Chapter 13
Climate

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13. Climate

13.1. Introduction

The Transport (Railway Infrastructure) Act 2001 (as amended) provides for the making of a Railway Order application by Córas Iompair Éireann (CIÉ) to An Bord Pleanála. The European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (S.I. No. 743 of 2021) gives further effect to the transposition of the EIA Directive (EU Directive 2011/92/EU as amended by Directive 2014/52/EU) on the assessment of the effects of certain public private projects on the environment by amending the Transport (Railway Infrastructure) Act 2001 ('the 2001 Act').

An examination, analysis and evaluation is carried out by An Bord Pleanála in order to identify, describe and assess, in the light of each individual case, the direct and indirect significant effects of the proposed railway works, including significant effects derived from the vulnerability of the activity to risks of major accidents and disasters relevant to it, on: population and human health; biodiversity, with particular attention to species and habitats protected under the Habitats and Birds Directives; land, soil, water, air and climate; material assets, cultural heritage and the landscape, and the interaction between the above factors.

This chapter of the EIAR identifies, describes and presents an assessment of the eventual significant effects of the proposed Project on climate. The assessment examines the potential impacts during the construction and operational phases of the Proposed Project. This chapter should be read in conjunction with the following chapters, which present related impacts arising from the proposed Project:

- Chapter 4 Project Description
- Chapter 5 Construction Strategy
- Chapter 6 Traffic and Transportation;
- Chapter 9 Land and Soils;
- Chapter 10 Water (Including Hydrology and Flood Risk);
- Chapter 12 Air Quality; and
- Chapter 19 Resource and Waste Management.

13.2. Legislation, Policy and Guidance

The key legislation and guidance referenced in the preparation of the EIAR is outlined in Chapter 1: Introduction (Sections 1.5, 1.6 and 1.7). Specific to Climate, the following legislation, guidance and planning framework relevant to the consideration of this factor has informed the assessment as outlined below.

13.2.1. Legislation

13.2.1.1. International Legislation

Ireland is a signatory to both the United Nations Framework Convention on Climate Change (UNFCC 1992) and the Kyoto Protocol (UNFCC 1997). The Paris Agreement (UNFCC 2015), which was implemented in 2016, is an integral milestone concerning international climate change accords. The charter underwrites an aim of restricting global temperature rise to no more than 2°C higher than pre-industrial levels via attempts to limit increase to 1.5°C. The aim is to confine global GHG emissions to 40 gigatonnes per year expeditiously, in addition to recognising that the decreasing of GHG emissions will be prolonged in developing countries.

13.2.1.2. European Legislation

Accomplishing the commitments of the Paris Agreement spurred the European Union (EU) to enforce 'Regulation (EU) 2018/842' on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action. Another Directive, 'Regulation (EU) No. 525/2013' was amended to procure realising EU climate goals (European Parliament and Council of Europe 2018). That regulation amendment intends to frugally deliver reductions in EU GHG emissions of 43% from the Emission Trading Scheme (ETS) and 30% from non-ETS sectors by 2030 relative to 2005.

The ETS is an EU-wide scheme which regulates the GHG emissions of larger industrial emitters which encompass electricity generation, cement manufacturing and heavy industry. The non-ETS sectors includes all domestic GHG emitters which do not fall under the ETS scheme and thus constitutes GHG emissions from transport, residential and commercial buildings and agriculture. Essentially, Ireland is required under 'Regulation (EU) No. 525/2013' to attain a 30% decline in non-ETS GHG emissions by 2030 compared to 2005 levels.

13.2.1.3. National Legislation

In 2015, the Climate Action and Low Carbon Development Act was enacted by the Oireachtas. The function of the 2015 Act was to facilitate Ireland's just-transition to a low carbon, climate resilient and environmentally sustainable economy, and this was cited as the 'national transition objective'.

In June 2020, the Government published the Programme for Government – Our Shared Future (Government of Ireland 2020). Regarding climate, there is a pledge to an average 7% per annum decrease in total greenhouse gas emissions from 2021 to 2030. This would result in 51% reduction by the end of the decade, and ultimately obtaining net zero emissions by 2050. Policy amendments will involve the rapid electrification of transport system: electric bikes, electric vehicles, and electric public transport. This will be enacted in tandem with a ban on new registrations of petrol and diesel cars from 2030. Furthermore, there will be a policy to incentivise behavioural changes by increased effective modal shift to walking, cycling and public transport infrastructure.

Ireland announced a climate and biodiversity emergency in May 2019 and shortly after, the European Parliament authorised a resolution declaring a climate and environment emergency across Europe in November 2021.

In 2021 the Climate Action and Low Carbon (Amendment) Act was passed in Ireland, granting statutory effect to the core objectives stated within the Climate Action Plan[1]. The 2021 Climate Act entails carbon budgets and sectoral emissions limits and outlines the carbon budget as the total greenhouse gas emissions that are allowed during the budget period. Consequently, the 2021 Climate Act has eradicated any mention of a national mitigation plan and replaced it with references to the former and latest versions of the Climate Action Plan as well as a sequence of National Long Term Climate Action Strategies. It has also updated the national transition objective to a national climate objective which commits "to pursue and achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy."

Section 6B(12) of the 2021 Climate Act requires the Minister for the Environment, Climate and Communications to publish the approved carbon budget programme. In May 2022 the budgets were published and the total emissions allowed under each budget is set out below, as well as the average annual reduction for each 5-year period:

- 2021-2025: 295 Mt CO_2eq - this represents an average reduction in emissions of 4.8% per annum for the first budget period.
- 2026-2030: 200 Mt CO_2eq - this represents an average reduction in emissions of 8.3% per annum for the second budget period.
- 2031-2035: 151 Mt CO_2eq - this represents an average reduction in emissions of 3.5% per annum for the third provisional2 budget.

To meet these targets, the government published a set of Sectoral Emissions Ceilings in July 2022 and the transport has been set a 50% reduction target on the 2018 baseline (12 Mt CO_2eq) to achieve a ceiling of 10 Mt CO_2eq by 2025 and 6 Mt CO_2eq by 2030.

The assessment in this chapter has been prepared in accordance inter alia with the 2001 Act and the EIA Directive.

The proposed project is consistent with the following plans, strategies and objectives specified in section 15 of the Climate Action and Low Carbon Development Act 2015, as amended:

- The National Climate Objective;
- The most recent Climate Action Plan;
- The most recent National Long-Term Climate Action Strategy;
- The most recent National Adaptation Framework; and
- The objective of mitigating greenhouse gas emissions and adapting to the effects of climate change in the State.

[1] Climate Actions Plans (CAP) had been prepared prior to the legislation in both 2019 and 2021. The current CAP23 is the first to be published under the new legislation.

The Act requires the relevant Minister to make the Climate Action Plan, the National Long-Term Climate Action Strategy and the National Adaptation Framework for the purpose of achieving the National Climate Objective.

The National Climate Objective (again, the objective of becoming 'climate neutral' by 2050) is the same objective (and is to be achieved within the same timeframe) as the climate objective that the EU as a whole has set for itself (in Regulation (EU) No 2021/1119 (the 'European Climate Law'). The 'European Climate Law' writes into law at EU level the goal set in the 'European Green Deal' for the EU to achieve climate neutrality (or 'net zero' greenhouse gas emissions) by 2050.

13.2.2. Policy

13.2.2.1. National Policy

As referred to above, the National Adaptation Framework is required to be submitted to the Irish Government for authorisation at five-year intervals and denotes a list of purposes:

- Define the national strategy for the adaptation framework in each sector as it manages the risk of the negative effects of climate change to Ireland and to take advantage of the positive effects of climate change that may occur; and
- Consider all current commitments made by Ireland subject to EU and international law.

The Climate Action Plan 2021 and the subsequent Climate Action Plan 2023 (CAP23) building on CAP21, provides a detailed plan for taking action to achieve the Government commitment to reduce the overall greenhouse gas emissions by 51% by 2030 and sets out specific actions to achieve net-zero emissions by 2050.

The CAP focuses on providing communities with cleaner air and water; establishing a greener economy and society; and working towards adaptation and recovery from climate change. It also seeks to reduce transportation emissions by 50% by 2030 and cutting our dependency on fossil fuels. The Action Plan focuses on the net-zero decarbonisation pathway for transportation based on the ‘Avoid - Shift - Improve’ framework.

The Climate Action Plan specifies that a paradigm shift from private to public transport can be enabled via completion of extensive sustainable-mobility projects including the DART+ Programme, BusConnects Programme and the MetroLink. The NTA modelling team have refreshed, revalidated and recalibrated the decarbonisation pathway that was developed for CAP21. This identified additional measures to close the ‘gap’ to delivering 50% emissions abatement by 2030 which has informed the development of transport measures in CAP23. One of the measures that were identified includes improvements to Public Transport Availability and Competitiveness by increasing the availability of rural transport and inter-urban connections; ramping-up the frequency and reliability of public transport through priority infrastructure and better integration of services; and reducing public transport fares (the modelled scenario considered a 50% reduction relative to 2018 prices).

The Climate Action Plan (CAP23) notes that “key milestones have already been achieved on major infrastructural projects, including BusConnects in each of our 5 cities and the Greater Dublin Area's DART+ Programme and Metrolink, which will continue to be progressed through public consultations and the planning systems”. Action TR/23/37 seeks to promote and support the advancement of the

DART + Programme to help decrease emissions. In this regard, the proposed DART+ South West Project is fully supported by the Climate Action Plan and will contribute to achieving its goals and targets.

The Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) was also under the National Adaptation Framework using the six-step approach outlined in the Sectoral Planning Guidelines for Climate Change Adaptation. The plan states that the adaptation measures should enable continued services and maintained infrastructure as well as safeguarding new assets from longer term impacts by ensuring that current design specifications will adequately address future infrastructure needs. Appendix II of the plan expands on how projected future climate change has the capacity to impact the transportation and heavy rail network, the risks involved in these impacts (i.e. heat waves which increased risk of rail buckling and misalignment of tracks which would increase the need for network-wide speed restrictions), the risks associated with the impacts and consequences of such risks.

13.2.2.2. Regional Policy

Action 8 of the National Adaptation Framework (DCCAE 2018) indicates that four regional climate offices must be established and the Dublin Metropolitan Climate Action Regional Office (CARO) is one of these offices.

One of the responsibilities of the CARO is to assist local authorities within their region in preparing a Climate Change Action Plan. There are four local governments in the Dublin region; Dublin City Council (DCC), Fingal County Council (FCC), South Dublin County Council (SDCC) and Dún Laoghaire Rathdown County Council (DLRCC) and each have individual climate change action plans. The individual plans were prepared having regard to 'A Strategy Towards Climate Change Action Plans for the Dublin Local Authorities' (Codema 2017a and 2017b). This combined plan sought to aid the Councils in tackling climate change and setting a path to tackling the challenges related to the consequences of climate change. As the proposed Project will pass through the jurisdictions of DCC, SDCC, and Kildare County Council (KCC) a more detailed discussion on the respective climate action plans for these three jurisdictions is outlined below.

The DCC 'Climate Change Action Plan' (Codema 2019a) outlines a number of goals and plans to prepare for and adapt to climate change. There are five key action areas within the plan: energy and buildings, transport, flood resilience, nature-based solutions and resource management. Some of the transport-related measures promoted within the DCC Climate Action Plan involve the development of segregated cycle routes, the promotion of bike share schemes and promotion of the use of green infrastructure. Transportation integration is discussed within the DCC Climate Action Plan with DCC confirming that they will work with the National Transport Authority (NTA), TII, Dublin Bus, Iarnród Éireann, Bus Éireann, Road Safety Authority (RSA) and private operators to improve the connectivity of public transport systems. The DCC Climate Change Action Plan noted that transport accounted for 24.8% of GHG emissions in 2018 with 32% of transport in Dublin completed using a private car. DCC aims to achieve a doubling of all active travel and public transport trips and to halve private vehicle trips in Dublin by 2030. Action T50 is to implement policy to increase modal shift to public transport. The DART+ Programme aims to add additional capacity to cope with the model shift.

The SDCC Climate Action Plan (Codema 2019b) aims to create a cleaner, greener, and more resilient county in unison with Dublin's other three local authorities. The Climate Action Plan has 130

specific actions that have either been delivered, are in development stage or drafted for the future implementation. For instance, in collaboration with the NTA, SDCC have delivered 300km of dedicated cycleways and aim to introduce more. SDCC are also assisted by the Office of Public Works on flood alleviation schemes with Ballycullen completed and Whitechurch, the Poddle and Camac at design stage. Both bodies seek to incorporate sustainable drainage systems to augment climate adaption.

The KCC Climate Adaptation Strategy (Kildare County Council 2019), includes 121 adaptation measures to deliver across six significant goals to mitigate climate change. The delivery of these goals varies between 1-5 years contingent on the aim.

Iarnród Éireann also aims to support national, regional and local climate policy. The heavy rail network is prone to interruptions during extreme weather. These weather events have accounted for over 33% of all service disruptions in the last six years. Iarnród Éireann collaborates with other agencies to establish robust infrastructure for these events which enables the rail network to adapt. The key components of the Iarnród Éireann climate adaptation policies include:

- Future proofing in the planning and implementation of infrastructure in line with Actions 17 & 18 of the Transport Sector 'Climate Change Sectoral Adaptation Plan';
- Initiation of the annual infrastructure steady state maintenance and renewal programme;
- Remote modelling of key assets to aid preventative measures;
- Cutting and embankment programme enhanced by risk modelling;
- Completion of east coast railway network protection programme in tandem with east coast local authorities;
- Protocol to avert and mitigate flooding in conjunction with other stakeholders;
- Dispatch of point heaters to minimise service cancellations during extreme cold or wintry weather;
- Back up electricity supplies for DART and signalling and distribution of the OHLE preventative maintenance strategy; and
- Repair and painting of station facilities and expedite programme to address backlog of defects.

Iarnród Éireann Sustainability Strategy 2021-2030 (Iarnród Éireann 2021) has set a target for 2027 of 600 new electric and battery powered carriages which will expand services and result in almost 80% of journeys being emission free (pending the source of the electricity). This includes the extension of the electrified DART services to Drogheda, Maynooth, M3 Parkway, Hazelhatch and Greystones, with the potential for the electrification of the Intercity services in future. As well as reducing emissions, there are also considerations of the potential impacts of climate change on the rail network. Iarnród Éireann aims to ensure that mitigation measures are put in place against coastal erosion, extreme weather and flooding to ensure rail connectivity is maintained. By 2027, the Iarnród Éireann Strategy states that 27 million annual passenger journeys will have been switched from diesel to electric due to network upgrades, with 77% of the electricity being supplied by renewable sources. In 2019, 2.75% of the network was electrified with an aim for this to be increased to 10% by

2027 and 40% by 2040. For parts of the network which cannot be electrified in the short to medium term, a transition to hybrid trains on InterCity and Regional services can reduce fuel consumption by up to 25%.

The National Transport Authority has published its draft Greater Dublin Area Transport Strategy 2022-2042 (NTA 2022). This Transport Strategy is based on national policies on sustainability as set out in climate action and low carbon legislation, and in climate action plans. The strategy states that there is a goal of all urban public transport vehicles operating State services in the Greater Dublin Area to be zero-emissions by 2035. The overall transport strategy includes the DART+ Programme, increasing the electrified rail network from roughly 50km to over 150km while also increasing demand. The NTA aim for this strategy to contribute to Ireland's transition to a low carbon and climate resilient society. The Strategy also notes that the DART+ Programme will be accompanied by a significant investment in rail carriages which will be required to serve these corridors. The new fleet will either be fully electric train sets or battery electric fleet which can operate in advance of full electrification, using terminal charging arrangements. This can assist in reducing the reliance on fossil fuel powered engines.

13.2.3. Guidance

The assessment has referred to national guidelines, where available, in addition to international standards and guidelines relating to the assessment of GHG emissions and associated climatic impact. These are summarised below:

- Institute of Environmental Management & Assessment (IEMA) Assessing GHG Emissions and Evaluating their Significance (IEMA 2022);
- Carbon Tool for Road and Light Rail Projects (TII, 2020);
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA 2020a);
- IEMA GHG Management Hierarchy (IEMA 2020b);
- Design Manual for Roads and Bridges (DMRB): LA 114 – Climate (UKHA 2019);
- Air Pollutant Emission Inventory Guidebook for Railways (EEA, 2019);
- Institute of Environmental Management & Assessment (IEMA) Assessing GHG Emissions and Evaluating their Significance (IEMA 2017);
- Publicly Available Specification (PAS) 2080: 2016;
- Integrating Climate Change into Strategic Environmental Assessment in Ireland – A Guidance Note (EPA, 2015);
- Carbon Management in Infrastructure; Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (European Commission, 2013); and
- National Roads Authority Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes (NRA 2011).

13.3. Methodology

Carbon dioxide (CO_2) emissions have a global climate warming effect. This is regardless of rate of release, location or the weather when released into the atmosphere. This is unlike pollutants that affect local air quality where the rate of release, location and prevailing weather, as well as the amount of pollutant, determines the local concentrations and the impact. Local ambient concentrations of CO_2 are not relevant for climate change and there are no limits or thresholds that can be applied to particular sources of carbon emissions. Any amount of CO_2 released into the atmosphere will contribute to climate warming, the extent of which is determined by the magnitude of the release. Although CO_2 emissions are typically expressed as kilogrammes or tonnes per year, there is a cumulative effect of these emissions because CO_2 emissions have a warming effect which lasts for 100 years or more.

In this regard, the methodology adopted for this assessment considers the total emissions from the construction and operation of the proposed Project. These total emissions are compared to the corresponding emissions from the Do Minimum scenario to assess the net change in emissions generation from the proposed Project. In addition, an assessment of climate adaption and vulnerability for the proposed Project is undertaken. Further details on the methodologies undertaken are presented in the following paragraphs.

13.3.1. Study Area

The proposed Project comprises the electrification of the rail line from Hazelhatch & Celbridge Station to Glasnevin via the Phoenix Park Tunnel Branch Line, covering a total length of approximately 20 kilometres. Effects arising from the potential impacts on climate are considered to impact on a national to EU to global level and the study area for climate is the State for both the construction and operation phases.

The proposed Project has been divided into four distinct geographic zones along the length of the corridor (Zones A to D) as outlined in Chapter 4 Project Description and summarised below. The proposed Project is described from west to east along the railway corridor.

- Zone A - Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station (refer to Section 4.6);
- Zone B - Park West & Cherry Orchard Station to Heuston Station (incorporating Inchicore Works) (refer to Section 4.7);
- Zone C - Heuston Yard & Station (incorporating New Heuston West Station) (refer to Section 4.8);
- Zone D - Liffey Bridge to Glasnevin Junction (Phoenix Park Tunnel Branch Line) (refer to Section 4.9).

13.3.2. Survey Methodology

13.3.2.1. Desk Surveys

This analysis was undertaken by means of a desktop assessment based on available relevant guidance and information sources, and with reference to other chapters of this EIAR as outlined in

Section 13.1. The following information sources have been consulted in relation to the assessment of climate aspects for the proposed Project:

- Key material, resource and cut/fill balance inputs from the description of the proposed Project presented in Chapter 4 Project Description and Chapter 5 Construction Strategy of this EIAR;
- Traffic figures from Chapter 6 Traffic and Transportation;
- Estimates of likely waste volumes from the description of the proposed Project presented in Chapter 4 Project Description, Chapter 5 Construction Strategy, Chapter 9 Land and Soils and Chapter 19 Resource and Waste Management of this EIAR; and
- Environmental Protection Agency (EPA) Greenhouse Gas Emissions Inventories and Projections;

Table 13.1 outlines the existing studies, datasets and information used to inform the assessment on climate within the Study Area that was collected through a detailed desktop review.

Table 13.1: Summary of Data Referenced in the Desktop Assessment

Title	Source	Year
Ireland's Provisional Greenhouse Gas Emissions 1990-2021	EPA	2022
Ireland's Provisional Greenhouse Gas Emissions 1990-2020	EPA	2021
Ireland's Greenhouse Gas Emissions Projections 2021-2040	EPA	2022
Ireland's Final Greenhouse Gas Emissions 1990-2019	EPA	2020
The Status of Ireland's Climate 2020	Met Éireann	2021
30 Year Averages: Casement 1981-2010[2]	Met Éireann	2022
Met Éireann Monthly Values for Casement	Met Éireann	2022

13.3.2.2. Field Surveys

No site-specific baseline surveys were undertaken as part of the assessment for climate. The baseline data presented in this section is derived from the EPA Projections and Met Éireann monitoring network and may be taken as representative of the background climate within the Study Area.

13.3.3. Assessment Methodology

13.3.3.1. Key Parameters for Assessment

This assessment has been undertaken in line with the Institute of Environmental Management and Assessment (IEMA) guide 'Assessing Greenhouse Gas Emissions and Evaluating their Significance', 2nd Edition, 2022. The following aspects of the proposed Project are assessed in this chapter:

- Potential direct greenhouse gas (GHG) emissions associated with the construction of the proposed Project – this includes site clearance, embodied carbon, material transport, construction activities and waste management;

[2] At the time of going to print, the 30 year averages from 1991 – 2020 were not publicly available from Met Éireann.

- Potential changes in GHG emissions associated with rail emissions during the operational phase of the proposed Project; and
- Vulnerability of both the construction and operational phases of the proposed Project to climate change.

13.3.3.2. Appraisal Method -Construction Phase (Including Material Delivery and Spoil Removal)

Transport Infrastructure Ireland's (TII) proprietary carbon tool has been used to quantify carbon emissions from the proposed Project. The carbon tool is a spreadsheet-based product, developed by TII, with the goal of identifying, estimating and mitigating greenhouse gas emissions that accrue on large road and rail infrastructure projects. The carbon tool is closely aligned with guidance set out in PAS 2080[3] which suggests a modular structure for capturing and reporting carbon emissions according to lifecycle phase. There are four main lifecycle stages as per this climate assessment:

- Pre-construction;
- Embodied carbon;
- Construction activities; and
- Maintenance.

Results are reported based on the above groupings, as per PAS 2080. The modular structure allows for the identification of carbon hotspots in the design and construction process. This helps the project team to see where the design may be improved with regard to carbon emissions.

In terms of reporting units, all units are in equivalent kilogrammes of carbon dioxide – hereafter kg CO_2eq. These are the default units used in the TII carbon tool. Equivalent kilograms of carbon dioxide (kg CO_2eq) are used as a standardised unit for numerous greenhouse gases such as methane and nitrous oxide. Summary data is presented as tonnes of CO_2eq for ease of reference of this data.

Design data for materials, earthworks and transport distances are based on input data from the design team. Where detailed designs are not available for various parts of the project, assumptions are made based on industry best practice and default values in the carbon tool. In particular, transport distances for materials have been estimated, as no specific suppliers have been selected at this early stage of the proposed Project. This allows for an estimate of transport emissions, using an emissions factor for kg CO_2eq/km in the carbon tool.

13.3.3.3. Appraisal Method - Construction Phase Traffic Diversions

Traffic data has been supplied that quantifies the traffic impacts of the main road closures to accommodate bridge demolition and reconstruction. The proposed traffic diversions do not generate higher traffic volumes but redistribute traffic through alternative routes. Chapter 6 Traffic & Transportation demonstrates that average journey time may be slightly longer due to the diversions causing road users to take less optimal routes. The main potential for significant impact will be during

[3] PAS 2080 is a global standard for managing infrastructure carbon

the closures of Le Fanu (OBC7), Kylemore (OBC5A) and Memorial (OBC3) bridges and these are addressed in detail. The temporary closure of the Sarsfield Road Underpass Bridge (UBC4) is expected to be 5-7 days in duration and while there is short term potential for traffic disruption, the resultant impact on GHG emissions from traffic in the area will be negligible in this timeframe and is not considered in detail in this analysis. Similarly, the temporary closure of the Glasnevin Cemetery Road Bridge (OBO10) will only be for a period of 21 days for the temporary closure where traffic will be suspended and while there is potential for impact in the shortened timeframe the magnitude of impacts to GHG emissions from traffic is considered negligible. Closure of the Khyber Pass Footbridge (OBC5) has no potential for GHG emissions from traffic as this is a footbridge and will not require traffic diversions. Traffic data has been supplied for all main routes in the study area as AADT and %HGV for each of the following scenarios:

- Existing (i.e. current traffic with all roads and bridges open to traffic);
- The closure of Le Fanu Road Bridge (OBC7);
- The closure of Kylemore Road Bridge (OBC5A); and
- The closure of Memorial Road Bridge (OBC3).

GHG emissions from changes to traffic patterns as a result of these diversions are quantified in line with the LA114 guidance (UKHA 2019).

13.3.3.4. Appraisal Method - Operational Phase Rail Emissions (Direct)

National emissions of the changes in rail car emissions are undertaken using the procedures outlined in the European Monitoring and Evaluation Programme (EMEP) and European Environment Agency (EEA) 2019 Air Pollutant Emission Inventory Guidebook for Railways. Emissions for diesel units are provided using the guidebook and are designed to facilitate reporting of emission inventories by countries to the UNECE Convention on Long-range Transboundary Air Pollution and the EU National Emission Ceilings Directive. Emissions from diesel engines can be broken in three categories and the stated emission factors for each category are presented in Table 13.2.

Table 13.2: EMEP Emission Factors for Rail

Tier 2 Shunting Locomotives		
Pollutant	**kg/Fuel Tonne** Note 1	**kg Pollutant/km** Note 2
CO_2	3190	1.79
CH_4	0.176	0.00010
N_2O	0.024	0.00001
Tier 2 Rail Cars		
Pollutant	**kg/Fuel Tonne** Note 1	**kg Pollutant/km** Note 2
CO_2	3140	1.76
CH_4	0.176	0.00010
N_2O	0.024	0.00001

Tier 2 Line-Haul Locomotives		
Pollutant	**kg/Fuel Tonne** Note 1	**kg Pollutant/km** Note 2
CO_2	3140	1.76
CH_4	0.182	0.00010
N_2O	0.024	0.00001

Note 1: Emissions factors from Air Pollutant Emission Inventory Guidebook for Railways (EMEP and EEA 2019)

Note 2: Emission factors based on Air Pollutant Emission Inventory Guidebook for Railways (EMEP and EEA 2019) and Iarnród Éireann's average diesel usage

13.3.3.5. Appraisal Method - Operation Phase Rail Emissions (Indirect)

Electrical multiple units (EMU) are powered by electricity generated at stationary power plants as well as other sources. As the rail stock shifts toward a great proportion of EMU compared to diesel multiple units (DMU), the associated emissions will be emitted at the power plants generating electricity rather than through the DMU tailpipe. The emissions of pollutants generated due to the electricity power demand for the EMUs are calculated using the carbon intensity of the fuel mix used in the generation of electricity nationally.

The pollutant intensity is the amount of a specific pollutant that will be released per kilowatt hour (kWh) of energy of a given fuel. For most fossil fuels the emissions per unit is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and on the efficiency of the technology employed. A figure for carbon (CO_2) is updated by Sustainable Energy Authority of Ireland (SEAI) annually. The emission factor is shown in Table 13.3. The estimate generated will be valid for 2019 however it is expected that the pollution intensity per kWh will reduce by the opening year.

The Climate Action Plan has set a national target to reach 80% of electricity demand by renewables by 2030. In 2020, approximately 42% of the national grid electricity was generated by renewable sources. Increasing the proportion of renewables will reduce the emissions per kWh of electricity produced on the national grid. Iarnród Éireann have agreed to purchase up to 80% of its operational demand from certified low or zero carbon electricity for operations. This will ensure that should the CAP target of 80% renewables not be achieved, the proposed Project will still achieve the target. For the purposes of the assessment, it has been assumed both the Do Nothing and Do Something have 80% renewables.

The remaining power on the national grid that will be supplied by fossil fuel the emissions of which are regulated by the EPA under the Industrial Emissions Licence regime. This regulation ensures that there are no significant emissions of air pollutants at generating stations that may impact nearby sensitive human or ecology receptors.

Table 13.3: GHG Emission Factors per kWh

Pollutant	kg Pollutant/kWh	Notes
CO_2	0.10204	In 2030 at 80% Renewables

13.3.3.6. Impact and Significance Assessment Criteria

13.3.3.6.1. Assessment Criteria for GHG Emissions

The LA114 guidance (UKHA 2019) outlines a recommended approach for determining the significance of impacts for both the construction and operational phases. The approach is based on comparing the Do something scenario and the net project GHG emissions (i.e. Do Something – Do Minimum) to the relevant carbon budgets.

After the publication of the 2021 Climate Amendment Act in July 2021 and the 2021 CAP, the carbon budgets were approved and a series of sectoral emissions ceiling were published[4], including sectoral emissions ceilings for the transport sector. These ceilings will allow a comparison with the net CO_2 projected GHG emissions from the Project. When assessing significance, LA114 recommends that the assessment of projects as significant should only occur '*where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets'*.

Significance determination for emissions generated by the project in this assessment is based on the criteria presented in Table 13.4 as guided by IEMA.

Table 13.4: Definition of Climate Significance

Magnitude of Impact	Description
Major or Moderate Adverse (i.e. significant)	A project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the net zero trajectory by 2050 or sectoral based transition to next zero targets, results in a significant adverse effect. It is down to the consultant completing the assessment to differentiate between the 'level' of significant adverse effects, e.g. 'moderate' or 'major' adverse effects. A project's impact can shift from significant adverse to non-significant effects by incorporating mitigation measures that substantially improve on business-as-usual and meet or exceed the science-based emissions trajectory of ongoing but declining emissions towards net zero. Meeting the minimum standards set through existing policy or regulation cannot necessarily be taken as evidence of avoiding a significant adverse effect. This is particularly true where policy lags behind the necessary levels of GHG emission reductions for a science based 1.5°C compatible trajectory towards net zero.
Minor Adverse (i.e. not significant)	A project that is compatible with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve an impact that has a minor adverse effect but is not significant. The project may have residual impacts but is doing enough to align with, and contribute to, the relevant transition scenario. A 'minor adverse' or 'negligible' non-significant effect conclusion does not necessarily refer to the magnitude of GHG emissions being carbon neutral (i.e. zero on balance) but refers to the likelihood of avoiding severe climate change and achieving net zero by 2050. A 'minor adverse' effect or better is a high bar and indicates exemplary performance where a project meets or exceeds measures to achieve net zero earlier than 2050.
Negligible	A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and

[4] Link: https://www.gov.ie/en/publication/76864-sectoral-emissions-ceilings/

Magnitude of Impact	Description
	emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant.
Beneficial	A project that causes GHG emissions to be avoided or removed from the atmosphere has a beneficial effect that is significant. Only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.

13.3.3.6.2. Assessment Criteria for Climate Vulnerability

The LA114 guidance (UKHA 2019) also outlines an approach for undertaking a risk assessment where there is a potentially significant impact on the proposed Project receptors due to climate change. The risk assessment assesses the likelihood and consequence of the impact occurring to each receptor, leading to the evaluation of the significance of the impact. The operational phase assessment, after identifying the hazards and benefits of the climate change impacts, assesses the likelihood and consequences using the framework outlined in Table 13.5 and Table 13.6.

The guidance advises that for the construction phase, a qualitative description of disruption risk is to be reported. This assessment approach is used as an example of an appropriate method in the 2020 IEMA EIA Guide to: Climate Change Resilience and Adaptation.

Table 13.5: Categories of Likelihood

Likelihood	Description (Probability and Frequency of Occurrence)
Very High	The event occurs multiple times during the lifetime of the project (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the project (60 years) e.g. once in 60 years.
Very Low	The event occurs can occur during the lifetime of the project (60 years).

Table 13.6: Categories of Consequence

Consequence	Description (Severity of Impact to the Rail Network)
Very Large Adverse	Operation – national level (or greater) disruption to strategic route(s) lasting more than 1 week.
Large Adverse	Operation – national level (or greater) disruption to strategic route(s) lasting more than 1 day but less than 1 week or regional level disruption to strategic route(s) lasting more than 1 week.
Moderately Adverse	Operation – regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor Adverse	Operation – regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Operation –disruption to an isolated section of a strategic route lasting more less than 1 day.

The likelihood and consequence of each impact is combined in the form of a matrix to identify the significance of each impact as outlined in Table 13.7. The significance conclusions for each impact are based on, and incorporate, confirmed design and mitigation measures. Where the assessment concludes that the project is significant, LA114 states that '*the design and mitigation hierarchy should be reassessed to reduce the significance of impacts to an acceptable level (not significant)'*.

Table 13.7: Significance Matrix

		Measure of Likelihood				
Measure of Consequence		**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Very Large Adverse	Not significant	Significant	Significant	Significant	Significant
	Large Adverse	Not significant	Not significant	Significant	Significant	Significant
	Moderately Adverse	Not significant	Not significant	Significant	Significant	Significant
	Minor Adverse	Not significant	Not significant	Not significant	Not significant	Not significant
	Negligible	Not significant	Not significant	Not significant	Not significant	Not significant

13.3.4. Consultation

The overall project stakeholder and public consultation undertaken in respect of the Project is set out in the Public Consultation No. 1 Findings Report (for PC1) and Public Consultation No. 2 Findings Report (for PC2) which are included in Volume 4, Appendix 1.3 and 1.4. All feedback was collated, including feedback specific to the EIAR topic 'Climate'. This feedback has informed this chapter including the baseline and impact assessment presented.

Specific consultation was also undertaken with key stakeholders in relation to EIA Scoping. A summary of the issues raised in relation to the scope of the EIA is included in Volume 4, Appendix 1.2. Feedback on the scope and level of detail of the assessment, data sources and methodologies as they pertain to the EIAR topic 'Climate' have been reviewed and have influenced this chapter of the EIAR.

Specific consultation was also undertaken with representatives of various Departments in Kildare, South Dublin and Dublin City Councils. This included a combination of presentations, workshops and meetings to discuss the project, technical design issues and environment and planning matters.

Nine pre-application meetings were held with ABP to explain the project and present technical and environmental information. A summary of the information presented and the environmental issues discussed at the nine meetings is provided in Volume 4, Appendix 1.6. Feedback relevant to the topic 'Climate' has been reviewed and has influenced this chapter of the EIAR.

13.3.5. Difficulties Encountered / Limitations

Difficulties were encountered during the quantification of materials at the design stage in order to assess the embodied construction carbon. The exact volumes of materials, location of waste disposal sites, sourcing of products and technical specification for materials are finalised during the detailed design phase and by the appointed contractor. Throughout the assessment, efforts have been made to provide the most likely scenario of the embodied carbon assessment. Where it is required to make assumptions as the basis of the assessment presented here, these assumptions are based on advice from competent project designers and are clearly outlined within the chapter.

13.4. Receiving Environment

Climate is defined as the average weather over a period of time (usually 30 years), 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 2015). 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 40 years. 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 carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

13.4.1. Current Baseline

13.4.1.1. Existing GHG Emissions Baseline

The EPA published the provisional 1990-2021 GHG inventory in July 2022 and the provisional national GHG emissions are estimated to be 61.53 million tonnes carbon dioxide equivalent (Mt CO_2eq). The breakdown of the sources of national emissions of GHG are shown in Table 13.8. The table shows that in 2021 transport accounted for 18% of national emissions (10.91 Mt CO_2eq) showing that this is the second largest source of emissions in the country after agriculture (38%).

Table 13.8: Total National GHG Emissions in 2021 (excluding LULUCF[5])

Category	Total Emissions (Mt CO_{2eq})	% of Total GHG emissions
Agriculture	23.10	38%
Transport	10.91	18%
Energy Industries	10.27	17%
Residential	7.04	11%
Manufacturing Combustion	4.59	7%
Industrial Processes	2.46	4%
F-gases	0.74	1%
Commercial Services	0.82	1%
Public Services	0.66	1%
Waste	0.94	2%
Total	**61.53**	**100**

A further breakdown of transport related emissions is not yet available for 2021 but the 2020 detail is shown in Table 13.9. The table shows that rail only accounts for 1% of national transport emissions while road transport accounts for 94%.

Table 13.9: Total Transport GHG Emissions in 2020

Category	Total Emissions (Mt CO_{2eq})	% of Total GHG emissions
Road Transportation	9.70	94.24%
Domestic Navigation	0.32	3.13%
Railways	0.11	1.05%
Domestic Aviation	0.01	0.13%
Other Transportation	0.15	1.43%
Total	10.30	100%

The EPA also publishes GHG emission projections to 2030 and predicts that Ireland will not achieve its legally binding climate target of 51% reduction by 2030 with existing measures (WEM) and these

[5] LULUCF - Land Use Land Use Change and Forestry. Covers the following categories; Forest land, Cropland, Grassland, Wetlands, Settlements, Other land and Harvested Wood products.

are shown in Table 13.10 (relative to the CAP21 targets as projections against the CAP23 targets are not yet published). The EPA advises implementation with additional measures (WAM) are required as soon as possible to meet the 30% decrease obligation by 2030. With existing measures attains 9% lower emissions over the next decade while WAM obtains a 28% downturn in GHG emissions by 2030.

Table 13.10: Comparison of WEM, WAM and Climate Action Plan 2021 Targets

Sector	WEM Projections 2030 vs 2018	WAM Projections 2030 vs 2018	CAP 21, 2030 vs. 2018
Agriculture	-0.8%	-22.4%	-22% → -30%
LULUCF	61.5%	20.9%	-37% → -58%
Transport	-15.1%	-39.3%	-42% → -50%
Energy Industries	-49.0%	-58.1%	-62% → -81%
Enterprise Manual Combustion Indirect Processes	-13.5% -21.9% 3.7%	-12.8% -21.0% 3.7%	-29% → -41%
F-gases*	25.1%	-22.8%	
Built Environment Residential Commercial Pub. Services	-24.1% -24.2% -23.6%	-42.2% -41.5% -44.7%	-44% → -56%
Waste	-16.7%	-16.7%	-15.4%
Total (excl. LULUCF)	**-17.0%**	**-33.2%**	**-51%**

13.4.2. Evolution of the Environment in the absence of the Project (Do Nothing)

Annex IV of the EIA Directive sets out the information required to be included in an EIAR. This includes:

> "*a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the Proposed Project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*".

In the event that the proposed Project does not proceed, an assessment of the future baseline conditions has been carried out and is described within this section. In the "do-nothing" scenario the

interventions for the modernisation of the railway corridor and areas outside of CIÉ lands for the Project would not be undertaken and includes the continued use of the existing railway line.

There is potential for indirect positive impact to climate from the proposed Project. In the absence of the proposed Project, the existing railway line will continue to function. The predicted GHG emissions associated with the proposed Project will not occur as well as any potential GHG reductions and increased local benefits with regard to modal shift from road traffic to rail traffic.

13.4.3. Vulnerability of Proposed Project to Climate Change

Impacts to the proposed Project as a result of climate change involve increases in temperatures and increases in the number of rainfall days per year. Ireland has observed increases in the annual rainfall in the north and west of the country, with small increases or decreases in the south and east including in the region where the proposed Project will be located. The EPA has compiled a list of potential adverse impacts as a result of climate change including the following which may be of relevance to the proposed Project:

- Increase of 1 to 4 degrees Celsius in average temperature;
- 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; and
- Changes in distribution of plant and animal species.

The region of the proposed Project has a temperate, oceanic climate, resulting in mild winters and cool summers. The Met Éireann weather station at Casement Aerodrome, County Dublin, is the nearest weather and climate monitoring station to the proposed Project that has meteorological data recorded for the 30-year period from 1981 to 2010. The monitoring station is located approximately 3km south of the proposed Project at its nearest point (Adamstown). Meteorological data recorded at Casement over the 30-year period from 1981 to 2010 indicates that the wettest months were October and December, and the driest month on average was February. July was the warmest month with a mean temperature of 15.7°C.

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 events including Storm Darwin in February 2014, Storm Emma in March 2018 and Storm Ophelia in October 2018. The maximum wind gust for Casement Airport occurred during Storm Ophelia, peaking at 117km/hr with a 10-minute speed of 85km/hr.

Yearly rainfall was 6% higher from 1989-2018 than the 30-year timeframe between 1961-1990. The rainfall recorded on 24 October 2011 totalled 76.5mm over a 9-hour period at Casement Airport, which has an annual probability of 60 years. As rainfall increases in Ireland, heavier historical precipitation events have also been recorded in recent years including heavy rainfall and flooding in the summer of 2008, severe flooding in November 2009, and heavy rainfall in the Greater Dublin Area on 24 October 2011. The latest information available from Met Eireann's 'The Status of Irish

Climate 2020 Report' highlights that the 10-year period from 2006-2015 was the wettest recorded decade.

The temperature of surface air is an important factor when examining climate. Surface air temperature has pervading effects on ecosystems, livelihoods, and human activity. Temperature changes impact health, agriculture, energy demand among other things. In Ireland, over 100 years of consecutive apparatus measurements are available. The global average surface air temperature has risen by 0.85°C over the last century, yet the rate of warming almost doubled since 1975 amounting to 1.65°C rise per century. The highest surface air temperatures recorded globally were for the 5 years 2015–2019 which is significant as the temperature record was initiated in the mid to late 1800s. Hot, dry summers and mild, moist winters are more prevalent now in many regions of the world (Met Éireann 2020).

The EPA sponsored research project 'Ensemble of Regional Climate Model Projections for Ireland Report No. 159' (EPA 2015) has projected significant decreases in mean annual, spring and summer precipitation amounts with extended dry periods. By mid-century, i.e. 2050, the decreases are largest for summer, with reductions ranging from 0% to 13% and from 3% to 20% for the medium-to-low and high emission scenarios, respectively. Conversely increases of heavy precipitation of up to 20% are projected to occur during the winter and autumn months.

The number of extended dry periods is projected to increase substantially by mid-century during autumn and summer.

In relation to storms, the report indicates that the overall number of North Atlantic cyclones is projected to decrease by 10% coinciding with a decrease in average mean sea-level pressure of 1.5 hectopascals (hPa) for all seasons by mid-century. Wind energy is also predicted to decrease for spring, summer and autumn with a projected increase in winter. A projected increase in extreme storm activity is expected to adversely affect the future wind energy supply.

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.

13.5. Description of Potential Impacts

13.5.1. Potential Construction Impacts

To quantify the construction phase embedded carbon, the TII Carbon toolkit was employed. This toolkit has the ability to quantify carbon in infrastructure projects using Ireland-specific emission

factors and data. Detailed project information including tonnage of materials was obtained from the Engineering Design Team. Greenhouse gas emissions have been quantified at all aspects of the construction phase including the following:

- Site clearance emissions associated with plant and machinery required to clear the site. The carbon tool has a range of assigned land use categories for estimating site clearance. Different land use types have higher or lower carbon intensity for site clearance, which is linked to the energy required to clear the site;
- Embodied carbon is the carbon contained within a material or product. It is the sum of all carbon emissions that have been generated during the extraction, processing, and manufacturing of a particular product. The impact of transporting materials from factory/source to site to facilitate construction is reported separately. A series of assumptions are made about the variables that impact transport emissions (material density, vehicle type, vehicle capacity and distance travelled) and assuming that the material may be transported from sources locally within 50km, regionally within 100km and nationally within 250km;
- Emissions arising from excavation activities based on the energy used in excavation activities. Energy expenditure varies depending on the type of ground to be excavated, e.g., rock excavation is much more energy intensive than topsoil excavation;
- Construction activities covers carbon emissions generated during the construction of the proposed Project based on the scale and duration of the project; and
- The generation of waste during the construction phase has potential for climate impact and the nature and scale of this impact depends on the type and volume of waste generated coupled with the nature of the waste treatment (reuse, recycling, recovery or disposal).

The results of the assessment of the above stages using the TII tool are presented in Table 13.11, Figure 13-1 and Figure 13-2. The results indicate that the total GHG emissions generated as a result of the construction of the proposed Project are 5,647,706 kg of CO_2eq (5,647 tonnes CO_2eq).

Construction phase emissions are compared against the Ireland's non-ETS 2030 target of 33,381,312 tonnes CO_2eq (as set out in Commission Implementing Decision (EU) 2020/2126). The quantified impact is equivalent to an annualised total of 0.0169% of Ireland's non-ETS 2030 target.

Table 13.11: Construction Phase Greenhouse Gas Emissions

Stage	Total CO_2 (kg of CO_2 equivalents)	Fraction of Total (%)
Pre-Construction	523	<0.01
Embodied Carbon	4,997,905	88.49
Construction Activities	586,945	10.39
Construction Waste	62,855	1.11
Total GHG during Construction	5,647,706	100

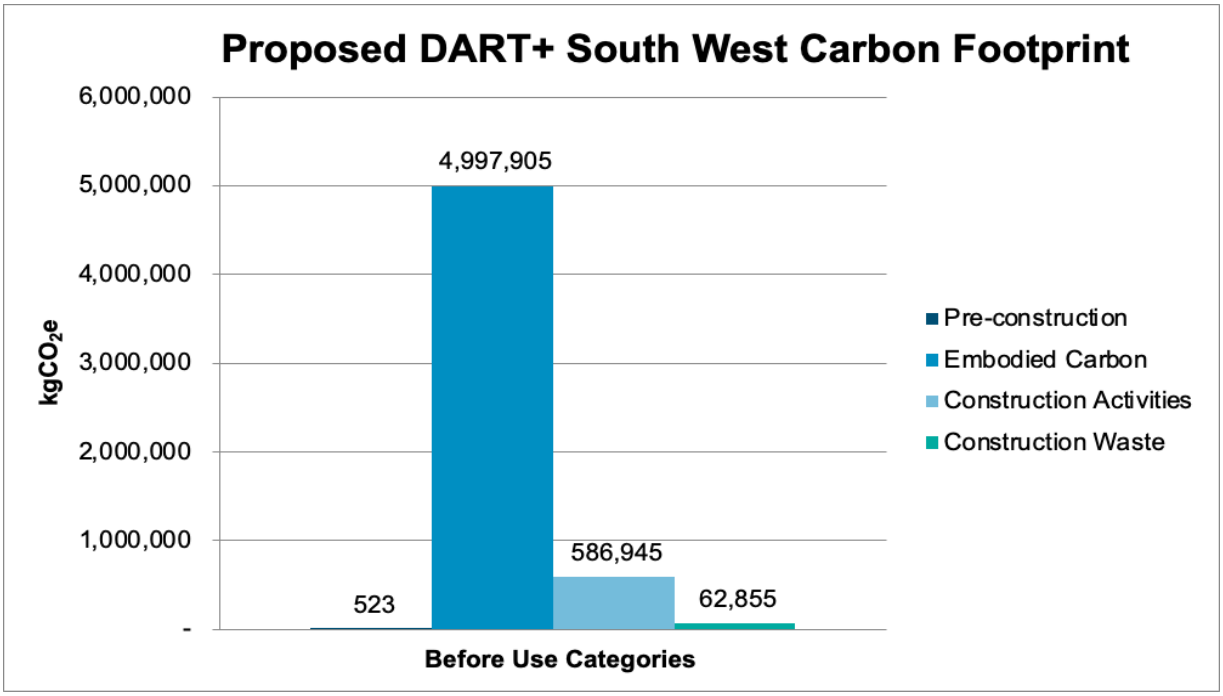

Figure 13-1: Construction Categories Greenhouse Gas Emissions

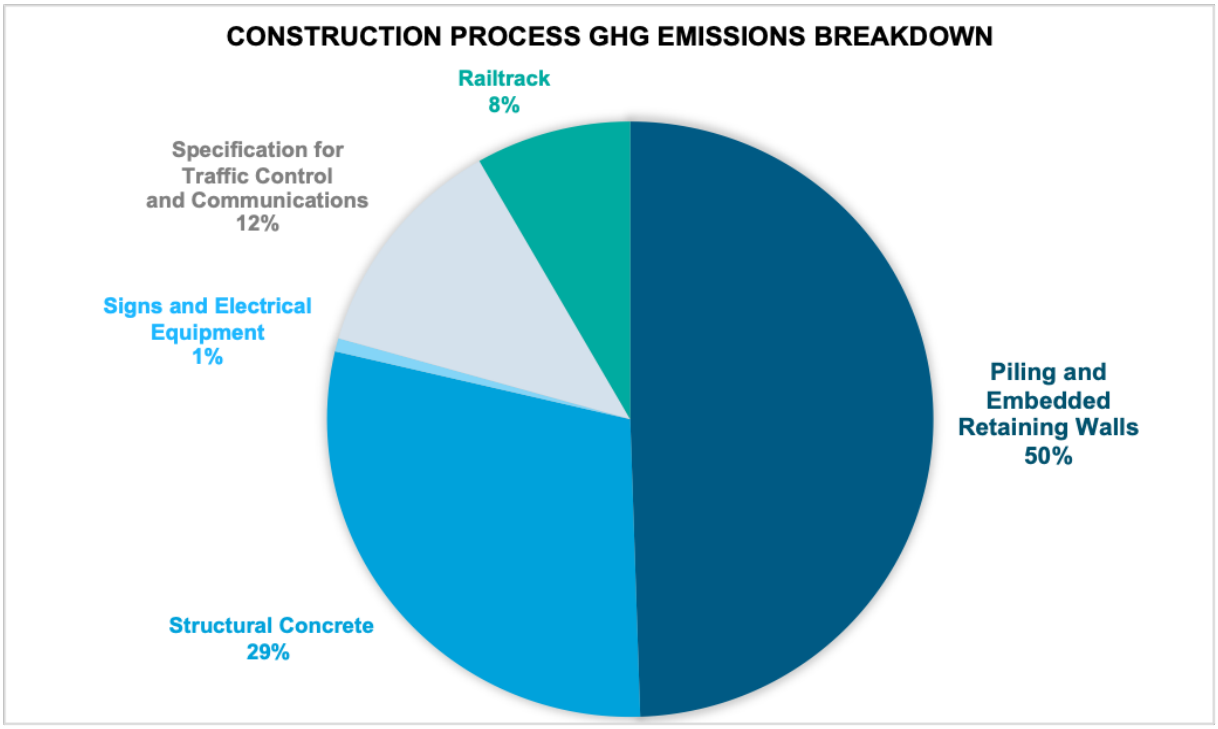

Figure 13-2: Construction Process Greenhouse Gas Emissions Breakdown

13.5.1.1. Construction Road Traffic Impacts

During construction , there are a number of temporary bridge closures across the Project area which will require a level of diversion and traffic management. The main potential for significant impact will be during the closures of Le Fanu Road Bridge (OBC7), Kylemore Road Bridge (OBC5A) and Memorial Road Bridge (OBC3) and these are addressed in detail below. The temporary closure of the Sarsfield Road Underpass Bridge (UBC4) is expected to be 5-7 days in duration and while there

is short term potential for traffic disruption, the resultant impact on emissions in the area will be negligible in this timeframe and is not considered in detail in this analysis. Similarly, the temporary closure of the Glasnevin Cemetery Bridge (OBO10) will only be for a period of 21 days for the temporary closure where traffic will be suspended and while there is potential for impact in the shortened timeframe the magnitude of impacts to emissions is considered negligible. Closure of the Khyber Pass Footbridge (OBC5) has no potential for vehicular emissions from traffic as this is a footbridge and will not require traffic diversions.

Revising the traffic patterns may have a resultant impact on emissions. The total vehicular emissions on the road network under the existing conditions and the predicted change with each of the proposed diversions are shown in Table 13.12. The results indicate that emissions from road traffic on the surrounding road network will increase as a result of all three diversions but the impact is minimal (circa 1-2%) over the existing traffic emissions. The total cumulative impact equates to an additional 909 tonnes of CO_2 per annum caused by the temporary road traffic diversions. The climate impact as a result of diversions is considered to be a short term 'slight adverse' impact.

Table 13.12: Regional Impact of Changes to Traffic Patterns as a result of Planned Diversions

Scenario	Total CO_2 (tonnes/year)
Existing (No Construction)	16,034
Closure of Le Fanu Road Bridge	16,412
Net Change (%)	2% Increase
Closure of Kylemore Road Bridge	16,441
Net Change (%)	2% Increase
Closure of Memorial Road Bridge	16,159
Net Change (%)	1% Increase
Total Potential Increase (tonnes/year)	**909**

13.5.1.2. Impact of Climate Change on the Proposed Construction Phase

Appropriate flood risk measures and extreme weather events have been considered as part of the construction planning. The 'LA 114 – Climate' guidance, successfully applied in the UK and referred to by the EPA, advises that for the construction phase, a qualitative description of disruption risk be reported. The potential for changes to long-term seasonal averages as a result of climate change are not considered to be as significant by the construction year as models consider the mid-century for predictions.

Flooding on construction sites have the potential to occur during the construction phase and the following flood risk areas are noted in Chapter 10 Water (Including Hydrology & Flood Risk).

- Hazelhatch & Celbridge Station and track are at risk of fluvial flooding for both the 1% and 0.1% Annual Exceedance Probability (AEP) flooding events;
- Adamstown Station track is at risk only during the most conservative High End Future Scenario (HEFS) 0.1% AEP climate change scenario;
- Zone B was identified as being at risk from pluvial flooding;

- Heuston Station and track are at risk of flooding during the HEFS 0.1% AEP climate change scenario; and
- Zone D was identified as being at risk from pluvial flooding due to the risk of the Royal Canal overflowing on the tracks.

Mitigation measures have been included in Section 10.6.1 of Chapter 10 Water (Including Hydrology & Flood Risk) to address construction stage impacts associated with flood risk to the rail line, the construction works areas and adjacent properties. With these measures in place, the risk of climate change impact, in particular flooding, on the construction phase of the proposed Project is not considered significant.

13.5.2. Potential Operational Impacts

13.5.2.1. Operational Rail Impacts

Fossil fuel powered trains have the potential to have direct GHG emissions. The proposed Project will introduce electrification to the rail line between Hazelhatch & Celbridge Station, and Heuston Station and on to Glasnevin Junction. The proposed Do Something system will see a shift towards electric multiple units (EMUs), however, diesel multiple units (DMUs), i.e. current intercity trains, will remain on the line. Unlike the diesel units, the electric DART units will have no localised tailpipe emissions.

This assessment compares the GHG emissions from the Do Minimum and Do Something scenarios for the proposed Project. Rail emissions are calculated using detailed information on the current and future service plans and emissions data for the rail stock. In addition, information has been provided on the electric power required to power an EMU (DART Unit 8537) for a km (1.43 kWh/km).

Table 13.13 shows the change to rail numbers from the Do Minimum and Do Something scenarios. These rail car numbers indicate an additional 126 EMU on the network as part of this project. In addition, the data shows a decrease of 12 commuter DMU on the network representing a 7% decrease in these rail cars on the proposed rail corridor.

Table 13.13: **Changes to Daily Rail Numbers**

Service Type	Train Model and Size	Do-Minimum	Do-Something (Proposed Project)
DART + Commuter	5 & 10 carriage BEMU or EMU	0	126
Outer Commuter	22000 Class DMU	84	72
Intercity	Existing MkIV + 201 locomotive	84	84
Freight	Shunting DMU	8	8
Empty Trains	22000 Class DMU	5	5
Total	-	**181**	**295**

GHG emissions produced in both the Do Minimum and Do Something scenarios during the operational phase are shown in Table 13.14 and Table 13.15 respectively.

For the Do Minimum scenario the emissions from the 181 DMU on the circa 20km rail corridor equate to circa 2,307 tonnes of GHG per annum. With the proposed decrease in diesel rail cars on the network under the Do Something scenario, there will be a corresponding decrease in GHG emissions from rail. For the Do Something scenario the emissions from the 169 DMU on the circa 20 km rail corridor equate to circa 2,155 tonnes of GHG per annum.

GHG emissions from the proposed 126 EMU operating on the network are estimated at 133 tonnes annually. This equates to a 6% share of the total annual emissions from the 126 EMU which make up 43% of the trains on the network illustrating the low impact of the EMU relative to the DMU. The proposed EMU fleet has minimal impact over and above the Do Minimum scenario.

Table 13.16 shows the change in GHG emissions between the Do Minimum and Do Something scenarios. Despite the significant increase in rail numbers, there is an overall net annual decrease of 20 tonnes in GHG emissions relative to the Do Nothing scenario. While this decrease is very low nationally, given the ongoing challenge for the State to meet climate targets any decrease is considered positive.

In accordance with the EPA Guidelines, the direct climate impacts associated with the operational phase rail traffic emissions pre-mitigation are overall slight beneficial in the long term.

Table 13.14: Do Minimum Rail Emissions

Do Minimum – All Trains	
Service Type	**GHG**
DART + Commuter (kg)	0
Outer Commuter (kg)	2,932
Intercity (kg)	2,932
Freight (kg)	284
Empty Trains (kg)	175
Sum Daily (kg)	**6,322**
Sum Annually (tonnes)	**2,307**
% of Ireland's non-ETS 2030 emissions target	**0.0069%**

Table 13.15: Do Something Rail Emissions

Do Something - DMUs	
Service Type	**GHG**
DART + Commuter (kg)	0
Outer Commuter (kg)	2,513
Intercity (kg)	2,932
Freight (kg)	284
Empty Trains (kg)	175
Sum Daily (kg)	**5,903**
Sum Annually (tonnes)	**2,155**

Do Something - EMUs	
Service Type	**GHG**
DART + Commuter (kg)	364
Outer Commuter (kg)	0
Intercity (kg)	0
Freight (kg)	0
Empty Trains (kg)	0
Sum Daily (kg)	**364**
Sum Annually (tonnes)	**133**
Do Something - All Rail	
	GHG
Sum Daily (kg)	**6,267**
Sum Annually (tonnes)	**2,287**
% of Ireland's non-ETS 2030 emissions target	**0.0069%**

Table 13.16: Change in Rail Emissions

All Rail	Do Minimum All Rail	Do Something All Rail	GHG
Change Daily (kg)	**6,322**	**6,267**	**-55**
Change Annually (tonnes)	**2,307**	**2,287**	**-20**
DS as Percentage of DN	**100**	**99**	**-1**
Change as % of Ireland's non-ETS 2030 emissions target	**0.0069**	**0.0069**	**0.0000**

13.5.2.2. Operational Road Traffic Impacts

In terms of road traffic changes during the operation phase, there are no station car parks, level crossings, depots or other infrastructure that will significantly alter the traffic patterns and natural growth on the road network. As such, no detailed analysis has been undertaken given the absence of any potential for significant effect on climate.

It is noted that there is potential for indirect positive impact to climate from the proposed Project. This potential positive impact may be realised if the proposed increase in rail services results in a meaningful modal shift from road traffic to rail traffic. Road transport is one of the principal sources of GHG emissions in Ireland and reducing the number of car kilometres travelled through modal shift will reduce emissions from road transport. The scale of any modal shift may not be fully quantified but even a moderate modal shift from road to rail transport on the proposed Project may result in a long term indirect slight positive impact for air quality.

13.5.2.3. Impact of Climate Change at Operational Phase

13.5.2.3.1. Flood Risk

The site specific flood risk assessment (SSFRA), as discussed in Chapter 10 Water (including Hydrology & Flood Risk), found that the vast majority of the proposed Project is located in Flood Zone C. Hydraulic models were built to investigate flooding at Hazelhatch, Adamstown and Heuston Station and these areas are discussed below detailing the flood risk management measures inherent in the design.

In Zone A, the analysis of the existing scenario found that the railway and proposed substation at Hazelhatch is at risk of flooding from both the 1% AEP and 0.1% AEP flooding events while the Adamstown area is not at risk. However, the railway is at risk at Adamstown during the 0.1% AEP HEFS climate change scenario. The proposed compound and substation at Hazelhatch are also at risk of flooding from the 1% AEP and 0.1% AEP flooding events.

Hydraulic modelling of possible hard mitigation measures included at Hazelhatch would increase flood risk to the surrounding area and would not reduce flooding below the Iarnród Éireann flood depth operational limits. Therefore, it was recommended that no hard mitigation measures are implemented as part of the current application and that Iarnród Éireann engage with the OPW which is currently progressing a Flood Relief Scheme for the wider Hazelhatch area. This scheme could reduce flooding to the railway station and its infrastructure.

The upgrading of infrastructure at Hazelhatch to facilitate the electrification will not increase flood risk to the surrounding area as the proposed ground levels will be maintained at the current levels to ensure that displacement of floodwaters does not occur and cause a residual risk. All critical equipment can be set at a level above the flood level while the substation site ground level can be maintained at existing levels.

Consideration was also given to the potential of proposed noise barriers in the Hazelhatch area to increase flood risk as they will be located within the 1% AEP and 0.1% AEP flood extents. A hydraulic model simulation showed that these noise barriers would cause a slight increase in flood level, particularly in the north-eastern vicinity of the railway culvert crossing on the Shinkeen River. To mitigate this impact to the flood level, a conveyance channel is proposed along the railway track along the north-eastern vicinity of the railway culvert crossing on the Shinkeen River. No impacts on the existing flooding regimes of the Lucan and Griffin Rivers in the Adamstown areas, due to the installation of noise barriers, is expected, since the proposed noise barriers are not located within the design flood extents.

The analysis of the existing scenario found that the railway and Heuston Station are not at risk of flooding from either the 1% AEP and 0.1% AEP flooding events. However, the railway track and car park are at risk during the HEFS 0.1% AEP climate change scenario from the River Liffey and River Camac. There is no flooding predicted at the proposed Heuston West Station. There is predicted flooding to the Heuston Station Terminal Building from the River Camac, however mitigation measures for that scenario are outside the scope of the proposed Project.

To reduce the risk of existing flooding along the track and to cater for the runoff volume likely to be generated from 1% AEP rainfall event (inclusive of 30% increase in rainfall due to future climate

change), the following track drainage systems in Zone D (River Liffey Bridge to Glasnevin Junction) are proposed:

- Phoenix Park Tunnel: The existing collection system (perforated pipe) will be replaced by a cast in-situ concrete channel drain 400mm wide by up to 500mm deep placed between tracks, to collect any surface water runoff on the track and convey flows from the upstream drainage network up to the existing outfall at The River Liffey. The current catchment area at the tunnel and its portals will not be modified by the proposed track works and therefore, the generated runoff volumes will not increase.
- North Portal of Phoenix Park Tunnel to Glasnevin: The drainage catchment between PPT and twin arch bridges (OBO8 and OBO9) will remain as existing, and therefore, runoff flows will not be increased as result of the proposed works. However, due to the proposed track level changes, lowering the existing pumping station will be required with an increase of the existing wet well chamber dimensions. This increase in size will allow holding the additional volumes collected by the drainage system in order to maintain the new water levels required by the EMU's. The proposed wet well will deal with the extra volume collected by the system whilst maintaining current pumping flows. Accumulated storm water will be pumped to the existing infiltration basin similar to the existing arrangement.

In summary, the findings of the SSFRA indicate that flood risk to the proposed Project can be managed with negligible effect on flood risk elsewhere.

A number of key areas of the proposed Project were found to have elevated levels of flood risk, however, management strategies are outlined in order to mitigate this risk. With the design mitigation measures in place the probability and frequency likelihood are considered to have the potential to be low likelihood, i.e. the event occurs approximately every fifteen years (see Table 13.5). The measure of consequences (see Table 13.6) can be classed as minor adverse as an operational phase impact would cause regional level disruption to strategic route lasting less than one day.

The significance conclusion (Table 13.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA114.

13.5.2.3.2. Increased Temperature

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). 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.

These increased temperatures have the potential to cause the temperature of materials, such as tracks /OHLE / asphalt / bitumen, to increase. However, based on an increase in temperature of between 1 to 3 degrees Celsius under RCP4.5, it is considered that the impact of increased temperatures on materials will not be significant.

The probability and frequency likelihood are considered to have the potential to be low likelihood, i.e. the event occurs approximately every fifteen years. The measure of consequences can be classed

as minor adverse as an operational phase impact would cause regional level disruption to strategic route lasting less than one day. The significance conclusion indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA114 guidance leading to a finding of a not significant impact.

13.5.2.3.3. Ice or Snow

The EPA future climate predictions (Research 339 – see above) predicts that there will be a substantial decrease of approximately 50% in the number of frost and ice days for the RCP4.5 and RCP8.5 scenarios. Snowfall is projected to decrease substantially by the middle of the century with 'likely' reductions of 51% and 60% for the RCP4.5 and RCP8.5 scenarios, respectively.

Overhead line equipment has the potential to be impacted by ice or snow events. Unmitigated, this is likely to occur with a high consequence of impact. The overhead line equipment will be designed to take into account a range of minimum and maximum temperatures (-200C to +400C) and loads under current and future climate conditions. The contact and messenger overhead wires will be automatically tensioned which will adjust for additional loading from ice, snow or wind. Ice loading has been considered within the design and ice coating will be applied for protection. The mechanical tension in the contact and messenger wires will be maintained within the system design parameters. In addition, Iarnród Éireann have applicable plans in place which can be activated if snow or ice are forecast;

- CCE-TEB-2014-05 Guidance on Service Restrictions during Adverse Weather Events; and
- Iarnród Éireann Weather Management Procedures.

The probability and frequency likelihood are considered to have the potential to be medium, i.e. the event occurs approximately every fifteen years. The measure of consequences can be classed as minor adverse as an operational phase impact would cause regional level disruption to strategic route lasting less than one day. The significance conclusion indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA114 guidance leading to a finding of a not significant impact.

13.5.2.3.4. Major Storm Damage

In terms of extreme weather, the EPA (EPA 2015) is predicting a reduction in storms and wind intensity by mid-century and thus the risk of extreme weather impacting on the proposed Project is not significant. However, more recent EPA research (EPA 2022b) show an overall reduction of ~10% in the numbers of storms affecting Ireland and suggest an eastward extension of the more severe windstorms over Ireland and the UK from the middle of the century. However, the research notes that this should be taken with some caution as extreme storms are rare events. In addition, the research indicated a summer reduction in windspeed range (as measured at 10m above ground level) from 0.3% to 3.4% for the RCP4.5 scenario and from 2% to 5.4% for the RCP8.5 scenario.

The Electricity & Gas Networks Sector Climate Change Adaptation Plan was prepared under the National Adaptation Framework in 2019. This considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. The Transport Climate Change Sectoral Adaptation Plan was also prepared in 2019. These adaptation plans include measures to ensure that the future electrical supply will have added resilience. The

electrical supply will be direct to the project by way of an underground cable which will be resistant to storm damage. The substations have looped connections with the ESB (redundant connection) and therefore already have a backup which will be used prior to the generator being required.

The probability and frequency likelihood are considered to have the potential to be high, i.e. the event occurs approximately every five years. This is an unmitigated scenario, however due to the design these events can be mitigated to reduce the probability and frequency likelihood to low (approximately once in the proposed Project's lifespan). Given the importance of the proposed Project the measure of consequences can be classed as moderately adverse as an operational phase impact would cause disruption on regional level disruption to strategic routes, but it is unlikely that temperatures would cause shutdown for longer than a week. The significance conclusion indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA 114 Guidance leading to a finding of a not significant impact.

13.5.2.3.5. Land Use Change

The Operational phase of proposed Project will not result in any direct significant change in land use in addition to the areas considered in the construction phase. Thus, there will be a negligible impact on carbon sequestration as a result of the operational phase of the proposed Project.

13.5.2.4. Maintenance Phase Impacts

The predicted operational phase GHG emissions can be averaged over the lifespan of the proposed Project to give the predicted annual emissions to allow for direct comparison with annual emissions and targets. Only GHG emissions generated from the areas on the rail corridor that were directly constructed as a result of the proposed Project are considered in this assessment, as routine maintenance, and associated GHG emissions generated, would be carried out on the existing infrastructure, irrespective of the proposed Project. Maintenance phase emissions have been compared against the Ireland's non-ETS 2030 target of 33,381,312 tonnes CO_2eq. The proposed Project is estimated to result in total maintenance phase GHG emissions of 97,978 kg CO_2eq per annum over the operational lifetime of the project. The emissions equate to 0.000294% of Ireland's non-ETS 2030 emissions target.

13.6. Mitigation Measures

13.6.1. Construction Phase

13.6.1.1. Construction Phase Embodied Carbon Mitigation

The need for informed choices of sustainable and circular materials at the detailed design stage is the optimum approach to mitigate these impacts. For example, the embodied carbon in Portland cement can be up to ten times higher than the embodied carbon of Ground Granulated Blastfurnace Slag (GGBS) cement. To that end, the following pre-construction mitigation shall be implemented:

- The design team and contractor shall maximise the use GGBS as a replacement for Portland cements to increase sustainability and the carbon footprint of civil and structural works. Only where GGBS is unsuitable for structural reasons can traditional Portland cements be employed on the project.

- Within the project design, the use of concrete will be minimised e.g. specify non-concrete assets where practicable such as gravel footpaths, grassed drains, etc.
- Iarnród Éireann will pursue procurement of the highest recycled steel content that is available for the particular steel usage. This may vary depending on engineering constraints. The carbon emissions emitted during the production of virgin steel can be higher than some other structural materials on a tonne-by-tonne basis and recycled steel should be used where possible.
- All aggregates required shall be secondary aggregates and virgin aggregates may only be employed where secondary aggregates do not fulfil structural requirements and/or are unavailable.
- In so far as possible, the contractor will secure the above materials from local/regional sources or sources within the State to minimise material transport emissions.
- Where possible materials will be re-used / recycled to reduce the need for procurement of new materials. In accordance with the IÉ Sustainability Strategy 2021 - 2030, 25% of raw material purchases will come from recycled sources.

13.6.1.2. Construction Phase General Mitigation

A description of the proposed climate mitigation measures that are to be implemented during the construction phase are described below:

- Iarnród Éireann will actively purchase materials and services with lower embodied/embedded emissions.
- The cut/fill balance will be further optimised to ensure that the minimal transport of material to and from the site is required thereby minimising transport emissions.
- There will be regular scheduled maintenance of construction plant machinery to maintain optimum operating efficiency.
- Transport distances (and associated carbon emissions from transport) of materials shall be minimised by securing or specifying local suppliers for materials, whenever feasible.
- For electricity generation at site compounds, hydrogen generators or electrified plant shall be used over traditional diesel generators.
- Precast over in-situ concrete for bridge construction, culverts, etc. will be specified where possible.
- The need for barriers or vehicle restraint systems (VRS) will be minimised through passive design to reduce the overall steel requirement on the proposed Project.
- The use of sustainable timber post fencing in boundary treatments over steel will be stipulated unless required by health and safety standards.
- Engines shall be switched off when machinery is not in use.
- A mobility strategy will be prepared to reduce the need for private vehicles to get to site (e.g., public transport and car sharing and maximising the amount of local labour).

13.6.2. Operational Phase

13.6.2.1. Maintenance Phase Embodied Carbon Mitigation

The maintenance phase GHG emissions will primarily consist of the maintenance of materials which were used in construction. No specific mitigation is set out ,however where possible, materials should be replaced in the most sustainable manner available. This may mean different materials used in replacement during the operational phase.

13.6.2.2. Operational Phase Rail Mitigation

Over 80% of Iarnród Éireann energy consumption is diesel fuel (Iarnród Éireann 2021). In addition to changing the rail corridor to facilitate a shift to EMUs, further mitigation through the improvements in fuel efficiency for the remaining DMUs shall be implemented. These include:

- Using timetable optimisation and driver training;
- Fuel consumption telematics for older rolling stock;
- Auto-Shut down for a significant portion of the fleet;
- Matching train sizes to customer demand;
- Elimination of Temporary Speed Restrictions (TSRs) arising from infrastructure renewals; and
- Use of a Corporate Power Purchase Agreement (CPPA) to ensure an energy mix of 80% renewables in the operational phase electricity use.

In addition, a number of fuel efficiency programs are currently in progress / on-trial (Iarnród Éireann 2021). These include the trial replacement of ICR gearboxes, replacement of ICR diesel engines with hybrid drives, Envirox fuel additive to increase fuel efficiency and to keep diesel engine DP filters clean and replacement of diesel vans with electric road vehicles supported by charging points at depots and stations.

13.6.2.3. Operational Phase Demand

The proposed Project also aims to reduce the energy demand with passive architectural strategies, reducing energy consumption with energy-efficient equipment and producing energy with renewable technologies. Energy is also related to CO_2 emissions and Iarnród Éireann's future Carbon Neutrality goal. The use of building design to maximise natural lighting and solar gain, use of motion-controlled lighting systems and LEDs will reduce building energy requirements.

Potable water consumption will be minimised using low consumption fixtures and recycling and reuse of greywater. In addition, Iarnród Éireann will prioritise the use of environmentally friendly materials and the use of recycled and recyclable materials during the operation of the proposed Project.

The Iarnród Éireann Sustainability Strategy (Iarnród Éireann 2021) notes the following key mitigation measures for reduction in the carbon footprint:

- Compliance with relevant ISO and national NSAI energy and environmental standards;
- Contributing to transport sector decarbonisation including improving fleet and buildings fuel / energy performance, fleet hybridisation, phased network electrification and promoting and facilitating a shift to rail;

- Recycling of 70% of all waste;
- Near Zero Energy Building standard in all new buildings, and upgrades of 140 existing buildings to minimum BER B;
- Reduction in overall carbon emissions by 51% between 2021 to 2030;
- Improving operations, infrastructure and fleet climate change resilience including partnership approach to emergency responses and wide-ranging mitigation measures including coastal protection;
- Reducing environmental impacts including LEAN management, waste and water management, green procurement in support of the circular economy and site decontamination; and
- Protecting habitats and promoting biodiversity in a partnership approach.
- The above actions and others within the Iarnród Éireann Sustainability strategy will be implemented as part of Iarnród Éireann's future mitigation and this includes the proposed Project mitigation.

13.7. Monitoring

No monitoring measures are proposed for the construction or operational phases.

13.8. Residual Effects

13.8.1. Construction Phase

The generation of greenhouse gas emissions at the construction stage of the project is mainly derived from embodied carbon, construction activities and waste generation.

Emissions from road traffic on the surrounding road network as a result of planned diversions during construction will increase but the impact is minimal (circa 1-2%) over the existing traffic emissions. The total cumulative impact equates to an additional 909 tonnes of CO_2 per annum caused by the temporary road traffic diversions. The residual impact as a result of diversions is considered to be a short term 'slight adverse' impact.

With the flood and incident response plans in place during construction, the risk of climate change impact on the construction phase of the proposed Project is not considered significant.

13.8.2. Operational Phase

The annualised emissions due to the ongoing maintenance of the proposed Project is predicted to reach, at most, 98 tonnes CO_2eq or 0.000294% of Ireland's non-ETS 2030 emissions target. The residual impact is considered to be a long term 'slight adverse' impact.

Despite the significant increase in rail numbers, there is an overall net decrease of 20 tonnes annually in GHG emissions relative to the Do Minimum scenario. While this decrease is very low nationally, given the ongoing challenge for the State to meet climate targets any decrease is considered positive. The direct climate impacts associated with the operational phase rail traffic emissions are 'slight beneficial' in the long term.

The risk of climate change impact on the operational proposed Project will not be significant for each of the main threats – flooding, increased temperature, ice/snow, major storms or land use change.

13.9. Cumulative Effects

The cumulative assessment of relevant plans and projects is undertaken separately in Chapter 26 of this EIAR.

13.10. References

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