Chapter 08
Climate

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8 CLIMATE

8.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) has considered the potential climate impacts (both positive and negative) associated with the Construction and Operational Phases of the Galway: Dublin Road scheme (hereafter referred to as the Proposed Development).

The aim of the Proposed Development when in operation is to provide enhanced walking, cycling and bus infrastructure in Galway city and its environs, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the corridor. The objectives of the Proposed Development are described in Chapter 1 (Introduction) of this EIAR. The Proposed Development which is described in Chapter 4 (Proposed Development Description) of this EIAR has been designed to meet these objectives.

The Proposed Development will facilitate a resilient, accessible public transport and cycling and pedestrian network providing an attractive alternative to private car travel, encouraging more passenger travel by sustainable modes while providing a better quality of life for citizens. The improvements in provision of sustainable modes of transport as a result of the Proposed Development will facilitate a reduction in congestion, reduced greenhouse gas (GHG) emissions and associated air quality improvements along the Proposed Development, resulting in enhanced community wellbeing. The delivery of the Proposed Development will also aid in contributing to the national target of 500,000 additional trips by walking, cycling and public transport per day by 2030 as outlined as a target in the 2024 Climate Action Plan (CAP24) (DECC, 2023).

Potential climate impacts due to GHG emissions embodied carbon associated with the proposed construction materials and construction activities associated with the Construction Phase of the Proposed Development were assessed. Construction activities included temporary activities such as earthworks, road resurfacing and road realignments, while construction materials included asphalt, concrete and granular material, among others. GHG emissions from construction traffic using access routes, as well as general traffic redistribution due to diversions are also assessed for this phase of the works.

Potential climate impacts are associated with the Operational Phase of the Proposed Development, in the form of predicted changes in traffic flows along the Proposed Development, reallocation of road space for sustainable modes and potential for displaced traffic flows. In addition, an assessment of the Proposed Development in relation to its vulnerability to climate change has been undertaken.

8.2 Climate Assessment Considerations

The Proposed Development aims to provide an attractive alternative to the private car and promote a modal shift to public transport, cycling and walking. It is, however, recognised that there will be an overall reduction in operational capacity for general traffic along the Proposed Development given the proposed changes to the road layout and the rebalancing of priority to walking, cycling and bus.

This reduction in operational capacity for general traffic along the Proposed Development is likely to create some level of trip redistribution onto the surrounding road network, in the absence of wider regional demand management measures (outside the scope of the Proposed Development).

It should be noted that the Do Minimum and Do Something scenarios are based on the assumption that travel behaviour will remain broadly consistent over the assessment period (2023-2043) and that car demand data used for this assessment, represents a reasonable worst-case scenario. However, it is anticipated that societal trends in the medium to long term may reduce car demand further due to the ongoing changes to travel behaviours and further shifts towards sustainable travel; flexibility in working arrangements brought on following COVID-19 restrictions; and delayed car ownership trends that are emerging.

The assessment also assumes that goods vehicles (HGVs and LGVs) continue to grow in line with forecasted economic activity with patterns of travel remaining the same. It should be noted, however, that CAP24 includes reference to a freight strategy for the Country which will seek to further integrate smart technologies in logistics management and may include the regulation of delivery times as far as practicable to off-peak periods to limit traffic congestion in urban areas. The CAP outlines proposals to manage the increase in delivery and servicing requirements as the population grows, which may include the development of consolidation centres to limit the number of 'last- mile' trips made by larger goods vehicles with plans for higher use of smaller electric vans or cargo bikes for 'last-mile' deliveries in urban areas. As proposals for the above are at a pre-planning stage, it was not possible to account for them in the assessments and a worst-case assessment has been undertaken based on continued growth in goods traffic.

The design of the Proposed Development has evolved through comprehensive design iteration, with particular emphasis on minimising the potential for environmental impacts, where practicable, whilst ensuring the objectives of the Proposed Development are achieved. Significant design iterations were undertaken to mitigate against traffic re-distribution impacts and consequent increases in trip kilometres and in turn GHG emissions. In addition, feedback received from the comprehensive consultation programme undertaken throughout the option selection and design development process has been incorporated where appropriate.

8.3 Methodology

8.3.1 General

Transport Infrastructure Ireland (TII) guidance PE-ENV-01105: Climate Assessment of Proposed National Roads – Standard (TII, 2022b) advises that the assessment of a Proposed Development should describe the likely significant effects on the environment resulting from both the:

- Impact of a project on climate (Greenhouse Gas Assessment (GHGA)); and
- Vulnerability of a project to climate change (Climate Change Risk Assessment (CCRA)) and appropriate adaptation measures.

The assessment methodology has been derived with reference to the most appropriate guidance documents relating to climate which are set out in the following sections of this Chapter. An overview of the methodology undertaken for the climate impact assessment is outlined below:

- A detailed baseline review of GHG emissions has been undertaken to characterise the baseline environment. This has been undertaken through review of available published GHG emission data (refer to Section 8.4);
- A review of the most applicable guidelines for the assessment of GHG emissions was undertaken in order to define the significance criteria for the Construction and Operational Phases of the Proposed Development in both the Opening Year (the year the Proposed Development becomes operational - 2028) and the Design Year (15 years after the Opening Year - 2043) (refer to Section 8.3.5.2.4);
- Predictive GHG calculations and impact assessment relating to the Construction Phase of the Proposed Development have been undertaken (refer to Section 8.3.5.2 for methodology and Section 8.5.2.1 for impact assessment);
- Predictive GHG calculations have been performed to assess the potential climatic impacts associated with the operation of the Proposed Development (refer to Section 8.3.5.2.3 for methodology and Section 8.5.3.1 for impact assessment);
- An assessment of the vulnerability of the Proposed Development to climate change has been undertaken (refer to Section 8.3.5.3 for methodology and Sections 8.5.2.2 and 8.5.3.2 for impact assessment); and
- Mitigation measures have been incorporated to reduce, where necessary, the identified potential climatic impacts associated with the Proposed Development (refer to Section 8.6).

8.3.2 Study Area

The Proposed Development is located along the R338 Dublin Road, representing a west-east approx. 3.9 km long public transport corridor commencing east of the Moneenageisha Junction where it ties into the BusConnects Galway: Cross City Link proposals and extends to the junction with Doughiska Road, tying into the Martin Junction Upgrade. Refer to Figure 1-1 Chapter 1 (Introduction) of this EIAR for the extents of the Proposed Development. In terms of the climate study area, the assessment has taken into account the travel distances associated with the Construction Phase of the Proposed Development and, for the operational phase, changes to traffic flow due to Proposed Development across Galway City.

The scope and boundary for the assessment taking into account the following criteria:

- Spatial boundary: As per PE-ENV-01105 (TII, 2022b), the study area with respect to the GHGA is Ireland's sectoral targets for GHG emissions, as outlined in CAP24. The study area with respect to the CCRA can be considered to include the Proposed Development boundary and its assets. The study area will be influenced by current and future baselines (Section 8.4). This study area is influenced by the input of other experts within the EIAR team;
- Climate hazards: The outcomes of the climate screening i.e. vulnerability assessment and baseline assessment; and
- Project receptors: TII state that the project receptors are the asset categories (as discussed hereunder) considered in the climate screening. In addition, any critical connecting infrastructure, and significant parts of the surrounding environment e.g. water bodies that should be considered as a part of the indirect, cumulative and in combination impact assessment should also be considered project receptors.

TII state in PE-ENV-01105 (TII, 2022b) that the list of asset categories and climate hazards that shall be used for TII projects includes:

- Asset categories - Pavements; drainage; structures; utilities; landscaping; signs, light posts, associated auxiliary buildings, and fences; and
- Climate hazards - Flooding (coastal); flooding (pluvial); flooding (fluvial); storms; extreme heat; extreme cold; wildfire; drought; extreme wind; lightning and hail and fog.

8.3.3 Relevant Guidelines, Policy, and Legislation

8.3.3.1 General

The assessment has been undertaken with reference to the most appropriate guidance documents relating to climate which are set out in the following sections.

In addition to specific climate guidance documents, the following guideline was considered and consulted in the preparation of this assessment:

- Guidelines on the Information to be contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA, 2022).

The assessment has made reference to national guidelines, where available, in addition to international standards, guidelines and legislation such as Directives and Regulations relating to the assessment of GHG emissions and associated climatic impacts from road schemes. These are summarised below:

- European Union (EU) Directive 2011/92/EU (as amended by Directive 2014/52/EU) on the assessment of the effects of certain public and private projects on the environment (the EIA Directive);
- European Union (EU) Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (European Climate Law);
- 2030 Climate and Energy Policy Framework (European Commission 2014);
- 2030 EU Climate Target Plan (European Commission, 2021b);

- Climate Action and Low Carbon Development Acts 2015 – 2021 (the Climate Act);
- Climate Action Plan 2024 (hereafter referred to as the CAP24) (DECC, 2023);
- National Adaptation Framework (hereafter referred to as the NAF) (DECC, 2024c);
- Department of Transport, Tourism and Sport (DTTAS) Transport Climate Change Sectoral Adaptation Plan (DTTAS, 2019);
- Galway City Council (GCC) Local Authority Climate Action Plan 2024-2029 (GCC, 2024);
- Transport Infrastructure Ireland (TII) PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document (TII, 2022a);
- Transport Infrastructure Ireland (TII) PE-ENV-01105: Climate Assessment of Proposed National Roads Standard (TII, 2022b);
- Transport Infrastructure Ireland (TII) GE-ENV-01106: Transport Infrastructure Ireland Carbon Assessment Tool for Road and Light Rail Projects User Guidance Document (TII, 2024a);
- Transport Infrastructure Ireland (TII) PE-ENV-01107: Air Quality Assessment of Proposed National Roads – Standard (TII, 2022c);
- Institute of Environmental Management and Assessment (IEMA) Assessing Greenhouse Gas Emissions and Evaluating their Significance 2nd Edition (IEMA, 2022);
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA, 2020a); and
- IEMA Greenhouse Gas Management Hierarchy (IEMA, 2020b).

8.3.3.2 International Policy

The Paris Agreement (UNFCCC, 2015), which entered into force in 2016, is an important milestone in terms of international climate change agreements and includes an aim of limiting global temperature increases to no more than 2°C (degrees Celsius) above pre-industrial levels with efforts to limit this rise to 1.5°C. Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs comprise the efforts and actions by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement requires each country to prepare the NDCs that it intends to achieve, updating and enhancing the NDCs every 5 years. Countries are required to implement mitigation measures, with the aim of achieving the objectives of such contributions. Each of the EU Member States submit their own NDCs, which contribute to the overall EU NDC.

The European Green Deal, published by the European Commission in December 2019, provides an action plan which aims for the EU to be climate neutral by 2050. The EU Green Deal highlights that further decarbonisation of the energy sector is critical to reach climate objectives in 2030 and 2050. The European Green Deal has increased the GHG emissions reduction 2030 target to at least 55% in comparison to 1990 levels. Targets for renewable energy and energy efficiency are also likely to be increased.

On 14 July 2021, the European Commission adopted a series of legislative proposals setting out how it intends to achieve climate neutrality in the EU by 2050, including the intermediate target of at least a 55% net reduction in greenhouse gas emissions by 2030. The package of proposals is known as the 'Fit for 55' package.

The package includes revisions to the legislation put forward as part of the Climate and Energy Framework 2021-2030, including the EU Emissions Trading System (ETS), Effort Sharing Regulation, transport and land use legislation, setting out in real terms the ways in which the Commission intends to reach EU climate targets under the European Green Deal.

The EU ETS was launched in 2005 as the world's first international company- level 'cap-and trade' system for reducing emissions of greenhouse gases cost-effectively. The EU ETS regulates the GHG emissions of larger industrial emitters including electricity generation, cement manufacturing and heavy industry.

Under this new package of legislative proposals, the sectors of the economy covered by the current ETS must reduce emissions by 61% by 2030 compared to 2005 levels by increasing annual emissions reduction to 4.2% per annum. This is a substantial increase from the previous target which was a 43% reduction by 2030.

The non-ETS sector includes all domestic GHG emitters which do not fall under the ETS scheme and thus includes GHG emissions from transport, residential and commercial buildings and agriculture. Under this new package of proposals, the Commission is now proposing to reduce emissions under the non-ETS sectors or the sectors which fall under the Effort Sharing Regulation by at least 40%, compared to 2005 levels. This is an increase of 11 percentage points compared to the existing target of a 29% emission reduction.

The European Climate Law aims to write into law the goal set out in the European Green Deal – for Europe's economy and society to become climate-neutral by 2050. On 17 September 2020, the Commission adopted a proposal to include a revised EU emissions reduction target of at least 55% by 2030 as part of the European Climate Law.

The 2021 EU Strategy on Adaptation to Climate Change sets out the pathway to prepare for the unavoidable impacts of climate change. The aim is that *"by 2050, when we aim to have reached climate neutrality, we will have reinforced adaptive capacity and minimised vulnerability to climate impacts…"* Adaptation refers to measures that can reduce the negative impact of climate change by, for example, ensuring a project is resilient to future increases in storm frequency and rainfall levels.

The EU has adopted integrated monitoring and reporting rules to ensure progress towards its 2030 climate and energy targets and its international commitments under the *2015 Paris Agreement*.

8.3.3.3 National Policy

The purpose of the Climate Action and Low Carbon Development Act 2015, as amended (Climate Act). was to enable Ireland 'to pursue, and achieve, the transition to a low carbon, climate resilient and environmentally sustainable economy by the end of the year 2050'. This is referred to in the Climate Act as the 'national transition objective'. The Climate Act allows for the submission of an adaptation framework for Ireland referred to as the 'National Adaptation Framework', which is required to be submitted to Government for approval every five years.

Ireland's first statutory National Adaptation Framework (NAF) (DECC, 2018), which was published in 2018 and builds on the work already carried out under the National Climate Change Adaption Framework (NCCAF), sets out the national strategy, for government and society, to reduce the vulnerability of the country to the negative effects of climate change.

In May 2019, the Government of Ireland declared a climate and biodiversity emergency. Following on from this, the Government of Ireland's first national Climate Action Plan (CAP) (DECC, 2019) was published in 2019. It commits to achieving a net zero carbon energy systems objective for Ireland.

In October 2019, the Transport Climate Change Sectoral Adaption Plan (Department of Transport, 2019) was published under the NCCAF. The Plan identifies the key vulnerabilities in the transport network and looks to promote greater resilience to safeguard its continued operation.

The Programme for Government Our Shared Future (Department of the Taoiseach, 2020), agreed in June 2020, accelerated the decarbonisation agenda, committing to a 7% average yearly reduction in overall greenhouse gases over the next decade, and to achieving net zero emissions by 2050.

The Government of Ireland's updated Climate Action Plan (CAP) 2021 (DECC, 2021) set out a detailed sectoral roadmap to deliver a cumulative reduction in emissions, building on the commitments of the first Climate Action Plan (2019). The core measures for transport focus on accelerating the electrification of road transport, increasing the use of biofuels and a shift to low energy transport modes such as walking, cycling, active travel and public transport. There are measures focused on increasing the 'modal shift' to reduce the fossil fuelled distances taken by car by 10%. The CAP acknowledges that policies need to be better aligned to achieve more ambitious targets for modal shift, which will involve the building of supporting infrastructure.

The Climate Action and Low Carbon Development (Amendment) Act 2021 (2021 Climate Act) was commenced in law in September 2021. The 2021 Climate Act commits Ireland, in law, to move to a climate resilient and climate neutral economy by 2050 in alignment with the European Green Deal (EC, 2024), and includes the following elements:

- Establishes a 2050 emissions target;
- Introduces a system of successive 5-year, economy-wide carbon budgets. The first two carbon budgets covering the periods 2021-2025 and 2026-2030 were announced by the Climate Change Advisory Council in 2021 (with a provisional budget from 2031). Once adopted by the Oireachtas, the carbon budgets will be used to prepare sectoral emissions ceilings for relevant sectors of the economy - this will include emission ceilings for the transport sector;
- Strengthens the role of the Climate Change Advisory Council in proposing carbon budgets;
- Introduces a requirement to annually revise the Climate Action Plan and prepare a National Long Term Climate Action Strategy at least every decade; and
- Introduces a requirement for all Local Authorities to prepare individual Climate Action Plans which will include both mitigation and adaptation measures.

In December 2023, the 2024 CAP was published (DECC, 2023). This is the second CAP since the publication of the carbon budgets and sectoral emissions ceilings, and it aims to implement the required changes to achieve a 51% reduction in carbon emissions by 2030. The 2023 CAP has six vital high impact sectors where the biggest savings can be made: renewable energy, energy efficiency of buildings, transport, sustainable farming, sustainable business and change of land-use. The 2023 CAP confirms that since the publication of the 2021 CAP several transport related measures have been implemented.

Aims within the 2023 CAP that have the potential to affect transport emissions include reducing the dependency on private cars and a target to reduce the overall total distance driven across all car journeys by 20%. In addition, the 2024 CAP has a 2030 aim that 1 in 3 cars will be electric and that there would be an annual increase in the percentage of biofuel in fossil fuels (E10:B12 by 2025 and E10:B20 by 2030). E10 is unleaded petrol blended with 10% ethanol, B20 is up to 20% biodiesel blended into diesel.

Within the 2024 CAP, key transport actions are considered using an ‘Avoid-Shift-Improve’ framework:

- Developing services, communities, and infrastructure in such a manner as to AVOID the need to travel as much as we do today;
- Improving the relative attractiveness of sustainable travel modes such as Public Transport, Cycling and Walking, to SHIFT away from car use; this will facilitate increased use of lower-carbon modes and reduce the percentage of total journeys that are made by private car (modal share) from 72% in 2018 to 53% in 2030; and
- Complement these measures by increasing the proportion of EVs in our car fleet to 30% by 2030, which will IMPROVE the efficiency of the national car fleet; electrification of the freight and public transport sector will also be key.

As part of the AVOID and SHIFT policies, the 2023 CAP highlights that the reallocation of existing road space towards public transport and active travel has been implemented including crucial elements of the BusConnects programme.

The first carbon budget programme proposed by the Climate Change Advisory Council was approved by Government and adopted by both Houses of the Oireachtas in April 2022. The carbon budgets comprise three successive 5-year budgets. The total emissions allowed under each budget is set out below in Table 8-1 as well as the average annual reduction for each 5-year period.

Table 8-1 2021 – 2035 Carbon Budgets

Period	Million tonnes (Mt) CO_2eq	Emission Reduction Target
2021-2025	295 Mt CO_2eq	Reduction in emissions of 4.8% per annum for the first budget period.
2026-2030	200 Mt CO_2eq	Reduction in emissions of 8.3% per annum for the second budget period.
2031-2035	151 Mt CO_2eq	Reduction in emissions of 3.5% per annum for the third provisional budget.

The 2023 CAP provides that the economy-wide carbon budgets will be supplemented by sectoral emissions ceilings, setting the maximum amount of GHG emissions that are permitted in a given sector of the economy during each five-year carbon budget. The Sectoral Emission Ceilings for each Sector, published in July 2022 (Department of the Taoiseach, 2022), is shown in Table 8-2. It should be noted that 5.25 Mt CO_2eq of annual emissions reductions are currently unallocated on an economy-wide basis for the second carbon budget period (2026-2030). These will be allocated following a mid-term review and identification of additional abatement measures. The transport sector emitted approximately 12 Mt CO_2eq in 2018 and has a ceiling of 6 Mt CO_2eq in 2030 which is a 50% reduction over this period.

Table 8-2 Sectoral Emission Ceilings (DECC, 2023)

Sector	Baseline (Mt CO_2e)	Carbon Budgets (Mt CO_2e)		2030 Emissions (Mt CO_2e)	Indicative Emissions % Reduction in Final Year of 2025- 2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Electricity	10	40	20	3	75
Transport	12	54	37	6	50
Built Environment - Residential	7	29	23	4	40
Built Environment - Commercial	2	7	5	1	45
Industry	7	30	24	4	35
Agriculture	23	106	96	17.25	25
Other (F-gases, waste, petroleum refining)	2	9	8	1	50
Land Use, Land-use Change and Forestry (LULUCF)	5	Reflecting the continued volatility for LULUCF baseline emissions to 2030 and beyond, CAP24 puts in place ambitious activity targets for the sector reflecting an EU-type approach.			
Total	**68**				
Unallocated Savings	-	-	26	-5.25	-
Legally Binding Carbon Budgets and 2030 Emission Reduction Targets	**-**	**295**	**200**	**-**	**51**

In April 2023 the Government published a draft *Long-Term Strategy on Greenhouse Gas Emissions Reductions* (DECC, 2024a). This strategy provides a long-term plan on how Ireland will transition towards net carbon zero by 2050, achieving the interim targets set out in the Climate Action Plan. The strategy will be updated on the basis of a second round of public consultation throughout 2023 with an updated strategy published after this is complete.

Public Sector Bodies Climate Action Roadmaps Guidance 2024 (Sustainable Energy Authority of Ireland (SEAI), 2024) aims to provide a climate action roadmap to encourage strategic vision, coordination, organisation, mobilisation, and planning within the public sector. The roadmap provides both minimum and recommended content on different sectors (e.g. water, food waste, construction, energy use) and recommends additional supporting documents that may assist with the public bodies achieving the aims of the roadmap. The roadmap mandates three overarching targets: to reduce GHG emissions by 51% in 2030; to increase the improvement in energy efficiency in the public sector from the 33% target in 2020 to 50% by 2030; and update Climate Action Roadmaps annually within six months of the publication of the CAP.

The NAF (DECC, 2024b) was published in June 2024 in line with the five-year requirement of the 2015 Climate Act. The plan provides a whole of government and society approach to climate adaptation in Ireland in order to reduce Ireland's vulnerability to climate change risks including extreme weather events, flooding, drought, loss of biodiversity, sea level rise and increased temperatures. Similar to the 'Just Transition' when considering carbon emissions, the NAF aims for 'Just Resilience' stating that:

"A climate resilient Ireland will have a reduced reliance on fossil fuel, it will have widely accessible electrified public transport and will have transitioned towards sustainable agricultural practices such as agroforestry and organic farming."

The NAF highlights that there is a projected increased frequency of droughts, coupled with higher evapotranspiration rates, which could cause reduced river flow, groundwater recharge, and reservoir refill capacity, leading to potential water supply shortages. The NAF warns that national long-term water supply projects must be planned for within budgets to ensure the adaptation required to make Ireland resilient by 2050 and beyond is funded. With respect to the water sector, the NAF states that the potential adaptation measures for the water sector are:

- Fully adopting the 'integrated catchment management' approach;
- Improving treatment capacity and network functions for water services infrastructure;
- Water resource planning and conservation – on both supply and demand sides; and
- The inclusion of climate actions in monitoring programmes and research.

The National Climate Change Risk Assessment (NCCRA) was published in May 2024 (EPA, 2024c). The NCCRA was required to be developed under Action 457 from the 2021 CAP (DECC, 2021). Action 457 seeks to "*Further develop Ireland's national climate change risk assessment capacity to identify the priority physical risks of climate change to Ireland.'*. The NCCRA uses definitions of the risk determinants from the Intergovernmental Panel on Climate Change (IPCC) risk framework (IPCC, 2023):

- Hazard - the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources;
- Exposure - the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected;
- Vulnerability - the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity; and
- Risk - the potential for adverse consequences for human or ecological systems.

When considering risk, the NCCRA assess exposure and vulnerability for two future climate change scenarios or Representative Concentration Pathways (RCPs):

- RCP4.5 was selected as it represents a scenario aligned with the global temperature trajectory; and
- RCP8.5 was selected as it represents a high-emissions scenario and achieves the highest level of modelled temperature increases by the end of the century. Consequently, this scenario will result in the highest level of physical risk for Ireland, and therefore the greatest requirement for adaptation.

These scenarios align with a conservative approach to assess risks to Ireland and assumes global emission reduction targets are not met. This aligns with the principle of precaution as stated in the NAF (DECC, 2024b). In addition to the future climate scenarios, the NCCRA assesses the risk from the future climate during the following timeframes:

- Present (~2030);
- Medium term (~2050); and
- Long term (~2100).

8.3.3.4 Local Policy

GCC has prepared a plan entitled Local Authority Climate Action Plan 2024-2029 (GCC, 2024). The plan outlines a number of transport orientated actions under Theme 3.2.5 Transport and Mobility relevant to the Proposed Development:

- Action 47 *"Support the development of greater accessibility, modal shift and active travel throughout Galway City through implementation of work programmes and Galway Transport Strategy (GTS)";* and
- Action 49 "*Support uptake of active travel modes across Galway City engaging with key stakeholders, community groups, institutions, and schools through workshops, co-design, and engagement. Includes delivery of primary, secondary school and business cycle training programme*."

GCC's Climate Action Plan 2024-2029 is also the primary instrument at local level to ensure a proper comprehension of the key risks and vulnerabilities of climate change and bring forward the implementation of climate resilient actions in a planned and proactive manner. The strategy ensures that climate adaptation considerations are mainstreamed into all plans and policies and integrated into all operations and functions of GCC.

8.3.4 Data Collection and Collation

Baseline data has been collected through carrying out a desk study, availing of the most up-to-date available data, at the time of writing. This comprises research data and relevant publications from the following organisations which have been reviewed.

- GCC;
- Department of the Environment, Climate and Communications;
- Met Eireann;
- Environmental Protection Agency (EPA); and
- Sustainable Energy Authority Ireland (SEAI).

Detailed traffic data used in the assessment of the Construction and Operational Phases was supplied by the traffic consultants for the Proposed Development.

8.3.5 Appraisal Method for the Assessment of Impacts

This section sets out how the climate assessment has been undertaken and highlights where input from other environmental disciplines has been included within the assessment.

8.3.5.1 Overview

The climate assessment has been carried out in accordance with the EPA Guidelines (EPA, 2022).

The assessment methodology has been derived with reference to the most appropriate guidance documents (see Section 8.3.3) relating to climate which are referenced where appropriate in the following sections of this chapter.

The climate assessment comprises two elements:

- Greenhouse Gas Emissions Assessment (GHGA) – Quantifies the GHG emissions from a project over its lifetime. The assessment compares these emissions to relevant carbon budgets, targets, and policy to contextualise magnitude; and
- Climate Change Risk assessment (CCRA) – Identifies the impact of a changing climate on a project and receiving environment. The assessment considers a projects vulnerability to climate change and identifies adaptation measures to increase project resilience.

A detailed discussion of the input data and appraisal methodology for both the Construction and Operational Phases is detailed in Section 8.3.5.2 and Section 0.

8.3.5.2 Greenhouse Gas Emissions Assessment (GHGA)

The assessment set out in PE-ENV-01105 (TII, 2022b) aims to quantify the difference in GHG emissions between the Proposed Development and the baseline scenario (without the Proposed Development). The assessment process is guided by the following documents:

- Publicly Available Specification (PAS) 2080:2023 on Carbon Management in Buildings and Infrastructure (BSI, 2023): this provides a framework that allows all parties involved in the development of an infrastructure project to work together to quantify the project's overall carbon impact; and
- The Institute of Environmental Management & Assessment Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2nd Edition) (IEMA, 2022) (hereafter referred to as the IEMA guidance): lays out the process of assessing GHG emissions to understand their significance in the context of an EIA.

The IEMA 2022 GHG Guidance does not recommend a particular approach for this due to variations of situations, but instead it sets out advice for the key common components necessary for undertaking a GHG emissions assessment. During the assessment the IEMA recommend use of a reasonable worst-case scenario rather than an absolute worst-case scenario. The IEMA 2022 GHG Guidance states that a GHG emissions assessment should incorporate the following steps into any climate assessment:

- Evaluate early opportunities to reduce GHG emissions;
- Set the scope and boundaries of the GHG assessment;
- Data collection;
- Develop the baseline and Do-Minimum Scenario;
- Calculate/determine the GHG emissions from the Proposed Project;
- Identify mitigation measures;
- Assess significance; and
- Assess cumulative impacts.

TII Guidance PE-ENV-01105 (TII, 2022b) states that: *"activities that account for less than 5% of the total energy usage and/or 5% of the mass balance can be excluded from the assessment scope. E.g., if electricity for operating signage is less than 5% of total electricity used of the project infrastructure, it can be excluded from the assessment scope."*

With respect to the requirement for a cumulative assessment PE-ENV-01105 (TII, 2022b) states that as the sensitive receptor "*for GHG Assessment is the global climate and impacts on the receptor from a project are not geographically constrained, the normal approach for cumulative assessment in EIA is not considered applicable."* However, by presenting the GHG impact of a project in the context of its alignment to Ireland's trajectory of net zero and any sectoral carbon budgets, this assessment will demonstrate the potential for the Proposed Development to affect Ireland's ability to meet its national carbon reduction target. Therefore, the assessment approach is considered to be inherently cumulative.

PE-ENV-01105 (TII, 2022b) outlines the recommended sources of input data and the appraisal methodology for the assessment of impacts for both the Construction Phase and Operational Phase as outlined in Table 8-3 (reproduced from Table 3.27 of PE-ENV-01105 (TII, 2022b), and Table 6.2 of PE-ENV-01104 (TII,

2022b) for more detail). The assessment is broken down into stages (construction and operational) and individual assessment techniques for each of these stages.

To define the boundary of the assessment consideration should be given to the temporal boundary and to the systems boundary. The temporal boundary is the time period which the assessment covers, in this case a design life of 30 years is considered. The system boundary includes the emission sources of the project and the lifecycle stage in which they arise. The GHG systems boundary for assessment and life cycle stages scoped in include preconstruction, products utilised in construction, the construction activities, maintenance of materials during the lifespan of the Proposed Development and the use or Operational Phase.

The Construction Phase of the Proposed Development will result in GHG emissions from various sources as outlined in Table 8.2. The Construction Phase embodied GHG emissions are considered at all construction stages including the following:

- Land clearance activities (including the removal of trees / vegetation);
- Manufacture of materials and transport to site;
- Construction works (including excavations, construction, water usage, personnel travel, and project size); and
- Construction waste products (including transport off site).

The Proposed Development is expected to have a Construction Phase of 24 months and an operational lifespan of 30 years. Standard maintenance required during the operation of the Proposed Development has also been included as part of the GHG assessment, including consideration of the maintenance cycles for embodied carbon for road pavements.

The predicted embodied carbon emissions can be averaged over the full Construction Phase and the lifespan of the Proposed Development to give the predicted annual emissions to allow for direct comparison with annual emissions and targets. Emissions have been compared to the transport sector carbon budget (Department of the Taoiseach, 2022) which has a ceiling of 6 Mt CO_2eq in 2030, and compared against Ireland's non-ETS 2030 target of 33.381 Mt CO_2eq (as set out in Commission Implementing Decision (EU) 2020/2126 of 16 December 2020 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council), as amended.

End-of-life demolition, or decommissioning, of roads rarely occurs (Lokesh, 2022) and has therefore been excluded from this analysis.

Table 8-3 Sources and Life Cycle Stages for a Project's GHG Emissions (reproduced from Table 3.27 of PE-ENV-01105 (TII, 2022b), and Table 6.2 of PE-ENV-01104 (TII, 2022a))

Main Stage of a Project Life Cycle	Sub-Stage of Life Cycle	Potential Sources of GHG Emissions (Not Exhaustive)	Examples of Activity Data
Construction Stage	Product stage: including raw material supply, transport and manufacture.	Embodied GHG emissions associated with the required raw materials.	Material quantities.
	Construction process stage: including transport to / from works site and construction / installation processes.	Activities for organisations conducting construction work.	Fuel / electricity consumption. Construction activity type / duration. Transportation of materials from point of purchase to site, mode / distance. Area of land use change.

Main Stage of a Project Life Cycle	Sub-Stage of Life Cycle	Potential Sources of GHG Emissions (Not Exhaustive)	Examples of Activity Data
	Land use change.	GHG emissions mobilised from vegetation or soil loss during construction.	Type and area of land subject to change of usage.
Operation ('use-stage') (to extend 60 years in line with appraisal period)	Use of infrastructure by the end-use (road user).	Vehicles using highways infrastructure.	Traffic count / speed by vehicle type for highway links.
	Operation and maintenance (including repair, replacement and refurbishment).	Energy consumption for infrastructure operation and activities of organisations conducting routine maintenance.	Fuel / electricity consumption. For vehicles, lighting and plant. Raw material quantities and transport mode / distance. Waste and arisings quantities, transport mode/distance and disposal rate.
	Land use and forestry.	Ongoing land use GHG emissions / sequestration each year.	Type and area of land subject to change in usage. Net change in vegetation.
Opportunities for Reduction	GHG emissions potential of recovery including reuse and recycling GHG emissions potential of benefits and loads of additional functions associated with the study system.	Avoided GHG emissions through substitution of virgin raw materials with those from recovered sources.	Waste and arisings material quantities and recycling / reuse rate.

Note: The first life cycle stage is 'construction', which includes GHG emissions from the construction process and the manufacture / transport of materials. The second life cycle stage is 'operation', which includes:

1) Operation and maintenance, repair, replacement, refurbishment and land use change (operational maintenance GHG emissions); and
2) Emissions from end-users (operational user GHG emissions).

The third life cycle stage comprises opportunities to minimise production / use of GHG emissions i.e. the potential for reduction of GHG emissions through reuse and recycling during the construction of the Proposed Development.

8.3.5.2.1 Embodied carbon emissions

To provide a consistent approach to GHG assessment TII have developed the Carbon Assessment Tool (TII, 2024c) for carbon accounting. PE-ENV-01105 (TII, 2022b) states that the '*Climate Practitioner shall use the TII Carbon Tool for the calculation of emissions arising from the construction and maintenance of a proposed project.*'

The Carbon Assessment Tool aligns with TII's project phases as well as Section 7 of PAS 2080 Carbon Management in Construction, which was published by the British Standards Institution (BSI), the Construction Leadership Council and the Green Construction Board in 2023 (BSI, 2023). At the time of assessment, the tool includes an emission factors library using factors developed by relevant industry bodies, including:

- Institution of Civil Engineers (ICE, 2013), Civil Engineering Standard Method of Measurement 4 (CESMM4) Carbon & Price Book 2013;
- Sustainable Energy Authority of Ireland (SEAI, 2023), Conversion Factors;
- European Commission (2010) Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C (2010) 3751);
- UK Environment Agency, Carbon Calculator for Construction Activities (Version 3.6) (UKEA, 2014); and
- UK Government (2021), Greenhouse Gas Reporting Conversion Factors.

The carbon emissions are calculated by multiplying the emission factor by the quantity of the material that will be used over the entire construction / maintenance phase. The TII Online Carbon Assessment Tool (TII, 2024c) has been commissioned by TII to assess GHG emissions associated with infrastructure projects using Ireland-specific emission factors and data. The goal of the tool is to assist project development as a decision-making tool that drives lower carbon infrastructure and to facilitate the integration of environmental issues into transport infrastructure planning, construction and operation.

Detailed information for the Proposed Development including volumes of materials were obtained from the design team for the Proposed Development. Construction materials and construction activities with associated embodied carbon or GHG emissions are given and discussed in Section 8.5.2.1.

8.3.5.2.2 Land use change

The land use change associated with the Construction Phase of the Proposed Development has also been quantified using the TII Carbon Assessment Tool (TII, 2024c), which considers the loss or gain of carbon sinks. Loss of mixed forest, natural grassland, transitional woodland scrub and peat bogs has the potential to release GHGs, while increasing the amount of these land use types has the potential to absorb GHGs from the atmosphere.

8.3.5.2.3 Transport related emissions

There will be carbon emissions associated with the operation of the Proposed Development due to the operational traffic.

To provide a consistent approach to GHG assessment TII have developed the Roads Emissions Model (REM) tool (TII, 2024b).

The TII REM tool focuses on road emissions of CO_2, CH_4 and N_2O, particularly from the National Road Network (NRN). It uses a link-by-link based emission calculation approach and detailed fleet predictions for age, fuel technology, engine size and weight. The following inputs are required for the REM tool: light duty vehicle (LDV) annual average daily traffic movements (AADT), annual average daily heavy-duty vehicles (HDV AADT), annual average traffic speeds, road link lengths, road type and project county location. The Default fleet mix option was selected along with the Intermediate Case fleet data base selection, as per TII Guidance (TII, 2022c). The Intermediate Case assumes a linear interpolation between the Business-as-Usual case – where current trends in vehicle ownership continue and the Climate Action Plan (CAP) case – where adoption of low emission light duty vehicles occurs. The TII REM uses county-based Irish fleet composition for different road types, for different European emission standards from pre-Euro to Euro 6/VI with scaling factors to reflect improvements in fuel quality, retrofitting, and technology conversions.

PE-ENV-01105 (TII, 2022b) states that road traffic related emissions information should be obtained from an Air Quality Practitioner to show future user emissions during operation without the project in place. TII guidance PE-ENV-01107 '*Air Quality Assessment of Proposed National Roads – Standard*' (TII, 2022c) outlines the approach for defining the scope of the air quality assessment providing criteria (applying to both construction and operational phase) within Section 4.3.3. PE-ENV-01107 states that road links can be defined as being 'affected' by a proposed development and should be included in the assessment if:

- Road alignment will change by 5 meters (m) or more; or
- Annual average daily traffic (AADT) flows will change by 1,000 or more; or
- Heavy duty vehicle (HDV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more; or
- Daily average speed change by 10 kph or more; or
- Peak hour speed will change by 20 kph or more.

Table 8-3 outlines the sources and activity classes for the Operational Phase of the Proposed Development including operational end-use (road user). The results of this assessment have been compared with the EPA's projected transport sector GHG emissions for Ireland for 2028 and 2043.

The Construction Phase traffic movements are modelled using the same approach. Emissions related to the transportation of products/materials and construction equipment from point of production/storage to construction site are included within the online carbon tool as per PE-ENV-01105 (TII, 2022b).

8.3.5.2.4 Significance criteria for GHGA

PE-ENV-01105 (TII, 2022b) states that significance of GHG effects is based on IEMA guidance (IEMA, 2022) which is consistent with the terminology contained within Figure 3.4 of the EPA Guidelines (EPA, 2022).

The 2022 Guidance (IEMA, 2022) document sets out the following principles for significance:

- When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative, or negligible;
- Where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project's residual emissions at all stages; and
- Where GHG emissions remain significant, but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered.

TII states that professional judgement must be taken into account when contextualising and assessing the significance of a project's GHG impact (TII, 2022b). In line with IEMA guidance (IEMA, 2022) TII state that the crux of assessing significance is *"not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050".* The IEMA guidance also states that *"the significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or negligible"*, to account for the potential for a development to replace existing development or baseline activity with higher GHG emissions.

- Significance is determined using

Table 8-4 (derived from Table 3.29 of PE-ENV-01105 (TII, 2022b)) along with a consideration of the following two factors:

- The extent to which the trajectory of GHG emissions from the project aligns with Ireland's GHG trajectory to net zero by 2050; and
- The level of mitigation taking place.

Table 8-4 GHGA Significance Matrix

Effects	Significance level Description	Description
Significant adverse	Major adverse	The project's GHG impacts are not mitigated.
		The project has not complied with do-minimum standards set through regulation, nor provide reductions required by local or national policies; and
		No meaningful absolute contribution to Ireland's trajectory towards net zero.
	Moderate adverse	The project's GHG impacts are partially mitigated.
		The project has partially complied with do-minimum standards set through regulation, and have not fully complied with local or national policies; and
		Falls short of full contribution to Ireland's trajectory towards net zero.

Effects	Significance level Description	Description
Not significant	Minor adverse	The project's GHG impacts are mitigated through 'good practice' measures.
		The project has complied with existing and emerging policy requirements; and
		Fully in line to achieve Ireland's trajectory towards net zero.
	Negligible	The project's GHG impacts are mitigated beyond design standards.
		The project has gone well beyond existing and emerging policy requirements; and
		Well, ahead of the curve' for Ireland's trajectory towards net zero.
Beneficial	Beneficial	The project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration.
		The project has gone well beyond existing and emerging policy requirements; and
		Well, ahead of the curve' for Ireland's trajectory towards net zero, provides a positive climate impact.

8.3.5.3 Climate Change Risk Assessment (CCRA)

This assessment involves determining the vulnerability of the Proposed Development to climate change. This involves an analysis of the sensitivity and exposure of the development to climate hazards which together provide a measure of vulnerability.

PE-ENV-01105 (TII, 2022b) states that the CCRA is guided by the principles set out in the overarching best practice guidance documents:

- Technical guidance on the climate proofing of Infrastructure in the Period 2021-2027 (European Commission, 2021a); and
- The Institute of Environmental Management and Assessment, Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (2nd Edition) (IEMA, 2022).

Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (European Commission, 2021a) outlines an approach for undertaking a climate change risk assessment where there is a potentially significant impact on the Proposed Development due to climate change. The risk assessment assesses the likelihood and consequence of the impact occurring, leading to the evaluation of the significance of the impact. The role of the climate consultant in assessing the likelihood and impact, described below in Section 8.3.5.3.1, is often to facilitate the climate change risk assessment process with input from the design team or specific specialists such as hydrology.

The CCRA involves an initial screening assessment to determine the vulnerability of the construction and operational phase of the Proposed Development to various climate hazards. The vulnerability is determined by combining the sensitivity and the exposure of the Proposed Development to various climate hazards.

Firstly, the project asset categories must be assigned a level of sensitivity to climate hazards irrespective of the project location (example: Sea level rise will affect seaport projects regardless of specific location). PE-ENV-01105 (TII, 2022b) provide the below list of asset categories and climate hazards to be considered. The asset categories (Section 0) will vary for project type and need to be determined on a project-by-project basis.

- **Asset Categories** Pavements; drainage; structures; utilities; landscaping; signs, light posts, buildings, and fences;
- **Climate Hazards** Flooding (coastal, pluvial, fluvial); extreme heat; extreme cold; wildfire; drought; extreme wind; lightning and hail; landslides; fog.

The asset sensitivity is based on a High, Medium or Low rating with a score of 1 to 3 assigned as per the criteria below. Asset sensitivity takes into account design mitigation measures.

- **High sensitivity**: The climate hazard will or is likely to have a major impact on the asset category. This is a sensitivity score of 3;
- **Medium sensitivity**: It is possible or likely the climate hazard will have a moderate impact on the asset category. This is a sensitivity score of 2; and
- **Low sensitivity**: It is possible the climate hazard will have a low or negligible impact on the asset category. This is a sensitivity score of 1.

Once the sensitivities have been identified the exposure analysis is undertaken. The exposure analysis involves determining the level of exposure of each climate hazard at the project location irrespective of the project type. Exposure is assigned a level of High, Medium or Low as per the below criteria.

- **High exposure**: It is almost certain or likely this climate hazard will occur at the project location i.e. might arise once to several times per year. This is an exposure score of 3;
- **Medium exposure**: It is possible this climate hazard will occur at the project location i.e. might arise a number of times in a decade. This is an exposure score of 2; and
- **Low exposure**: It is unlikely or rare this climate hazard will occur at the project location i.e. might arise a number of times in a generation or in a lifetime. This is an exposure score of 1.

Once the sensitivity and exposure are categorised, a vulnerability analysis is conducted by multiplying the sensitivity and exposure to calculate the vulnerability.

8.3.5.3.1 Significance criteria for CCRA

The assessment of vulnerability to climate change combines the outcomes of the sensitivity and exposure analysis with the aim of identifying the key vulnerabilities and potentially significant climate hazards which could impact the Proposed Development. The vulnerability assessment takes any proposed mitigation into account.

Vulnerability = Sensitivity x Exposure

Table 8-5 details the vulnerability matrix; vulnerabilities are scored on a high, medium and low scale. A risk that is low or medium is classed as non-significant, while a high or extreme risk is classed as a significant risk.

TII guidance (TII, 2022b) and the EU technical guidance (European Commission, 2021a) note that if all vulnerabilities are ranked as low in a justified manner, no detailed climate risk assessment may be needed. The impact from climate change on the Proposed Development can, therefore, considered to be not significant. The impact from climate change on the Proposed Development can therefore considered to be not significant. Where residual medium or high vulnerabilities exist, the assessment may need to be progressed to a detailed climate change risk assessment and further mitigation implemented to reduce risks. An assessment of construction phase CCRA impacts is only required according to the TII guidance (TII, 2022b) if a detailed CCRA is required.

Table 8-5 Vulnerability Matrix

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

The screening CCRA, discussed in Section 8.5.3, did not identify any residual medium or high risks to the Proposed Development as a result of climate change. Therefore, a detailed CCRA for the construction and operational phase were scoped out.

While a CCRA for the construction phase was not required, best practice mitigation against climate hazards is still recommended in Section 8.6.1.

8.4 Baseline Environment

8.4.1 Climate Pollutants

Climate is defined as the average weather over a period of time, whilst climate change is a significant change to the average weather. Climate change is a natural phenomenon but in recent years human activities, through the release of GHGs, have impacted on the climate (IPCC, 2023).

The release of anthropogenic GHGs is altering the Earth's atmosphere resulting in a 'Greenhouse Effect'. This effect is causing an increase in the atmosphere's heat trapping abilities resulting in increased average global temperatures over the past number of decades. The release of CO_2 as a result of burning fossil fuels, has been one of the leading factors in the creation of this 'Greenhouse Effect'. The most significant GHGs are CO_2, methane (CH4) and nitrous oxide (N_2O).

GHGs have different efficiencies in retaining solar energy in the atmosphere and different lifetimes in the atmosphere. In order to compare different GHGs, emissions are calculated on the basis of their Global Warming Potential (GWPs) over a 100-year period, giving a measure of their relative heating effect in the atmosphere. The IPCC *AR6 Synthesis Report: Climate Change 2021* (IPCC, 2023) sets out the global warming potential for a 100-year time period (GWP100) for CO_2 as the basic unit (GWP = 1) whereas CH_4 has a global warming potential equivalent to 29.8 units of CO_2 (for fossil sources) and N_2O has a GWP100 of 273.

PE-ENV-01105 (TII, 2022b) states that a baseline climate scenario should identify, consistent with the study area for the Proposed Development, GHG emissions without the Proposed Development for both the current and future baseline.

Given the circumstances of Ireland's declaration of a climate and biodiversity emergency in May 2019 and the November 2019 European Parliament approval of a resolution declaring a climate and environment emergency in Europe, in conjunction with Ireland's current failure to meet its EU binding targets under the EU Effort Sharing Regulation, changes in GHG emissions either beneficially or adversely are of more significance than previously viewed prior to these declarations. Thus, the baseline climatic environment should be considered a highly sensitive environment for the assessment of impacts.

8.4.2 Current GHGA Baseline

Data published in July 2024 (EPA, 2024a) indicates that Ireland exceeded (without the use of flexibilities) its 2023 annual limit set under EU's Effort Sharing Decision (ESD) (EU 2018/842) by 2.27 Mt CO_2e. However, the 2023 emissions were the first time that Irelands emission were below (-1.2%) 1990 levels.

ETS[1] emissions decreased (-17.0%) and ESR emissions decreased (-3.4%). Ireland's target is an emission reduction of 626 kt of CO2e by 2030 on an average baseline of 2016 to 2018[2].

The sectoral breakdown of 2023 GHG emissions is shown in Table 8-6. The sector with the highest emissions in 2023 was agriculture at 37.6% of the total, followed by transport at 21.4%. For 2023 total national emissions (including LULUCF) were estimated to be 60.62 Mt CO_2e (EPA, 2024a). The provisional 2023 figures indicate that Ireland has used 63.9% of the 295 Mt CO_2e Carbon Budget for the five-year period 2021-2025.

The EPA estimate that 2023 total national greenhouse gas emissions (excluding LULUCF) have decreased by 6.8% on 2022 levels to 55.01 Mt CO_2e, with a 2.2 Mt CO_2e (-21.6%) reduction in electricity industries alone. This was driven by a 40.7% share of energy from renewables in 2023 and increasing our imported electricity. Manufacturing Combustion and Industrial Processes decreased by 5.1% to 6.3 Mt CO_2e in 2023 due to declines in fossil fuel usage.

Table 8-6 Provisional Total National GHG Emissions in 2022 (EPA, 2024a)

Category	2022 Emissions (Mt CO_2e)	2023 Emissions (Mt CO_2e)	% Total 2023 (including LULUCF)	% Change from 2022 to 2023	Total Budget (Mt CO_2e) (2021-2025)	% Budget 2021-2025 used
Electricity	9.694	7.558	12.5%	-22.0%	40	67.9%
Transport	11.76	11.791	19.5%	0.3%	54	64.1%
Buildings (Residential)	5.753	5.346	8.8%	-7.1%	29	62.0%
Buildings (Commercial and Public)	1.447	1.409	2.3%	-2.6%	7	61.4%
Industry	6.622	6.288	10.4%	-5.0%	30	66.7%
Agriculture	21.795	20.782	34.3%	-4.6%	106	60.9%
Other Note 1	1.931	1.832	3.0%	-5.1%	9	62.5%
LULUCF	3.983	5.614	9.3%	40.9%	-	-
Total including LULUCF	**62.99**	**60.62**		**-3.8%**	**295**	**63.9%**

In relation to transport GHG emissions, the dominant source is road transportation (94%). In relation to road transport GHG emissions in Ireland IN 2022 (EPA, 2024a), the dominant source is cars at 49% of total road transport GHG emissions with Heavy Goods Vehicles responsible for 21%, Light Goods Vehicles for 22% and Buses 8%.

In terms of modal split, private cars accounted for 73.7% of all road trips in 2019 whilst bus journeys accounted for 6.5% (DOT, 2020). Compared to 2018, there was a 3% increase in the number of public

1 ETS emissions in this report refers to CO_2 emissions from stationary installations and from domestic aviation. It does not include emissions from intra-EU aviation as those are not considered part of Ireland's total reportable greenhouse gas emissions.

2 Regulation (EU) 2023/839 (19 April 2023)

transport passenger journeys in 2019 whilst the total kilometres driven by private cars reduced by 1.5% (DOT, 2020). A more recent version of these trends (Transport Trends 2021 (DOT, 2021)) was published in 2022, however the 2020 discussed within are heavily influenced by COVID-19 and its consequences, therefore trends during this period are not considered representative of pre or post COVID-19 modal shares.

8.4.3 Future GHGA Baseline

In May 2024, the EPA released the report *Ireland's Greenhouse Gas Emissions Projections 2023-2050* (EPA, 2024b), which includes total projected emissions and a breakdown of projected emissions per sector under the "With Existing Measures" and "With Additional Measures" scenarios.

Implementation of "Additional Measures" (including those in the 2023 Climate Action Plan) is projected to save 50 Mt CO_2 eq over the period 2022-2030 compared to the "With Existing Measures". This represents a reduction of 1% per annum in emissions over the period.

Table 8-7 presents the EPA With Existing Measures and Additional Measures scenarios for 2028 (Opening Year) and 2043 (representative of 2043 Design Year).

Table 8-7 Projected Emissions for the Transport Sector and Total Emissions (EPA, 2023b)

Projections	Year	Transport Sector Only (Mt CO_2 eq.)	Road Transport Only (Mt CO_2 eq.)	Total (Mt CO_2 eq.) (including LULUF)
Projections (with existing measures)[3]	2028	11.4	10.8	61.4
	2043	6.6	6.0	51.9
Projections (with additional measures)[4]	2028	9.9	9.3	53.3
	2043	5.2	4.7	38.4

The future baseline with respect to the GHGA can also be considered in relation to the future climate targets which the assessment results will be compared against. In line with TII (TII, 2022b) and IEMA guidance (IEMA, 2022) the future baseline is a trajectory towards net zero by 2050, *"whether it [the project] contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050"*.

The future baseline will be determined by Ireland meeting its targets set out in the CAP23, and future CAPs, alongside binding 2030 EU targets. In order to meet the commitments under the Paris Agreement, the European Union (EU) enacted *'Regulation (EU) 2018/842 on binding annual GHG emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No. 525/2013'* (hereafter referred to as the Regulation) (European Union, 2018). The Regulation aims to deliver, collectively by the EU in the most cost-effective manner possible, reductions in GHG emissions from the Emission Trading Scheme (ETS) and non-ETS sectors amounting to 43% and 30%, respectively, by 2030 compared to 2005. The Regulation was amended in April 2023 and Ireland must now limit its greenhouse gas emissions by at least 42% by 2030. The ETS is

[3] With Existing Measures Scenario assume that no additional policies and measures beyond those already in place by the end of the latest national GHG inventory year at the time of the projections compilation. (EPA, 2024b)

[4] With Additional Measures scenarios assume implementation of the WEM scenario in addition to, based on current progress, further implementation of planned government policies and measures adopted after the end of the latest inventory year. In the case of the latest projections, this includes the implementation of Ireland's 2023 Climate Action Plan. (EPA, 2024b)

an EU-wide scheme which regulates the GHG emissions of larger industrial emitters Including electricity generation, cement manufacturing and heavy industry. The non-ETS sector includes all domestic GHG emitters which do not fall under the ETS scheme and thus includes GHG emissions from transport, residential and commercial buildings and agriculture.

8.4.4 Current CCRA Baseline

The region where the Proposed Development will be located has a temperate, oceanic climate, resulting in mild winters and cool summers. The recent weather patterns and extreme weather events recorded by Met Éireann have been reviewed. A noticeable feature of the recent weather has been an increase in the frequency and severity of storms, with notable red warning level events including four in 2017 (Doris, Ophelia, Brian and Dylan), nine in 2018 (Eleanor, Fionn, David, Emma, Hector, Ali, Callum, Diana and Deirdre), seven in 2019 (Erik, Freya, Gareth, Hannah, Lorenzo, Atiyah and Elsa), seven in 2020 (Brendan, Ciara, Dennis, Jorge, Ellen, Aiden and Bella), two in 2021 (Arwen and Barra), two in 2022 (Eunice and Franklin) and two in 2023 (Noa and Agnes), as well as numerous orange warning level storms. Heavier historical rainfall events have also been recorded in recent years including heavy rainfall and flooding.

The Met Éireann weather station at Shannon Airport, County Clare, is the nearest weather and climate monitoring station to the Proposed Development that has historical regional meteorological data recorded for the 30-year period from 1981 to 2010 (Met Eireann, 2023). The meteorological station is located approximately 65 km south of the Proposed Development at the closest point. Meteorological data recorded at Shannon Airport over the 30-year period from 1981 to 2010 indicates that the wettest months were August and October, and the driest month on average was February. The warmest month was July, with a mean temperature of 15.6°C.

Met Éireann's 2023 Climate Statement (Met Éireann, 2024) states 2023's average shaded air temperature in Ireland is provisionally 11.20 °C, which is 1.65°C above the 1961-1990 long-term average. Previous to this 2022 was the warmest year on record, however 2023 was 0.38 °C warmer (see Figure 8-1).

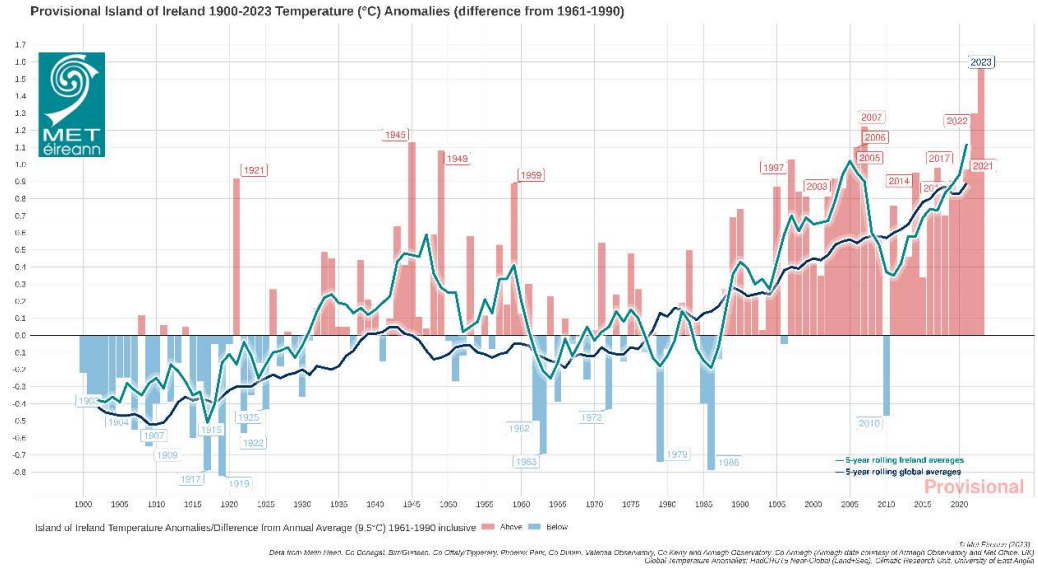

Figure 8-1 - 1900-2023 Temperature (°C) Temperature Anomalies (differences from 1961-1990 (Met Éireann, 2024)

2023 also had above average rainfall, the warmest June on record and the wettest March and July on record. Record high sea surface temperatures (SST) were recorded since April 2023 which included a severe marine heatwave to the west of Ireland during the June 2023. This marine heatwave contributed to the record rainfall in July.

Recent weather patterns and records of extreme weather events recorded by Met Éireann have been reviewed. Considering the extraordinary 2023 data, Met Éireann states that the latest Irish climate change projections indicate further warming in the future, including warmer winters. The record temperatures means the likelihood of extreme weather events occurring has increased. This will result in longer dry periods and heavy rainfall events. Storm surges and coastal flooding due to sea level rise. Compound events, where coastal surges and extreme rainfall events occur simultaneously will also increase. Met Éireann has high confidence in maximum rainfall rates increasing but not in how the frequency or intensity of storms will change with climate change.

8.4.5 Future CCRA Baseline

The Galway City Council Climate Adaptation Strategy 2019-2024 (GCC, 2019) states that the main risks around the City of Galway include the following:

- Sea level rise and inundation of low-lying communities;
- Ocean warming and acidification;
- Changes to natural ecosystems;
- Increased temperatures increasing heat stress and diseases; and
- Increased incidence of heavy rainfall events, flooding and more sever cyclones.

The EPA's Climate Change Research Programme carries out relevant and up to date studies on climate change in Ireland (overview available online (EPA, 2013)). Analysis of the meteorological records shows that Ireland's climate is changing in line with global patterns.

According to the EPA (EPA, 2021a) climate change is expected to lead to the following adverse effects:

- sea level rise;
- more intense storms and rainfall events;
- increased likelihood and magnitude of river and coastal flooding;
- water shortages in summer in the east;
- adverse impacts on water quality;
- changes in distribution of plant and animal species; and
- effects on fisheries sensitive to changes in temperature.

The EPA (2019) *Research 277: Irish Climate Futures: Data for Decision Making* report states that it is expected that weather extremes will become more likely and more frequent with future climate change.

The EPA (2021b) *Research 386: The Status of Ireland's Climate, 2020* report includes a number of climate observations for Ireland. The report states that the annual average surface air temperature in Ireland has increased by approximately 0.9°C over the last 120 years, with a rise in temperatures being observed in all seasons. This compares with a global average temperature estimated to be 1.1°C above pre-industrial levels. The report indicates that the sea level around Ireland has risen by approximately 2–3 mm per year since the early 1990s. In addition, annual precipitation was 6% higher in the period 1989 to 2018, compared to the 30-year period 1961 to 1990.

The EPA's *Research 369: CIViC: Critical Infrastructure Vulnerability to Climate Change* report (EPA, 2021) assesses the future performance of Ireland's critical infrastructure when climate is considered. With respect to transport, fluvial flooding and coastal inundation/coastal flooding are key climate change risks. The report finds that while the present and future exposure of the road and rail networks to fluvial flooding is higher than it is for coastal flooding, the percentage increase in exposure is higher for coastal flooding, with coastal transport infrastructure expected to be at greater risk in future. Most coastal sections of the national road network are located on the west and south coasts where sea level rise is expected to be the highest.

Future climate predictions undertaken by Met Éireann have been published in *'Ireland's Climate: the road ahead' (*Met Éireann, 2013*)* based on four scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) which are named with reference to a range of radiative forcing values for the year 2100 (i.e. 2.6, 4.5, 6.0 and 8.5 W/m^2

(watts per square metre)) respectively with focus on RCP4.5 (medium-low) and RCP8.5 (high) scenarios. In terms of mean temperatures, it is predicted that increases of between 1°C to 3°C will occur under RCP4.5 rising to 2°C to 4°C under RCP8.5. Warm extremes are expected to rise by 2°C to 3°C (RCP4.5) but by up to 5°C under RCP8.5.

More recent future climate predictions undertaken by the EPA have been published in *Research 339: High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach* (EPA, 2020). The future climate was simulated under both Representative Concentration Pathway 4.5 (RCP4.5) (medium-low) and RCP8.5 (high) scenarios. This study indicates that by the middle of this century (2041–2060), the mid-century mean annual temperatures are projected to increase by 1–1.2°C and 1.3–1.6°C for the RCP4.5 and RCP8.5 scenarios, respectively, with the largest increases in the east. Warming will be enhanced at the extremes (i.e. hot days and cold nights), with summer daytime and winter night-time temperatures projected to increase by 1–2.4°C. There will be a substantial decrease of approximately 50% projected in the number of frost and ice days. Summer heatwave events are expected to occur more frequently, with the largest increases in the south. In addition, precipitation is expected to become more variable, with substantial projected increases in the occurrence of both dry periods and heavy precipitation events

National Framework for Climate Services (NFCS) was founded in June 2022 to streamline the provision of climate services in Ireland and will be led by Met Éireann. The aim of the NFCS is to enable the co-production, delivery and use of accurate, actionable and accessible climate information and tools to support climate resilience planning and decision making. In addition to the NFCS, further work has been ongoing into climate projects in Ireland through research under the TRANSLATE project. TRANSLATE (Met Éireann, 2023b) has been led by climate researchers from University of Galway – Irish Centre for High End Computing (ICHEC), and University College Cork – SFI Research Centre for Energy, Climate and Marine (MaREI), supported by Met Éireann climatologists. TRANSLATE's outputs are produced using a selection of internationally reviewed and accepted models from both CORDEX and CMIP5. Representative Concentration Pathways (RCPs) provide a broad range of possible futures based on assumptions of human activity. The modelled scenarios include for "least" (RCP2.6), "more" (RCP4.5) or "most" (RCP8.5) climate change (refer to Figure 8-2).

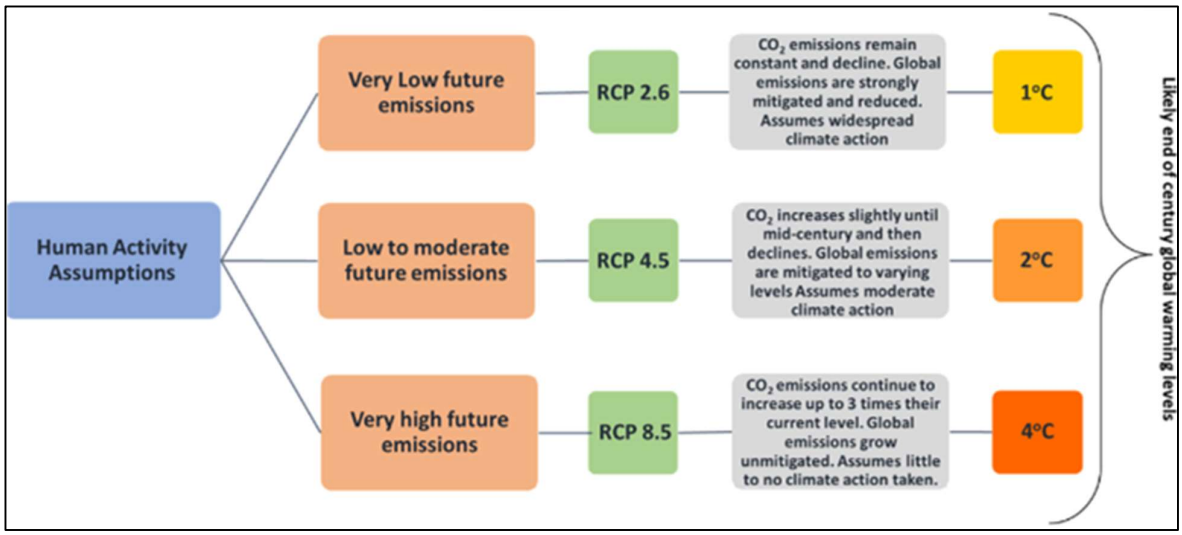

Figure 8-2 Representative Concentration Pathways associated emission levels (Met Éireann, 2023b)

TRANSLATE (Met Éireann, 2023b) provides the first standardised and bias-corrected national climate projections for Ireland to aid climate risk decision making across multiple sectors (for example, transport, energy, water), by providing information on how Ireland's climate could change as global temperatures increase to 1.5˚C ,2˚C, 2.5˚C, 3˚C or 4˚C. Projections broadly agree with previous projections for Ireland. Ireland's climate is dominated by the Atlantic Meridional Overturning Circulation (AMOC), a large system of

ocean currents – including the Gulf Stream – characterised by a northward flow of warm water and a southward flow of cold water. Due to the AMOC, Ireland does not suffer from the extremes of temperature experienced by other countries at a similar latitude. Recent studies have projected that the AMOC could decline by 30 – 40 % by 2100, resulting in cooler North Atlantic Sea surface temperatures (SST)s (Met Éireann, 2023b). Met Éireann projects that Ireland will nevertheless continue to warm, although the AMOC cooling influence may lead to reduced warming compared with continental Europe. AMOC weakening is also expected to lead to additional sea level rise around Ireland. With climate change Ireland's temperature and rainfall will undergo more and more significant changes e.g. on average summer temperature could increase by more than 2°C, summer rainfall could decrease by 9% while winter rainfall could increase by 24% (see Figure 8-3). Future projects also include a 10-fold increase in the frequency of summer nights (values > 15°C) by the end of the century, a decrease in the frequency of cold winter nights and an increase in the number of heatwaves. A heatwave in Ireland is defined as a period of 5 consecutive days where the daily maximum temperature is greater than 25°C.

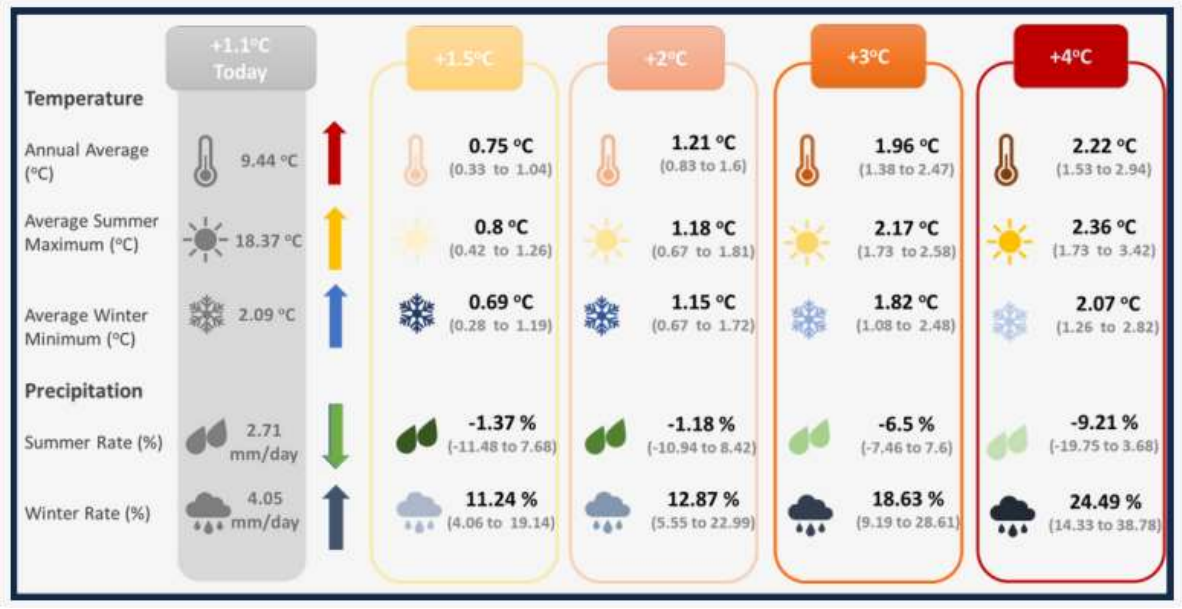

Figure 8-3 Change of climate variables for Ireland for different Global warming thresholds (Met Éireann, 2023b)

8.5 Potential Impacts

8.5.1 Characteristics of Proposed Development

In the context of the Proposed Development, the potential air quality impact on the surrounding environment must be considered for two distinct stages:

- Construction Phase; and
- Operational Phase.

The likely significant climatic impacts for the Construction and Operational Phases are discussed below.

During the Construction Phase, the focus is on the enabling infrastructure provision, which forms the Proposed Development including utility road widening works, road excavation works (where required), road reconfiguration and resurfacing works, and construction traffic.

During the Operational Phase, the focus is on GHG emissions associated with the Proposed Development including GHG emissions due to changes to mobility demands, changes to modal split and changes in traffic along diverted traffic routes within the study area. Potential impacts to climate relate to modal shifts towards more sustainable modes of transport, changes to traffic patterns, maintenance and changes to the number and type of traffic trips including public transport. The assessment of the Operational Phase will also examine the vulnerability of the Proposed Development to climate change, including the risk of flooding and the potential increased frequency of storms and the measures that have been put in place to ensure the resilience of the Proposed Development to climate change.

8.5.2 Greenhouse Gas Assessment

There is the potential for greenhouse gas emissions to atmosphere during the construction and operational phases of the Proposed Development. As per the TII guidance (2022b), the significance of the effect of GHG emissions on climate is assessed for the total GHG emissions across all Proposed Development stages (Section 8.3.5.2.4).

8.5.2.1 Construction Phase

The Construction Phase of the Proposed Development will involve predominately utility diversions, road widening works, road excavation works (where required), road and junction reconfiguration and resurfacing works, public realm improvements including landscaping, pavement works including bus lanes, cycle tracks, bus terminals, and movement of machinery and materials within and to and from the Construction Compound along the Proposed Development.

During the Construction Phase, site clearance, landscaping, road and junction construction works all have the potential to generate GHG emissions on-site.

Chapter 5 (Construction) of this EIAR provides a full description of the proposed construction phasing and works for the Proposed Development.

The total Construction Phase for the overall Proposed Development is estimated at approximately 24 months. However, individual activities will have shorter durations. The programme identifies the estimated duration of works at each sub-section. Works are envisaged to proceed concurrently on multiple work-fronts to minimise the overall construction duration.

In general, road works are transient in nature as the works will progress along the length of the route of the Proposed Development. This includes excavation and fill works, structures, and road completion works. Construction compounds will be set up typically at the commencement of the works and will remain in place until all construction in the area is completed.

To quantify the Construction Phase embodied carbon, the assessment team utilised the TII Carbon Tool (TII, 2024c), as outlined in Section 8.3.5.2. The carbon footprint of the Proposed Development during the Construction Phase is estimated, based on an assessment of worst-case carbon equivalents, outlined in Table 8-8. The carbon assessment assumes no improvement in the carbon intensity of the production of cement and steel is achieved through time. The assessment assumes as a worst-case the recycling processes for materials being reused on site will occur off-site which is reflected in the transport distances. However, it is likely that some of these processes will occur on-site to minimise transport distances.

The TII Carbon Tool considers a change in the land use categories mixed forest, transitional woodland scrub, natural grassland or peat bogs to result in a significant loss or gain of carbon sinks. As the land the Proposed Development is located on is already developed for urban use and does not fall into any of the aforementioned categories, there is no significant change to carbon sequestration in either the Construction or Operational of the Proposed Development.

Detailed project information including tonnage of materials was obtained from the engineering design team. The Proposed Development is expected to have a Construction Phase of 24 months approximately.

In addition to direct impacts from the construction works including the construction compounds, as included in Table 8-8, there is also the potential for GHG impacts from additional construction vehicles using public roads. The transport distances have been included in the embodied carbon calculations for the transport of waste from site, and additional traffic generated due to construction works has been assessed using the TII REM tool (TII, 2024b) (accounted for in Table 8-8).

The following assumptions were made when calculating the total Construction Phase GHG emissions:

- Quantities for all materials to be used during construction were not available at the time of the assessment. Quantities of the main and most GHG intensive materials were included in the assessment;
- It was assumed that construction waste will be handled either through reuse or recycling and that no waste has been identified as requiring landfill;
- GHG emissions calculated based on transport of waste assumed a 60 km transport distance per trip, based on a review of waste facilities with the capacity to accept and recover/recycle waste in the Galway/Mayo/Roscommon area. A vehicle trip to the construction area to collect the waste and a vehicle trip to the waste facility was assumed for a total of 120 km travelled per trip;
- The use of reclaimed asphalt and recycled aggregate will reduce the virgin material needs. An estimated saving of 130 tonnes of CO_2eq (derived from the avoidance of use of virgin asphalt and its emission factor) has been accounted for in the Construction Phase GHG emissions shown in Table 8-8; and
- Approx. 20 tonnes of metal in the form of existing traffic signs, miscellaneous posts, gates, safety barriers, lighting columns was identified for removal from the construction area. This metal will be stored by GCC and reused on either the Proposed Development or other schemes. There is therefore no significant quantity of GHG emissions generated by this material due to its reuse. The GHG savings associated with this reuse have been quantified and are discussed in Section 8.6.1.

Decommissioning of the Proposed Development has not been assessed as the Proposed Development is major national infrastructure and will instead by continually maintained.

The predicted GHG emissions associated with the Proposed Development are presented in Table 8-8. The Proposed Development is estimated to result in total construction phase GHG emissions of 7,840 tonnes CO_2eq for the material use and construction processes. The assessment indicates that the key sources of GHG emissions are associated with Construction Phase is the embodied carbon from the materials used, accounting for 90% of emissions.

Table 8-8 Estimated GHG emissions associated with the Construction Phase

Phase	Activity	Tonnes CO_2eq	% of Total	Sector
Pre-Construction	Site Clearance (approx. 4 ha)	1.75	0.02%	Industry
Embodied Carbon (Materials)	Asphalt, concrete, aggregate, road markings	7,017	90%	Industry
Construction Activities	Excavation	13.3	0.2%	Industry
	Generator use – gasoil/diesel	139.7	2%	Electricity
Construction Waste	Recycling and transport of waste plastic piping, concrete walling, bituminous materials, soil and stone	15.2	0.2%	Waste
Transport	Traffic generated during Construction Phase (including materials and staff transport) - LDV	446	6%	Transport

Phase	Activity	Tonnes CO_2eq	% of Total	Sector
	Traffic generated during Construction Phase (including materials and staff transport) - HDV	207	3%	Transport
Total		**7,840**		

The predicted GHG emissions can be averaged over the full Construction Phase and the lifespan of the Proposed Development to give the predicted annual emissions to allow for direct comparison with national annual emissions and targets.

In Table 8-9, GHG emissions have been compared against the carbon budget for the electricity, transport, industry and waste sectors in 2030 (DECC, 2023) and against Ireland's EU 2030 target of a 30% reduction in non-ETS sector emissions based on 2005 levels (33 Mt CO_2eq) (set out in Regulation EU 2018/842 of the European Parliament and of the Council). The predicted results are also compared to Ireland's total CO_2eq emissions for 2022 assuming additional measures, as a worst-case projection.

The estimated total construction phase GHG emissions, when annualised over the 30-year Proposed Development lifespan, are equivalent to 0.0004% of Ireland's total GHG emissions in 2023 and 0.001% of Ireland's non-ETS 2030 emissions target. The estimated GHG emissions associated with energy use during the Construction Phase are equivalent to 0.0002% of the 2030 Electricity budget, while the total GHG emissions associated with transport-related activities are 0.0004% of the 2030 Transport budget, construction waste GHG emissions are 0.00005% of the Waste budget and industry-related activities are 0.006% of the 2030 Industry budget (DECC, 2023).

Table 8-9 Estimated GHG emissions relative to sectoral budgets and GHG baseline

Comparison	t CO_2eq	Annualised Construction Phase EGHG Emissions	% of Relevant Target/Budget
Ireland's 2023 Total GHG Emissions (existing baseline)	60,620,000	Total GHG Emissions	0.0004%
Non-ETS 2030 Target	33,000,000	Total GHG Emissions	0.001%
2030 Sectoral Budget (Industry Sector)	4,000,000	Total Industry Emissions	0.006%
2030 Sectoral Budget (Transport Sector)	6,000,000	Total Transport Emissions	0.0004%
2030 Sectoral Budget (Electricity Sector)	3,000,000	Total Energy Use Emissions	0.0002%
2030 Sectoral Budget (Waste Sector)	1,000,000	Total Waste Emissions	0.00005%

As improvements in sustainability and recycling measures are progressed throughout the construction industry it is expected that the embodied carbon calculated as part of this assessment can be taken as a worst case as, with time, this figure will improve. In addition, the embodied carbon is calculated on the basis that all emissions occur over one year, a worst-case consideration.

In line with TII (TII, 2022a) and IEMA guidance (IEMA, 2022), the impact of GHG emissions associated with a development on climate should be assessed over its lifetime, rather than for individual phases. The overall impact of the Proposed Development on climate due to GHG emissions is therefore discussed in Section 8.5.2.3, where the Operational Phase is also taken into account.

8.5.2.2 Operational Phase

As outlined in Chapter 4 (Proposed Development Description) of this EIAR, the Proposed Development includes the reconfiguration of traffic movements to facilitate improved pedestrian, cyclist and bus accessibility and movement, infrastructural works at certain roads and junctions, and improvements to the public realm at a number of locations. The infrastructural works proposed as part of the Proposed Development will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes. A greater share of the demand will be by sustainable modes (public transport, walking and cycling).

The Proposed Development will result in the redistribution of traffic which may result in an increase in vehicle kilometres travelled in some locations. However, this is expected to be offset by a shift away from private car use.

The potential changes in GHG emissions due to the direct Operational Phase traffic impacts of the Proposed Development have been assessed using the TII REM tool (TII, 2024b).

The predicted concentrations of CO_2 for the future years of 2033 and 2043 are detailed in Table 8-10. These are significantly less than the 2028 and 2030 targets set out under EU legislation[5] (targets beyond 2030 are not available). It is predicted that in 2028 the Proposed Development Do Something scenario total CO_2 emissions decrease by 506 t CO_2eq, relative to the Do Minimum scenario, which is 0.0014% of the EU 2030 target. Similarly, decreases in CO_2 emissions are predicted to occur in 2043 with total CO_2 emissions decreasing in the Do Something by 124 t CO_2eq, relative to the Do Minimum, or 0.0004% of the EU 2030 target.

The overall CO_2 decrease in each scenario is driven by mainly by reductions in total LDV flows across the full modelled traffic network, while the small increase in CO_2 emissions in the Design Year scenario is due to localised increases in HDV flows and speeds on specific road links.

Table 8-10 Operational Phase GHG emissions – Opening Year (2028) and Design Year (2043)

Year	Scenario	Total CO_2eq (tonnes/annum)	LDV CO_2eq (tonnes/annum)	HDV CO_2eq (tonnes/annum)
2028	Do Minimum	117,298	99,051	18,247
	Do Something	116,792	98,496	18,296
2043	Do Minimum	142,409	103,792	22,007
	Do Something	142,285	103,637	21,983
Change in 2028		-506	-555	49
Change in 2043		-124	-154	-24
Emission Ceiling (Tonnes) 2028		35,625,332		
Emission Ceiling (Tonnes) 2030		33,381,312		
Impact in 2028 (%)		-0.0014%		
Impact in 2043 (%)		-0.0004%		

[5] Target under Commission Implementing Decision (EU) 2020/2126 of 16 December 2020 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council

There will be a decrease in GHG emissions associated with the Proposed Development, which is attributable to a shift towards more sustainable modes of transport. Thus, the predicted impact to climate during the Operational Phase of the Proposed Development is predicted to be positive and long-term.

Furthermore, as outlined in Section 8.3.5.2, the TII guidance stipulates that significance ratings should not solely be based on GHG emissions alone, but how the project makes a relative contribution towards achieving a transition to net zero emissions. The infrastructural works proposed as part of the Proposed Development will support the delivery of government strategies outlined in the Climate Action Plan (CAP) and the Climate Act, outlined in Section 8.3.3, by enabling sustainable mobility and delivering a sustainable transport system. The aim of the Proposed Development is to provide enhanced walking, cycling and bus/public transport infrastructure on key access corridors in Galway City and its environs. This will subsequently enable and deliver integrated sustainable transport movement along these corridors. The proposed infrastructural works will provide connectivity and integration with other public transport services leading to more people availing of public transport.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes. A greater share of the demand will be by sustainable modes (public transport, walking and cycling).

In relation to decarbonising the transport sector, CAP24 has set a target that all new cars and vans sold in Ireland will be zero carbon emissions or zero emission capable by 2030. Targets are also included for public transport buses and trains.

The impact on climate due to the Operational Phase of the Proposed Development in accordance with the TII significance criteria (see Table 8-4) is ***beneficial***. In accordance with the EPA guidelines (EPA, 2022) this is a direct, long-term, positive effect and not significant, which is not significant in EIA terms.

8.5.2.3 GHGA Significance of Effects

The TII guidance states that the following two factors should be considered when determining significance:

- The extent to which the trajectory of GHG emissions from the project aligns with Ireland's GHG trajectory to net zero by 2050; and
- The level of mitigation taking place.

The level of mitigation described in Section 8.6. has therefore been taken into account when determining the significance of the Proposed Development GHG emissions. The nature of the Proposed Development, in providing enhanced walking, cycling and bus infrastructure on key access corridors in Galway city and its environs, has also been considered in determining significance. According to the TII significance criteria described in Section 8.3.5.2.4 and Table 8-4, the significance of the GHG emissions during the construction and operational phase is ***beneficial.***

In accordance with the EPA guidelines (EPA, 2022), the above significance equates to a significance of effect of GHG emissions during the construction and operational phase, which is ***direct, long-term, positive*** and ***not significant***, which is not significant in EIA terms.

8.5.3 Climate Change Risk Assessment

8.5.3.1 Construction Phase

Examples of potential climate impacts during construction are included in Annex D (Climate Proofing and Environmental Impact Assessment) of the *Technical Guidance on the Climate Proofing of Infrastructure* (European Commission, 2021a). Potential impacts of climate change on the Proposed Development include:

- Flood risk due to increased precipitation, and intense periods of rainfall. This includes fluvial and pluvial flooding;

- Increased temperatures potentially causing drought, wildfires, and prolonged periods of hot weather;
- Reduced temperatures resulting in ice or snow;
- Geotechnical impacts; and
- Major storm damage – including wind damage.

During the Construction Phase consideration will be given to the project's vulnerability to climate impacts. During construction, the Contractor will be required to mitigate against the effects of extreme rainfall / flooding through site risk assessments and method statements. The Contractor will also be required to mitigate against the effects of extreme wind / storms, temperature extremes through site risk assessments and method statements. Temperatures can affect the performance of some materials; this will require consideration during construction. All materials used during construction will be accompanied by certified datasheets which will set out the limiting operating temperatures.

8.5.3.2 Operational Phase

Climate adaptation seeks to ensure adequate resilience of major projects to the adverse impacts of climate change, such as increased flooding or droughts. Mitigation, on the other hand, seeks to reduce the emissions of GHGs by implementing low-carbon energy options. Adaptation during the Operational Phase of the Proposed Development aims to ensure potential climate change impacts will not significantly impact the Operational Phase.

A risk assessment has been conducted for potentially significant impacts on the Proposed Development associated with climate change. The risk assessment assesses the likelihood and consequence of potential impacts occurring and then provides an evaluation of the significance of the impact using the framework set out in Section 0.

In order to determine the vulnerability of the Proposed Development to climate change the sensitivity and exposure of the Scheme to various climate hazards must first be determined. The following climate hazards have been considered in the context of the Proposed Development: flooding (coastal, pluvial, fluvial); extreme heat; extreme cold; wildfire; drought; extreme wind; lightning, hail, landslides and fog. Wildfire and landslides were not considered relevant to the Proposed Development due to the project location and have been screened out of the assessment.

The sensitivity of the Proposed Development to the above climate hazards is assessed irrespective of the project location. Table 8-11 details the sensitivity of the Proposed Development on a scale of high (3), medium (2) and low (1). Once the sensitivity has been established the exposure of the Proposed Development to each of the climate hazards is determined, this is the likelihood of the climate hazard occurring at the project location and is also scored on a scale of high (3), medium (2) and low (1). The product of the sensitivity and exposure is then used to determine the overall vulnerability of the Proposed Development to each of the climate hazards as per Table 8-5 in Section 8.3.5.3.1. The results of the vulnerability assessment are detailed in Table 8-11 below.

Table 8-11 Climate Change Vulnerability Assessment

Climate Hazard	Sensitivity	Exposure	Vulnerability
Flooding (coastal, pluvial, fluvial)	1 (Low)	1 (Low)	1 (Low)
Extreme Heat	1 (Low)	2 (Medium)	2 (Low)
Extreme Cold	1 (Low)	2 (Medium)	2 (Low)
Drought	1 (Low)	1 (Low)	1 (Low)
Extreme Wind	1 (Low)	1 (Low)	1 (Low)
Lightning & Hail	1 (Low)	1 (Low)	1 (Low)
Fog	1 (Low)	1 (Low)	1 (Low)

The sensitivity and exposure of the area was determined with reference to a number of online tools and with input from the various discipline specialists, such as hydrologists, on the project team. It was concluded that the Proposed Development does not have any significant vulnerabilities to the identified climate hazards as described in the below sections. All vulnerabilities are classified as low.

8.5.3.2.1 Flood Risk

Flooding of the local transport infrastructure is a potential impact of climate change on the Proposed Development. A comprehensive flood risk assessment (FRA) has been carried out; full details of the FRA can be found in Appendix 13.2 Volume 4 of this EIAR.

The Proposed Development is within Flood Zone C which indicates that it is at low risk of fluvial and coastal flooding, while there is a moderate risk of pluvial and groundwater flooding. There is also a risk of flooding from failure of the pumping stations that is assessed as a moderate/high risk. The FRA concludes that *"mitigation measures have been included for the proposed drainage works which has reduced the flood risk to acceptable levels. Surface water management measures including upgraded surface water drainage system, additional green area and SuDS features, oversized pipes and attenuation tanks with flow control are incorporated in the design. The scope of the Proposed Development is in keeping with the existing road profile and does not increase the risk of flooding elsewhere."* Additionally, the drainage for the Proposed Development has been designed with an additional 20% to allow for increased rainfall in future years as a result of climate change. This is in line with the "Medium Risk" RCP4.5 scenario and the requirements of GCC. An additional 30% would align with the "High Risk" RCP8.5 scenario, therefore, the exposure has been classified as medium, however the resulting vulnerability remains low.

8.5.3.2.2 Extreme Wind, Fog, Lightning & Hail

In relation to extreme winds, the appropriate wind loadings are to be calculated in line with the relevant structure requirements (e.g. signage and lamp poles). The EPA Research 159: Ensemble of regional climate model projections for Ireland report (2015) there is a reduction in storms and wind intensity by mid-century predicted, thus the vulnerability of the Proposed Development during the Operational Phase to extreme wind is low.

Lightning protection will be provided and designed by a specialist. Hail and fog are not predicted to significantly affect the Proposed Development assets (such as road furniture) due to their design.

8.5.3.2.3 Wildfires

In relation to wildfires, the *Think Hazard!* online tool developed by the Global Facility for Disaster Reduction and Recovery (GFDRR) (2023), indicates that the wildfire hazard is classified as medium for Galway County. This means that there is between a 10% to 50% chance of experiencing weather that could support a hazardous wildfire that may pose some risk of life and property loss in any given year. Future climate modelling indicates that there could be an increase in the weather conditions which are favourable to fire conditions, these include increases in temperature and prolonged dry periods. However, due to the Proposed Development location in a suburban area the risk of wildfire is significantly lessened, and it can be concluded that the Proposed Development is of low vulnerability to wildfires.

8.5.3.2.4 Landslides

Landslide susceptibility mapping developed by the Geological Survey of Ireland (GSI, 2023) indicates that the Proposed Development location is not within an area that is susceptible to landslides and there are no recorded historical landslide events at the Proposed Development location. It can be concluded that landslides are not a risk to the Proposed Development site.

8.5.3.2.5 Extreme Temperatures (Heat & Cold)

Future climate predictions undertaken by Met Éireann have been published in Ireland's Climate: the road ahead (Met Éireann, 2013) based on four scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) which are named with reference to a range of radiative forcing values for the year 2100 (i.e. 2.6, 4.5, 6.0 and 8.5 W/m^2) respectively with focus on RCP4.5 (medium-low) and RCP8.5 (high) scenarios. In terms of mean temperatures, it is predicted that increases of between 1°C to 3°C will occur under RCP4.5 rising to 2°C to 4°C under RCP8.5. Warm extremes are expected to rise by 2°C to 3°C (RCP4.5) but by up to 5°C under RCP8.5.

These increased temperatures have the potential to cause the temperature of construction materials, such as asphalt / bitumen, to increase. However, based on an increase in temperature of up to 5°C under RCP8.5, it is considered that the impact of increased temperatures on construction materials will be not significant. At the detailed design stage, the building materials chosen will be high quality, durable and hard-wearing and chosen to withstand increased variations in temperature in the future as a result of climate change.

Thus, in line with the methodology outlined in Section 0, the vulnerability of the Proposed Development during the Operational Phase to increased temperatures is assessed to be low.

8.5.3.3 CCRA Significance of Effects

In line with the methodology outlined in Section 0, the vulnerability of the Proposed Development during the Operational Phase to flooding and all other climate hazards is assessed to be low, and therefore no detailed risk assessment is required.

With design mitigation in place, there are no significant risks to the Proposed Development as a result of climate change. In accordance with the EPA Guidelines (EPA, 2022), the significance of effect of the impacts to the Proposed Development as a result of climate change are ***direct, long-term, negative*** and ***imperceptible***, which is not significant in EIA terms.

8.6 Mitigation and Monitoring Measures

A schedule of mitigation measures has been formulated for the Construction and Operational Phases of the Proposed Development.

8.6.1 Construction Phase

The construction traffic and the embodied energy of construction materials will be the dominant source of GHG emissions as a result of the Construction Phase of the Proposed Development. Construction vehicles, generators etc., may give rise to some CO_2 and N_2O emissions.

A series of mitigation measures have been incorporated into the construction design with the goal of reducing the embodied carbon associated with the Construction Phase of the Proposed Development.

These mitigation measures include:

- The replacement, where feasible, of concrete containing Portland cement with concrete containing ground granulated blast furnace slag (GGBS). This measure has the potential to result in an estimated saving of 641 tonnes of CO_{2eq} in the current design of the Proposed Development;
- The provision of designated cycle and pedestrian facilities will see an increase of 4% in modal share;
- The provision of dedicated cycle lane will see a slight decline in private car usage accompanied by a corresponding increase in public transport mode share;
- The Proposed Development will minimise wastage of materials due to poor timing or over ordering on site thus helping to minimise the embodied carbon footprint of the Proposed Development;
- Where practicable, opportunities for materials reuse will be incorporated within the extent of the Proposed Development including the use of reclaimed asphalt and recycled aggregate, which will

reduce the virgin material needs. This measure has led to an estimated saving of 130 tonnes of CO_2eq; and
- Where practicable, materials will be sourced locally to reduce the embodied emissions associated with transport.

The combined measures, including the incorporation of GGBS, recycled and reused material where practicable has led to an estimated saving of 771 tonnes of CO_2eq.

The construction traffic GHG emissions associated with the Construction Phase of the Proposed Development will be short-term and temporary in nature. The appointed contractor will develop a Construction Traffic Management Plan (CTMP) to manage traffic during the Construction Phase. An outline CTMP is included in the CEMP (Appendix A5.1 in Volume 4 of this EIAR). As outlined in Section 8.5.3.2, the GHG emissions associated with the additional construction traffic due to the Proposed Development will be negligible.

8.6.2 Operational Phase

As the impact of the Operational Phase traffic of the Proposed Development is predicted to be positive, there are no further mitigation measures proposed during the Operational Phase. As outlined above, the proposed infrastructural works will support the delivery of government strategies outlined in the Climate Act 2021 by enabling sustainable mobility and delivering a sustainable transport system.

Its aim is to provide enhanced walking, cycling and bus infrastructure on key access corridors in Galway city and its environs. This will subsequently enable and deliver integrated sustainable transport movement along these corridors.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes while providing a better quality of life for citizens. Total trip demand is increasing into the future in line with population, employment and growth of jobs. The projected population growth within Galway City and its suburbs is expected to grow by 50-60% by 2040, or up to a total of 120,000 individuals. A greater share of the demand will be by sustainable modes (public transport, walking and cycling). It is expected that the infrastructural works will reduce car use and increase sustainable modes by 2043, as outlined in Chapter 6 (Traffic and Transport) of this EIAR. This will facilitate a reduction in congestion and associated air quality improvements along the corridors, resulting in enhanced community wellbeing. It will also enable the development of more efficient urban and intermodal transport solutions by removing traffic from Galway City.

8.7 Residual Impacts

8.7.1 Construction Phase

The impacts of the Proposed Development on climate due to GHG emissions should be considered for the development as a whole, over its lifetime, rather than for individual phases, in line with TII (TII, 2022a) and IEMA (IEMA, 2022) guidance. The residual impacts of the Proposed Development on climate due to Construction Phase GHG emissions, post mitigation, is therefore discussed below in Section 8.7.2 alongside residual Operational Phase impacts.

8.7.2 Operational Phase

The residual impacts of the Proposed Development on climate due to GHG emissions in both the Construction and Operational Phases, after the inclusion of mitigation measures given in Section 8.6, is predicted to be positive, long-term and not significant, which is not significant in EIA terms.

The proposed infrastructural works will support the delivery of government strategies, outlined in Section 8.3.3, by enabling sustainable mobility and delivering a sustainable transport system. Its aim is to provide

enhanced walking, cycling and bus infrastructure on key access corridors in Galway City and its environs. This will subsequently enable and deliver integrated sustainable transport movement along these corridors. The proposed infrastructural works will provide connectivity and integration with other public transport services leading to more people availing of public transport.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes.

As a result, a greater share of the demand will be by sustainable modes (public transport, walking and cycling), which aligns with the scheme objectives set out in Chapter 1 (Introduction) of this EIAR.

Based on the analysis outlined above, it is concluded that the Proposed Development achieves the project objectives in supporting the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets. This has the effect of a reduction in total vehicle kilometres, a reduction in fuel usage, and increases to sustainable transport trips and modal share in accordance with CAP24 (DECC, 2023).

It is concluded that the Proposed Development will make a positive, long-term and not significant contribution to reduction in carbon emissions.

8.8 References

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