_2) increase in the atmosphere, they act like a 'blanket' around the earth. Sunlight passes through the blanket and continues until it reaches the surface of the planet. The earth absorbs some of the infrared radiation and emits some of the infrared radiation back out to space. Greenhouse gases cause some of the radiation leaving the atmosphere to become trapped. This causes the surface of the earth to heat – in a process known as the 'greenhouse effect'[2].

12.1.3 Average global temperatures have risen by more than 10°C since the 1850's. The years 2015-2018 were the hottest years ever recorded. A warming planet leads to many other changes in our climate, including (but not limited to):

- Heatwaves;
- Rising sea levels; and,

[1] Definition as per Met Office UK: https://www.metoffice.gov.uk/weather/climate-change/what-is-climate-change
[2] As described online: https://www.nationalgeographic.org/encyclopedia/greenhouse-effect/

- Ocean acidification.

12.1.4 Within the United Kingdom (UK), all the UK's ten warmest years on record have occurred since 2002 and heatwaves are now 30 times more likely to happen due to climate change. UK winters are projected to become warmer and wetter on average with cold or dry winters to still occur at times.

12.1.5 According to a study[3], the transport sector became the largest emitter of GHGs in 2016. This is still the case, according to a report by the Office of National Statistics (2019)[4] which states that the transport sector remains the largest emitter of GHGs, responsible for 27% of all GHG emissions in the UK.

12.1.6 This chapter identifies and assesses the likely effects of the Scheme on climate change (i.e. greenhouse gas/carbon emissions). It also considers how the Scheme adapts to climate change and how climate change resilience could be designed into the Scheme.

12.1.7 Therefore, this chapter will be presented in two parts:

- Greenhouse Gas (GHG) Impact Assessment: An impact assessment that focuses on the potential effect of the Scheme on Climate Change. GHG emissions are converted into tonnes of carbon dioxide equivalent (tCO_2e), a calculation which normalises the global warming potential of the main GHGs into one measure, based on the global warming potential of CO_2.

- Climate Change Risk (CCR) Assessment: The resilience of the Scheme to future predicted climate change impacts. This element of the report considers the potential impacts that climate change could have on the construction and operation of the Scheme over its lifetime.

[3] As per 'Department for Transport's 'Decarbonising Transport – Setting the Challenge'. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878642/decarbonising-transport-setting-the-challenge.pdf

[4] As per Office for National Statistics '2019 UK Greenhouse Gas Emissions, Final Figures'. Available online at: 2019 UK Greenhouse Gas Emissions, Final Figures (publishing.service.gov.uk)

12.2 Relevant Legislative, Plans, Policies and Background

12.2.1 The following relevant legislative plans, policies and guidance documents have been referred to, informing the content of this chapter.

The Town and Country Planning (Environmental Impact Assessment) Regulations 2017

12.2.2 Section 5(f) of the Town and Country planning (Environmental Impact Assessment) Regulations 2017 ('EIA Regulations' herein) require the inclusion of:

'A description of the likely significant effects of the development on the environment resulting from 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.'

Climate Change Act 2008

12.2.3 The Climate Change Act 2008 sets a legally binding target for the UK to reduce its GHG emissions from 1990 levels by at least 100% by 2050. This overall target is supported by a system of binding five-year 'carbon budgets' (refer to Table 3 in the Climate Change Act 2008) as well as an independent body to monitor progress, the Committee on Climate Change.

Paris Agreement 2015

12.2.4 The Paris Agreement - in full 'Paris Agreement under the United Nations Framework Convention on Climate Change', or 'COP21' - was signed in April 2016, and deals with GHG emission mitigation, adaptation, and finance from 2020. The Paris Agreement sets out to improve upon and replace the Kyoto Protocol 1997, an earlier international treaty designed to curb the release of greenhouse gasses.

12.2.5 The Paris Agreement sets a commitment to keep global warming to below 2 degrees Celsius, with further discussions suggesting that a new limit of 1.5 degrees Celsius should be established to avoid dangerous levels of climate change.

12.2.6 The Paris Agreement also requires all Parties to put forward their best efforts through 'nationally determined contributions' (NCDs) and to strengthen these efforts in future years. It also includes requirements that all Parties report regularly on their emissions and on their implementation efforts. There will also be a global stocktake every 5 years to assess the collective progress towards achieving the purpose of the Paris Agreement.

12.2.7 The Paris Agreement addresses crucial areas necessary to combat climate change including; Long-term temperature goal, Global peaking and 'climate neutrality', mitigation, sinks and reservoirs, adaptation, loss and damage, finance, technology and capacity-building support, education, transparency and global stocktake.

12.2.8 COP26 took place in 2021, the member states of the conference committed to more urgent greenhouse gas emissions cuts and a promise of more climate finance for developing countries to adapt to climate impacts.

12.2.9 Specifically, the climate pact agreed by member states reaffirms the Paris Agreement temperature goal of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. The pact also recognizes that limiting global warming to 1.5 °C requires rapid, deep and sustained reductions in global greenhouse gas emissions, including reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around midcentury, as well as deep reductions in other greenhouse gases.

A Green Future: Our 25 Year Plan to Improve the Environment, 2018

12.2.10 Published in January 2018 A Green Future is a 25 Year Environment Plan setting out the actions the UK Government will take to help the natural world regain and retain good health. The goals include mitigation and adaptation to climate change and using resources from nature more sustainably and efficiently.

12.2.11 The 25-year plan states that – 'we will take all possible action to mitigate climate change, while adapting to reduce its impact. We will do this by:

- Continuing to cut greenhouse gas emissions including from land use, land use change, the agriculture and waste sectors and the use of fluorinated gases. The UK Climate Change Act 2008 commits us to reducing total greenhouse gas emissions by at least 80 per cent by 2050 when compared to 1990 levels;
- Making sure that all policies, programmes and investment decisions take into account the possible extent of climate change this century; and,
- Implementing a sustainable and effective second National Adaptation Programme.

National Planning Policy

National Planning Policy Framework (

12.2.12 The National Planning Policy Framework (MHCLG, 2021) (the NPPF) states that new development should be planned for in ways that:

- avoids 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

- 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.

Policies for the Sixth Carbon Budget and Net Zero

12.2.13 The Climate Change Committee advises that the UK set its Sixth Carbon Budget (i.e. the legal limit for UK net emissions of greenhouse gases over the years 2033-37) to require a reduction in UK emissions of 78% by 2035 relative to 1990, a 63% reduction from 2019 levels.

12.2.14 The Carbon Budget states that the 2020s would be crucial in mainstreaming Net Zero solutions and the recovery from the pandemic should include the building-in of climate policy.

Local Planning Policy

Central Lancashire Adopted Core Strategy

12.2.15 T The Central Lancashire Adopted Core Strategy (Preston City Council et al., 2012) 'Vision for Central Lancashire in 2026' is aligned with a sustainable approach to development that states, 'energy use will be minimised with an emphasis on sustainable sources, including mitigation measures and wherever possible, adaptation to Climate Change' and overall, the strategy highlights tackling climate change as one of three key cross cutting themes to be addressed in all areas. For example:

- Chapter 7 'Catering for Sustainable Transport' focuses on the location of development in proximity to work and amenities to reduce the need to travel and reduce transport associated emissions in the area;
- Chapter 10 'Design' discusses high environmental standards for construction and the use of green and blue infrastructure to offset climate change effects;

- Within Chapter 11 ‘Health and Wellbeing’ future climatic conditions are considered a high risk to human health, especially to the elderly and infirm; and,

- Chapter 12 ‘Climate Change’ is dedicated in entirety to achieving the strategic objectives of reducing energy consumption and emissions, encouraging the generation and use of renewables, managing flood risk and reducing water usage to protect and enhance Central Lancashire’s resources.

Preston Local Plan

12.2.16 The Preston Local Plan 2012-26 (Preston City Council, 2015) does not contain a specific policy tackling climate change is a cross cutting theme of the Core Strategy and it includes policies to encourage energy efficiency in new developments and encourage renewable and low carbon energy generation in Preston city. This all helps to reduce carbon emissions.

12.3 Part 1: Assessment of GHG Emissions

Methodology and Significance Criteria

12.3.1 For the purpose of this chapter the EIA guidance published by the Institute of Environmental Management and Assessment (IEMA) "Assessing Greenhouse Gas Emissions and Evaluating their Significance" in 2022 was followed. As the Scheme is a transport scheme, this guidance aligns the GHG assessment process more closely than perhaps the DMRB LA 114 Climate guidance (which is primarily for specific road schemes).

12.3.2 The IEMA guidance provides a framework for the consideration of GHG emissions. The guidance sets out a 'six-step' approach to assessment GHG emissions, as follows:

1. Set the scope and boundaries of the GHG assessment

2. Develop the baseline

3. Decide upon the emissions calculation methodologies

4. Data collection

5. Calculate/determine the GHG emissions inventory

6. Consider mitigation opportunities and repeat steps 4 & 5

Step 1: Setting the scope and boundaries

12.3.3 The first step of the assessment is to consider the scope of the Scheme, its purpose and activities that apply to life cycle stages that could contribute to GHG emissions.

12.3.4 Therefore, the 'study area' considered for the GHG assessment would cover all direct GHG emissions (those arising from construction and operational activities) and indirect GHG emissions (those associated with construction materials and the transportation of materials and waste) as well as the following:

- Product stage: including raw material supply, transport and manufacture; and transport of the product to the works site;
- Construction process stage: including transport of workers to/from works site and construction/installation processes;
- Land use change during construction;
- Use of the infrastructure by the end-user (road and station user);
- Operation and maintenance (including repair, replacement and refurbishment); and,
- Land use during operation.

Step 2 and 3: Developing the baseline and assessment methodology

12.3.5 The baseline for the GHG assessment is a scenario whereby the Scheme does not proceed. This assumes a 'business as usual' scenario where there would be no Scheme.

12.3.6 In terms of developing the current baseline, as there is no physical activity or development within the study area, the current baseline would be a 'zero' GHG emission to report. However, as per the IEMA guidance, land use changes would be considered in this assessment, for example, where any trees that can sequester carbon are removed from the site.

12.3.7 For the future baseline, this would capture both operational and user GHG emissions (such as vehicle user movements, lighting, maintenance and upgrades).

12.3.8 The key anticipated GHG emissions sources during construction of the Scheme are presented in Table 12.1 and have been categorised in line with guidance set out in PAS 2080:2016 (British Standards Institution, 2016).

Table 12.1: Key Anticipated GHG Emission Sources - Construction

Lifecycle Stage	Activity	Primary Emission Sources
Product Stage	Raw material extraction and manufacturing of products / materials.	Embodied GHG emissions.
	Transport of products / materials to site.	Emissions from fuel used for the transportation of products / materials to

		site.
Construction process stage	On-site construction activity Transport of construction workers. Disposal of construction waste.	GHG emissions from fuel consumption by vehicles, plant, and equipment for construction of the Scheme. Emissions from fuel used for worker commuting. GHG emissions from fuel used for the transport and disposal of waste.

12.3.9 Although there would be the loss of existing carbon sink (i.e. removal of trees/vegetation) as part of the Scheme, it is assumed that proposed new planting would be sufficient to replace this vegetation.

12.3.10 The key anticipated GHG emissions sources during the operational, maintenance and use phases of the Scheme are presented in Table 12.2.

Table 12.2: Key Anticipated GHG Emission Sources - Operation

Lifecycle Stage	Activity	Primary Emission Sources
Operational stage	Vehicle journeys	GHG emissions per vehicle kilometre
	Lighting of the Scheme (including car park, Station, platforms and footbridge and access road)	Energy usage

Step 4 and 5: Data Collection and calculating GHG emissions

12.3.11 The impact from GHG emissions is a national and global issue. Consequently, the potential impact of the Scheme on GHG emissions will be assessed by comparing the Scheme's estimated GHG emissions against the UK's carbon budgets (refer to Table 12.3).

12.3.12 The global climate has been identified as the receptor for the purposes of the GHG emissions assessment. However, to enable the significance of the estimated GHG emissions arising from the Scheme to be evaluated, the UK's carbon budgets were used as a proxy of the level of effect on the global climate.

12.3.13 The sensitivity of the receptor, the UK's carbon budgets (as a proxy for the global climate), has been defined as 'high'. The rationale for this approach is as follows:

- Any additional GHG impacts could compromise England's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets; and,

- The extreme importance of limiting global warming to below 2°C this century, as broadly asserted by the International Paris Agreement (UNFCCC, 2015) and the climate science community. Additionally, a report by the IPCC highlighted the importance of limiting global warming below 1.5°C (IPCC, 2018).

12.3.14 Due to the absence of any defined industry guidance for assessing the magnitude of GHG impacts for EIA, standard GHG accounting and reporting principles have been followed to assess impact magnitude. In GHG accounting, it is common practice to consider exclusion of emission sources that are <1% of a given emissions inventory. This would therefore suggest that a Scheme with emissions of <1% of the relevant carbon budgets would be minimal in its contribution to the wider national GHG emissions.

12.3.15 The appropriate carbon budgets that span the construction programme for the Scheme are for the years 2023-2027 (i.e., the 4th Carbon Budget).

12.3.16 The operational phase of the Scheme (fully operational by 2024) has been compared to all the appropriate and available carbon budgets within the design life of the Scheme. As the budgets have only been calculated to 2037, this assessment uses the carbon budgets from 2024 to 2032 and 2033 to 2037 (fifth carbon budget and sixth carbon budget respectively).

12.3.17 Table 12.3 shows the past, current and future carbon budgets up to 2037 which highlights a reduction in the amount of GHG England can legally emit in the future. This means that any source of emissions contributing to England's Carbon Budgets will have a greater impact on the carbon budgets in the future.

Table 12.3: UK Carbon Budgets 2008-2037

Budget	Carbon Budget Level	Reduction below 1990 levels
1st Carbon budget (2008-2012)	3,018 MtCO2e	25%
2nd Carbon budget (2013-2017)	2,782 MtCO2e	31%
3rd Carbon budget (2018-2022)	2,544 MtCO2e	37% by 2020
4th Carbon budget (2023-2027)	1,950 MtCO2e	51% by 2025
5th Carbon budget (2028-2032)	1,725 MtCO2e	57% by 2030
6th Carbon budget (2033-2037)	965 MtCO2e	78% by 2037

12.3.18 The classification and significance of effects has been determined using the matrix in Table 12.4. This has been adapted from Assessing Greenhouse Gas Emissions and Evaluating their Significance IEMA guidance (IEMA, 2022).

Table 12.4: Classification and Significance of Effects Matric for GHG Impact Assessment

Significance of effect	Descriptor
Major adverse	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a

	meaningful contribution to the UK's trajectory towards net zero.
Moderate adverse	The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
Minor adverse	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.
Negligible	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.
Beneficial	The project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

12.3.19 National Highways (formerly Highways England) Carbon Calculator Tool was utilised to determine the estimated GHG emissions associated with the access road and the Rail Safety and Standards Board - Rail Carbon Tool to assess the GHG emissions associated with the railway station buildings and platforms from the Scheme and how this would affect the UKs Carbon Budgets.

Limitations

12.3.20 In the absence of a finalised bill of quantities, the platform, railway sattion building and access road construction data has been estimated using professional judgement and known values from similar building projects. Consequently, the values stated in this GHG assessment should be read as a best guess estimate at this stage. A more accurate assessment of GHG emissions would become available at the detailed design phase.

Step 6: Mitigation

12.3.21 The likely mitigation measures for this Scheme will be set out in Section 12.6 this chapter.

Potential Impacts – Construction

12.3.22 The total GHG emissions from the construction of the access road are estimated to be 825 tCO_2e. The total GHG emissions from the construction of the railway station building and platforms are estimated to be 726 tCO_2e. In total, the estimated GHG emissions associated with the construction of the Scheme would be 1551 tCO_2e. The primary GHG emissions sources and the breakdown of the calculated GHG emissions can be found in Appendix 12.1in volume 3 of this ES. Table 12.5 provides an overview of the construction related GHG emissions for the Scheme.

12.3.23 GHG emissions from construction activities would be limited to the anticipated duration of the 24-month construction programme where all enabling, construction and landscaping would be taking place.

12.3.24 The largest contributor to GHG emissions during the construction of the Scheme would be the construction of the access road. Specifically, the paving work.

12.3.25 For railway station platform construction, a worst-case scenario has been calculated from the available platform dimensions. The calculation has assumed that a solid concrete block construction has been applied to the Scheme at this stage. This construction method is unlikely to be part of the final design of the Scheme.

Table 12.5: Estimated Construction GHG Emissions

Lifecycle stage	Project Activity/Emissions Source	Emissions (tonnes)	% of construction emissions
Construction	Earthworks	288	18
	Pavements	463	30
	Kerbs Footways and Paved Areas	74	5
	Building materials	280	18
	Platforms	446	29
	Total construction emissions tCO2e	1551	

Potential Impacts – Operation

12.3.26 The operational impacts of the Scheme on GHG emissions is currently unknown as there are still unknown variables relating to the operation and energy demand of the lighting and heating of the railway station building, car park and access road. This information would become available in the

detailed design phase and would provide a more thorough assessment of the potential GHG emissions during the operation of the Scheme.

12.4 Part 2: CCR Assessment

Methodology and Significance Criteria

12.4.1 The IEMA 2015 'Guidance for assessing climate change resilience and adaptation in EIA' has been followed. It provides guidance on how to consider the impacts of climate change within project design. The guidance sets out how to:

- Define climate change concerns and environmental receptors vulnerable to climate factors;
- Define the environmental baseline with changing future climate parameters; and,
- Determine the resilience of project design and define appropriate mitigation measures to increase resilience to climate change.

Significance Criteria

12.4.2 The identification and assessment of climate change resilience within EIA is an area of emerging practice. The IEMA guidelines (2015) state that their guidance is not proposing changes to the significance criteria used in the EIA process however, 'the susceptibility or resilience of the receptor to climate change must be considered as well as the value of the receptor'. Table 12.6 demonstrates this criteria.

Table 12.6: Significance Criteria for Climate Change Resilience Assessment

Measure of consequence	Sensitivity Receptor				
	Very Low	Low	Medium	High	Very High
Negligible	Not significant	Not significant	Not significant	Not significant	Not significant
Minor	Not significant	Not significant	Not significant	Significant	Significant
Moderate	Not significant	Not significant	Significant	Significant	Significant
Large	Not significant	Significant	Significant	Significant	Significant
Very Large	Not significant	Significant	Significant	Significant	Significant

Study Area

12.4.3 The study area considered for the Climate Change Resilience assessment of the Scheme consists of the infrastructure within the site boundary (i.e. the red line boundary), which will consider predicted changes over approximately 60 years from pre-construction to operation of the Scheme.

Baseline

12.4.4 The existing baseline for the climate change resilience assessment is the current climate in the location of the Scheme. Historic climate data obtained from the Met Office Website recorded by the closest meteorological (8km north of the site) station to the scheme (Myerscough Station, Preston) for the 30 year climate period of 1981-2010 is summarised in Table 12.7.

Table 12.7: Baseline data for Myerscough Station, Preston for 30 year climate period 1981-2010

Climatic Factor	Month	Climate Figure
Average annual maximum daily temperature (ºC)	N/A	13.9
Warmest month on average (ºC)	July	20.7
Coldest month on average (ºC)	February	1.5
Mean annual rainfall levels (mm)	N/A	153.2
Wettest month on average (mm)	October	120.4
Driest month on average (mm)	April	58.5

12.4.5 The Met Office baseline climate averages for the North England region identify gradual warming between 1961 and 2010, as well as increased rainfall. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in Table 12.8.

Table 12.8: Climatic Averages for North England

Climate Period	Climatic Variables	
	Mean Maximum average temperatures (oC)	Mean annual rainfall (mm)
1961-1990	11.8	162
1971-2000	12	162.9

1981-2010	12.3	164.9

Future Baseline Methodology

12.4.7 Climate trends and projections are published by the Met Office through the UK Climate Projections website. The UK Climate Projections 2018 (UKCP18) became available in November 2018 and provides the most up to date assessment of how the climate of the UK may change over this century.

12.4.8 UKCP18 uses scenarios for future greenhouse gas emissions called Representative Concentration Pathways (RCPs). The four RCPs attempt to capture a range of potential alternative futures and outcomes linked to global temperature increases and include a wide variety of assumptions on socioeconomic development and commitment to emissions reductions. The sensitivity of the scenario responses is much more pronounced in the second half of the 21st century, where the responses diverge more rapidly than in the first half of the century.

Table 12.9: Description of Representative Concentration Pathways (RCPs)

RCP	Description
RCP 2.6	Represents a pathway where greenhouse gas emissions are strongly reduced, resulting in a best estimate global average temperature rise of 1.6°C by 2100 compared to the pre-industrial period.
RCP 4.5	Medium stabilisation pathway, with some level of mitigation, resulting in a best estimate global average temperature rise of 2.4°C by 2100 compared to the pre-industrial period.

RCP 6.0	Medium stabilisation pathway, with some level of mitigation, resulting in a best estimate global average temperature of 2.8°C by 2100 compared to the pre-industrial period.
RCP 8.5	A pathway where greenhouse gas emissions continue to grow unmitigated, leading to a best estimate global average temperature rise of 4.3°C by 2100 compared to the pre-industrial period.

12.4.9 For the purpose of this assessment, *RCP8.5* is utilised as the future baseline, as it represents the 'worst-case' scenario.

12.4.10 Projected climatic changes at the 50% probability level (central estimate) are utilised as the 'most likely' change. This is the level where there is as much evidence pointing to a lower outcome as a higher one. There is much stronger evidence that the outcome will be in the 10th (10%) to 90th (90%) percentile range and this is also utilised for some assessment parameters.

- 10% probability level – this demonstrates what the future change is unlikely to be less than. There is a 90% chance the projected change will be more than this.
- 50% probability level – this is known as the central estimate, with an even chance of it occurring and not occurring.
- 90% probability level – this demonstrates what the future change is unlikely to be more than. There is a 10% chance the projected change will be more than this.

12.4.11 A temperature anomaly is the difference from an average, or baseline, temperature. A positive temperature anomaly indicates the observed temperature was warmer than the baseline, while a negative temperature anomaly indicates the observed temperature was cooler than the baseline.

As with precipitation rate, a positive precipitation anomaly indicates the observed precipitation rate was greater than (i.e. wetter) the baseline, while a negative precipitation anomaly indicates the observed precipitation rate was less than the baseline (i.e. drier).

12.4.12 The future baseline is expected to differ from the present-day baseline. UK UKCP18 has been developed by the UK Climate Impacts Programme (UKCIP) to provide projections for future climate scenarios and trends. UKCP18 is the most robust source of information on the UK's future climate.

12.4.13 Alongside these changes in the average conditions, it is possible, but less certain, that climate change will also increase the frequency and severity of extreme weather events, such as heavy rainfall, storms and heatwaves.

12.4.14 UKCP18 provides climate change projections for pre-defined climate periods, at annual and seasonal levels for changes to mean climatic conditions over land areas. For the purpose of this report, UKCP18 projections for the following average climate variables have been obtained and analysed against a baseline of 1981-2010:

- Change in mean summer temperature (°C)
- Change in mean winter temperature (°C)
- Precipitation rate change in summer (%)
- Precipitation rate change in winter (%)

Table 12.10: Probabilistic Climate Projections for RCP 8.5 for North England Region (changes shown relative to a 1981-2010 baseline)

Climate Variable		Climate period projections						
		2020's	2030's	2040's	2050's	2060's	2070's	2080's
Change in mean winter temperature (°C)	50% probability (central estimate)	**0.6**	**0.9**	**1.2**	**1.6**	**2.0**	**2.4**	**2.9**
	Range 10% to 90%	0.4-1.3%	0.1-1.7%	0.3-2.2%	0.4-2.8%	0.6-3.4%	0.8-4.2%	1.1-4.9%
Change in mean summer temperature (°C)	50% probability (central estimate)	**0.8**	**1.0**	**1.4**	**1.9**	**2.6**	**3.3**	**4.1**
	Range 10% to 90%	0.1-1.4%	0.2-1.9%	0.4-2.5%	0.7-3.3%	1.0-4.2%	1.4-5.3%	1.8-6.4%
Precipitation rate change in winter (%)	50% probability (central estimate)	**2.3**	**2.2**	**5.4**	**7.9**	**10.7**	**13.5**	**16**
	Range 10% to 90%	-5.1-10%	-7.3-12%	-5-16.7%	-4.1-21.1%	-2.7-26.4%	-2.7-32.3%	-2.1-36%
Precipitation rate change in summer (%)	50% probability (central estimate)	**-4.8**	**-7.5**	**-12.08**	**-17.2**	**-21.2**	**-24.6**	**-28.2**
	Range 10% to 90%	-15.7-6.7%	-19.9-4.8%	-26.4-2.35	-33.7- -0.6%	-39.6- -2.9%	-45.3- -4.4%	-51.6- -6.0

12.4.15 Table 12.10 demonstrates that over the 2020-2100 period that the average temperature in the North West of England are expected to increase, summers are expected to be hotter and drier and winters are expected to get warmer and wetter.

Limitations

12.4.16 Limitations associated with the approach taken for the climate change resilience review relate to uncertainties inherent within UKCP18 data. The UKCP18 do not provide a single precise prediction of how weather and climate will change years into the future. Instead UKCP18 provides ranges that aim to capture a spread of possible climate responses. This better represents the uncertainty of climate prediction science. It should be noted that the level of uncertainty of the projections is dependent on the climate variable, for example, there is greater confidence around changes in temperature than there is in wind.

Potential Impacts - construction

12.4.17 Potential impacts during the construction phase could include:

- Inaccessible construction site due to severe weather events (flooding, snow, drought and ice, storms) restricting working hours and delaying construction;
- Health and safety risks (i.e. heat stroke, dehydration) to the workforce during severe weather events;
- Unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and,
- Damage to construction materials, plant and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, for example from stormy weather.

Potential Impacts - Operation

12.4.18 The Scheme also has the potential to be impacted upon by a changing climate and more frequent severe weather events in the medium to long-term. Potential impacts on the Scheme during the operational phase include:

- Material and asset deterioration due to high temperatures;
- Damage to roads from periods of heavy rainfall;
- Potential flood risk (surface, groundwater, fluvial and snow/ice melt) on the network and damage to drainage systems with the potential for increased runoff from adjacent land contributing to surface water flooding; and,
- Potential impacts that require maintenance of the Scheme such as pothole formation, ground expansion/subsidence, ground water level changes, repairing storm damage to buildings and platforms.

12.5 Statement of Significance

GHG Assessment - Construction

12.5.1 The fifth carbon budget was set in 2016. It limits UK greenhouse gas emissions from all sources, excluding international aviation and shipping, to 1,725 $MtCO_2$ between 2028 and 2032. This is equivalent to a 57 per cent reduction in annual UK emissions over this period on average, relative to 1990.

12.5.2 The sixth carbon budget was set in 2020. It limits UK greenhouse gas emissions from all sources, excluding international aviation and shipping, to 965 MtCO2e between 2033 and 2037. This is equivalent to a 78 per cent reduction in annual UK emissions over this period on average, relative to 1990.

12.5.3 The construction GHG emissions from the Scheme would represent approximately $4.2x10^{-5}$% of the UK carbon budget from 2028 to 2032 and $7.5x10^{-5}$% of the UK carbon budget from 2033 to 2037. These values fall well below the indicative threshold of 5% of the UK carbon budget (IEMA, 2022) in the applicable time period.

12.5.4 The Scheme's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. The Scheme would be fully in line with measures necessary to achieve the UK's trajectory towards net zero. As the GHG emissions of the Scheme are lower than 5% of the fifth and sixth carbon budget, the effect of GHG emissions associated with the Scheme are considered non-significant. Consequently, the Scheme is predicted to have a minor non-significant adverse impact on GHG emissions.

12.5.5 The full breakdown of the GHG emissions of the Scheme can be found in Appendix 12.1 in volume 3 of this ES.

GHG Assessment - Operation

12.5.6 Operational GHG emissions of the Scheme are predicted to be below the emissions created during the construction of the Scheme. This is due to the extraction and transportation required for the materials during construction. Comparatively, the station would utilise sustainable energy generation once operational and energy efficient lighting and heating/cooling systems. Consequently, GHG emissions associated with the operation of the Scheme over its lifetime are considered to be non-significant.

CCR Assessment - Construction

12.5.7 Short-term effects from the construction of the Scheme are not likely to be significant. This is due to the mitigation that would be implemented, the nature of the construction activities and the dates of the construction period.

CCR Assessment – Operation

12.5.8 The assessment of operational impacts and effects has considered the likelihood of climate events and hazards occurring, and the consequence of the potential impacts on disruption to the Scheme, taking account of the identified embedded and standard mitigation measures.

12.5.9 The findings of the assessment are presented in Table 12.11, and these have concluded that no significant effects would occur to the Scheme in respect of climate change.

Table 12.11: Summary of Impacts and Effects from Climate Change on the Scheme – Operational Phase

Receptor	Climate Event	Impact (climate event and hazard occurring together)	Embedded / standard mitigation measure	Likelihood	Consequence	Significance of effect
End-users (member of the public, commercial operators, etc) The assets and their operation, maintenance, and refurbishment (i.e. pavements, structures, earthworks & drainage, technology assets, etc.)	Severe weather event	Health and safety risks to users and disrupted and / or inaccessible network	Identification of suitable network redundancies and diversion routes. Emergency response and contingency plans in place. Standard operating procedures in place for use in the event of necessary road closure and/or traffic diversion. Regular maintenance of drainage systems.	Low	Moderate Adverse	Not significant

	Gradual Climate Change Severe Weather Events	Traffic related rutting and migration of material	Consideration of the use construction materials with superior properties which offer increased tolerance to fluctuating temperatures.	Low	Minor Adverse	Not significant
	Increased frequency of heavy precipitation events	Damage to roads, cuttings, car park, platforms and drainage systems due to flooding	Consideration of climate change projections within maintenance plans and drainage systems to protect against a return period of 1-in-100 years flood event. Regular maintenance of assets to detect deterioration and damage.	Medium	Minor Adverse	Not Significant
	Snow and ice Increased frequency of heavy precipitation	Reduced pavement, car park friction coefficient	Consideration of the use of construction materials with superior	Low	Minor Adverse	Not Significant

	events Increasing average temperatures and increasing frequency of hot days and heatwaves		properties which offer increased tolerance to fluctuating temperatures. Regular maintenance of assets to detect deterioration and damage and sweeping and cleaning to remove debris.			
	Increasing average temperatures and increasing frequency of hot days and heatwaves.	Material and asset deterioration due to high temperatures. Thermal expansion and movement of bridge joints and paved surfaces.	Consideration of use of construction materials with superior properties which offer increased tolerance to fluctuating temperatures. Regular maintenance of assets to detect deterioration and damage.	Low	Minor Adverse	Not Significant

	Severe weather events	Reduced safety and visibility as a result of standing water	Regular maintenance and cleaning of drainage systems. Emergency response and contingency plans in place	Low	Minor Adverse	Not Significant
		Safety risks due to snow and ice	Road user warning systems in place. Ensure effective, essential winter maintenance. Emergency response and contingency plans in place. Standard operating procedures in place for use in the event of necessary road closure and/or traffic diversion.			

12.6 Mitigation

GHG Impact Assessment

12.6.1 A series of mitigation measures have been identified to reduce GHG emissions from the Scheme. These measures include:

- Where feasible, carrying out measures to reduce GHG emissions from material use and waste, including:
    - The sustainable reuse of soil and aggregate materials won from excavation;
    - The reuse, where possible of materials and waste generated from construction works;
    - The use of materials with lower embodied carbon, such as those with a higher recycled content;
    - Procuring locally sourced materials where reasonably practicable; and,
    - Careful consideration of material quantity requirements to avoid over-ordering and generation of waste materials, while also reducing transportation-related emissions.
- The appointed contractor would develop and implement a plan to reduce energy consumption and GHG emissions throughout construction, including, for example:
    - Monitoring of fuel use on site;
    - Training of plant operatives in fuel efficient driving techniques; and,
    - Consideration of renewable and/or low carbon energy sources.

CCR Assessment

12.6.2 Several mitigation and adaptation measures to address the potential impacts associated with climate change are proposed. Many of these have been identified within other topic chapters and through the Scheme design. These measures include:

- Consideration of the dangers associated with working in more extreme weather conditions to be within the Construction Environmental Management Plan (CEMP);
- Consideration of the use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures) to be included within detailed designs;
- Consideration of climate change projections to be within maintenance plans;
- Drainage systems design to protect against a return period of 1-in-100 years flood event;
- Procedures would be identified in the CEMP for severe weather events including, identification of suitable network redundancies and diversion routes, emergency response and contingency plans and standard operating procedures for use in the event of necessary road closure and/or traffic diversion; and,
- Regular maintenance of assets.

12.7 Monitoring

12.7.1 As no significant effects have been identified for the climate assessment, no monitoring of significant effects is proposed during the construction and operation of the Scheme.

12.7.2 A CEMP would set out details of the monitoring to be undertaken during the Scheme construction stage to determine whether the mitigation measures embedded in the Scheme design are being appropriately implemented.

12.7.3 It is not considered practical to monitor GHG emissions from users during the Schemes operational phase.

12.8 Residual Impacts

12.8.1 The Scheme is not predicted to have a significant impact on climate change. Therefore, no residual impacts are predicted as a result of the construction and operation of the Scheme.

12.9 Summary

12.9.1 As previously mentioned, Climate Change is large-scale, long-term shift in the planet's weather patterns and average temperatures. It is at the fore-front of many environmental reports and assessments and is one of the core land-use principles in the NPPF.

12.9.2 This chapter has assessed the resilience of the Scheme to potential future climate changes and weather events and has concluded that with mitigation measures, would be able to withstand any possible future threats.

12.9.3 The GHG emissions caused during the construction and operation of the Scheme are not significant when viewed against the UK carbon budget 2028 – 2032 and carbon budget for 2033 - 2037. As such, no mitigation or monitoring is proposed going forwards.

12.10 References

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