
ESTUARY
Park & Ride
SEATOWN
SWORDS CENTRAL
FOSTERSTOWN
DUBLIN AIRPORT
DARDISTOWN
NORTHWOOD
BALLYMUN
COLLINS AVENUE
GRIFFITH PARK
GLASNEVIN
MATER
O'CONNELL STREET
TARA
ST STEPHEN'S GREEN
CHARLEMONT

17 Climate

Contents

List of Abbreviations

Acronym	Meaning
AADT	Average Annual Daily Traffic
AZ	Assessment Zone
CAP	Climate Action Plan
CARO	Climate Action Regional Office
CESSM	Civil Engineering Standard Method of Measurement
CH4	Methane
CO2eq	Carbon dioxide equivalent
COP	Conference of the Parties
CPPA	Corporate Power Purchase Agreement
CTMP	Construction Traffic Management Plan
DANP	Dublin Airport North Portal
DART	Dublin Area Rapid Transit
DASP	Dublin Airport South Portal
DCC	Dublin City Council
DCCAE	Department of Communications, Climate Action & Environment
DECC	Department of the Environment, Climate and Communications
DLRCC	Dún Laoghaire Rathdown Council
DM	Do Minimum
DMRB	Design Manual for Roads and Bridges
DN	Do Nothing
DS	Do Something
DTTAS	Department of Transport, Tourism and Sport
EC	European Commission
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
EPD	Environmental Product Declaration
ERM	Eastern Regional Model
ESD	Effort Sharing Decision
ETS	Emission Trading Scheme
EU	European Union
FCC	Fingal County Council
FRA	Flood Risk Assessment
GDA	Greater Dublin Area
GGBFS	Ground Granulated Blast Furnace Slag
GHG	Greenhouse Gases
GWP	Global Warming Potential
HEFS	High-End Future Scenario
HGV	Heavy Goods Vehicles
hPa	Hectopascals

Acronym	Meaning
IEMA	Institute of Environmental Management and Assessment
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
Kt	Kilo tonnes
kV	Kilovolt
MMP	Mobility Management Plan
Mt CO2eq	Million tonnes CO2 equivalent
MW	Megawatt
N2O	Nitrous oxide
NAF	National Adaptation Framework
NDP	National Development Plan
NIFTI	National Investment Framework for Transport in Ireland
NPF	National Planning Framework
NTA	National Transport Authority
OCC	Operations Control Centre
RCP	Representative Concentration Pathway
RSA	Road Safety Authority
SDCC	South Dublin City Council
SEAI	Sustainable Energy Authority Ireland
STMP	Scheme Traffic Management Plan
TBM	Tunnel-boring Machine
TFC	Total Final Energy Consumption
TII	Transport Infrastructure Ireland
UK	United Kingdom
UKHA	United Kingdom Highways Agency
UNFCCC	United Nations Framework Convention on Climate Change

17. Introduction

17.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) assesses the impact of the MetroLink Project (hereafter referred to as the proposed Project), on Climate during the Construction Phase and Operational Phase. This chapter describes and assesses the likely direct and indirect significant effects of the proposed Project on Climate, in accordance with the requirements of Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (i.e., the EIA Directive). This Chapter also provides a characterisation of the receiving environment within the proposed Project and within a wider study area in the vicinity of the proposed Project.

This Chapter should be read in conjunction with the following Chapters, and their Appendices, which present related impacts arising from the proposed Project and proposed mitigation measures to ameliorate the predicted impacts:

- Chapter 4 (Description of the MetroLink Project);
- Chapter 5 (MetroLink Construction Phase);
- Chapter 6 (MetroLink Operations & Maintenance);
- Chapter 9 (Traffic and Transport);
- Chapter 15 (Biodiversity);
- Chapter 16 (Air Quality);
- Chapter 18 (Hydrology);
- Chapter 24 (Materials & Waste Management); and
- Chapter 28 (Risk of Major Accidents & Disasters).

The assessment is based on a reasonable worst-case scenario with respect to potential carbon emissions arising from the proposed Project as described in Chapters 4 to 6 of this EIAR. Two alterative scenarios are also considered with respect to Operational Phase traffic which are as follows:

- Do Minimum (DM) Committed scenario which includes additional committed transport schemes in addition to MetroLink; and
- The Likely Future scenario, which presents the planned future transport network scenario.

A reasonable worst-case scenario describes the most significant potential carbon emission impacts arising from the proposed Project based on the project information available at this stage of the project advised by an experienced and competent project design team.

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.

Limits of deviation have been set for the proposed Project and this is addressed in the Wider Effects Report annexed at Appendix A5.19.

17.2 Outline Project Description

A full description of the proposed Project is provided in the following chapters of this EIAR:

- Chapter 4 (Description of the MetroLink Project);
- Chapter 5 (MetroLink Construction Phase); and
- Chapter 6 (MetroLink Operations & Maintenance).

Table 17.1 presents an outline description of the key proposed Project elements which are appraised in this Chapter. Diagram 17.1 presents an outline of the main elements of the proposed Construction Phase

that are appraised in this Chapter and Diagram 17.2 presents an outline of the main elements of the Operational Phase of the proposed Project that are appraised in this Chapter.

Table 17.1: Outline Description of the Principal Project Elements

Project Elements	Outline Description
Permanent Project Elements	
Tunnels	It is proposed to construct two geographically separate, single-bore tunnels, using a Tunnel Boring Machine (TBM). Each section of tunnel will have an 8.5m inside diameter and will contain both northbound and southbound rail lines within the same tunnel. These tunnels will be located as follows: ▪ The Airport Tunnel: running south from Dublin Airport North Portal (DANP) under Dublin Airport and surfacing south of the airport at Dublin Airport South Portal (DASP) and will be approximately 2.3km in length; and ▪ The City Tunnel: running for 9.4km from Northwood Portal and terminating underground south of Charlemont Station.
Cut Sections	The northern section of the alignment is characterised by a shallow excavated alignment whereby the alignment runs below the existing ground level. Part of the cut sections are open at the top, with fences along the alignment for safety and security. While other sections are "cut and cover", whereby the alignment is covered.
Tunnel Portals	The openings at the end of the tunnel are referred to as portals. They are concrete and steel structures designed to provide the commencement or termination of a tunnelled section of route and provide a transition to adjacent lengths of the route which may be in retained structures or at the surface. There are three proposed portals, which are: ▪ DANP; ▪ DASP; and ▪ Northwood Portal. There will be no portal at the southern end of the proposed Project, as the southern termination and turnback would be underground.
Stations	There are three types of stations: surface stations, retained cut stations and underground stations: ▪ Estuary Station will be built at surface level, known as a 'surface station'; ▪ Seatown, Swords Central, Fosterstown Stations and the proposed Dardistown Station will be in retained cutting, known as 'retained cut stations'; and ▪ Dublin Airport Station and all 10 stations along the City Tunnel will be 'underground stations'.
Intervention Shaft	An intervention shaft will be required at Albert College Park to provide adequate emergency egress from the City Tunnel and to support tunnel ventilation. Following the European Standard for safety in railway tunnels TSI 1303/2014: Technical Specification for Interoperability relating to 'safety in railway tunnels' of the rail system of the European Union, it has been recommended that the maximum spacing between emergency exits is 1,000m. As the distance between Collins Avenue and Griffith Park is 1,494m, this intervention shaft is proposed to safely support evacuation/emergency service access in the event of an incident. This shaft will also function to provide ventilation to the tunnel. The shaft will require two 23m long connection tunnels extending from the shaft, connecting to the main tunnel. At other locations, emergency access will be incorporated into the stations and portals or intervention tunnels will be utilised at locations where there is no available space for a shaft to be constructed and located where required (see below).
Intervention Tunnels	In addition to the two main 'running' tunnels, there are three shorter, smaller diameter tunnels. These are the evacuation and ventilation tunnels (known as Intervention Tunnels). Airport Intervention Tunnels: parallel to the Airport Tunnel, there will also be two smaller diameter tunnels; on the west side, an evacuation tunnel running northwards from DASP for about 315m, and on the east side, a ventilation tunnel connected to the main tunnel and extending about 600m from DASP underneath Dublin Airport Lands. In the event of an incident

Project Elements	Outline Description
	in the main tunnel, the evacuation tunnel will enable passengers to walk out to a safe location outside the Dublin Airport Lands. Charlemont Intervention Tunnel: The City Tunnel will extend 360m south of Charlemont Station. A parallel evacuation and ventilation tunnel is required from the end of the City Tunnel back to Charlemont Station to support emergency evacuation of maintenance staff and ventilation for this section of tunnel.
Park and Ride Facility	The proposed Park and Ride Facility next to Estuary Station will include provision for up to 3,000 parking spaces.
Broadmeadow and Ward River Viaduct	A 260m long viaduct is proposed between Estuary and Seatown Stations, to cross the Broadmeadow and Ward Rivers and their floodplains.
Proposed Grid Connections	Grid connections will be provided via cable routes with the addition of new 110kV substations at DANP and Dardistown (Approval for the proposed grid connections to be applied for separately, but are assessed in the EIAR).
Dardistown Depot	A maintenance depot will be located at Dardistown. It will include: ▪ Vehicle stabling; ▪ Maintenance workshops and pits; ▪ Automatic vehicle wash facilities; ▪ A test track; ▪ Sanding system for rolling stock; ▪ The Operations Control Centre for the proposed Project; ▪ A substation; ▪ A mast; and ▪ Other staff facilities and a carpark.
Operations Control Centre	The main Operations Control Centre (OCC) will be located at Dardistown Depot and a back-up OCC will be provided at Estuary.
M50 Viaduct	A 100m long viaduct to carry the proposed Project across the M50 between the Dardistown Depot and Northwood Station.
Temporary Project Elements	
Construction Compounds	There will be 34 Construction Compounds including 20 main Construction Compounds, 14 Satellite Construction Compounds required during the Construction Phase of the proposed Project. The main Construction Compounds will be located at each of the proposed station locations, the portal locations, and the Dardistown Depot Location (also covering the Dardistown Station) with satellite compounds located at other locations along the alignment. Outside of the Construction Compounds there will be works areas and sites associated with the construction of all elements of the proposed Project, including an easement strip along the surface sections.
Logistics Sites	The main logistics sites will be located at Estuary, near Pinnock Hill east of the R132 Swords Bypass and north of Saint Margaret's Road at the Northwood Compound (These areas are included within the 14 Satellite Construction Compounds).
Tunnel Boring Machine Launch Site	There will be two main Tunnel Boring Machine (TBM) launch sites. One will be located at DASP which will serve the TBM boring the Airport Tunnel and the second will be located at the Northwood Construction Compound which will serve the TBM boring the City Tunnel.

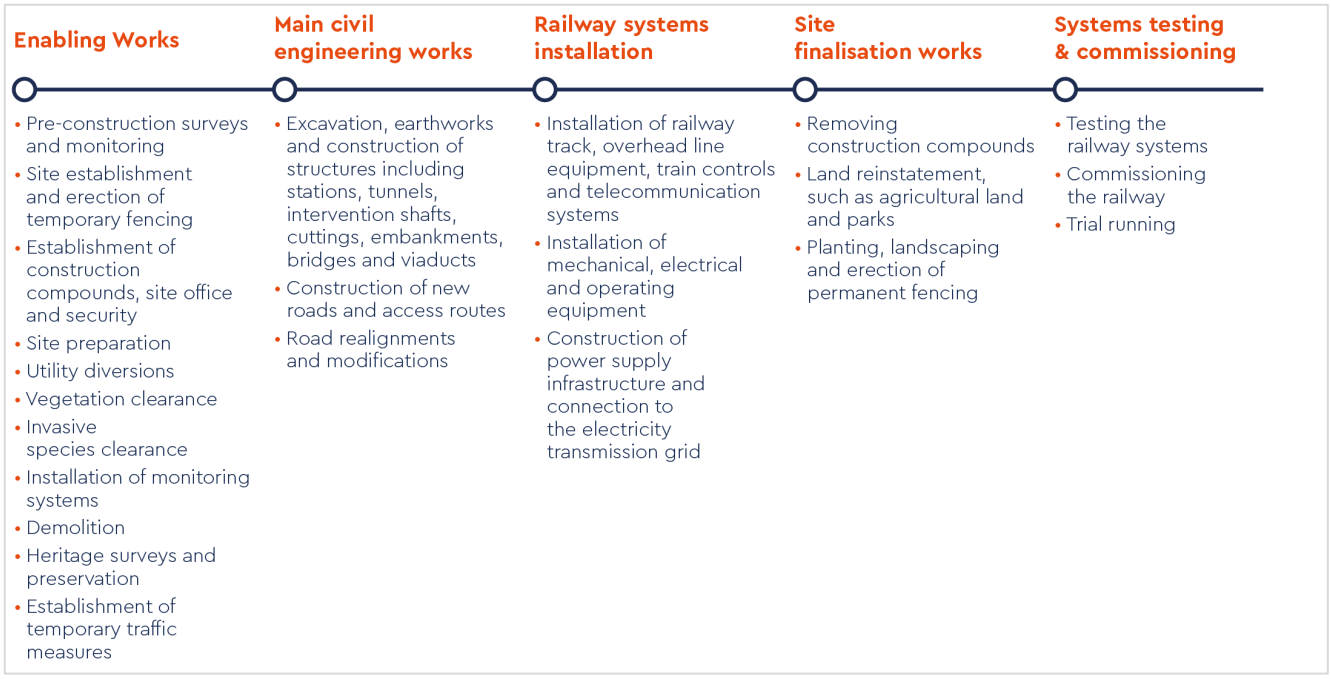

Diagram 17.1: Summary of Key Activities during the Construction Phase of the Proposed Project

Diagram 17.2: Summary of Key Activities during the Operation Phase of the Proposed Project

17.3 Methodology

Guidance from the United Kingdom (UK) Highway Agency (UKHA) Design Manuals for Roads and Bridges (DMRB) - LA 114 Climate (hereafter referred to as LA 114 Climate) (UKHA 2019) advises that the assessment of a proposed road scheme should describe the likely significant effects on the environment resulting from both the:

- Impact of a project on climate arising from Greenhouse Gas (GHG) emissions; and
- Vulnerability of a project to climate change (climate adaptation).

While this is not a road scheme, the guidance provided the basis for methodology for the assessment of the impacts that is applicable to the proposed Project. LA 114 Climate has also been utilised on other recent Irish major infrastructure projects (BusConnects and DART + West) and consistency in methodology across projects facilitates comparison.

The assessment methodology has been derived with reference to the most appropriate guidance documents (see Section 17.3.2) 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 in order to characterise the baseline environment. This has been undertaken by way of a review of available published GHG emissions data. See Section 17.4;
- A review of the most applicable guidelines for the assessment of GHG emissions has been reviewed in order to define the significance criteria for the Construction and Operational Phases of the proposed Project. See Section 17.3.2;
- Predictive calculations and impact assessments relating to the likely Construction Phase climatic impacts of the proposed Project have been undertaken. See Section 17.5.2;
- Predictive calculations have been performed to assess the potential climatic impacts associated with Operational Phase electrical power requirements, including maintenance. See Section 17.5.3;
- An assessment of the design adaptation and vulnerability of the proposed Project to climate change has been undertaken. See Section 17.5.3.7;
- A schedule of mitigation measures has been incorporated where required to reduce, where necessary, the identified potential climatic impacts associated with the proposed Project. See Section 17.6; and
- The predicted residual impact is compared against Ireland's non-ETS 2030 target of 33,381.3Kt CO2eq (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) and the 2030 transport sectoral carbon budget (Department of the Taoiseach 2022). See Section 17.7.

17.3.1 Study Area

The proposed Project covers an extensive linear study area between Estuary and Charlemont Station via Dublin City Centre. Full details of the Project Description can be found in Chapter 4 (Description of the MetroLink Project). The assessment study area is split into four assessment zones (AZ's), which run linearly from north to south of the proposed Project:

- **AZ1 The Northern Section:** This section of the proposed Project from Estuary to north of the Dublin Airport North Portal. Includes the proposed Park and Ride Facility at Estuary (P&R);
- **AZ2 The Airport Section:** This section of the proposed Project from the Dublin Airport North Portal (DANP), the tunnel underneath Dublin Airport, Dublin Airport Station, and Dublin Airport South Portal (DASP);
- **AZ3 Dardistown – Northwood:** This section of the proposed Project from south of DASP until the Northwood Portal. This section includes the proposed Depot site at Dardistown, the M50 Viaduct and the proposed Construction Compound at Northwood; and
- **AZ4 Northwood – Charlemont:** This section includes the underground tunnel between Northwood and Charlemont. All stations along this section are included.

The study area for Construction and Operational Phase traffic impacts extends to the area considered to be impacted due to an altered traffic environment during both phases. The impacted area extends outside the four AZ's described above that run along the proposed Project alignment when considering the impact of the proposed Project on climate change. The relevant study is determined based on the criteria set out in Section 17.3.5 (any road that is impacted by a 10% change in operational traffic flows (UKHA 2019)) and modelled traffic area provided by the traffic consultant. The modelled traffic area covered the Eastern Regional Model (ERM) and for robustness of assessment all roads within the ERM have been included in the assessment. The ERM covers the counties within Leinster and the Greater Dublin Area (GDA).

The land uses in the immediate vicinity of the proposed Project is predominantly urban but also comprises some greenfield and brownfield sites to the north of the proposed Project.

The study area for impacts on climate due to the proposed Project differs from other aspects of the EIAR as emissions are compared to sectorial (i.e., transport) GHG emissions and Irish GHG emission targets. The study area for impacts of climate change on the proposed Project covers the area within the Project Boundary (i.e., AZ1 to AZ4) and extends to areas that are sensitive to future climate change impacts such as flooding which can extend to impact the Project Boundary.

During the Construction Phase, the study area focus is on the enabling infrastructure provision, which forms the proposed Project including utility diversions, tunnelling, land take activities, excavation works, road reconfiguration, significant construction materials and construction traffic emissions.

During the Operational Phase, the study area focus is on GHG emissions associated with the proposed Project including GHG emissions along impacted traffic routes within the study area. Potential impacts to climate relate to alterations to road traffic patterns, power for running stations and the proposed Project, maintenance and changes to the number and type of traffic trips. The assessment of the Operational Phase also examines the vulnerability of the proposed Project to climate change, including the risk of flooding and the potential increased frequency of storms.

17.3.2 Relevant Guidelines, Policy, and Legislation

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 guidelines were considered and consulted in the preparation of this Chapter:

- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002);
- Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) (EPA 2003);
- Draft Advice Notes for Preparing Environmental Impact Statements (EPA 2015a); and
- Guidelines on the Information to be contained in Environmental Impact Statements (hereafter referred to as the EPA Guidelines) (EPA 2022a).

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

- Climate Action and Low Carbon Development Act (Act. No. 46 of 2015) (hereafter referred to as the Climate Act);
- Department of Communications, Climate Action & Environment (DCCAE) National Mitigation Plan (DCCAE 2017a);
- National Adaptation Plan (DCCAE 2017b);
- Climate Action Plan 2021 (hereafter referred to as the CAP) (DCCAE 2021a);
- Department of Transport, Tourism and Sport (DTTAS) Transport – Climate Change Sectoral Adaptation Plan (DTTAS 2019);
- General Scheme of the Climate Action (Amendment) Bill 2019 (hereafter referred to as the General Scheme) (DECC 2021);
- Dublin City Council (DCC) Climate Change Action Plan 2019 – 2024 (DCC and Codema 2019);
- European Commission 2030 Climate and Energy Policy Framework (European Commission 2014);
- Fingal County Council (FCC) Climate Change Action Plan 2019 – 2024 (FCC and Codema 2019);
- Transport Infrastructure Ireland (TII) Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes (TII 2011);
- Design Manual for Roads and Bridges (DMRB): LA 114 – Climate (UKHA 2019);
- Institute of Environmental Management & Assessment (IEMA) Assessing GHG Emissions and Evaluating their Significance (IEMA 2022);
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA 2020a);
- IEMA GHG Management Hierarchy (IEMA 2020b);
- Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (European Commission 2021a);
- Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change (European Commission 2021b); and
- Climate Action and Low Carbon Development (Amendment) Act 2021 (No. 32 of 2021) (hereafter referred to as the 2021 Climate Act).

17.3.2.1 International and National Guidelines, Policy, and Legislation

Ireland is party to both the United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC 1992) and the Kyoto Protocol (UNFCCC 1997). 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 above pre-industrial levels with efforts to limit this rise to 1.5°C. The aim is to limit global GHG emissions to 40 gigatonnes as soon as possible whilst acknowledging that peaking of GHG emissions will take longer for developing countries. Contributions to GHG emissions were based on Intended Nationally Determined Contributions (INDCs) which formed the foundation for climate action after 2020. Significant progress was also made in the Paris Agreement on elevating climate adaption in response to climate change onto the same level as action to cut and curb emissions. This work was furthered at the 26th Conference of the Parties (COP) of the UNFCCC COP26 (UNFCCC 2021) summit in Glasgow in 2021. At COP26 Ireland committed to phasing out oil and gas production, as part of the Beyond Oil and Gas Alliance. The outcome of COP26 sets out work that is required to cut emissions this decade, and to keep global average temperature rise below 1.5°C.

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 ETS is 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.

In 2015, the Climate Action and Low Carbon Development Act was enacted by the Oireachtas. The purpose of the 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*' (3 (1) of No. 46 of 2015). This is referred to in the Climate Action and Low Carbon Development Act as the '*national transition objective*'. The 2015 Climate Act made provision for a national mitigation plan (which was struck down by the Supreme Court on 31 July 2020). However, the 2021 Climate Act subsequently removed any reference to a national mitigation plan and instead refers to both the 2019 Climate Action Plan (CAP) (DCCAE 2019), as published in 2019, and a series of National Long Term Climate Action Strategies. The Climate Act Adaptation Plan, referred to as the 'National Climate Change Adaptation Framework', which is required to be submitted to Government for approval every five years, outlines a range of objectives to:

- Specify the national strategy for the adaptation measures in different sectors which reduces the vulnerability of the State to the negative effects of climate change and to avail of the positive effects of climate change that may occur; and
- Take into account any existing obligations of the State under the law of the EU or any international agreement.

The Climate Action Plan (DCCAE 2019a) was published in 2019 and outlined the status across key sectors including electricity, transport, built environment, industry and agriculture and outlines the various broadscale measures required for each sector to achieve ambitious decarbonisation targets. The CAP also detailed the required governance arrangements for implementation which includes:

- Carbon-proofing of policies;
- The establishment of carbon budgets;
- A strengthened Climate Change Advisory Council; and
- Greater accountability to the Oireachtas.

An updated CAP was published in 2021 and contains updated objectives from the 2019 CAP.

The proposed Project is specifically mentioned in the 2019 CAP under (Section 10.3 Measures to Deliver Targets), while the 2021 CAP calls for the *"Commence delivery of MetroLink"* under action 241. The CAP notes that a modal shift from private to public transport should be facilitated by implementation of major sustainable-mobility projects such as DART Expansion, MetroLink, and the BusConnects Programme. These projects will assist in achieving the committed additional 500,000 public transport and active travel journeys daily by 2035.

Following on from Ireland declaring a climate and biodiversity emergency in May 2019 and the European Parliament approving a resolution declaring a climate and environment emergency in Europe in November 2019, the Government approved the publication of the General Scheme in December 2019, followed by the publication of the 2021 Climate Bill in March 2021 and the 2021 Climate Act in July 2021. The Climate Action and Low Carbon Development (Amendment) Act was prepared for the purposes of giving statutory effect to the core objectives stated within the CAP (DCCAE 2019a).

The Climate Action and Low Carbon Development Act provided for the establishment of the Climate Change Advisory Council (hereafter referred to as the Advisory Council) with the function to advise and make recommendations on the preparation of the national mitigation and adaptation plans and compliance with existing climate obligations.

The Climate Change Advisory Council is to advise and make recommendations on the following:

- The preparation of a CAP;
- The preparation of a national long term climate action strategy;
- The preparation of a national adaptation framework;
- The finalization and revision of a carbon budget; and
- Compliance with any existing obligations of the State under EU law or any international agreements.

The Climate Change Advisory Council is to conduct a review by 15 September in each year of the progress made during the immediately preceding year in:

- Achieving reductions in GHGs;
- Complying with the carbon budget and each sectoral emissions ceiling for that period; and
- Furthering the achievement of the national climate objective.

In June 2020 the Government published the Programme for Government – Our Shared Future (Government of Ireland 2020). In relation to climate, there is a commitment to an average 7% per annum reduction in overall GHG emissions from 2021 to 2030 (51% reduction over the decade) with an ultimate aim to achieve net zero emissions by 2050. Policy changes will include the acceleration of the electrification of the transport system, including electric bikes, electric vehicles, and electric public transport, alongside a ban on new registrations of petrol and diesel cars from 2030. In addition, policies to ensure an unprecedented model shift in all areas by a reorientation of investment to walking, cycling and public transport are considered key.

The purpose of the 2021 Climate Act was to provide for the approval of plans 'for the purpose of pursuing the transition to a climate resilient, biodiversity rich and climate neutral economy by no later than the end of the year 2050'. The 2021 Climate Act will also 'provide for carbon budgets and a sectoral emissions ceiling to apply to different sectors of the economy'. The 2021 Climate Act removes any reference to a national mitigation plan and instead refers to both the CAP, as published in 2019, and a series of National Long Term Climate Action Strategies. In addition, the Environment Minister is required to request that each local authority prepare a 'local authority climate action plan' lasting five years and specifying the mitigation measures and the adaptation measures to be adopted by the local authority. The 2021 Climate Act has set a target of a 51% reduction in the total amount of GHGs over the course of the first two carbon periods ending 31 December 2030 relative to 2018 annual emissions. The 2021 Climate Act defines the carbon budget as 'the total amount of GHG emissions that are permitted during the budget period'.

The 2021 Climate Act outlines a series of specific actions including:

- To make a strategy to be known as the 'National Long Term Climate Strategy' not less than once in every five-year period with the first to be published for the period 2021 to 2035 and with each subsequent Strategy covering the next three five-year carbon budgets and also include a longer-term perspective of at least 30 years;
- To adopt a system of carbon budgets which will be determined as part of a grouping of three five-year periods calculated on an economy-wide basis, starting with the periods 2021 to 2025, 2026 to 2030, and 2031 to 2035 (See Table 17.2);
- To introduce a requirement for Government to adopt "sectoral emission ceilings" for each relevant sector within the limits of each carbon budget;
- To request all local authorities to prepare CAPs for the purpose of contributing to the national climate objective. These plans should contain mitigation and adaptation measures that the local authority intends to adopt;
- Increasing the power of the Advisory Council to recommend the appropriate climate budget and policies;
- Requiring the Minister to set out a roadmap of actions to include sector specific actions that are required to comply with the carbon budget and sectoral emissions ceiling for the period to which the plan relates; and
- Reporting progress with the CAP on an annual basis with progress including policies, mitigation measures and adaptation measures that have been adopted.

The Minister with responsibility for each sector, will give an account of matters during the period to which the annual report relates including:

- Sector specific progress under the most recent CAP and any significant failure to implement such policies and measures, or to achieve sector specific targets;
- Whether there has been a reduction or increase in GHG emissions based on the annual EPA GHG report;
- Compliance with the sectoral emissions ceiling and any measures envisaged to address any failures to comply with the target; and
- The implementation of adaptation policy measures and any adaptation policy measures envisaged, where a sectoral adaptation plan has been prepared.

As part of the preparation of a 'local authority climate action plan', each local authority shall consult and co-operate with an adjoining local authority in making a local authority CAP and co-ordinate the mitigation measures and adaptation measures to be adopted, where appropriate. Each local authority is also required to consider any significant effects the implementation of the local authority CAP may have on the adjoining local authority.

The 2021 CAP, published in November 2021, outlines the current status across key sectors including electricity, transport, built environment, industry and agriculture and outlines the various broadscale measures required for each sector to achieve ambitious decarbonisation targets. The 2021 CAP also details the required governance arrangements for implementation including carbon-proofing of policies, establishment of carbon budgets (Department of the Taoiseach 2022), a strengthened Advisory Council and greater accountability to the Oireachtas. The 2021 CAP (in Section 15.3) acknowledges that policies need to be better aligned to achieve more ambitious targets for modal shift, which will involve the building of supporting infrastructure. This is intended to result in a significant increase in public transport and active travel journeys. The 2021 CAP also states that there will be an expansion of sustainable-travel measures.

The 2021 CAP identifies the electrification of transport as the most cost-effective abatement opportunity. The 2021 CAP outlines a range of targets for electrification of vehicles including:

- Commence delivery of MetroLink (Action 241);
- Increasing the number of passenger electric vehicles (EVs) on the road to 845,000 by 2030, from a 2018 number of c. 2,000;
- Reaching 95,000 electric vans and trucks by 2030, from a 2018 number of c. 85;

- Removal of obstacles to decarbonisation of our transport fleet;
- Procuring 1,500 low-emission buses for public transport in cities; and
- Increasing the biofuel blend rate from the current E5 and B5 blends to E10 and B20 in petrol and diesel, respectively (i.e., increasing the percentage of bioethanol in petrol from 5% to 10% and increasing the amount of biodiesel in diesel from 5% to 20%).

In relation to carbon budgets, the Climate Action and Low Carbon Development (Amendment) Act states 'A carbon budget, consistent with furthering the achievement of the national climate objective, shall be proposed by the Climate Change Advisory Council, finalised by the Minister and approved by the Government for the period of 5 years commencing on the 1 January 2021 and ending on 31 December 2025 and for each subsequent period of 5 years (in this Act referred to as a 'budget period')'. The carbon budget is to be produced for 3 sequential budget periods, as shown in Table 17.2. The carbon budget can be revised where new obligations are imposed under the law of the European Union or international agreements or where there are significant developments in scientific knowledge in relation to climate change. In relation to the sectoral emissions ceiling, the Minister for the Environment, Climate and Communications (the Minister for the Environment) shall prepare and submit to government the maximum amount of GHG emissions that are permitted in different sectors of the economy during a budget period and different ceilings may apply to different sectors. The sectorial emission ceilings for 2030 were published July in 2022 and are shown in Table 17.3. Transport has a 50% reduction required and emissions ceiling of 6,000Kt CO_2eq.

Table 17.2: 5-Year Carbon Budgets 2021-2025, 2026-2030 and 2031-2025 (Department of the Taoiseach 2022)

Sector	Reduction Required	2018 Emissions (Mt CO_2eq)
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.

Table 17.3: Sectoral Emission Ceiling 2030 (Department of the Taoiseach 2022)

Sector	Reduction Required	2018 Emissions (Mt CO_2eq)	2030 Emission Ceiling (Mt CO_2eq)
Electricity	75%	10.5	3
Transport	50%	12	6
Buildings (Commercial and Public)	45%	2	1
Buildings (Residential)	40%	7	4
Industry	35%	7	4
Agriculture	25%	23	17.25
Other	50%	2	1

The European Green Deal (European Commission 2019) proposes ambitious targets for reducing the CO_2 emissions of new cars and vans, including a 55% reduction in emissions from cars by 2030, a 50% reduction in emissions from vans by 2030, and no emissions from new cars by 2035. The European Green Deal aims to use one third of the 1.8 trillion-euro investments from the Next Generation EU Recovery Plan from the COVID-19 pandemic, and the EU's seven-year budget to finance it. The deal aims to transition to cleaner, greener, and smarter mobility transport solutions. By increasing connectivity and shifting more passengers and freight to rail and inland waterways, by supporting the roll-out of charging points, alternative refuelling infrastructure, and new digital technologies, by placing a stronger focus on sustainable urban mobility, and by making it easier to choose different transport options in an efficient

multimodal transport system, the proposals will put the transport sector on track to cutting its emissions by 90%.

The National Development Plan (NDP) 2021-2030 (Government of Ireland 2021a) includes the MetroLink as one of the National Strategic Outcomes under the Sustainable Mobility. Sustainable mobility deals with the decarbonisation of transport in order to secure Ireland's climate action goals. The plan states that MetroLink is likely the largest ever public investment project in the history of the State and this Government is committed to its funding and delivery as quickly as possible given its MetroLink's location as the spine of the overall integrated public transport system for Dublin, alongside BusConnects and DART+.

The European Union Commission has recently published technical guidance on climate-proofing of infrastructure projects for the period 2021 to 2027 (European Commissions 2021). This guidance was published in order to improve climate considerations in infrastructure projects by integrating climate change mitigation and adaptation measures into the development of infrastructure projects. The guidance notes that infrastructure projects need to take account of the likely significant changes in the frequency and intensity of extreme weather events which will occur due to climate change. In addition, the guidance on the climate proofing infrastructure of notes that:

"Most projects will have an impact on GHG emissions, compared to the Baseline, through their construction, operation, and eventual decommissioning and through indirect activities that occur because of the project. This should be seen in the context of the project not as an isolated event but as a set of different and complementary interventions – in particular stemming from a plan. This might mean that a certain specific project does not have an individual net GHG reduction effect but is integral part of an overall plan that reduces emissions"

In 2021 the EU published an Adaptation Strategy on Climate Change (European Commission 2021b) entitled "Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change". The Strategy has four objectives: to make adaptation smarter, swifter and more systemic, and to step up international action on adaptation to climate change. It sets a long-term vision of in 2050, the EU will be a climate-resilient society, fully adapted to the unavoidable impacts of climate change. The strategy aims to research knowledge gaps which will further improve adaptation modelling, risk assessment and management tools. The strategy notes that a few sectors in particular are likely to see the biggest investments, one of these sectors is transport. Action 7 under the measures to be developed under the new EU Adaptation Strategy is the Climate-proofing of Infrastructure and Disaster Risk Management.

TII have produced a document entitled Strategy for Adapting to Climate Change on Ireland's Light Rail and National Road Network (TII 2017) and a Luas Severe Weather Management Plan in association with Transdev (TII and Transdev 2015). The documents review the methods that the light rail sector in Ireland can plan, mitigate, and prevent future impacts due to increasingly severe weather events. The Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) was also prepared under the National Adaptation Framework used 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 discusses how future climate change has the potential to impact the transportation network, the risks involved in these impacts (i.e., heat waves causes overheating passengers on buses), the risks associated with the impacts and consequences of such risks.

In 2021 TII published a Sustainability Implementation Plan – "Our Future" (TII 2021a). Within this plan, six key sustainability principles have been developed to reflect TII's organisational ambition to lead in the delivery and operation of sustainable transport. 'Transition to net zero' principles focus on reduction of the carbon impact of construction, operation, and use of the transport network through responsible use of resources, reuse and repurposing, as well as driving the net-zero transition and enabling customers to make more sustainable choices.

The Electricity & Gas Networks Sector Climate Change Adaptation Plan prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and

Environment (DCCAE 2019b) and considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. The plan proposes to avoid or minimise future adverse impacts within the sector and to exploit opportunities. Steps include diversification of energy sources, improved communication between relevant bodies/stakeholders, a requirement for energy network companies to continue to ensure climate change is taken into account in planning and design standards and engineering management practices and identification of vulnerable areas and measures to take with respect to climate impacts.

The National Planning Framework (NPF) (Government of Ireland 2018b) is a guide for future development and investment with a key goal to provide environmentally sustainable public transport. By 2040 the NPF aims that Irish cities and towns will enjoy a cleaner, quieter environment free of combustion engine driven transport systems. Under the NPF, the Government will support:

- Integrating climate considerations into statutory plans and guidelines;
- More energy efficient development;
- The roll-out of renewables and protection and enhancement of carbon pools such as forests, peatlands, and permanent grasslands;
- The development of sustainable supply chains in the bio economy; and
- Grey and green adaptation.

National Investment Framework for Transport in Ireland (NIFTI) (DTTAS 2021) prioritises investment in decarbonisation through the application of its modal and intervention hierarchies. NIFTI has given priority to a number of investment areas to enable future transport investment to help deliver the needs of the NPF. It's investment priorities include mobility of people and goods in urban areas, protection, and renewal, enhanced regional and rural connectivity, and decarbonisation. The decarbonisation priority specifically acknowledges the urgent role the transport sector must play in meeting Ireland's climate change targets.

17.3.2.2 Regional Climate Change Policy

A Dublin Metropolitan Climate Action Regional Office (CARO) was established as one of four regional climate change offices, in response to Action 8 of the 2018 National Adaptation Framework (NAF) (DCCAE 2018). One of its roles is to assist the local authorities within the region in preparing their Climate Change Action Plan. The four local authorities within the Dublin region (DCC, FCC, South Dublin County Council (SDCC) and Dún Laoghaire Rathdown Council (DLRCC)) 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). This combined plan stated aims including aiding 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 both DCC and FCC areas, a more detailed discussion on DCC and FCC's jurisdictions respective CAPs is outlined below.

The DCC 'Climate Change Action Plan' (DCC and Codema 2019) 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 CAP 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 CAP with DCC confirming that they will work with the National Transport Authority (NTA), TII, Dublin Bus, Irish Rail, Bus Éireann, Road Safety Authority (RSA) and private operators to improve the connectivity of public transport systems. The proposed Project will directly connect with DART, Luas and the proposed BusConnects projects. The DCC Climate Change Action Plan noted that transport accounted for 24.8% of Dublin's 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.

FCC has also produced a 'Climate Change Action Plan for 2019–2024' (FCC and Codema 2019) which outlines FCC's goals to mitigate GHG emissions and plans to prepare for and adapt to climate change. Appendix II of the FCC plan states that transport accounted for 44.6% of FCC total GHG emissions in

2016. The FCC Plan states that FCC Climate Change Action Plan aims to reduce car dependency by encouraging modal shifts from car to more sustainable modes, including public transport and cycling. Similar to DCC, FCC states that it wishes to work with the relevant transportation bodies to introduce measures to achieve better integration of transportation and land use planning, modal shifts and promote interchange between modes. A target of a 40% reduction in the FCC region GHG emissions by 2030 has been set by FCC. Part of the mechanism to achieve these goals will be through the improvement of public transport, MetroLink is specifically mentioned as part of this integrated transport strategy (Action T24).

The FCC Climate Change Action Plan highlights the risks that climate change poses to the transportation network with risks mainly associated with extreme weather events and sea level rise. The FCC Climate Change Action Plan notes that sea level rise, extreme weather events (and in particular cold snaps, heat waves and dry spells) and coastal, fluvial, and pluvial flooding have the greatest future risk when both the likelihood and consequence are accounted for. Increases in fluvial and pluvial flooding will cause road damage, which can lead to disruption of transport services.

The Eastern and Midlands Regional Spatial and Economic Strategy 2019 – 2031 (Eastern & Midland Regional Assembly 2019) specifically discusses the MetroLink strategic development corridor which it states will unlock significant long-term capacity for development in a sustainable way. The corridor unlocked by the proposed Project stretches south towards Kiltiernan and Glenamuck due to the MetroLink interconnectivity with the Luas Greenline. The strategy plans to ensure that the Luas Green Line capacity is increased prior to the opening of the proposed Project as the MetroLink is expected to increase demand for the connected service. Regional Policy Objective 4.31: Support Swords-Dublin Airport as a key location for airport related economic development and employment provision linked to the protection and enhancement of access to Dublin Airport lands including the delivery of Metrolink. Regional Policy Objective 5.2 includes MetroLink as part of the sustainable development strategy alongside the DART+ and Luas, BusConnects and the Greater Dublin Metropolitan Cycle Network.

17.3.3 Consultations

Consultation is important in order to ensure that a sufficiently robust environmental baseline is established for the proposed Project and its surroundings, full details of the consultations are detailed in Chapter 8 (Consultation). It helps to identify specific concerns and issues relating to climate early in the process. Public consultation was conducted as part of the early-stage design of the proposed Project.

Consultation helps to identify specific concerns and issues relating to climate early in the assessment process. As part of the assessment EPA and Sustainable Energy Authority Ireland (SEAI) published resources were consulted, as well as other specialists contributing to the EIAR. In addition, consultation with DCC (Meeting held 26/05/2020) and FCC (Meeting held 14/01/2020) was conducted (Chapter 8 (Consultation)).

17.3.4 Appraisal Method for the Assessment of Impacts

The Institute of Environmental Management and Assessment (IEMA) guidance note on "Assessing Greenhouse Gas Emissions and Evaluating their Significance" (IEMA 2022) states that *the crux of significance regarding impact on climate 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*. Mitigation has taken a leading role within the Guidance compared to the previous edition published in 2017. Early engagement is key and therefore mitigation should be considered from the outset of the project and continue throughout the project's lifetime in order to maximise GHG emissions savings. As well as stakeholders, key points of engagement include the design team and client who have a significant role to play in the reduction of GHG emissions. Section 4.6.2 and Section 4.6.3 of Chapter 4 (Description of the MetroLink Project) references details of early engagement which lead to lower GHG emissions.

The assessment aims quantify the difference in GHG emissions between the proposed project and the baseline scenario (the alternative project/solution in place of the proposed project). This is done by calculating the difference in whole life net GHG emissions between the two options. The IEMA EIA

guidance (IEMA 2022) 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 IEMA recommend use of a reasonable worst-case scenario rather than an absolute worst-case scenario. The IEMA Guidance (IEMA 2022) which state that GHG emissions assessment should incorporate the following steps into any climate assessment, these steps have been utilised when developing the methodology for this assessment:

- Set the scope and boundaries of the GHG assessment;
- Develop the baseline;
- Decide upon the emissions calculation methodologies;
- Data collection;
- Calculate/determine the GHG emissions inventory; and
- Consider mitigation opportunities and repeat data collection and calculate/determine the GHG emissions inventory.

Activities that do not significantly change the result of the assessment can be excluded where expected emissions are less than 1% of total emissions, and where all such exclusions should be clearly stated and total a maximum of 5% of total emissions as per IEMA Guidance (IEMA 2022).

When considering the cumulative assessment, all global cumulative GHG sources are relevant to the effect on climate change. As a result, the effects of GHG emissions from specific cumulative projects therefore in general should not be individually assessed. This is due to the fact that there is no basis for selecting any particular (or more than one) cumulative project that has GHG emissions for assessment over any other. The following section details the specific appraisal methods utilised in order to complete the assessment in accordance with the IEMA Guidance (IEMA 2022).

'LA 114 – Climate' (UKHA 2019) 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 17.4 (reproduced from Table 3.11.1 of LA 114 – Climate). A detailed discussion of the input data and appraisal methodology for both the Construction and Operational Phases is detailed in Sections 17.3.4.1.1 and 17.3.4.2.2. While the proposed Project is not a highways project the methodology for assessment of impacts is relevant. The assessment is broken down into stages (construction and operational) and individual assessment techniques for each of these stages which are conducted in the same manner for a highways project, rail project, housing project or commercial development.

The GHG systems boundary for assessment and life cycle stages scoped in are discussed in the sections 17.3.4.1.1 to 17.3.4.2.2. At a high level they include: pre-construction, products utilised in construction, the construction activities, maintenance of materials during the lifespan of the proposed Project and the use or Operational Phase. Given the extent of the Operational Phase, 'LA 114 – Climate' (UKHA 2019) states that decommissioning should be excluded from the boundary of the climate assessment.

17.3.4.1 Construction Phases Appraisal Method

17.3.4.1.1 Embodied Construction Emissions

Section 3.13 of 'LA 114 – Climate' (UKHA 2019) recommends, that when calculating GHG emissions for a project's life cycle, '*an industry recognized carbon calculation tool(s)*' should be used. The embodied construction emissions for the proposed Project were calculated using the TII Carbon Assessment Tool (Version 2.1) (TII 2021b). The TII Carbon Tool (TII 2021b) uses emission factors from recognized sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database (CESSM, 2013). 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 Carbon tool (TII 2021b) has been commissioned by TII to assess GHG emissions associated with infrastructure projects using Ireland-specific emission factors and data. TII are in the process of updating this tool currently to add additional functionality and update emission factors, the updated tool is currently not available at the time of publication of the proposed Project EIAR. TII have provided updated factors to the project team which have been integrated into Version 2.1 of the TII Carbon Assessment Tool where its functionality allows. 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.

The Construction Phase of the proposed Project will result in GHG emissions from various sources, as outlined in . Embodied carbon refers to GHGs emitted during the manufacture, transport, and use of building materials, together with end-of-life emissions. As part of the proposed Project, Construction Phase embodied GHG emissions are categorised under the following headings:

- Land clearance activities;
- Transport of excavated material to and from the site;
- Manufacture of materials and transport to site;
- Construction works (including excavations, tunnelling, construction, water usage, electrical power/fuel usage, personnel travel, and project size); and
- Construction waste products (including transport off-site).

Detailed project information including volumes of materials required for construction and generated during the Construction Phase were obtained from Chapter 24 (Materials & Waste Management). The proposed Project is expected to have a Construction Phase of approximately nine and a quarter year and an operational lifespan of 60 years. The predicted embodied emissions can be averaged over the full Construction Phase and the lifespan of the Proposed project 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) has a ceiling of 6,000Kt CO_2eq in 2030 and compared against the Ireland's non-ETS 2030 target of 33,381.3Kt 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).

The assessment commences with the preliminary design of the proposed Project, through the pre-construction or site clearance period, followed by the assessment of the embodied carbon associated with all materials used in the construction of the proposed Project, the emissions during the Construction Phase and additionally emissions related to waste generated during the Construction Phase. The TII Carbon Tool also assesses on-going maintenance associated with the default 60-year lifetime of the proposed Project. For public infrastructure such as the proposed Project, it is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage.

The TII Carbon Tool V2.1 (TII 2021b) uses emission factors from recognized sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database (CESSM, 2013). An emission factor is a coefficient which allows to convert activity data into GHG emissions. 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.

Standard maintenance, as indicated through the TII Carbon tool (TII 2021b), required over the Operational Phase has also been considered as part of the embodied construction emissions including consideration of the maintenance cycles for embodied carbon for road pavements. Given the extent of the Operational Phase, 'LA 114 – Climate' (UKHA 2019) states that decommissioning should be excluded from the boundary of the climate assessment.

17.3.4.1.2 Land Use Change

The land use change associated with the Construction Phase of the proposed Project has also been quantified using the approach outlined in Table 17.4. Trees are a natural carbon sink and absorb carbon dioxide (CO_2) from the atmosphere helping in the reduction of climate change; any felling of trees has the potential to result in a loss of this carbon sink thus increasing the levels of CO_2 in the atmosphere. In contrast, increased planting of trees on suitable lands will, over time, help to increase the carbon sink potential of the land and benefit climate. The change in land use associated with the proposed Project, including felling and planting of trees and vegetation, has been calculated using the methodology outlined in the Intergovernmental Panel on Climate Change (IPCC) 'Guidelines on National GHG

Inventories – Chapter 4: Forest Land' (IPCC 2006). Consideration is also given to the 2010 European Commissions Guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive EU 2009/28/EC (European Union 2010). Operational land use change is also appropriately assessed.

Chapter 15 (Biodiversity), Chapter 27 (Landscape & Visual) and Chapter 23 (Agronomy) of this EIAR have been consulted with respect to land use changes.

Table 17.4: Sources and Life Cycle Stages for a Project's GHG Emissions (reproduced from Table 3.11.1 of LA 114 – Climate (UKHA 2019))

Main Stage of a Project Life Cycle	Sub-stage of Life Cycle	Potential Sources of GHG Emissions (Not Exhaustive)	Examples of Activity Data
Construction Phase	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.
	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)	Operation and maintenance (including repair, replacement, and refurbishment). This also includes electrical power required for stations and traction of MetroLink.	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 fate.
	Use of infrastructure by the end-use.	Vehicles using highways infrastructure.	Traffic count/speed by vehicle type for highway links.
	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 fate.

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 Project.

17.3.4.1.3 Traffic Related Emissions

The change in GHG emissions due to Construction and Operational Phases traffic impacts of the proposed Project have been assessed using the NTA Environmental Appraisal Module, which is based on the ENEVAL software. ENEVAL was developed by Systra Ltd in 2015 on behalf of the NTA. Emissions from the zonal level ENEVAL tool can provide information on the CO_2 emissions for the different traffic scenarios on a regional basis. The ENEVAL software is recommended by the Codema in the publication 'Developing CO_2 Baselines – A Step-by-Step Guide for your Local Authority' (Codema 2017b).

TII guidance (TII 2011) on regional assessments for climate impacts is based on the methodology provided in Annex 2 in the UK DMRB (UKHA 2007). This methodology has historically been used routinely for the climate impact of schemes which impact road traffic in Ireland. However, the emission factors in the DMRB are based on the COPERT III database with the DMRB last updated in 2007. The database does not take account of the recent advances in engine technology and thus would not be now viewed as appropriate for current use. Therefore, the updated LA 114 – Climate' (UKHA 2019) guidance is more applicable and so is used in this assessment.

Section 3.16 of 'LA 114 – Climate' (UKHA 2019) appraisal guidance recommends that '*an appropriate validated traffic model shall be used to estimate operational road user GHG emissions*. The guidance also outlines the approach for defining the scope of the assessment. 'LA 114 – Climate' states that road links meeting one or more of the following criteria can be defined as being 'affected' by a proposed development and should be included in the assessment:

- A change of more than 10% in Average Annual Daily Traffic (AADT);
- A change of more than 10% to the number of heavy-duty vehicles; and
- A change in daily average speed of more than 20km/hr.

Table 17.4 above outlines the sources and activity classes for the Operational Phase of the proposed Project including operational end-use (road user) and operation and maintenance. Modelling of the Construction Phase traffic movements are also modelled using the same approach.

17.3.4.2 Operational Phase Appraisal Method

The Operational Phase impacts of the proposed Project have two significant sources that have the potential to result in GHG emissions. The most significant potential source of GHG emissions is the operational power requirements for the running of Dardistown Depot, stations, P&R Facility and the traction system. There is also the potential for road traffic related emissions associated with the Operational Phase of the proposed Project including from the P&R Facility users. Standard maintenance required over the Operational Phase has also been considered as part of the Construction Phase embodied construction emissions. In addition, the potential for rolling stock embodied carbon and operational waste has been reviewed within the Operational Phase assessment.

17.3.4.2.1 Road Traffic Related Emissions

Operational Phase traffic emissions have been modelled using ENEVAL (as per 17.3.4.1.3), as described above in relation to the Construction Phase. The 3,000 space P&R Facility has the potential to change emissions by attracting people living to the north of Swords to use a private car to arrive at P&R Facility and finish a journey into the city using the proposed Project. With the exception of the P&R Facility no other stations have car parking facilities and therefore are not predicted to attract significant additional private car journeys.

17.3.4.2.2 Operational Phase Power Requirements

The CO_2 (which is a GHG) generated due to the electricity power demand of the traction system and other MetroLink requirements can be calculated using the carbon intensity of the fuel mix used in the

generation of electricity nationally. Carbon intensity is the amount of CO_2 that will be released per kilowatt hour (kWh) of energy of a given fuel. For most fossil fuels the value of this is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and also on the efficiency of the technology employed. This figure is updated by SEAI annually. The carbon intensity of the fuel mix used to generate electricity in Ireland has dropped by 64% since 1990 driven by an 84% reduction in the use of coal for electrical generation and a 54% increase in renewables used in electricity generation. The 2021 SEAI Energy Emissions Report states that the carbon intensity of electricity was 296gCO_2/kWh in 2020 which was based on 36.5% of the national grid electricity being generated from renewable sources (SEAI 2021). The 2021 CAP has set a national target of up to 80% of electricity demand by renewables by 2030 for the national grid. In a keynote speech for the EPA's Climate Change conference in June 2022 the ESB Chief Executive stated that the projected carbon intensity figure for 2030 is 66gCO_2/kWh (ESB 2022). In addition, the current projections presented see the energy supply reaching 0gCO_2/kWh by 2036. This would significantly further reduce the carbon intensity of the operation of the proposed Project.

The GHG emissions due to the operational power requirements for traction and stations can be compared against the transport sectors carbon budget.

17.3.5 Impact Assessment Criteria

17.3.5.1 Construction and Operational Phase Significance Criteria

'LA 114 – Climate' (UKHA 2019) outlines a recommended approach for determining the significance of 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 (Department of the Taoiseach 2022). With the publication of the Climate Action Act in 2021, sectoral carbon budgets have been published for comparison with the Net CO_2 project GHG emissions from the proposed Project. The transport sector emitted approximately 12Mt CO_2eq in 2018 and has a ceiling of 6,000Kt CO_2eq in 2030 which is a 50% reduction over this period. The comparison of impacts with the relevant budget has been completed in Section 17.5 and 17.7.

When assessing significance, LA 114 Climate 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'.

There are three overarching principles are particularly relevant in considering the aspect of significance in the 2010 IEMA Principles Series on Climate Change Mitigation & EIA (IEMA 2010):

- The GHG emissions from all projects will contribute to climate change, the largest interrelated cumulative environmental effect;
- The consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive (e.g., human health, biodiversity, water, land use, air quality); and
- GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit; as such any GHG emissions or reductions from a project might be considered to be significant. The environmental limit is the national global GHG emission budget that defines a level of dangerous climate change, and any GHG emission that contributes to exceedance of that budget or threatens efforts to stay within it can be considered as significant.

The 2020 Guidance (IEMA 2022) document builds on those principles with three points:

- 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.

The criteria for determining the significance of effects are a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Chapter 3: Environmental Assessment Methodology (UKHA 2019). In relation to climate, there is no project specific assessment criteria, but the proposed Project will be assessed against the recommended IEMA (IEMA 2022) significance determination. This takes account of any embedded or committed mitigation measures that form part of the design should be considered.

- **Major or Moderate Adverse Impact (Significant):** A project that follows a 'business-as-usual' or 'Do Minimum' approach and is not compatible with the net zero[1] 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 nonsignificant 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 Impact (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 that has a minor adverse effect that 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[2] (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 Impact (Not Significant):** A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant.
- **Beneficial Impact (Significant):** 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.

Where the fundamental reason for a proposed project is to combat climate change and this beneficial effect drives the project need, then it is likely to be significant.

IEMA states (IEMA 2022) that GHG emissions are not geographically limited due to the global nature of impacts rather than directly affecting any specific local receptor.

However, as Ireland declared a climate and biodiversity emergency in May 2019 and it is currently failing to meet its EU binding targets under Regulation (European Union 2018) the sensitivity of the environment

[1] *Net Zero: "When anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period." Net zero is achieved where emissions are first educed in line with a 'science-based' trajectory with any residual emissions neutralised through offsets.*

[2] *Carbon Neutral: "When anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period irrespective of the time period or magnitude of offsets required."*

can be considered high. The declaration of the biodiversity emergency results in changes in GHG emissions either beneficial or adverse are of more significance than previously considered prior to these declarations. This ties in with the IEMA Guidance (IEMA 2022) which states that the sensitive receptor for GHG emissions is the global atmosphere. The receptor has a high sensitivity, given the severe consequences of global climate change and the cumulative contributions of all GHG emission sources.

As further context to this approach to significance, it is recognised that there are many activities and sectors which are contributing to net GHG emissions in Ireland. Large industrial and power GHG emissions are captured in the context of the EU-wide ETS which has set defined targets which are being met due to the structure of the Cap-and-Trade mechanism which allows the price of carbon to rise to ensure that GHG emissions are reduced at least cost. Most other activities such as agriculture, transport, built environment, waste and smaller industry, however, are subject to the GHG Regulations which has set a specific target for Ireland of a 30% reduction in GHG emissions by 2030.

17.3.5.2 Significance Criteria – Vulnerability of Proposed Project to Climate Change

'LA 114 – Climate' (UKHA 2019) outlines an approach for undertaking a risk assessment where there is a potentially significant impact on 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 Construction and 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 17.5 and Table 17.6. The guidance advises that for the Construction Phase, a qualitative description of disruption risk be reported. This assessment criteria are used as an example of an appropriate method in the IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA 2020a) and therefore can be considered an industry standard.

Table 17.5: Likelihood Categories

Likelihood Category	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 17.6: Measure of Consequence

Consequence of Impact	Description
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.

Consequence of Impact	Description
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 less than 1 day.

The likelihood and consequence of each impact are then combined in the form of a matrix to identify the significance of each impact, as outlined in Table 17.7. The significance conclusions for each impact should be based on and incorporate confirmed design and mitigation measures. Where the assessment concludes that the project is significant, 'LA 114 – Climate' (UKHA 2019) states that '*the design and mitigation hierarchy should be re-assessed to reduce the significance of impacts to an acceptable level (not significant)*'. This level of risk assessment is considered appropriate for the preliminary design stage, and will be developed further during future design, construction, operation, and maintenance stages.

Table 17.7: Significance Matrix

		Measure of Likelihood				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Measure of Consequence	**Very Large**	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S
	Minor	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

Note: NS = Not significant; S = Significant

17.4 Baseline Conditions

17.4.1 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 2022). 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 (CH_4) and nitrous oxide (N_2O).

For the purposes of this assessment, the definition outlined in Council Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (European Union 2009) for GHGs has been used. In 'Annex V, C. Methodology Point 5' the relevant GHGs are defined as CO_2, CH_4 and N_2O. CO_2 accounted for 60.9% of total GHG emissions in Ireland in 2020 while CH_4 and N_2O combined accounted for 37.7%. The main source of CH_4 and N_2O is from the agriculture (~93%) sector (EPA 2022a).

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 Sixth Assessment Report (AR6) (IPCC 2021) sets out the global warming potential for 100-year time period (GWP100) for CO_2 as the basic unit (GWP = 1) whereas methane gas (CH_4) has a global warming potential equivalent to 27-30 units of CO_2 and N_2O has a GWP100 of 273.

17.4.2 Existing GHG Emissions Baseline

'LA 114 – Climate' (UKHA 2019) states that a baseline climate scenario should identify, consistent with the study area for the project, GHG emissions without the project for both the current and future baseline (Do-Minimum scenarios).

Ireland declared a climate and biodiversity emergency in May 2019 and in November 2019 European Parliament approval of a resolution declaring a climate and environment emergency in Europe, in addition to Ireland's current failure to meet its EU binding targets under Regulation (European Union 2018). This results in changes in GHG emissions either beneficial or adverse are of more significance than previously considered prior to these declarations.

Data published in 2022 (EPA 2022b) predicts that Ireland exceeded (without the use of flexibilities) its 2021 annual limit set under EU's Effort Sharing Decision (ESD) (EU 2018/842) by 2.71million tonnes CO_2 equivalent (Mt CO_2eq) as shown in Table 17.8. The sector with the highest emissions in 2021 is agriculture at 35.3% of the total, followed by transport at 20.3%. GHG emissions from the transport sector reduced to 17.8% in 2020 as a result of COVID-19 lockdowns. Ireland's GHGs increased by 4.7% in 2021 compared to 2020. For 2021 (EPA 2022b), total national emissions were estimated to be 59.8797 Mt CO_2eq as shown in Table 17.8.

Table 17.8: Total National GHG Emissions In 2021 and 2020

Category	2021 Kilotonnes CO_2eq	% of Total GHG emissions
Waste	885	1.5%
Energy Industries	9,445	15.8%
Residential	6,527	10.9%
Manufacturing Combustion	4,589	7.7%
Commercial Services	891	1.5%
Public Services	887	1.5%
Transport	12,187	20.3%
Industrial Processes	2,260	3.8%
F-gases	1,075	1.8%
Agriculture	21,151	35.3%
Total	**59,897**	**100.0%**
Category	**2020 Kilotonnes CO_2eq**	**% of Total GHG emissions**
Waste	906	1.6%
Energy Industries	8,739	15.1%
Residential	7,115	12.3%
Manufacturing Combustion	4,521	7.8%
Commercial Services	938	1.6%
Public Services	896	1.6%
Transport	10,296	17.8%
Industrial Processes	2,111	3.7%
F-gases	784	1.4%
Agriculture	21,411	37.1%
Total	**57,716**	**100%**

In relation to transport GHG emissions (EPA 2022c), the dominant source is road transportation at 95.3% of total transport GHG emissions in 2021 as shown in Table 17.9. Railways made up of 1.1% of transportation emissions in 2021.

Table 17.9: Total Transport GHG Emissions In 2021 and 2020

Category	2021 Kilotonnes CO_2eq	% of Total GHG emissions
Domestic aviation	20	0.1%
Road transportation	10,301	95.3%
Railways	116	1.1%
Domestic navigation	322	2.3%
Other transportation	152	1.2%
Total	**10,912**	**100%**
Category	**2020 Kilotonnes CO_2eq**	**% of Total GHG emissions**
Domestic aviation	14	0.1%
Road transportation	9,693	94.2%
Railways	108	1.1%
Domestic navigation	322	3.1%
Other transportation	148	1.4%
Total	**10,285**	**100%**

In 2020 passenger cars were responsible for 54% of road transport emissions, with Heavy Goods Vehicles responsible for 20%, Light Goods Vehicles for 18% and Buses 7% (EPA 2022). In relation to road transport GHG emissions (2019 data) (EPA 2021a), the dominant source is cars at 57.4% of total road transport GHG emissions with heavy duty trucks and buses accounting for 27.1% of total road transport CO_2 emissions.

The Opening Year (2035) of the proposed Project has total projected GHG emissions for Ireland, with additional measures in place, of 49,7542Kt CO_2eq with transport emissions accounting for 7,818Kt CO_2eq or 16% of total emissions (EPA 2020a). The 2040 total projected GHG emissions for Ireland, with additional measures in place, are 51,071Kt CO_2eq. Transport emissions in 2040 account for 7,059Kt CO_2eq or 14% of the total (EPA 2020a). No data is available post-2040 and thus a comparison with the design year of 2050 is not directly possible.

17.4.3 Climate Baseline and Future

The four geographical sections of the proposed Project will cover an 18.8km linear study area. 'LA 114 – Climate' (UKHA 2019) outlines that the study area for assessing a project's vulnerability to climate change should be based on the construction footprint/project boundary (including compounds and temporary land take). Impacts as a result of climate change involve increases in global temperatures and increases in the number of rainfall days per year. Therefore, it is expected that the baseline climate will evolve over time and consideration is needed with respect to this within the detailed design of the proposed Project as per the European Commission Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (European Commission 2021a) should the proposed Project proceed. Ireland has seen 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 (EPA 2021b). The EPA have compiled a list of potential adverse impacts (EPA 2021b) as a result of climate change including the following which may be of relevance to the proposed Project:

- 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 Dublin Airport, 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 historical regional weather data for Dublin Airport which is representative of the current climate in the region of the proposed Project is shown in Table 17.10. The proposed Project will run through Dublin Airport and therefore it is a highly representative meteorological station. The data for the 30-year period from 1981 to 2010 indicates that the wettest months at Dublin Airport were August and October, and the driest month on average was February. July was the warmest month with a mean temperature of 15.6° Celsius. The data for the 30-year period from 1991 to 2020 is due to be published by Met Éireann and shared with the World Meteorological Organisation in late 2022 however at the time of submission of the EIAR the data was not available (Met Éireann 2022).

Recent weather patterns and records of 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 Dublin Airport occurred during Storm Ophelia, peaked at 104km/hr with a 10-minute speed of 70km/hr.

Rainfall events with more rainfall 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 GDA on 24 October 2011. The rainfall recorded on 24 October 2011 totalled 66.8mm over a nine-hour period at Dublin Airport, which has an annual probability of 100 years.

Future climate predictions developed by Met Éireann have been published in 'Ireland's Climate: the road ahead' (Met Éireann 2013) based on four scenarios (Representative Concentration Pathway (RCP) 2.6, RCP4.5, RCP6.0 and RCP8.5) which is named with reference to a range of radiative forcing values for the year 2100 (i.e. 2.6, 4.5, 6.0 and 8.5W/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.

The EPA sponsored research project 'Ensemble of regional climate model projections for Ireland (Report No. 159)' (EPA 2015b) has projected significant decreases in mean annual, spring and summer precipitation amounts with extended dry periods. 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.

EPA's State of the Irish Environment Report (Chapter 2: Climate Change) (EPA 2020b) notes that projections show that full implementation of additional policies and measures, outlined in the 2019 Climate Action Plan, will result in a reduction in Ireland's total GHG emissions by up to 25% by 2030 compared with 2020 levels. Climate change is not only a future issue in Ireland, as a warming of approximately 0.8°C since 1900 has already occurred. The EPA state that it is critically important for the public sector to show leadership and decarbonise all public transport across bus and rail networks to the lowest carbon alternatives. The report (EPA 2020b) underlines that the next decade needs to be one of major developments and advances in relation to Ireland's response to climate change in order to achieve these targets and that Ireland must accelerate the rate at which it implements GHG emission reductions. The report states that mid-century mean annual temperatures in Ireland are projected to increase by between 1.0°C and 1.6°C (subject to the emissions trajectory). In addition, heat events are

expected to increase by mid-century (EPA 2020b). While individual storms are predicted to have more severe winds, the average wind speed has the potential to decrease (EPA 2020b).

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 2020c). The future climate was simulated under both RCP4.5 (medium-low) and RCP8.5 (high) scenarios. This study indicates that by the middle of this century (2041–2060). Mid-century mean annual temperatures are projected to increase by 1 to 1.2°C and 1.3 to 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 to 2.4°C. There will be a substantial decrease of approximately 50% are 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. Climate change also has the potential to impact future energy supply which will rely on renewables such as wind and hydroelectric. Wind turbines need a specific range of wind speeds to operate within and droughts or low ground water levels may impact hydroelectric energy generating sites. More frequent storms have the potential to damage the communication networks requiring additional investment to create resilience within the network.

Table 17.10: Averaged 30-Year Historical Weather Data for Dublin Airport 1981 to 2010 (source Met Éireann 2022)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (°C)													
Mean Daily Max	8.1	8.3	10.2	12.1	14.8	17.6	19.5	19.2	17.0	13.6	10.3	8.3	13.3
Mean Daily Min	2.4	2.3	3.4	4.6	6.9	9.6	11.7	11.5	9.8	7.3	4.5	2.8	6.4
Mean	5.3	5.3	6.8	8.3	10.9	13.6	15.6	15.3	13.4	10.5	7.4	5.6	9.8
Absolute Max.	16.5	16.2	17.2	20.5	23.5	25.7	27.6	28.7	24.6	21.0	18.0	16.2	28.7
Min. Maximum	-3.1	-0.1	2.4	4.5	6.6	10.4	11.7	11.9	11.2	5.3	-1.8	-4.7	-4.7
Max. Minimum	11.8	11.9	11.9	12.8	13.2	16.2	19.0	18.2	17.3	15.2	12.8	12.9	19.0
Absolute Min.	-9.5	-6.7	-7.9	-4.0	-1.6	2.1	4.6	2.4	1.2	-3.3	-8.4	-12.2	-12.2
Mean Num. of	6.4	6.5	3.8	2.4	0.3	0.0	0.0	0.0	0.0	0.5	3.0	6.4	29.4
Mean Num. of	15.0	14.0	12.0	10.0	3.0	0.0	0.0	0.0	0.0	4.0	10.0	14.0	82.0
Mean 5cm Soil	3.8	3.8	5.4	8.2	12.2	15.2	16.7	15.8	13.1	9.4	6.2	4.5	9.5
Mean 10cm Soil	4.1	4.1	5.5	7.9	11.5	14.6	16.2	15.4	13.0	9.7	6.6	4.8	9.4
Mean 20cm Soil	4.6	4.7	6.1	8.4	11.7	14.8	16.5	16.0	13.7	10.5	7.3	5.3	10.0
Relative Humidity (%)													
Mean at	87.0	86.4	84.0	79.5	76.9	76.7	78.5	81.0	83.4	85.5	88.5	88.0	83.0
Mean at 1500UTC	80.6	75.7	71.0	68.3	68.0	68.3	69.0	69.3	71.5	75.1	80.3	83.1	73.3
Sunshine (hours)													
Mean Daily	1.9	2.7	3.5	5.3	6.2	5.8	5.3	5.1	4.3	3.3	2.4	1.7	3.9
Greatest Daily	8.1	9.8	11.9	13.3	15.4	15.9	15.6	14.2	12.4	10.2	8.8	7.3	15.9
Mean Num. of	9.1	6.2	4.7	2.5	2.0	1.9	1.4	1.5	2.6	4.8	7.3	10.5	54.6
Rainfall (mm)													
Mean Monthly	62.6	48.8	52.7	54.1	59.5	66.7	56.2	73.3	59.5	79.0	72.9	72.7	758.0
Greatest Daily	27.1	28.1	35.8	30.4	42.1	73.9	39.2	72.2	40.6	53.2	62.8	42.4	73.9
Mean Num. of	17	15	17	15	15	14	16	16	15	17	17	17	191
Mean Num. of	12	10	11	10	11	10	10	11	10	11	11	12	129
Mean Num. of	4	3	3	3	3	3	3	4	4	4	4	4	42

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Wind (knots)													
Mean Monthly	12.5	12.0	11.6	9.9	9.2	8.6	8.7	8.7	9.2	10.4	11.0	11.3	10.3
Max. Gust	80	73	66	59	58	53	54	56	59	69	66	76	80
Max. Mean 10-	53	49	45	39	39	38	36	37	36	51	43	55	55
Mean Num. of	2.3	1.5	1.1	0.1	0.1	0.1	0.1	0.1	0.2	0.5	0.8	1.3	8.2
Weather (Mean No. of Days with.)													
Snow or Sleet	4.6	4.2	2.8	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.8	2.9	16.6
Snow Lying at	1.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	3.4
Hail	1.2	1.5	2.0	1.9	1.3	0.1	0.2	0.1	0.1	0.3	0.3	0.7	9.7

17.5 Predicted Impacts

When considering a development of this nature, the potential impact on climate change related emissions on the surroundings must be considered for each of two distinct stages:

- Construction Phase; and
- Operational Phase.

During the Construction Phase the predicted impacts on climate emissions are considered with respect to the embodied carbon used for the construction of the proposed Project. This has been calculated using the TII Carbon tool V2.1 (TII 2021) as outlined above in Section 17.3.4. In addition, to this the emissions due to vehicles associated with construction and the redistribution of other road traffic as an impact of the Construction Phase of the proposed Project have been modelled. For each of the modelling scenarios two different models are assessed:

- Do Minimum (DM) model - This scenario models the traffic data in the relevant future year without the proposed Project; and
- Do Something (DS) model - This scenario models the traffic data in the relevant future year and includes the proposed Project.

For the Construction Phase the worst-case traffic impact scenario has been modelled using ENEVAL across the NTAs whole Eastern Regional Model (ERM) region representing the worst-case traffic impacts, as advised by the proposed Project traffic consultants. Traffic impacts will vary across the Construction Phase and the modelled scenarios are based on a worst-case month with these emissions modelled as if the traffic continued at these levels for an entire year. The resultant impacts are not representative of impacts over the entire construction period and are considered the worst-case potential impacts.

For the Operational Phase two traffic impact scenarios have been considered, these are:

- Scenario A: the Do Committed Minimum scenario includes additional transport schemes that are under construction or committed to be implemented post the base-year of the ERM base (2016). 'Committed' refers to schemes that have planning permission and also have a funding commitment; and
- Scenario B: the Likely Future scenario, presents an enhanced transport network scenario which has been developed to understand how usage of the MetroLink may change if other planned infrastructure schemes are delivered during the appraisal period. A scheme bundle approach has been developed to examine the impacts of the enhanced network, with one bundle representing the schemes within the NDP (2018-2027) (Government of Ireland 2018a) and the other bundle representing the full build out of the infrastructure and initiatives contained within the NTA's Transport Strategy for the Greater Dublin Area (GDA) (2016-2035).

Further details on the proposed Project that have been included within the Scenario A (Do Committed Minimum scenario), and the Scenario B (Likely Future scenario), are contained within the Appendix A9.5 (Scheme Traffic Management Plan) and detailed in Chapter 9 (Traffic & Transport). The Operational Phase traffic impacts, the impact of operational power requirements has been assessed.

In addition, the vulnerability of climate change on the proposed Project is assessed using a risk assessment which considers the resilience and designed in adaptation of the proposed Project to future climate change.

Indirect impacts such as the carbon emissions associated with the power demand to run the rolling stock and operate stations and changes in road traffic users' behaviour associated with the construction or operation of the proposed Project have been included within the assessments for robustness.

17.5.1 'Do Nothing' Scenario

Should the proposed Project not proceed, the GHG emissions described in Section 17.5 would not occur. The Do Nothing (DN) scenario assumes no changes in emissions from the current scenario takes place. Under this scenario, the GHG emissions experienced within the study area will remain largely unchanged. In contrast, the DM is a defined scenario within the traffic modelling exercise in Chapter 9 (Traffic & Transport). A comparison between the DM and DS scenarios is outlined in Section 17.5.2 and 17.5.3.

Thus, the climatic impact would be adverse under this scenario as the proposed Project would not provide a sustainable public transport method that assists in reducing the reliance on private transport or other low-density modes of transport such as taxis. The Do Nothing will not assist the completion of Action 241 of the CAP *"Action of the Commence delivery of MetroLink*" or the pursuit to the transition to a climate resilient, biodiversity rich and climate neutral economy by no later than the end of the year 2050'.

The DN Scenario for the vulnerability of the environment to climate change assumes no changes to the transport infrastructure within the extents of the proposed Project. Under this scenario, the vulnerability of the existing environment to climate change will remain largely unchanged from what it is currently.

17.5.2 Construction Phase

During the Construction Phase of the Proposed project, construction activities which will take place are outlined below and discussed in detail in Chapter 5 (MetroLink Construction Phase):

- Enabling works;
- Main civil works:

- Construction of P&R Facility;
- Earthworks and Roadworks;
- Construction of surface stations;
- Construction of water crossings including the Broadmeadow and Ward River Viaduct;
- Construction of the M50 Viaduct;
- Piling;
- Construction of underground stations;
- Construction of retained Cut Stations;
- Construction of the retained Cut Alignment;
- Construction of cut and cover tunnels;
- Tunnel boring;
- Construction of the Tunnel Portals;
- Construction of the intervention and escape shafts;
- Construction of the intervention and escape tunnels;
- Construction of the High Voltage ESB Grid Connection;
- Construction of HV and Substations;
- Construction of the Overhead Catenary System;
- Track and Railway Systems Installation;
- Track Installation;
- Building Works and Fit Out; and
- Material Management.

- Reinstatement works:

- Topsoil spread and seed;
- Removal of temporary infrastructure;
- Landscape Planting; and
- Removal of temporary fencing / hoarding.

Potential climatic impacts associated with the proposed Project will be associated with the Construction Phase and the Operational Phase. During the Construction Phase, site clearance, piling, tunnel boring, earthworks and station works all have the potential to generate GHG emissions on site.

17.5.2.1 Construction Phase Carbon Calculations

The unmitigated embodied carbon within the construction materials has been calculated. This calculation was based on the updated TII Carbon Tool (V2.1) (TII 2021b) (See, Section 17.3.4), the breakdown of the activities between the different phases of the proposed Project has been assessed. As shown in Table 17.11, the assessment indicates that the key sources of GHG emissions are associated with the embodied carbon of the construction materials and the construction activities (i.e. use of water, provision of facilities to staff, excavated materials, materials), which when combined account for over 52.54% of all carbon emissions. Fuel and electricity usage account for 39.45% of unmitigated emissions. Pre-construction together with construction waste and maintenance account for 8% of all emissions.

As calculated using the TII Carbon Tool (V2.1) the proposed Project will result in total Construction Phase GHG emissions of 1,017Kt CO_2eq over an 9.25-year period equivalent to an annualised total of 0.32% of Ireland's non-ETS 2030 target. Over the predicted 60-year lifespan the annualised emissions due to the initial Construction Phase and ongoing maintenance of the proposed Project will reach at most 0.044% of Ireland's non-ETS 2030 emissions target. The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the proposed Project as a whole, over its lifecycle rather than individual elements. Mitigation will be required in order to minimise the contribution of the embodied carbon from the construction of the proposed Project and therefore the overall significance rating.

Table 17.11: Unmitigated Construction & Maintenance Stage GHG Emissions

Activity	Kt CO_2eq / Total	% Of Total
Pre-Construction	0.05	0.004%
Embodied Carbon	479.3	47.15%
Construction Activities	54.8	5.39%
Construction Waste	55.7	5.48%
Construction Fuel/Power	401.0	39.45%
Maintenance	25.7	2.5%
All	1,017	100%

17.5.2.2 Construction Phase Traffic Emissions

In addition to direct impacts from the construction works including site compounds, there is also the potential for GHG impacts from the redistribution of traffic and construction related traffic along public roads.

A detailed analysis of construction traffic volumes has been conducted to determine the expected Heavy Goods Vehicles (HGV) movements required to transport the materials extracted and delivered to site, details of the movements can be found in Chapter 9 (Traffic & Transport). Particular roads have been identified as required haul routes where construction traffic will be permitted to travel along. Whilst the overall construction period is forecast as nine and a quarter year, construction traffic movements will vary across this period.

The potential changes in GHG emissions due to the Construction Phase traffic impacts shown in Table 17.12 of the proposed Project have been assessed using the NTA Environmental Appraisal Module, which is based on the ENEVAL software, see Section 17.3.4. The worst-case Construction Phase scenario has been modelled. The ENEVAL output for the modelled construction traffic impacts is assumed to stay at these peak rates for a full year, with emissions provided in tonnes per year.

As shown in Table 17.12, a comparison between the Do Something and Do Minimum GHG emissions in the worst-case construction year indicates that there is an overall increase of 14.37 kilo tonnes annually in CO_2eq due to the Construction Phase of Proposed project. This is equivalent to a 0.364% increase in CO_2eq relative to the construction Do Minimum estimates. However, it should be caveated that these figures are conservative as they consider the worst-case Construction Phase to be extended over a full year. To put these figures in context, the carbon budget for the transport sector in 2030, two years after the worst-case construction peak, is 6,000Kt CO_2eq. The increase due to the proposed Project equates to 0.2% of the overall 2030 transport sector carbon budget (Department of the Taoiseach 2022).

The majority of these increases result from a construction traffic (goods) due to construction activities.

Table 17.12: Construction Phase GHG emissions – Worst-Case Construction Peak (ENEVAL Output)

	Vehicle Class	Kt CO_2eq
DM	Car	1,861
DS		1,863
Change		1.20
% Change		0.064%
DM	Urban Bus	33
DS		33
Change		0.03
% Change		0.084%
DM	Goods	2,051
DS		2,065
Change		13.15
% Change		0.641%
DM	**Total**	3,946
DS		3,960
Change		14.37
% Change		0.364%

17.5.2.3 Impact of Climate Change on the Proposed Project Construction Phase

A risk assessment has been conducted for potentially significant impacts on the proposed Project associated with climate change during the Construction Phase. 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 17.3.5.2. The 'LA 114 – Climate' (UKHA 2019) guidance advises that for the Construction Phase, a qualitative description of disruption risk be reported. The assessment in Chapter 28 (Risk of Major Accidents & Disasters), which takes into account the risk arising from climate change due to severe meteorological events found potential for risks during the Construction Phase to be low when identified mitigation measures are applied.

Potential impacts are considered in accordance with the criteria set out in Section 17.3.5.2 (Table 17.5) in combination with the measure of consequences (Table 17.6) in order to assess the significance conclusion.

Examples of potential climate impacts during operation are included in Table 3.35N of LA 114 (UK HA 2019) and 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 of the proposed Project Construction Phase include:

- Flood Risk due to increased precipitation, and intense periods of rainfall. This includes coastal (i.e., sea level rise), 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.

Each of these potential risks are considered with respect to the Operational Phase of the proposed Project in Sections 17.5.2.3.1 to 17.5.2.3.5. A summary of the risk assessments conducted, in line with LA 114 (UK HA 2019), are provided in Table 17.13. In accordance with LA 114 (UK HA 2019) and as shown in Table 17.7, events that require the closure of the proposed Project for a day or less at a time are considered not significant even if they occur annually.

Table 17.13: Summary of Assessment of Consequence during the Construction Phase

Risk	Likelihood Category (As per Table 17.5)	Consequence of Impact (as per Table 17.6)	Measure of Consequence (as per Table 17.7)
Flood Risk	Very Low	Negligible	Not Significant
Increased Temperature	Low	Negligible	Not Significant
Snow/Ice	Low	Negligible	Not Significant
Geotechnical	Very Low	Negligible	Not Significant
Storms	Low	Negligible	Not Significant

17.5.2.3.1 Flood Risk

There is the potential for flood risk during surface construction, tunnelling, dewatering, filtration, and river works, the likelihood of risk has the potential to be increased as a consequence of climate change. During the preliminary design stage, a comprehensive Flood Risk Assessment (FRA) has been carried out, full details of the FRA can be found in the MetroLink Flood Risk Assessment Report (Appendix A18.5). The FRA considers three types of flood risk:

- Coastal flooding is caused by higher sea levels than normal;
- Fluvial flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise when the river flow following heavy rain exceeds the capacity of the river channel and can be exacerbated where a channel is blocked or constrained; and
- Pluvial flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the ground to absorb it. This excess water flows overland, ponding in hollows, low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system. This type of flooding is driven by short, intense rainstorms.

The assessment found that parts of the proposed Project will be located in Flood Zone A (as detailed in the FRA) which is classified as having a probability of flooding from rivers and the sea, greater than 1 in 100 for river flooding and 1 in 200 for coastal flooding. Given the length of the construction period the risk of these events occurring is less than during the Operational Phase, however, there still is a potential for them to occur. A Water Management Plan, Sediment Erosion and Pollution Control Plan, Groundwater Monitoring Plan and Construction Flood Protection Plan will be developed by the appointed contractor. Further measures to reduce the Construction Phase risk are included in the Outline Construction Environmental Management Plan (CEMP) (Appendix A5.1) and Appendix A5.11 (Water Management).

With the above resilience measures in place the probability and frequency likelihood to surface construction, tunnelling, dewatering, filtration, and river works from flooding are considered in accordance with the criteria set out in Section 17.3.5.2 to be very low (the event can occur during the lifetime of the project) (Table 17.5). As this is Construction Phase risk rather than Operational Phase risk there will not yet be any regional reliance on the infrastructure as the proposed Project is not yet operational, which is the main consideration in the measure of consequences. Therefore, for the proposed Project the measure of consequences (Table 17.6) can be classed as negligible. The significance conclusion (Table 17.7) indicates that the potential impact is not significant.

17.5.2.3.2 Increased Temperatures

The EPA has stated that published five-year (2015–2019) and ten-year (2010–2019) average temperatures are both the warmest on record (EPA 2021b). Since the 1980s, each successive decade has been warmer than any preceding decade since 1850 (EPA 2021b). These increased temperatures have the potential to cause the temperature in the tunnels to rise and work compounds to be impacted, which may impact workers conditions. 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 between 1°C to 3°C under RCP4.5, it is considered that the impact of increased temperatures on construction materials will not be significant. The standards followed in the design account for both a minimum and maximum temperature but also a variation in temperature around a median. The temperatures vary depending on each building material. Consultation with the Engineering Design team confirmed that the design of the proposed Project accounts for potential future increases in temperature due to climate change. The Contractor will pay due consideration to the impacts of extreme weather events during the Construction Phase. The contractors will utilise available meteorological forecast data from Met Eireann or other approved provider of meteorological data to inform short- to medium-term program management, environmental control, and impact mitigation measures.

In addition to drought, warmer summers may increase the susceptibility of suitable areas to an increased risk of wildfires during the construction period. Risk due to climate change related wildfires are also increased due to other climate change related risks such as high winds and dry conditions may spread fire into proposed Project. However, due to the predominantly urban or agricultural nature of the proposed Project material to burn for a wildfire are not available and therefore the risk of a significant one occurring is low.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to have the potential to be low i.e., the event occurs during the lifetime of the project (Table 17.5). The event in this circumstance would be that work is impacted for an extended period due to extremely warm temperatures. However, given Irelands temperate climate it is unlikely that any temperature that impacts work programs would last for last for more than a few days and construction can be altered to accommodate the hot weather during these periods. As this is Construction Phase risk rather than Operational Phase risk there will not yet be any regional reliance on the infrastructure, which is the main consideration in the measure of consequences. Therefore, for the proposed Project the measure of consequences (Table 17.6) can be classed as negligible. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level.

17.5.2.3.3 Ice or Snow

Construction works have the potential to be impacted by extreme cold weather events such as ice or snow. The section of the proposed Project which is in tunnel will be protected from cold weather event such as ice/snow however the events may impact delivery timelines due to impassable roads for an extended period of time. All Contractors will pay due consideration to the impacts of extreme weather events during the Construction Phase. The Contractors will utilise available meteorological forecast data from Met Eireann or other approved provider of meteorological data to inform short- to medium-term program management, environmental control, and impact mitigation measures.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to have the potential to be low i.e., approximately once every 60 years (Table 17.5). The event in this circumstance would be that work is impacted for an extended period due to extremely cold temperatures which may prevent deliveries, concrete pours that cannot be conducted at freezing temperatures, workers attendance or workers health and safety. However, given Irelands temperate climate it is unlikely that any temperature that impacts work programs would last for last for more than a few days and construction can be altered to accommodate the ice, snow, or very cold weather during these periods. As this is Construction Phase risk rather than Operational Phase risk there will not yet be any regional reliance on the infrastructure, which is the main consideration in the measure of consequences. Therefore, for the proposed Project the measure of consequences (Table 17.6) can be classed as negligible. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level.

17.5.2.3.4 Geotechnical Impacts

There is a potential impact of increased shrinkage of soil due to decrease in groundwater level resulting in settlement. A detailed analysis of the potential ground settlement has been drafted as part of the Preliminary Design and mitigation measures are proposed where necessary in order to ensure that the potential fluctuations in groundwater stability have been accounted for within the proposed Project design. More details can be found in the Chapter 28 (Risk of Major Accidents & Disasters), Chapter 20 (Soils & Geology) and Appendix A22.1 (Summary of Utilities Settlement Analysis Study) where settlement is covered. This has the potential to impact during the construction and Operational Phases.

Given the inclusion for the potential of soil shrinkage that would impact the construction of the proposed Project within the design the probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to be very low i.e. the event occurs can occur during the lifetime of the project (Table 17.5). As this is Construction Phase risk rather than Operational Phase risk there will not yet be any regional reliance on the infrastructure, which is the main consideration in the measure of consequences. Therefore, for the proposed Project the measure of consequences (Table 17.6) can be classed as negligible. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level.

17.5.2.3.5 Major Storm Damage

The EPA (EPA 2021b) have compiled a list of potential adverse impacts as a result of climate change which includes more intense storms. The review of recent weather patterns shows an increase in the frequency and severity of storms with notable events. The maximum wind gust for Dublin Airport occurred during Storm Ophelia, peaked at 104km/hr with a 10-minute speed of 70km/hr. There is the potential that a storm may occur during the Construction Phase which would impact works.

The Contractor will pay due consideration to the impacts of extreme weather events during the Construction Phase. In addition to impacts on the works areas the ESB power supply has the potential to be impacted leading to shutdown of the service. The contractors will utilise available meteorological forecast data from Met Eireann or other approved provider of meteorological data to inform short to medium-term program management, environmental control, site safety and impact mitigation measures. Further measures to reduce the Construction Phase risk are included in the Outline CEMP (Appendix A5.1).

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to have the potential to be low i.e., the event occurs during the lifetime of the project (Table 17.5). The event in this circumstance would be that work is impacted due to a major storm event and construction can be altered to accommodate high winds or potential storms. As this is Construction Phase risk rather than Operational Phase risk there will not yet be any regional reliance on the infrastructure, which is the main consideration in the measure of consequences. Therefore, the proposed Project the measure of consequences (Table 17.6) can be classed as negligible. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level.

17.5.2.4 Land Use Change

The proposed Project will necessitate the removal of approximately 76.15ha during construction with approximately 26.72ha permanently removed from 'agricultural' use during the operation phase as detailed in Chapter 23 (Agronomy) (Section 23.6.1). This land take is from agricultural land and will be required to facilitate the alignment of the proposed Project, construction sites and construction compounds. The Guidelines for the calculation of land carbon stocks (European Union 2010) state that the carbon sequestration value for agricultural land or crop land is zero tonnes of carbon per ha. This value is also used in the TII Carbon Assessment Tool (Version 2.1) (TII 2021b) for land principally occupied by agriculture.

As the carbon sequestration value for agricultural land is zero, this land take is not considered to impact carbon sequestration and has a negligible impact.

17.5.2.5 Biodiversity Loss Due to Climate Change During the Construction Phase

Climate change has the potential to impact biodiversity, therefore the potential for biodiversity loss associated with the proposed Project exacerbation by future climate change that may occur during the Construction Phase should be considered.

Consultation with the project ecologist responsible for Chapter 15 (Biodiversity) has been conducted to ensure consideration can be given to any impacts on biodiversity due to the proposed Project which may be exacerbated due to climate change impacts. This consultation did not raise any additional requirement for assessment.

17.5.2.6 Summary of Construction Phase Predicted Impacts

The sum of the total Construction Phase transport related emissions and embodied carbon, including future maintenance, is 1,149Kt CO_2eq.

Over the predicted 60-year lifespan the annualised emissions due to the initial Construction Phase and ongoing maintenance of the proposed Project will reach at most 0.049% of Ireland's non-ETS 2030 emissions target or 0.27% of the 2030 transport sector carbon budget. It should be noted there is some double counting in these figures as the ENEVAL regional traffic model accounts for some of the construction transport. ENEVAL will account for any deliveries within the modelled area but also the impact on other road transport redistribution and speeds. However, ENEVAL will not capture emissions from deliveries outside the modelled area. Transport related emissions are also accounted for within the embodied carbon assessment using the TII Tool. This tool can account for transport emissions outside of the region covered by ENEVAL but will not account for the redistribution and speed changes of other traffic due to construction vehicles. Rather than miss a proportion and potentially underestimate the emissions, a decision was made to double count them. In addition, the ENEVAL model assumes the worst-case construction period with respect to traffic movements for the full 9.25-year period, which again is conservative as these conditions are likely to last an estimated six months.

This is a major infrastructure tunnelling project and the large embodied capital carbon estimate is indicative of this. While the capital carbon is significant, the proposed Projects ability to transport people during its' Operational Phase will also be significant.

Table 17.14: Unmitigated Summary of Construction & Maintenance Phase

Activity	Kt CO_2eq / Total	% Of Total
Pre-Construction	0.05	0.004%
Embodied Carbon	479.3	41.7%
Construction Activities	54.8	4.8%
Construction Waste	55.7	4.8%
Construction Fuel	401.0	34.9%

Activity	Kt CO_2eq / Total	% Of Total
Maintenance	25.7	2.2%
ENEVAL Regional Traffic Note 1	132.9	11.6%
All	1,149	100%

Note 1: Modelled Traffic Assumed to Worst Case throughout the 9.25-Year Construction Period

In summary, the significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual elements. Mitigation will be required in order to minimise the contribution of the embodied carbon due to construction materials and offset Construction Phase traffic. This mitigation has the potential to reduce any adverse impact of the proposed Project.

17.5.3 Operational Phase

17.5.3.1 Operational Phase Embodied Carbon

The proposed Project is expected to have an operational lifespan of 60 years. The predicted GHG emissions from the maintenance of the materials which were used during construction can be averaged over the full lifespan of the proposed Project to give the predicted annual emissions to allow for direct comparison with annual emissions and targets. These emissions are referred to as maintenance phase emissions and they have been included in the Construction Phase embodied carbon calculations as they relate to construction materials.

Maintenance phase emissions have been compared against the Ireland's non-ETS 2030 target of 33,381.3Kt 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). In addition, emissions have been compared against the transport sector carbon budget (Department of the Taoiseach 2022) has a ceiling of 6,000Kt CO_2eq in 2030.

The TII Carbon Tool (TII 2021b) assesses on-going maintenance associated with the default 60-year lifetime of the proposed Project. For major transport infrastructure projects, it is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage.

The proposed Project is estimated to result in total maintenance during the Operational Phase GHG emissions of 25.7Kt CO_2eq over the predicted 60-year lifespan as shown in Table 17.11. This figure is associated with the replacement of materials associated with the construction of the proposed Project that do not have a lifespan as long as the proposed Projects lifespan. This includes road or pavement surfaces. The annualised emissions due to the ongoing maintenance of the proposed Project will reach 0.001% of Ireland's non-ETS 2030 emissions target or 0.006% of the 2030 transport sector carbon budget. The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual elements. Mitigation will be required in order to minimise the contribution of the embodied carbon from the ongoing maintenance of the proposed Project and therefore the overall significance rating.

17.5.3.2 Operational Traffic Scenario A

The potential changes in GHG emissions due to the Operational Phase Scenario A (see Section 17.5) traffic impacts of the proposed Project have been assessed using the NTA Environmental Appraisal Module, which is based on the ENEVAL software, details of which can be found in the section on Appraisal Method for the Assessment of Impacts, see Section 17.3.4.

As shown in Table 17.15, a comparison between the Do Something (scenario A) and Do Minimum GHG emissions in the Opening Year of 2035 indicates that there is an overall decrease of 12.8Kt CO_2eq due to the proposed Project. This is equivalent to a 0.298% reduction in CO_2eq relative to the Opening Year Do Minimum estimates. To put these figures in context, the carbon budget (Department of the Taoiseach

2022) for the transport sector in 2030 is 6,000Kt CO_2eq. The reduction due to the proposed Project equates to a reduction of 0.2% of the overall transport sector carbon budget.

There is no set budget for 2035 currently however given the required reduction in emissions of 3.5% per annum after 2030 the budget for 2035 is likely to be even lower.

Table 17.15: Operational Phase GHG Emissions – Scenario A Opening Year 2035

	Vehicle Class	Kt CO_2eq
DM	Car	2,230
DS		2,219
Change		-10.44
% Change		-0.468%
DM	Bus	36
DS		36
Change		-0.08
% Change		-0.225%
DM	Goods	2,053
DS		2,050
Change		-2.36
% Change		-0.115%
DM	**Total**	**4,318**
DS		**4,305**
Change		**-12.88**
% Change		**-0.298%**

As shown in Table 17.16, a comparison between the Do Something (Scenario A) and Do Minimum GHG emissions in the proposed Project year of 2050 indicates that there is an overall decrease of 13.83 Kilotonnes in CO_{2eq}. This is equivalent to a 0.77% reduction in CO_{2eq} relative to the 2050 Do Minimum estimates. For context, approximately 4,400Kt CO_2 equivalent are projected to be emitted in Ireland by the Transport sector in 2040 (2050 projection unavailable, EPA 2021a). By 2050 it is assumed that the car fleet is fully electric, so the majority of these emissions relate to changes in goods vehicles. Both the Do Minimum and Do Something benefit from predicted increases in electric car usage and further electrification of the bus fleet. Light and heavy goods vehicles are estimated to contribute the majority of CO_2 emissions in 2050, reflecting the technical challenges in converting particularly the heavy goods fleet to electric vehicles.

Table 17.16: Operational Phase GHG Emissions – Scenario A Design Year 2050

	Vehicle Class	Kt CO_2eq
DM	Car	-
DS		-
Change		-
% Change		0%
DM	Bus	37
DS		36
Change		-0.13
% Change		-0.344%

	Vehicle Class	Kt CO_2eq
DM	Goods	1,764
DS		1,751
Change		-13.70
% Change		-0.777%
DM	**Total**	**1,801**
DS		**1,787**
Change		**-13.83**
% Change		**-0.768%**

The predicted impact to climate during the Operational Phase for Scenario A of the proposed Project, prior to mitigation, is long-term, positive, and significant.

17.5.3.3 Operational Traffic Scenario B

As shown in Table 17.17, comparison between the Do Something (Scenario B) and Do Minimum GHG emissions in the Opening Year of 2035 indicates that there is an overall decrease of 12.1Kt CO_2 equivalent due to the proposed Project. This is equivalent to a 0.281% reduction in CO_2eq relative to the Opening Year Do Minimum estimates. To put these figures in context, the carbon budget (Department of the Taoiseach 2022) for the transport sector in 2030 is 6,000Kt CO_2eq. The reduction due to the proposed Project equates to 0.2% of the overall transport sector carbon budget. The reduction due to the proposed Project equates to 0.2% of the overall transport sector carbon budget.

There is no set budget for 2035 currently however given the required reduction in emissions of 3.5% per annum after 2030 the budget for 2035 is likely to be even lower.

Table 17.17: Operational Phase GHG Emissions – Scenario B Opening Year 2035

	Vehicle Class	Kt CO_2eq
DM	Car	2,219
DS		2,208
Change		-11.11
% Change		-0.501%
DM	Bus	33
DS		33
Change		-0.07
% Change		-0.199%
DM	Goods	2,063
DS		2,062
Change		-0.94
% Change		-0.046%
DM	**Total**	**4,315**
DS		**4,303**
Change		**-12.12**
% Change		**-0.281%**

As shown in Table 17.18, a comparison between the Do Something (Scenario B) and Do Minimum GHG emissions in the proposed Project year of 2050 indicates that there is an overall decrease of 2.17Kt CO_2eq. This is equivalent to a 0.281% reduction in CO_2eq relative to the 2050 Do Minimum estimates. For context, approximately 4,400Kt CO_2 equivalent are projected to be emitted in Ireland by the Transport

sector in 2040 (2050 projection unavailable, EPA 2021a). By 2050 all cars are considered to be fully electric, alongside the majority of buses.

Table 17.18: Operational Phase GHG Emissions – Scenario B Design Year 2050

	Vehicle Class	$KtCO_2eq$
DM	Car	-
DS		-
Change		-
% Change		0%
DM	Bus	33
DS		33
Change		-0.14
% Change		-0.439%
DM	Goods	1,761
DS		1,759
Change		-2.03
% Change		-0.115%
DM	**Total**	**1,794**
DS		**1,792**
Change		**-2.17**
% Change		**-0.121%**

The predicted impact to climate during the Operational Phase for Scenario B of the proposed Project, prior to mitigation, is long-term, positive, and significant.

17.5.3.4 Operational Phase Power Requirements

The key features of the power supply system and efficiency measures are described in Chapter 4 (Description of the MetroLink Project). The power supply system will be required to provide power to operate the rolling stock and all elements of infrastructure that form part of the proposed MetroLink Project system such as station lighting, ventilation and back of house services. Metrolink's Total Final Energy Consumption (TFC) is estimated to be 94.6GWh in the Opening Year and increase to 116GWh by 2050, as shown in Table 17.19. This is an approximately 22% increase in power demand from the Opening Year to 2050, however as the power demand from MetroLink increases the carbon intensity of the grid will decrease as a higher proportion of renewables replace fossil fuels. It is expected that the decrease in carbon intensity will offset any increase in the proposed Projects power demand. By 2050 the aim is that the national grid will be net carbon zero in line with the 2021 Climate Action and Low Carbon Development (Amendment) Act.

The GHG emissions due to the TFC in the Opening Year can be compared against the transport sectors carbon budget (Department of the Taoiseach 2022). The CO_2 generated from the generation of electricity from the national grid has been calculated using the carbon intensity of the fuel. The 2020 carbon intensity figure carbon intensity of electricity from the National Grid of $296gCO_2/kWh$ as published the SEAI Energy in Ireland Report (SEAI 2021b). Projecting this to the Opening Year, the ESB Chief Executive stated in his presentation at the EPA's Climate Change conference in June 2022 that the projected carbon intensity figure for 2030 is $66gCO_2/kWh$ (ESB 2022). The current projections presented see the energy supply reaching $0gCO_2/kWh$ by 2036.

As part of the assessment a comparison of the emissions per km travelled and per passenger km travelled have been completed.

To put the emissions into perspective, the figure for a km travelled for a single occupancy private passenger car has also been provided based on the average emissions of the new car fleet. Older cars will have considerably higher emissions. From 2020, EU Regulation 333/2014 sets a target of 95gCO_2/km for the average emissions of the new car fleet. In addition, from 2025 the average emissions from new car fleet are required to reduce by 15% relative to 2021 levels and, by 2030, the average emissions from new car fleet are required to reduce by 37.5% relative to 2021 levels as outlined in Regulation (EU) 2019/631. The average consumption of a new electric car in 2021 within the EU was 122.3gCO_2/km (EEA, 2021).

In the Opening Year it is predicted that emissions from the TFC will be 28.0Kt CO_2 annually or 0.3466% of the total predicted 2030 Emission Ceiling for Transport Sector, based on the 2020 carbon intensity (Table 17.20). Should the carbon intensity be projected forward the ESBs projected 2030 carbon intensity, the estimated emissions have the potential to reduce to an estimated 6.24Kt CO_2 annually 0.104% of the 2030 Emission Ceiling for Transport Sector.

As shown in Table 17.20 if the Opening Year power requirements are considered on a per passenger km basis the results indicates a value 0.00016879gCO_2 per passenger km based on the 2020 carbon intensity, which is significantly lower than the EU Regulation 333/2014 or the average electric car emission rate in 2021 (EEA 2021) of 36.2gCO_2 per km based on the 2020 carbon intensity and single occupancy. Using the 2030 projected carbon intensity power requirements on a per passenger km basis reduce to 0.000038gCO_2 per passenger km. These can be compared to the average electric car emission rate in 2021 of 8.07gCO_2 per km based on single occupancy.

The current projections presented see the energy supply reaching 0gCO_2/kWh by 2036, therefore the emissions associated with operational power by 2050 are projected to be 0Kt CO_2.

Table 17.19: Operational Phase Power Requirements

Year	Total Energy Consumption (GWh)
2030	94.6
2035	101.7
2040	107.1
2045	112.4
2050	116

Table 17.20: Operational Phase Power Requirements GHG Emissions Opening Year

Activity	Power Requirements (MWh)	
Stations	94,600	
Traction	9,500	
Activity	**Tonnes CO_2 from Power Demand Based on 2020 Renewables Carbon Intensity**	**Tonnes CO_2 from Power Demand Based on Projected 2030 Carbon Intensity**
Total	28,002	6,244
gCO_2 Per km travelled	9,043	2,016
gCO_2 Per Passenger (Opening Year 2035)	524	117
gCO_2 Per Passenger km (Opening Year 2035)	0.000169	0.000038
Comparison (Single Occupancy)		
Electric Car Emissions (ESB 2030 Projected Carbon Intensity) (EEA 2021)	8	g CO_2/KM

Activity	Power Requirements (MWh)	
Fossil Fuel Car Regulations post 2020 (EU) 2019/631	95	g CO_2/KM
Targets		**Total Traction and Station Emissions as % Based on ESBs 66 gCO2/kWh Target for 2030**
EU ESD Targets 2030 (Kt CO_2eq)	33,381	0.019%
2021 Total CO2 emissions (Kt CO_2)	37,502	0.017%
2021 Transport CO2 emissions (Kt CO_2)	10,791	0.058%
2030 Emission Ceiling for Transport Sector (Kt CO_2eq)	6,000	0.104%

17.5.3.5 Rolling Stock Embodied Carbon

The rolling stock for the operation of the proposed Project will also have an embodied carbon associated with its manufacture. Once the rolling stock is finalised an Environmental Product Declaration (EPD) will be prepared for the exact specification. An EPD is a document that details the environmental and sustainable attributes of a product. As this is currently not available for the proposed Project as the rolling stock has not been finalised, an EPD for rolling stock that is utilised on a similar Metro project has been sourced to give a likely estimate of the embodied carbon of the rolling stock. The Sydney Metro Northwest project EPD was developed by Alstom (Alstom 2019). Sydney Metro Northwest is 36km in length, has eight new stations and five upgraded stations. The main components of the rolling stock are metallic materials and electronic and electrical equipment which allow a high recyclability (95.2%) potential. A total of 236,160kg of materials are used for the manufacturing of the rolling stock. In addition, 161,659kg of materials are required to produce the spare parts used for the maintenance.

The CO_2e emissions are declared per passenger km and broken down into three main categories:

- Upstream;
- Core; and
- Downstream.

The downstream emissions per passenger km have been included are part of the Operational Phase assessment i.e., the operational power. Upstream emissions include the extraction and production of raw materials, production of auxiliary materials, transportation from tier 1 suppliers. While core emissions include vehicle assembly: energy consumption, vehicle assembly: water consumption, vehicle assembly: waste generation, vehicle assembly: other auxiliaries (welding), rolling stock delivery.

The Sydney Metro Northwest EPD for rolling stock had upstream and core emissions of 0.3447gCO_2e per passenger km. With future improvements in technology, energy efficiency and sustainable practices the proposed Project aims to future reduce the rolling stock embodied carbon.

17.5.3.6 Operational Waste

Operational impacts associated with material and waste management at stations has not been assessed as part of Chapter 24 (Materials and Waste Management), as they were considered not to be significant (by quantity) in the context of the proposed Project.

17.5.3.7 Impact of Climate Change on the Proposed Project 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 (Section 17.4.3). Adaptation during the design phase of the proposed Project aims to ensure potential climate change impacts will not significantly impact the Operational Phase of the proposed Project.

A risk assessment has been conducted for potentially significant impacts on the proposed Project 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 17.3.5.2. LA 114 (UK HA 2019) Guidance states that once a risk is classed as not significant in accordance with Table 17.7 the risk is at an acceptable level.

Examples of potential climate impacts during operation are included in Table 3.35N of LA 114 (UK HA 2019) and 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 of the proposed Project Operational Phase include:

- Flood Risk due to increased precipitation, and intense periods of rainfall. This includes coastal (i.e., sea level rise), 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.

Each of these potential risks are considered with respect to the Operational Phase of the proposed Project in Sections 17.5.3.7.1 to 17.5.3.7.5. A summary of the risk assessments conducted, in line with LA 114 (UK HA 2019), are provided in Table 17.21. In accordance with LA 114 (UK HA 2019) and as shown in Table 17.7, events that require the closure of the proposed Project for a day or less at a time are considered not significant even if they occur annually.

Table 17.21: Summary of Assessment of Consequence during the Operational Phase

Risk	Likelihood Category (As per Table 17.5)	Consequence of Impact (as per Table 17.6)	Measure of Consequence (as per Table 17.7)
Flood Risk	Very low	Moderately adverse	Not Significant
Increased Temperature	Low	Moderately adverse	Not Significant
Snow/Ice	Low	Moderately adverse	Not Significant
Geotechnical	Very low	Moderately adverse	Not Significant
Storms	Low	Moderately adverse	Not Significant

17.5.3.7.1 Flood Risk

Flooding of the track, cuttings and within tunnels is a potentially significant risk that could affect the proposed Project. South the proposed of Northwood Station, the proposed Project is entirely in tunnel meaning there is no direct risk of flooding to the line. The accesses to all the stations along this section route are all at surface level. During the preliminary design stage, a comprehensive flood risk assessment (FRA) (Appendix A18.5) has been carried out, full details of the FRA can be found in the MetroLink Flood Risk Assessment Report and an overview of the three types of flood risk (coastal, fluvial, and pluvial) are described in Section 17.5.2.

The assessment found that parts of the proposed Project will be located in Flood Zone A (as detailed in the Appendix A18.5) which is classified as having a probability of flooding from rivers and the sea, greater than 1 in 100 for river flooding and 1 in 200 for coastal flooding. The proposed Project surface channel drainage for the track is designed to convey 1 in 100 years plus climate change design storm. The size of the channel is oversized by 20% is to allow for potential uncertainty in the runoff calculations and to mitigate the impact of an over-design event on the track drainage. The Viaducts are also designed for a 1000-year flood event + 20% climate change design flow conditions.

Surface water runoff rates for the design storm for each track catchment were calculated in Section 3.5 of The MetroLink Swords to Charlemont Flood Risk Assessment Report (See Appendix A18.5 of the EIAR).

The design storm is taken as the 1 in 100-year storm plus 20% for climate change although the track drainage design was checked for the 1 in 1000 year plus climate change storm. Sustainable Drainage Measures including attenuation storage for each catchment was sized to contain the 1 in 100-year storm plus 20% for climate change plus 300mm freeboard allowance.

The FRA (Appendix A18.5) found that Tara Station has a risk of coastal flooding due to the river Liffey during the 1 in 1000-year flood event. Therefore, there is a risk that climate change has the potential to significantly increase the risk of flooding to Tara Station. The High-End Future Scenario for climate change predicts a 1.0m increase in coastal flood levels by 2100, which would equate to a 1 in 1000-year flood level of approximately 4.40mOD. The FRA also notes that it is likely the 1 in 1000-year flood level from the river channel overestimates the potential depth of flooding at Tara Street Station for both the current situation and with future climate change, as this will not include hydraulic losses when the Liffey overtops its banks. Tara Station will be designed, including the provision of demountable defences for the 0.1% AEP flood with, to be resilient to the High-End Future Scenario (HEFS) scenario for climate change.

The proposed Project is designed to ensure the pluvial flood (+ climate change) risk is reduced to 1 in 100 years with the risk of flooding from river/sea being lower at 1 in 1000 years. The frequency can be considered that an event can occur during the lifetime of the project (60 years) however it should be noted a 1 in 100 years flood may occur in successive years and then not repeated for 200 years. With the design resilience measures in place, as set out in the FRA, the probability and frequency likelihood to track, cuttings and tunnels from flooding are considered in accordance with the criteria set out in Section 17.3.5.2 to be very low (Table 17.5). Given the importance of the proposed Project the measure of consequences (Table 17.6) can be classed as moderate adverse as an Operational Phase impact would cause disruption on a regional level to a strategic route. Flooding would have the potential to cause damage which would result in a shutdown on a temporary basis which may last up to a week if repairs are required. The significance conclusion (Table 17.7) indicates that the impact is not significant due to designed in protections and therefore the significance of impacts is at an acceptable level in accordance with LA 114 (UK HA 2019) Guidance.

17.5.3.7.2 Increased Temperatures

EPA published in 'Research 339: High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (EPA 2020c). The future climate was simulated under both RCP4.5 (medium-low) and RCP8.5 (high) scenarios. This study indicates that by the middle of this century (2041–2060). Mid-century mean annual temperatures are projected to increase by 1°C to 1.2°C and 1.3°C to 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°C to 2.4°C. There will be a substantial decrease of approximately 50% are 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.

These increased temperatures have the potential to cause the temperature of materials, such as asphalt / bitumen, to increase. However, based on an increase in temperature of between 1°C to 3°C under RCP4.5, it is considered that the impact of increased temperatures on construction materials will not be significant. Increased temperatures also have the potential to cause the temperature in both stations and the tunnels to rise and overheat trains. However, during operation, the Heating, Ventilation and Air Conditioning (HVAC) system will ensure comfort and fresh air for passengers and staff and prevent over-heating of sensitive equipment. The standards followed in the design account for both a minimum and maximum temperature but also a variation in temperature around a median. The temperatures vary depending on each building material. Consultation with the Engineering Design team confirmed that the design of the proposed Project accounts for potential future increases in temperature due to climate change. MetroLink equipment will comply with the requirements of I.S. EN 1991-1-5 + NA General actions - Thermal actions, IEC 60146, among others ensuring the are within the operating temperature range.

In addition to drought, warmer summers may increase the susceptibility of the area to an increased risk of wildfires during the operational period. Risk due to climate change related wildfires are also increased due to other climate change related risks such as high winds and dry conditions may spread fire into

proposed Project. Chapter 28 (Risk of Major Accidents & Disasters) has put in place measures to be integrated into the design and operation that will ensure that the impact of any risk from wildfires due to climate change (or other reasons) are brought down to a suitably low level of risk. Table 28.10 list these under Risk Event O2. The proposed Project route is predominantly urban/sub-urban with some greenfield areas along the north of the alignment which does not provide ideal conditions for a wildfire.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to have the potential to be high i.e., the event occurs several times during the lifetime of the project (Table 17.5). This is an unmitigated scenario, however due to the design space left to facilitate design updates and additional ventilation, which will account for climate change scenarios, these events can be mitigated to reduce the probability and frequency likelihood to low (approximately once in the proposed Projects lifespan). Given the importance of the proposed Project the measure of consequences (Table 17.6) 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 (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA 114 (UK HA 2019) Guidance.

17.5.3.7.3 Ice or Snow

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 of -20°C to +40°C 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. The mechanical tension in the contact and messenger wires will be maintained within the system design parameters. The standards followed in the design account for both a minimum temperature and snow/ice loading within the design. Consultation with the Engineering Design team confirmed that the design of the proposed Project accounts for potential future changes in loading due to climate change.

The section of the proposed Project which is in partly within a tunnel will be protected from cold weather event such as ice/snow. Given the design consideration for future climate conditions and ability to strategically plan and mitigate for forecast cold weather events, that would impact the running of the proposed Project, the probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to be low i.e. the event occurs once during the lifetime of the project (Table 17.5). Given the importance of the proposed Project the measure of consequences (Table 17.6) can be classed as moderate adverse as an Operational Phase impact would cause disruption on regional level disruption to strategic route for potentially up to a week. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA 114 (UK HA 2019) Guidance.

17.5.3.7.4 Geotechnical Impacts

There is a potential impact of increased shrinkage of soil due to decrease in groundwater level resulting in settlement. A detailed analysis of the potential ground settlement has been drafted as part of the Preliminary Design and mitigation measures are proposed where necessary in order to ensure that the potential fluctuations in groundwater stability have been accounted for within the proposed Project design. More details can be found in the Chapter 28 (Risk of Major Accidents & Disasters), Chapter 20 (Soils & Geology) and Appendix A22.1 (Summary of Utilities Settlement Analysis Study) where settlement is covered.

Given the inclusion for the potential of soil shrinkage that would impact the running of the proposed Project within the design the probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to be very low i.e. the event occurs can occur during the lifetime of the project (Table 17.5). Given the importance of the proposed Project the measure of consequences (Table 17.6) can be classed as moderate adverse as an Operational Phase impact would cause disruption on regional level disruption to strategic route for potentially up to a week. The significance conclusion

(Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA 114 (UK HA 2019) Guidance.

17.5.3.7.5 Major Storm Damage

In Chapter 28 (Risk of Major Accidents & Disasters) an assessment of the risk potential of meteorological events was undertaken with unmitigated risk ranging from low to high. The highest risk was found to be due to storm damage during the Operational Phase to the proposed Project. In addition, major storms have the potential to lead to failure of ESB power supply leading to shutdown of the service or to cause serious damage to the infrastructure causing significant disruption to transport services. In addition, detailed design will consider the potential for more severe storm events to ensure impacts are minimised. The Electricity & Gas Networks Sector Climate Change Adaptation Plan Prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and Environment (DCCAE 2019b) which considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. In addition, there is a Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) which was also prepared under the National Adaptation Framework to account for future climate change. These adaptation plans will ensure that the future electrical supply will have added resilience by considering the observed and projected impacts of climate variables for Ireland and prioritising the elements of the transport sector most at risk for impact for adaption and mitigation. The electrical supply will be direct to the proposed Project will be by way of an underground cable which will be resistant to storm damage. The provision of two substations is being provided to ensure that if there is an outage on one of the feeds, the other would be a back up to ensure a reliable electrical supply.

To ensure no damage from falling trees during storms or gusts of winds regular upkeep works are included for the Operational Phase as discussed in Section 6.8 of Chapter 6 (MetroLink Operations & Maintenance). This works will the maintenance of planting and trees that has the potential to impact the operation of the proposed Project.

With a severe weather management plan in place alongside designed in mitigation the potential of a major storm that would significantly impact the running of the proposed Project is considered. Impacts could be direct or indirect by the electric grid being shut down. With mitigation in place, the probability and frequency likelihood are considered in accordance with the criteria set out in Section 17.3.5.2 to be low i.e. the event occurs during the lifetime of the project (60 years) (Table 17.5). The measure of consequences (Table 17.6) once risk is mitigated by the severe weather and major incident management plans (which will be contractual obligation to be prepared by the future MetroLink Operator) is considered to be moderate adverse. This is due to a potential shut down of the MetroLink for up to a week. The significance conclusion (Table 17.7) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with LA 114 (UK HA 2019) Guidance.

17.5.3.8 Biodiversity Loss Due to Climate Change During the Operational Phase

Climate change has the potential to impact biodiversity, therefore the potential for biodiversity loss associated with the proposed Project exacerbation by future climate change should be considered.

Consultation with the project ecologist responsible for Chapter 15 (Biodiversity) has been conducted to ensure consideration can be given to any impacts on biodiversity due to the proposed Project which may be exacerbated due to climate change impacts. This consultation did not raise any additional requirement for assessment.

17.5.3.9 Land Use Change

Chapter 23 (Agronomy) and Chapter 21 (Land Take) calculates that the proposed Project will necessitate the permanent removal of 27.716ha of agricultural land from production from the total 308ha of total land take. The majority of the non-agricultural land take will be suburban/urban in nature. The permanent agricultural land take from agricultural land will be required to facilitate the alignment, Estuary Station, P&R, Dardistown Depot, tunnel portal, station box locations and access roads. The Guidelines for the calculation of land carbon stocks (European Commissions 2010) which state that the carbon

sequestration value for agricultural land or crop land is zero. This value is also used in the TII Carbon Assessment Tool (Version 2.1) (TII 2021b) for land principally occupied by agriculture. All other permanent land take relates to sites which do not offer significant current carbon sequestration.

As the carbon sequestration value for agricultural land is zero, this land take is not considered to impact carbon sequestration and has a negligible impact.

17.5.3.10 Summary of Unmitigated Operational Phase Predicted Impacts

The sum of the total Opening Year Operational Phase transport related emissions, operational power demands and land use change is -6.64Kt CO_2eq for Scenario A and -5.88Kt CO_2eq for Scenario B.

Combined Construction and Operational Phase emissions have been compared against the Ireland's non-ETS 2030 target of 33,381.3Kt 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) and the 6,000Kt CO_2eq 2030 transport carbon budget. Over the predicted 60-year lifespan the annualised emissions due to the ongoing operation of the proposed Project will reduce CO_2eq emissions between 0.11% and 0.10% of the 2030 transport carbon budget. The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual elements. Mitigation is required in order to minimise the contribution of the operational power to run the proposed Project and therefore the overall significance rating.

Table 17.22: Summary of Predicted Operational Phase Impacts Prior to Implementation of Mitigation and Monitoring Measures

Activity	Kt CO_2eq / Total	% Of Irelands EU Non ETS Targets 2030 (Kt CO2eq)	As % of 2030 Transport Carbon Budget
Scenario A			
Vehicle Emissions (Scenario A Opening Year (2035))	-12.88	-0.04%	-0.21%
Operational Power (Projected 2030 Carbon Intensity)	6.24	0.02%	0.10%
Total	-6.64	-0.02%	-0.11%
Scenario B			
Vehicle Emissions (Scenario B Opening Year (2035))	-12.12	-0.04%	-0.20%
Operational Power (Projected 2030 Carbon Intensity)	6.24	0.02%	0.10%
Total	-5.88	-0.02%	-0.10%

17.5.3.11 Summary of Unmitigated Construction and Operational Phase Predicted Impacts

The sum of the conservatively calculated and non-mitigated total Opening Year Operational Phase and annualised Construction Phase emissions is 9.96Kt CO_2eq for Scenario A and 10.72Kt CO_2eq for Scenario B. Over the predicted 60-year lifespan the annualised emissions due to the proposed Project will reach at most 0.03% of Ireland's non-ETS 2030 emissions target or 0.18% of the 2030 transport carbon budget. This is a major infrastructure tunnelling project, and the large, embodied carbon is indicative of this. While the capital carbon is significant, the proposed Projects ability to transport people will be significant in the Operational Phase.

Table 17.23: Summary of Predicted Combined Construction and Operational Phase Impacts Prior to Implementation of Mitigation and Monitoring Measures – Opening Year

Activity	Kt CO_2eq / Total	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of 2030 Transport Carbon Budget
Scenario A			
Operational Vehicle Emissions – Based on Scenario A in the Opening Year (2035)	-12.88	-0.04%	-0.21%
Operational Power (Projected 2030 Carbon Intensity)	6.24	0.02%	0.10%
Construction Phase Emissions (including maintenance) Annual	16.60	0.05%	0.28%
Total	**9.96**	**0.03%**	**0.17%**
Scenario B			
Operational Vehicle Emissions – Based on Scenario B in the Opening Year (2035)	-12.12	-0.04%	-0.20%
Operational Power (Projected 2030 Carbon Intensity)	6.24	0.02%	0.10%
Construction Phase Emissions (including maintenance) Annual	16.60	0.05%	0.28%
Total	**10.72**	**0.03%**	**0.18%**

As per IEMA Guidance (IEMA 2022) mitigation is to be required in order to minimise the contribution of the embodied carbon from the construction of the proposed Project and therefore the overall significance rating.

17.6 Mitigation Measures

The proposed Project sets out mitigation measures with respect to the Construction and Operational Phases in order to reduce its impact on climate related GHG emissions by implementing low-carbon energy options. The IEMA GHG Management Hierarchy (IEMA 2020b) has been followed for impact minimisation. The Hierarchy is as follows:

- First Eliminate:

- Influence business decisions/use to prevent GHG emissions across the lifecycle;
- Potential exists when organisations change, expand, rationalise, or move business;
- Transition to new business model, alternative operation, or new product/service;

- Then Reduce:

- Real and relative (per unit) reductions in carbon and energy;
- Efficiency in operations, processes, fleet, and energy management;
- Optimise approaches (e.g., technology) and digital as enablers;

- If you can't eliminate or reduce, then Substitute:

- Adopt renewables/low-carbon technologies (on site, transport etc);
- Reduce carbon (GHG) intensity of energy use and of energy purchased;

- Purchase inputs and services with lower embodied/embedded emissions;

- The final option is to Compensate:

- Compensate 'unavoidable' residual emissions (removals, offsets etc);
- Investigate land management, value chain, asset sharing, carbon credits;
- Support climate action and developing markets (beyond carbon neutral).

The hierarchy states where possible the aim is to design out and eliminate potential impacts completely. Where this is not possible impacts should be reduced/substituted to reduce impacts. Finally, if impacts cannot be eliminated by design or reduced/substituted then the IEMA GHG Management Hierarchy final mitigation measure that should be considered is compensation, this includes the use of carbon offsets.

IEMA Guidance (IEMA 2022) states that the crux of significance regarding impact on climate 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 proposed Project's sustainability aims align with the project being net zero by 2050 and the mitigation measures below will be implemented in order to ensure that this aim is met.

Chapter 4 (Description of the MetroLink Project) Section 4.6.3.1 of the EIAR details some of the sustainable design elements in relation to Climate Change Mitigation and Adaptation which have already been integrated into the proposed Project. Section 4.6.3.2 details the sustainability of the project with respect to Materials and Resources. These include elements such as designing underground stations includes for a natural light glass roof box where possible, which maximises light ingress into the station below, thereby reducing energy requirements during the Operational Phase.

In addition to the IEMA GHG Management Hierarchy, the detailed design, build and operation of proposed Project will ensure it is aligned to PAS 2080 Carbon management in Infrastructure standard. PAS 2080 is a specification for managing whole life carbon in infrastructure. PAS 2080 was developed with the British Standards Institution by Mott MacDonald and Arup under the aegis of the Green Construction Board.

17.6.1 Construction Phase

Construction traffic and embodied energy of construction materials are expected to be the dominant source of GHG emissions as a result of the Construction Phase of the proposed Project. Construction vehicles, generators etc., may give rise to some CO_2 and N_2O emissions, the assessment of which are included in the embodied carbon assessment in Section 17.5.2.1 via the construction traffic assessment and embodied carbon assessment (fuel requirements).

Monitoring and reporting of the embodied carbon in the Construction Phase will be conducted. The aim of the monitoring will be to seek further ways to minimise climate impacts. Monitoring will include contractual obligations, in line with the most recent Climate Action Plan and sectoral targets, for the successful tenderer to ensure the proposed Project stays in line with updated aims. Commitments to monitor GHG emissions during Construction Phase will also be secured through the outline CEMP (Appendix A5.1). Monitoring will include; embodied carbon of construction materials, water usage, power and fuel usage and waste generation (including reuse and recycling rates). In addition, the aim to produce 10% of electricity on-site through renewable sources will be monitored. Where monitoring shows the proposed Project is not meeting its targets further mitigation will be put in place.

Monitoring will also include the ongoing management of adaptation and mitigation in order to measure their effectiveness. If monitoring of adaptation measures and mitigation measures indicates the measures are not effectively minimising embodied carbon or climate is impacting on the construction of the proposed Project, then they should be reviewed and updated.

17.6.1.1 Traffic Mitigation Measures

Construction vehicles, generators etc., will give rise to some GHG emissions, however the proposed Project's impact on climate due to traffic (Section 17.5.2) can be minimised through mitigation measures. The following mitigation measures will be put in place to minimise emissions:

- Implement a policy which prevents idling of vehicles both on and off-site including HGV holding sites;
- Construction Phase traffic should be monitored to ensure construction vehicles are using the designated haul routes;
- All plant and machinery will be maintained and serviced regularly;
- Efficient scheduling of deliveries will be undertaken to minimise emissions; and
- Construction vehicles should conform to the latest EU emissions standards and where reasonably practicable, their emissions should meet upcoming standards prior to the legal requirement date for the new standard. This will ensure emissions on haul routes are minimised.

In addition, as part of the proposed Project a scheme traffic management plan will be put in place for the construction and Operational Phases, see Scheme Traffic Management Plan (STMP) which is included in Appendix A9.5. The Construction Traffic Management Plan (CTMP) will be put in place for the Construction Phase following consultation with local authorities. Regional roads, primary roads and sections of the M50 Motorway will be used at every opportunity in order to reduce traffic impacts on local roads with reduced capacity which may result in traffic congestion and associated increased emissions. In addition, the CTMP will minimise construction impacts on pedestrians, cyclists and on the operation of bus services which will ensure public transport remains a priority.

A Mobility Management Plan (MMP) will also be put in place for the Construction Phase. This plan will support and promote sustainable travel for construction staff travelling to and from the proposed Project site. This will be achieved by setting out a strategy to eliminate barriers to sustainable travel modes, improving travel choices and significantly reducing single occupancy car trips. Parking will not be available at construction sites for workers. The MMP would be an active document that will require to be updated on a regular basis as construction activities take place and will present a series of measures designed to encourage travel to the constructions site(s) in a sustainable way.

17.6.1.2 Embodied Carbon Mitigation Measures

Elements that will mitigate construction carbon include:

- Implement a whole-life Carbon Management Plan aligned to PAS 2080 (Green Construction Board 2016) to inform the detailed design, build and operation of MetroLink;
- Deliver a reduction in capital and embodied carbon against baseline produced in this chapter during detailed design;
- Integrate and maintain measures to manage construction and operational surface water and stormwater runoff;
- Undertake updated Climate Change Risk Assessments for all assets and implement measures to mitigate identified impacts during detailed design and prior to the commencement of operation;
- Implement a Waste Management Plan for Construction and Demolition Waste to facilitate a maximum of 5% construction and demolition waste (non-hazardous) and 5% of operational waste (by weight / volume) disposed in landfill. Waste sent to landfill has a significantly higher embodied carbon compared to incinerated waste or recycled waste. Waste generated during the Construction Phase will be carefully managed according to the accepted waste hierarchy set out in the Waste Framework Directive (2008/98/EC), which gives precedence to prevention, minimisation, reuse, and recycling over disposal with energy recovery and finally disposal to landfill. A notification under Article 27 of the European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011), as amended (Waste Directive Regulations (2011)) (referred to as Article 27) has been made to the Environmental Protection Agency on behalf of TII to classify much of the inert material to be generated by the proposed Project as a by-product and not a waste. This will allow the material to be re-used. Article 27 is discussed further in Chapter 24 (Materials & Waste

Management). It is predicted that an overall recovery rate of 95% can be achieved for construction and demolition (C&D) wastes (excluding soils and stones);
- Undertake lifecycle assessments for major asset components and implement recommendations to influence procurement of low carbon / sustainable materials and equipment;
- Procure materials for major asset components that have verified Environmental Product Declarations (EPD).
- Specify the use of low carbon materials with a minimum of 20% secondary and recycled content e.g., concrete or steel. The replacement, where technically feasible, of concrete containing ordinary Portland cement with concrete containing ground granulated blast furnace slag (GGBFS). The replacement, where feasible, of concrete with concrete containing up to 50% GGBFS. The majority of concrete is assumed to be RC 32/40Mpa which has an embodied carbon of 211 kgCO2e per m3 with 50% GGBFS replacement compared to a standard embodied carbon of 359kgCO2e per m^3, a 41% reduction;
- Achieve a reduction in mains water use during construction through the use of rainwater harvesting, water re-use and efficiency systems and devices at all work sites, stations, and buildings;
- Materials will be reused as much as possible within the extent of the sites, in addition, materials will be sourced locally where possible to reduce the embodied carbon emissions associated with transport;
- Requiring operations to achieve high recycling rates with an aspiration to achieve zero waste directly to landfill. This will also include audits prior to any demolition/excavation to review for material that can be reused on site;
- Rainwater and pumped water from excavations will be collected and reused on site. This will account for at least 25% of the water required during the Construction Phase;
- The diversion of waste materials from landfill / incineration to re-use onsite or offsite or recycling of material; and
- Where generators are expected to be the only option for power supply at satellite compounds, the use of portable solar panels with battery packs, and (potentially) wind generators will be considered as alternatives to diesel power.

17.6.1.3 Climate Change Vulnerability Mitigation

The proposed Projects vulnerability to the impact of climate change has been considered for the Construction Phase. The majority of mitigation measures with respect to the proposed Project's vulnerability to climate change are set out through management plans or assessments by other experts within the EIAR. Risk to the project due to climate change vulnerability and the potential mitigation measures are also set out in Chapter 29 (Interactions between the Various Environmental Aspects). Mitigation measures such as those to manage flood risk and extreme weather events are incorporated in the Outline CEMP (Appendix A5.1), these mitigation measures include:

- The Contractor will pay due consideration to the impacts of extreme weather events during the Construction Phase. The contractors will utilise available meteorological forecast data from Met Eireann or other approved provider of meteorological data to inform short to medium-term program management, environmental control, and impact mitigation measures. A Severe Weather Management Plan (this prepared by the contractor having regard to the CEMP and the water management plan) will be considered in order to ensure mechanisms are in place should this impact arise. The documents should contain plans and mitigation to prevent future impacts due to increasingly severe weather events. Further measures to reduce the Construction Phase risk are included in the Outline CEMP (Appendix A5.1);
- The Electricity & Gas Networks Sector Climate Change Adaptation Plan Prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and Environment (DCCAE 2019b) which considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. Resilience built in the energy sector will assist with ensuring the availability of a stable electrical supply for the MetroLink;
- A Water Management Plan, Sediment Erosion and Pollution Control Plan, Groundwater Monitoring Plan and Construction Flood Protection Plan will be developed by the appointed contractor.

Further measures to reduce the Construction Phase risk are included in the outline CEMP (Appendix A5.1) and Appendix A5.11 (Water Management); and

- Excavations will be waterproofed by using watertight retaining walls (diaphragm walls) to prevent water inflow into the station and the risk of settlement. In addition, flood protection barriers around sites with deep excavation such as underground stations and portals will be put in place. Use robust systems such as attenuation barriers around shaft and tunnel entrance. Construction Flood Protection will form part of the Outline CEMP. Impacts from flooding and potential mitigation measures are further detailed in Chapter 18 (Hydrology) (Section 18.6.1: Mitigation Measures) and Chapter 28 (Risk of Major Accidents & Disasters).

17.6.2 Operational Phase

17.6.2.1 Maintenance Phase Embodied Carbon Mitigation

The maintenance phase GHG emissions will primarily consist of replacement of bitumen, cables, fence posts and lighting columns containing material as these materials have a lifespan that is shorter than the 60-year lifespan assessed for the Operational Phase. In addition, there are also other consumables that require replacement for the MetroLink rail stock parts such as steel tyres, windows, seats, bogie parts. These materials will be sourced based on the IEMA GHG Management Hierarchy principles (IEMA 2020b) and old parts will be reused or recycled, in as far as practicable reducing the amount of waste which will be disposed of to landfill.

17.6.2.2 Operation of the Proposed Project

Elements that will mitigate operational carbon include:

- Implement a whole-life Carbon Management Plan aligned to PAS 2080 (Green Construction Board 2016) to inform the design, build and operation of MetroLink utilising TII's Carbon Assessment Tool;
- Achieve Net Zero for operational energy by the design year of with a stretch aspiration to be close (>80%) to Net Zero at start of operation through energy efficiency, innovation, green power purchases and offsetting residual emissions;
- Maintain measures to support Metrolink's resilience for a 1 in 1000-year flood event +40% for climate change. Impacts from flooding and potential mitigation measures are further detailed in Chapter 19 (Hydrogeology);
- Regular maintenance to ensure drainage systems are not blocked by debris during heavy storms, this will ensure any allowances made for climate change related increases in the intensity of rainfall events and will be maintained;
- Achieve a reduction in mains water use during operation through the use of rainwater harvesting, water re-use and efficiency systems and devices at all work sites, stations, and buildings. Wastewater from the vehicle washing plant will be treated and recycled in-situ to reduce water usage; and
- Requiring operations to achieve high recycling rates with an aspiration to achieve zero waste directly to landfill.

Within the proposed Project there is the ambition to achieve net zero carbon for operational energy by the Design Year of 2050. Prior to this TII is exploring the purchase of up to 80% of its operational demand from certified low or zero carbon electricity for operations and, additionally, to research the feasibility of offsetting any residual emissions. A Corporate Power Purchase Agreement (CPPA) is a financial contract with a renewable generator that will allow for a guaranteed source of renewable power for the operation of the Proposed Project in future. In addition, up to 10% of the power requirement will come from on-site generation of power (Solar PV) as shown in Table 17.24. Should there be a period where the on-site generation is not operating to full capacity, the shortfall to ensure 10% is met can be made through Green Tariffs etc. The remaining 10% of power will be required to be sourced from the National Grid.

In the Opening Year it is predicted that mitigated emissions from the operational power demand (see Table 17.25 and Table 17.26) will be 2,812Kt CO_2 annually or 0.047% of the 2030 emission ceiling for transport sector, based on the 2020 carbon intensity. Should the carbon intensity be projected forward to the Opening Year of 2035 (ESB 2022), the estimated emissions have the potential to reduce to 627Kt CO_2 annually or 0.01% of the 2030 emission ceiling for transport sector. This is a saving of an estimated 25,190Kt CO_2 annually based on 2020 carbon intensities or 5,617Kt CO_2 based on projected carbon intensities from the Operational Phase power demands from traction and stations, see Table 17.25.

Table 17.24: Operational Phase Power Requirements

Year	Total Energy Consumption (GWh)	Corporate Power Purchase Agreements (GWh)	On-Site Generation (GWh)	Other (i.e., National Grid) (GWh)
2030	94.6	76.6	9.5	9.5
2035	101.7	81.3	10.2	10.2
2040	107.1	85.7	10.7	10.7
2045	112.4	90.0	11.2	11.2
2050	116.0	92.8	11.6	11.6

Table 17.25: Avoided Emissions due to CPPA

Scenario	MWh	Tonnes CO_2/year at 2020 Carbon Intensity	Tonnes CO_2/year at Projected 2030 Carbon Intensity
Metrolink's Total Final Energy Consumption ('TFC')	94,600	28,002	6,244
TFC from non CPPA or on-site Generation	9,500	2,812	627
Avoided due to CPPA and on-site Generation	85,100	25,190	5,617

Table 17.26: Mitigated Operational Phase Power Requirements GHG Emissions Opening Year

Activity	**Power Requirements (MWh)**			
Total Final Energy Consumption ('TFC') (Opening Year)	94,600			
TFC from non-CPPA or on-site generation	9,500			
Activity	**Tonnes CO2 from Power Demand Based on 2020 Carbon Intensity**	**Tonnes CO2 from Power Demand Based on Projected 2030 Carbon Intensity**		
Emissions related to TFC from non-CPPA or on-site generation	2,812	627		
gCO_2 Per km travelled	908	202		
gCO_2 Per Passenger (Opening Year)	53	12		
gCO_2 Per Passenger km (Opening Year)	0.0000170	0.0000038		
Comparison (Single Occupancy)				
Electric Car Emissions (ESB 2030 Projected Carbon Intensity) (EEA 2021)	8.07	g CO2/KM		
Fossil Fuel Car Regulations post 2020 (EU) 2019/631	113.0	g CO2/KM		
Targets			**Total Power Emissions as % Based on 2020 Carbon Intensity**	**Total Traction and Station Emissions as % Based on ESBs 66 CO_2/kWh Target**
EU Non ETS Target 2030 (Kt CO_2eq)	33,381		0.008%	0.002%
2021 Total CO_2 emissions (Kt CO_2)	37,502		0.008%	0.002%
2021 Transport CO_2 emissions (Kt CO_2)	10,791		0.023%	0.006%
2030 Emission Ceiling for Transport sector (Kt CO_2eq)	6,000		0.031%	0.01%

In relation to decarbonising the transport sector, Ireland 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 CAP 2021 (DCCAE 2021) states that the uptake in electric vehicles needs to be increased to achieve the 2030 target. To facilitate this the electric vehicle charging network is to be developed further as well as other incentives to encourage the purchase of electric vehicles such as car scrappage schemes.

The CAP 2021 (Government of Ireland 2021) intends to raise the blend of biofuels in road transport to 10% (E10) in petrol and 20% (B20) in diesel. This measure and others that reduce the impact of the private car fleet will reduce the impact of any demand created by the P&R Facility that creates additional journeys during the Operational Phase.

Mitigation measures can also be applied to the power operational demand as metro systems offer an immediate opportunity for reducing energy requirements. This will be achieved on the proposed Project by the recycling of braking energy. When vehicles brake, their kinetic energy is converted into electricity and returned to the traction power line. The installation of reverse substations on the proposed Project system will offer the opportunity to reuse a portion of braking energy. Based on the inclusion of two reverse substations (at Dardistown and Charlemont) it is estimated that the system could potentially regenerate 0.119MW. This recovery equates to 0.6% of the energy needed to run the stations (19.58MW).

Monitoring and reporting of the operational carbon will be conducted. The aim of the monitoring will be to seek further ways to minimise climate impacts. Monitoring will include contractual obligations, which are in line with the most recent Climate Action Plan and sectoral targets, for the successful tenderer to ensure the proposed Project stays in line with updated aims.

Monitoring will also include the ongoing management of mitigation measures in order to measure effectiveness. If monitoring of mitigation measures indicates the measures are not effectively minimising embodied carbon during the operation of the proposed Project, then they should be reviewed and updated.

17.6.2.3 Climate Change Vulnerability Mitigation

The proposed Projects vulnerability to the impact of climate change has been considered for the Operational Phase. The majority of mitigation measures with respect to the proposed Projects vulnerability to climate change are set out through management plans, designing out potential issues. Risk to the project due to climate change vulnerability and the potential mitigation measures are also set out in Chapter 29 (Interactions between the Various Environmental Aspects). Operational Phase climate vulnerability should be reassessed on an annual basis in order to respond to new scientific data on potential climate change impacts.

Examples of the designed in measures that mitigates the proposed Projects vulnerability to climate change are:

- The proposed Project is designed to ensure the pluvial flood (+ climate change) risk is reduced to 1 in 100 years with the risk of flooding from river/sea being lower at 1 in 1000 years;
- The proposed Project surface channel drainage for the track is designed to convey 1 in 100 years plus climate change design storm;
- The size of the channel is oversized by 20% is to allow for potential uncertainty in the runoff calculations and to mitigate the impact of an over-design event on the track drainage. The Viaducts are also designed for a 1000-year flood event + 20% climate change design flow conditions;
- Surface water runoff rates for the design storm for each track catchment were calculated in Section 3.5 of the MetroLink FRA Report (Appendix A18.5). The design storm is taken as the 1 in 100-year storm plus 20% for climate change although the track drainage design was checked for the 1 in 1000 year plus climate change storm. Sustainable Drainage Measures including attenuation storage for each catchment was sized to contain the 1 in 100-year storm plus 20% for climate change plus 300mm freeboard allowance;
- The Electricity & Gas Networks Sector Climate Change Adaptation Plan Prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and Environment (DCCAE 2019b) which considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. This resilience will in turn provide indirect resilience to the proposed Projects power supply;
- The Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) was also prepared under the National Adaptation Framework used the six-step approach outlined in the Sectoral Planning Guidelines for Climate Change Adaptation. The plan aims to ensure that adaptation measures will enable continued services and maintained infrastructure from the impacts of future climate change for the transport sector;
- The risk due to changing temperatures with respect to heat or cold during operation can be mitigated through the use of a HVAC system which will ensure comfort and fresh air for passengers and staff and prevent over-heating of sensitive equipment;
- TII will prepare a Major Incident Management and Severe Weather Team Plan to ensure critical MetroLink infrastructure is protected during operation from the impacts of severe weather;
- The overhead line equipment will be designed to take into account a range of minimum and maximum temperatures of -20°C to +40°C 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. The mechanical tension in the contact and messenger wires will be maintained within the system design parameters; and

- Monitoring will also include the ongoing management of adaptation and resilience of the Operational Phase in order to measure their effectiveness. If monitoring of adaptation and resilience measures indicates the measures are not effective and climate is impacting on the construction of the proposed Project, then they should be reviewed and updated.

17.7 Residual Impacts

17.7.1 Construction Phase

In order to determine significance, the key test, as outlined in the IEMA Guidance (IEMA, 2022) is *"whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050"*. The approach used to assess significance is based on the following principles:

- Is the project "business as usual" in terms of climate reduction? – This would result in a major or moderate negative impact;
- Is the project compatible with net zero by 2050 and complies with "good practice" reduction measures? – This would result in a minor adverse impact that is not significant;
- Does the project achieve emissions that go substantially beyond the reduction trajectory and has minimal residual emissions? – This would result in a negligible effect that is not significant; and
- Does the project cause GHG emissions to be avoided or removed from the atmosphere? – This would result in a beneficial effect that is significant.

The residual Construction Phase embodied carbon within the construction and maintenance materials and regional traffic impacts have been calculated in Table 17.27.

As noted previously there is some double counting in these figures as the ENEVAL regional traffic model accounts for some of the construction transport which is also accounted for in the embodied carbon assessment. In addition, the ENEVAL model assumes the worst-case construction period with respect to traffic movements for the full nine and a quarter year period, which again is conservative as these conditions are likely to last an estimated six months rather than nine and a quarter years.

The proposed Project with mitigation measures will result in total Construction Phase GHG emissions of 1,1149Kt CO_2eq over an 9.25-year period equivalent to an annualised total of 0.37% of Ireland's non-ETS 2030 emissions target or 2.0% of the 2030 transport sector carbon budget. Over the predicted 60-year lifespan the annualised emissions due to the initial Construction Phase and ongoing maintenance of the proposed Project will reach at most 0.049% of Ireland's non-ETS 2030 emissions target or 0.27% of the 2030 transport sector carbon budget. The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual phases.

Table 17.27: Residual Construction Phase GHG Emissions

Activity	Kt CO_2eq / Total	% Of Total
Pre-Construction	0.05	0.004%
Embodied Carbon	479.3	41.7%
Construction Activities	54.8	4.8%
Construction Waste	55.7	4.8%
Construction Fuel	401.0	34.9%
Maintenance	25.7	2.2%
ENEVAL Regional Traffic	132.9	11.6%
All	**1,149.5**	**100%**

Activity	Kt CO_2eq / Total	% Of Total
Annualised over Construction and Operational Phases (69.25 Years)	16.6	

17.7.2 Operational Phase

17.7.2.1 Residual Impact of Proposed Project on Climate Change

The residual sum of the total Opening Year Operational Phase transport related emissions and operational power demands is -12.26Kt CO_2eq for Scenario A and -11.49Kt CO_2eq for Scenario B (Table 17.28). This is a conservative calculation as it is based on projected 2030 carbon intensity rates (ESB 2022). The savings in GHG emissions are a result of the modal shift away from passenger cars, with decreased car usage and a cleaner and model shift to a more efficient MetroLink. As part of mitigation 90% of operational power for traction and stations will be purchased from a certified renewable energy supplier. This will mitigate the impact on climate by reducing the annual impact by 5,617Kt of CO_2 (based on 2030 carbon intensity). The future power demands of MetroLink will increase due to increased passenger numbers, however the carbon intensity figure will also reduce as the national grid becomes more renewable and moves to net zero carbon by 2036 (ESB 2022).

Residual Operational Phase emissions have been compared against the Ireland's non-ETS 2030 target of 33,381.3Kt 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) and the 2030 transport sector carbon budgets (Department of the Taoiseach 2022). In the Opening Year the annualised emissions due to the operation of the proposed Project will reduce Irelands emissions by between -0.037% and - 0.034% of Ireland's non-ETS 2030 emissions target. When compared to the transport sectoral carbon budget for 2030 (6,000Kt CO_2eq) the reduction due to the proposed Project equates to 0.135% for Scenario A and 0.0126% for Scenario B. This reduction occurs while providing a significant increase (more than 50,000,000) in public transport journeys annually.

Table 17.28: Summary of Residual Predicted Operational Phase Impacts – Opening Year 2035

Activity Scenario A	Kt CO_2eq / Total	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of Projected 2030 Transport Carbon Budget
Traffic Scenario A			
Operational Vehicle Emissions Scenario A	-12.88	-0.039%	-0.142%
Operational Power (2030 Carbon Intensity)	0.63	0.002%	0.007%
Total	**-12.26**	**-0.037%**	**-0.135%**
Traffic Scenario B			
Operational Vehicle Emissions Scenario B	-12.12	-0.036%	-0.133%
Operational Power (2030 Carbon Intensity)	0.63	0.002%	0.007%
Total	**-11.49**	**-0.034%**	**-0.126%**

17.7.3 Summary of Residual Construction and Operational Phase Predicted Impacts

The sum of the Opening Year GHG emissions for Scenario A is 4.27Kt CO_2eq. There is also some double counting within the construction figures with respect to traffic emissions, as previously noted in Section 17.5.2. Over the predicted 60-year lifespan the annualised emissions due to the proposed Project will reach at most 0.013% of Ireland's non-ETS 2030 emissions target or 0.071% of the 2030 Transport Sector Carbon Budget (Department of the Taoiseach 2022). The increase occurs due to the considerable

Construction Phase embodied carbon, which will be further mitigated during detailed design, and is not as a result of operational emissions as this phase is beneficial with respect to carbon emissions.

Table 17.29: Summary of Predicted Residual Combined Construction and Operational Phase Impacts – Opening Year (2035) Traffic Scenario A

Activity	Kt CO_2eq Annually	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of the 2030 Transport Sector Carbon Budget
Operational Vehicle Emissions – Based on Scenario A in the Opening Year (2035)	-12.88	-0.039%	-0.215%
Operational Power Opening Year (Projected 2035 Carbon Intensity)	0.63	0.002%	0.010%
Construction and Maintenance Annualised	16.53	0.050%	0.275%
Total	**4.27**	**0.013%**	**0.071%**

Table 17.30: Summary of Predicted Combined Construction and Operational Phase Impacts – Design Year Traffic (2050) Scenario A

Activity	Kt CO_2eq Annually	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of the 2030 Transport Sector Carbon Budget
Operational Vehicle Emissions – Based on Scenario A in the Design Year (2050)	-13.83	-0.041%	-0.230%
Operational Power (Projected 2050 Carbon Intensity)	0	0.000%	0.000%
Construction Phase Emissions (including maintenance) Annual	16.53	0.050%	0.275%
Total	**2.70**	**0.008%**	**0.045%**

The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle, as provided in Table 17.29 and Table 17.30 for Scenario A. Scenario A is the core scenario in the proposed Projects business case. For both 2035 and 2050 here is a residual impact that cannot be offset by reduction in Operational Phase traffic emissions. IEMA Guidance (IEMA 2022) states (Section 17.3.5) a project that has a negligible impact achieves emissions mitigation that goes substantially beyond the reduction trajectory and has minimal residual emissions. The proposed Projects provides an attractive sustainable form of public transport that prevents the use of the private car and therefore reduces Operational Phase vehicle emissions sufficiently enough to offset Construction Phase emissions. Residual impacts for Scenario A are less than 0.071% of the 2030 Transport Sector Carbon Budget which is considered a minimal residual impact. The source of residuals is due to the Construction Phase embodied carbon which will be further mitigated during detailed design.

The predicted potential effect to climate over the lifetime of the project for the core business case scenario (Scenario A) due to the combined construction and Operational Phases, is long-term, negligible, and not significant.

IEMA significance (IEMA 2022) notes that:

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 is a high bar

and indicates exemplary performance where a project meets or exceeds measures to achieve net zero earlier than 2050.

Scenario A is the core scenario in the proposed Projects business case and is also more beneficial in the Operational Phase compared to Scenario B. The reason for this is that in Scenario B, other planned public transport options such as BusConnects and the DART+ are included within the DM Scenario and roads are less congested due to increased capacity provided as a result of the additional public transport options. Less congestion means that the public are more likely to travel in their private vehicles as there may be a lower journey time benefit of shifting to public transport.

By 2050 passenger cars are considered to be all electric so the benefits of the proposed Project are not as significant as in 2035 when a higher percentage of fossil fuel car journeys are offset by MetroLink journeys.

Table 17.31: Summary of Predicted Residual Combined Construction and Operational Phase Impacts – Opening Year Traffic Scenario B

Activity	Kt CO_2eq Annually	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of the 2030 Transport Sector Carbon Budget
Operational Vehicle Emissions– Based on Scenario B in the Opening Year (2035)	-12.12	-0.036%	-0.202%
Operational Power Opening Year (2035 Carbon Intensity)	0.63	0.002%	0.010%
Construction and Maintenance Annualised	16.53	0.050%	0.275%
Total	**5.03**	**0.015%**	**0.084%**

Table 17.32: Summary of Predicted Combined Construction and Operational Phase Impacts – Design Year Traffic Scenario B

Activity	Kt CO_2eq Annually	% of Irelands EU Non ETS Targets 2030 (Kt CO_2eq)	As % of the 2030 Transport Sector Carbon Budget
Operational Vehicle Emissions – Based on Scenario B in the Design Year (2050)	-2.17	-0.007%	-0.036%
Operational Power Design Year (2050 Carbon Intensity)	0	0.000%	0.000%
Construction Phase Emissions (including maintenance) Annual	16.53	0.050%	0.275%
Total	**14.35**	**0.043%**	**0.239%**

If traffic Scenario B is to occur, it is likely that other elements of the CAP such as the move away from fossil fuels as an electricity source also occur. If only the Operational Phase is considered the proposed Project is predicted to have a beneficial impact for Scenario B. However, with consideration for the Construction Phase emissions spread across the lifetime of the proposed Project the likely effects are considered minor adverse in accordance with IEMA significance criteria (Section 17.3.5) as by 2050 the residual impacts for Scenario B are 0.239% of the 2030 Transport Sector Carbon Budget and subsequent carbon budgets will be even lower. In reality, construction carbon will be associated with the carbon emissions of the construction years of the proposed Project rather than spread across the lifetime of the project. Once operational the proposed Project is predicted to beneficially impact the transport sector carbon emissions annually compared to a scenario where it is not built.

This is a major infrastructure tunnelling project and the large embodied carbon is indicative of this. While the capital carbon is significant, the proposed Project's ability to transport people will be significant in the Operational Phase. The project will have residual impacts, mainly as a result of the high embodied construction carbon but is showing the projects commitment to the minimisation of the construction and operational GHG emissions. Mitigation that goes above and beyond the legal requirements on the proposed Project include the Operational Phase use of at least 90% renewable power from the Opening Year.

In line with the IEMA significance criteria set out in Section 17.3.5 the overall residual likely effect of the proposed Project when Scenario A, which is the core business case scenario, is long-term, negligible, and not significant. When Scenario B is considered, the likely effect is minor adverse, long-term, and not significant in the long term due to the high embodied carbon associated with the Construction Phase.

If construction carbon is associated with the carbon emissions of the construction years of the proposed Project rather than spread across the lifetime of the project, both the Scenario A and Scenario B will be significant and beneficial in the long term as the proposed Project causes GHG emissions to be avoided and assists in Ireland achieving net zero by 2050 as the project will have beneficial impacts by the Opening Year of 2035.

The results of the residual impacts assessment with respect to EIA Guidance (EPA 2022), which uses different significance criteria to IEMA, show that there is a long-term, significant, and adverse likely effect to climate during the Construction Phase. The results of the residual Operational Phase impacts assessment with respect to EIA Guidance (EPA 2022) show that there is a long-term, beneficial, and significant likely effect to climate during the operational stage.

The European Commission's Technical guidance on the climate proofing of infrastructure (European Commissions 2021) notes that:

"Most projects will have an impact on GHG emissions, compared to the Baseline, through their construction, operation, and eventual decommissioning and through indirect activities that occur because of the project. This should be seen in the context of the project not as an isolated event but as a set of different and complementary interventions – in particular stemming from a plan. This might mean that a certain specific project does not have an individual net GHG reduction effect but is integral part of an overall plan that reduces emissions"

MetroLink will support the delivery of government strategies outlined in the CAP and the 2021 Climate Act by enabling sustainable mobility and delivering a sustainable transport system. Action 241 of the 2021 CAP is the Commence delivery of MetroLink. Its aim is to provide enhanced public transport infrastructure on a key access corridor in the Dublin region in a sustainable way. This will subsequently enable and deliver an integrated sustainable transport movement along these corridors. MetroLink provides connectivity and integration with other public transport services leading to more people availing of public transport.

The Promotion of the Use of Energy from Renewable Sources Directive (EU) 2018/2001 specifies a legally binding 14% renewable energy in transport target to be achieved by all Member States by 2030. In addition, the National Investment Framework for Transport in Ireland (NIFTI) (DTTAS, 2021) prioritises investment in decarbonisation through the application of its modal and intervention hierarchies with public transport being prioritised. Given its use of electricity, the proposed Project has an ability to utilise renewable energy throughout its operation and assist in Ireland meeting the EU target and NIFTI decarbonisation goal.

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

17.8 Difficulties Encountered in Compiling Information

Difficulties were encountered during the quantification of materials at the preliminary design stage in relation to the quantification and sourcing of materials and how these informed 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 by the appointed contractor. Throughout the assessment, efforts have been made to provide the most likely, or a conservative scenario when a most likely is not known, of the embodied carbon assessment.

In addition, climate impact assessment criteria and guidance are changing and therefore the requirements for assessment may change between publication of this document and assessment by An Bord Pleanála.

17.9 Glossary

Term	Meaning
Alignment	Alignment refers to the three-dimensional (3D) route of the railway, considering both the horizontal and vertical alignment.
Atmosphere	Layer of gas or layers of gases that envelope a planet and is held in place by the gravity of the planetary body.
Carbon emissions	The release of carbon into the atmosphere, which is one of the main contributors to the climate change.
Climate	The average weather over a period of time, whilst climate change is a significant change to the average weather.
Climate change	Is a long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates.
Coastal flooding	Caused by extreme sea levels, which arise as combinations of four main factors: waves, astronomical tides, storm surges and relative mean sea level.
Construction compound	An area occupied temporarily for construction-related activities. The main construction compounds will act as strategic hubs for core project management activities (i.e., engineering, planning and construction delivery) and for office-based construction personnel. The main construction compounds will include offices and welfare facilities, workshops and stores, and storage and laydown areas for materials and equipment (e.g., aggregate, structural steel, and steel reinforcement).
Dewatering	Process of draining rainwater or groundwater from an excavated area before construction can begin.
Easement strip	During construction, easement strips will be located along the proposed railway alignment within AZ1 and AZ3 to aid construction of retained cutting, cut and cover, elevated track, and surface track sections. The easement strips will range between 10m and 25m wide on either side of the alignment. A portion of these strips will be retained as permanent features for rail maintenance purposes during the Operational Phase.
Embodied carbon	Embodied carbon refers to GHGs emitted during the manufacture, transport, and use of building materials, together with end-of-life emissions.
Emissions	The production and discharge of something, especially gas or radiation.
Emissions factor	An emission factor is a coefficient which allows to convert activity data into GHG emission.
Enabling works	These are works to prepare a site in advance of the main construction works, for example, demolition, removal of vegetation, land levelling.
Fluvial flooding	Occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise when the river flow following heavy rain exceeds the capacity of the river channel and can be exacerbated where a channel is blocked or constrained.
Fossil fuels	A fuel formed by natural processes, such as anaerobic decomposition of buried dead organisms, containing organic molecules originating in ancient photosynthesis that release energy in combustion.
Greenhouse gases (GHG)	Constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. Primary GHGs are Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3).
Intervention shaft	Required to allow access for the fire and rescue service in the event of an emergency underground; to allow control of smoke in the event of fire in the tunnel; and to maintain the tunnel air quality and temperature within prescribed limits during periods of train service congestion.

Term	Meaning
Intervention tunnel	A tunnel parallel to the railway tunnel to provide emergency access.
Park & ride facility	A location usually sited out of the main urban areas comprising a large car park and connected with a mass transit system, in the case of MetroLink an urban metro to attract potential travellers to drive and park at the facility and take the metro into the city centre and avoid driving into the city centre.
Pluvial flooding	Occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the ground to absorb it. This excess water flows overland, ponding in hollows, low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system. This type of flooding is driven by short, intense rainstorms.
Retained cut station	A railway station constructed primarily below ground level with vertical retaining walls either side of the alignment to reinforce the walls and no roof or enclosure overhead.
Surface station	A railway station designed at ground level.
Tunnel portal	The openings at the end of the tunnel.
Underground stations	A railway station located fully underground with a roof slab over the station to enclose it fully.
Wildfire	Uncontrolled fire in a forest, grassland, brushland, or land sown to crops.

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