Greater Dublin Drainage Project Addendum

Environmental Impact Assessment Report Addendum: Volume 3A Part B of 6

Appendix A14.1 Climate (Greenhouse Gas Assessment)

Uisce Éireann

November 2023

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Appendix A14.1 Climate (Greenhouse Gas Assessment)

1. Introduction

This Appendix to Chapter 14A (Air Quality, Odour and Climate) in the Environmental Impact Assessment Report (EIAR) Addendum presents the full assessment of the impact of greenhouse gas (GHG) emissions from the proposed Greater Dublin Drainage Project (hereafter referred to as the Proposed Project) on climate during both the Construction and the Operational Phases.

The GHG assessment within this Appendix recognises and responds to developments in climate-related legislation, policy and guidance which have emerged since the submission of the original planning application in 2018 and 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 (hereafter referred to as the Environmental Impact Assessment (EIA) Directive).

The requirement to reconsider the climate aspects for the Proposed Project reflects the advancement in the EIA process in relation to carbon emission assessments since the submission of the EIAR in the 2018 planning application. These advancements are primarily driven by the accelerating impacts of climate change, and the introduction by the Irish Government of 'net zero' targets by 2050 for the public sector, as well as the introduction of legally binding GHG reduction targets. A climate assessment was originally reported in Chapter 14 (Air Quality, Odour and Climate) in Volume 3 Part A of the EIAR in 2018 planning application. To reflect the advancement in the EIA process, this updated assessment in this Appendix has been undertaken with reference to the most appropriate guidance documents relating to climate (referred to in Section 2.2).

In addition to specific climate guidance documents, the following updated guidelines were considered and consulted in the preparation of this Appendix:

- The Environmental Protection Agency (EPA) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (hereafter referred to as the updated EPA Guidelines) (EPA 2022a).

As outlined in the EIAR in the 2018 planning application, the Proposed Project will form a significant component of a wider strategy to meet future wastewater treatment requirements within the Greater Dublin Area (GDA), as identified in a number of national, regional, and local planning policy documents. The plant, equipment, buildings, and systems associated with the Proposed Project will be designed, equipped, operated, and maintained in such a manner to ensure a high level of decarbonisation, energy performance, energy efficiency and deployment of renewable forms of energy. The Proposed Project will serve the projected wastewater treatment requirements of existing and future drainage catchments in the north and north-west of the Dublin agglomeration, up to the Proposed Project's 2050 design horizon. The Proposed Project will comprise the following interlinked elements, which remain unchanged from the 2018 planning application:

- Proposed wastewater treatment plant (WwTP) to be located on a 29.8-hectare (ha) site in the townland of Clonshagh (Clonshaugh) in Fingal;
- Sludge Hub Centre (SHC) to be co-located on the same site as the proposed WwTP;
- Proposed orbital sewer route from Blanchardstown to the proposed WwTP at Clonshagh;
- Proposed odour control unit (OCU) at the interface between the rising main and gravity sewer elements of the proposed orbital sewer route;
- Proposed North Fringe Sewer (NFS) diversion sewer to the proposed WwTP;
- Proposed Abbotstown pumping station to be located in the grounds of the National Sports Campus (NSC); and
- Proposed outfall pipeline route from the proposed WwTP to the outfall discharge location approximately 1km (kilometre) north-east of Ireland's Eye.

The GHG assessment within this Appendix evaluates the impact of the GHG emissions from the Proposed Project and compares the quantified outputs against the relevant sectoral carbon budgets (refer to Section 2.3) and sectoral emissions ceilings for 2030 set out in the Sectoral Emissions Ceilings September 2022

documents (Government of Ireland 2022a) (i.e., construction emissions are compared against the Industry budget and operational emissions are compared against the Other (sub-category Waste) budget).

An independent GHG assessment has been completed for the Regional Biosolids Storage Facility (RBSF) Component and is reported in Appendix A8.1 in Volume 4A Part B of this EIAR Addendum. To ensure that GHG emissions from infrastructure projects align with the Government's national climate objectives, consideration must be given to the impact of the whole life carbon of a scheme and not isolated elements. Therefore, it is recommended that the evaluation of the impact of the GHG emissions of the Proposed Project be considered with the impact of the GHG emissions of the RBSF Component to provide a total whole-system comparison against the relevant sectoral carbon budgets.

This GHG assessment recognises and responds to developments in climate-related legislation, policy, and guidance which have emerged since the submission of the original planning application in 2018 and describes and assesses the likely direct and indirect significant effects of the Proposed Project on climate.

This GHG assessment is based on a reasonable worst-case scenario with respect to the most significant potential carbon emissions arising from the Proposed Project based on project information available at this stage of the Proposed Project and considers emissions from both Construction and Operational Phases.

This Appendix 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 potential impacts (detailed in Section 5 of this Appendix):

- Chapter 4 (Description of the Proposed Project) in Volume 2 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 4A (Description of the Proposed Project) in Volume 2A Part A of this EIAR Addendum;
- Chapter 5 (Consideration of Alternatives) in Volume 2 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 5A (Consideration of Alternatives) in Volume 2A Part A of this EIAR Addendum;
- Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 13A (Traffic and Transport) in Volume 3A Part A of this EIAR Addendum
- Chapter 20 (Waste) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 20A (Waste) in Volume 3A Part A of this EIAR Addendum;
- Chapter 24 (Summary of Mitigation Measures) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 24A (Summary of Mitigation Measures) in Volume 3A Part A of this EIAR Addendum; and
- Outline Construction Environmental Management Plan (CEMP) included as a standalone document in the 2018 planning application, as supplemented by the Addendum to the CEMP, which is a standalone document in this Addendum.

1.1 Greenhouse Gas Emissions Considerations

The updated Climate Action Plan 2023 (CAP 2023) (Government of Ireland 2022b) identified that climate change will result in further pressure on water resources and that Uisce Éireann (formerly Irish Water) need to provide sectoral resilience to the impacts of climate change. The Proposed Project, while having an impact on climate, is also designed to provide such resilience by providing capacity to meet the demand based on population forecasts to 2040. The evaluation which considers the vulnerability of the Proposed Project to future climate change is referred to in Section 2.

As noted in Section 1, this assessment considers the total GHG emissions anticipated as a result of the construction and operation of the Proposed Project and describes and assesses the likely significant effects of the Proposed Project on climate, in accordance with the requirements of the EIA Directive.

Climate represents long-term weather patterns and considers environmental aspects such as climate change resulting from GHG emissions. Potential emissions of GHGs from the Proposed Project that can contribute to

climate change include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Climate impacts are considered by taking account of the existing baseline, the nature and magnitude of the projected impacts and compliance with relevant standards and recent industry guidance and best practice which considers the life cycle carbon emissions footprint of infrastructure projects.

The GHG primarily generated from the Construction Phase will be CO_2 which is emitted from the burning of fossil fuels during product manufacture, transportation, construction, and installation activities.

In relation to the Operational Phase of the Proposed Project, the principle GHGs of concern are CO_2 released from various energy systems associated with the operations, fugitive CH_4 emissions from both the proposed Abbottstown pumping station and WwTP, and N_2O from the proposed activated sludge process to be installed at the proposed WwTP. Although typically emitted in lower volumes than CO_2, the global warming potential (GWP) of both CH_4 and N_2O are considerably higher than CO_2 (refer to Section 3.1), and therefore require quantification as tonnes of carbon dioxide equivalents (t CO_{2e}) to evaluate the relative impact of these GHGs.

Number 32 of 2021 – Climate Action and Low Carbon Development (Amendment) Act 2021 (hereafter referred to as the 2021 Climate Act) outlines a series of specific actions including to provide for carbon budgets and sectoral emissions ceilings to apply to different sectors of the economy. These carbon budgets are 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 (refer to Section 2.3). In September 2022, the Government adopted Sectoral Emissions Ceilings for each relevant sector within the limits of each carbon budget and against which the impact of the Proposed Project is evaluated. For the Construction Phase of the Proposed Project, the relevant sector emissions ceiling which applies is the 'Industry' sector, whilst for emissions during the Operational Phase, the sectoral emissions ceiling which applies is 'Other' (sub-category 'Waste').

The Operational Phase of the Proposed Project is estimated to commence following the 48-month construction and commissioning period scheduled for completion in Q4 2029 and CO_2 emissions will be generated (as indirect emissions) as a result of the electricity power demand of the proposed Abbottstown pumping station and the proposed WwTP and SHC at Clonshagh. CO_2 emissions from the operational power demand of the Proposed Project is calculated using the carbon intensity of the fuel mix used in the generation of electricity nationally. As a national target of up to 80% of electricity demand by renewables by 2030 for the national grid has been set in the CAP 2023, the impact of the decarbonisation of the national electricity grid is considered in this assessment.

2. Methodology

To align with the requirements of EIA Directive, the climate assessment should describe the likely significant effects on the environment resulting from both the:

- Impact of the Proposed Project on climate arising from GHG emissions; and
- Vulnerability of the Proposed Project to climate change (climate adaptation).

The scope of this appendix includes an assessment of the impact of the Proposed Project in climate arising from GHG emissions. The vulnerability of the Proposed Project to climate change is considered in Chapter 22A (Risk of Major Accidents and/or Disasters) in Volume 3A Part A of this EIAR Addendum.

The measurement and quantification of the GHG emissions associated with the Proposed Project is based upon the methodology proposed in the Institute of Environmental Management and Assessment (IEMA) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (hereafter referred to as the IEMA GHG Guidance) (IEMA 2022). It further aligns with the methodology and requirements used for assessing and reporting the effects of climate on highways projects (other large infrastructure projects), and the effect on climate of GHGs from construction, operation and maintenance projects, as set out in United Kingdom Highway Agency (UKHA) Design Manual for Roads and Bridges (DMRB) - LA 114 Climate (UKHA 2021).

From the IEMA GHG Guidance, the GHG quantification within this assessment follows the principles outlined in the GHG Protocol Corporate Standard, International Organization for Standardization (ISO) ISO 14064-2 Greenhouse gases – Part 2 (ISO 2019) and British Standard institute (BSI) British Standard (BS) PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023). Based on the methodologies outlined in each standard, this assessment seeks to quantify the difference in GHG emissions between the Proposed Project and the 'do nothing' scenario (as detailed in Section 3). The assessment results reflect the difference in whole life net GHG emissions between these two options.

The assessment includes all material emissions during the Construction and Operational Phases of the Proposed Project within the boundary defined in Section 2.1. Any assumptions, inclusions and exclusions are detailed in Appendix A of this Appendix.

From the IEMA GHG Guidance, the GHG assessment should incorporate the following six-step methodological framework:

- Set the scope and boundaries of the GHG assessment (refer to Section 2.1);
- Develop the baseline scenario (refer to Section 3);
- Select of emissions calculation methodologies (refer to Section 2.5);
- Data collection (refer to Section 2.4.1);
- Calculation of GHG emissions inventory (refer to Appendix B of this Appendix); and
- Consider mitigation opportunities and repeat previous two steps (refer to Section 5 and Section 6).

This methodology assesses the total net impact of the Proposed Project by calculating the GHG emissions from both the Construction and Operational Phases using the approach outlined below:

- A detailed review of GHG emissions has been undertaken in order to characterise the baseline environment. This has been undertaken using emissions data available from sources identified in Section 3;
- A review of appropriate national and international guidelines for the assessment of GHG emissions has been completed to define the significance criteria for the Construction and Operational Phases of the Proposed Project (refer to Section 2.2);
- Predictive calculations and impact assessments relating to the likely Construction Phase climate impacts of the Proposed Project have been completed (refer to Appendix B of this Appendix and Section 4);

- Predictive calculations and impact assessments relating to the likely Operational Phase electrical power demand, process emissions and maintenance have been completed (refer to Appendix B of this Appendix and Section 4);
- A schedule of mitigation measures has been provided to demonstrate the mitigation hierarchy adopted to incorporate GHG emissions' reduction opportunities in the design to reduce climate impacts (refer to Section 5); and
- The potential predicted residual impact is compared against the following targets and sectoral carbon budgets:
    - Ireland's non- Emission Trading Scheme (ETS) 2030 target of 33.4Mt CO_{2e} (million tonnes of carbon dioxide equivalent) (as outlined 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 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council);
    - 2030 Industry sectoral carbon budget (Government of Ireland 2022) for Construction Phase emissions of 24Mt CO_2e;
    - 2030 'Other' ('Waste') sectoral carbon budget (Government of Ireland 2022) for Operational Phase Emissions of 4Mt CO_2e; and
    - The residual impact comparison is reported in Section 6.

2.1 Study Area

The Proposed Project covers an extensive study area comprising the following key infrastructural elements outlined in Section 1. Full details of the Proposed Project Description can be found in Chapter 4 (Description of the Proposed Project) in Volume 2 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 4A (Description of the Proposed Project) in Volume 2A Part A of this EIAR Addendum.

The Proposed Project is generally located along the southern fringe of Fingal in North County Dublin, covering an area from Blanchardstown, in the west of the county, to Baldoyle / Portmarnock, in the east of the county and in the marine environment off North County Dublin between Baldoyle Bay and Ireland's Eye.The land uses in the immediate vicinity of the Proposed Project are predominantly urban and agricultural and the main pipeline route will cross lands which are used for agriculture, recreation, commercial activities and lands within the boundaries of the Connolly Hospital in Blanchardstown.

In accordance with the recently published IEMA GHG Guidance (IEMA 2022), the approach to assessing the cumulative effects of GHG emissions differs from that for other environmental topics (e.g., odour emissions or dust), as GHG emission impacts and the resulting effects cannot be evaluated within a geographically bounded study area. Therefore, all global cumulative GHG sources are relevant to the effect on climate change which needs to be factored when defining the study area and receptor. The receptor, in the case of GHG emissions, is the atmospheric concentration of GHGs and it is defined as being of 'high' sensitivity to further emissions.

The contextualisation of the impacts of GHG emissions from the Proposed Project should incorporate the cumulative contributions of other GHG sources, even if not based on a geographical boundary.

The Irish Government has defined national and sectoral carbon budgets which are compatible with international climate commitments, and with the 2021 Climate Act in which specific actions to provide for carbon budgets and sectoral emissions ceilings for different sectors of the economy were defined. The Government's Sectoral Emissions Ceilings (Government of Ireland 2022) were published in September 2022. GHG emissions assessed within the study area will be compared to both the national and sectoral 'Industry' and 'Other' (sub-category 'Waste') GHG emissions targets, as detailed in Section 2.3.

The study area for climate includes all new infrastructural elements to be provided as part of the Proposed Project (refer to Image 2.1) and includes GHG emissions from both the Construction and Operational Phases. The objective of the updated GHG emissions assessment in this case is to determine the percentage contribution of the Proposed Project's net emissions to the national and sectoral carbon budgets for both the Construction and Operational Phases based on the carbon budgets allocated to each of the relevant sectors, as detailed in the recently published Sector Emissions Ceilings.

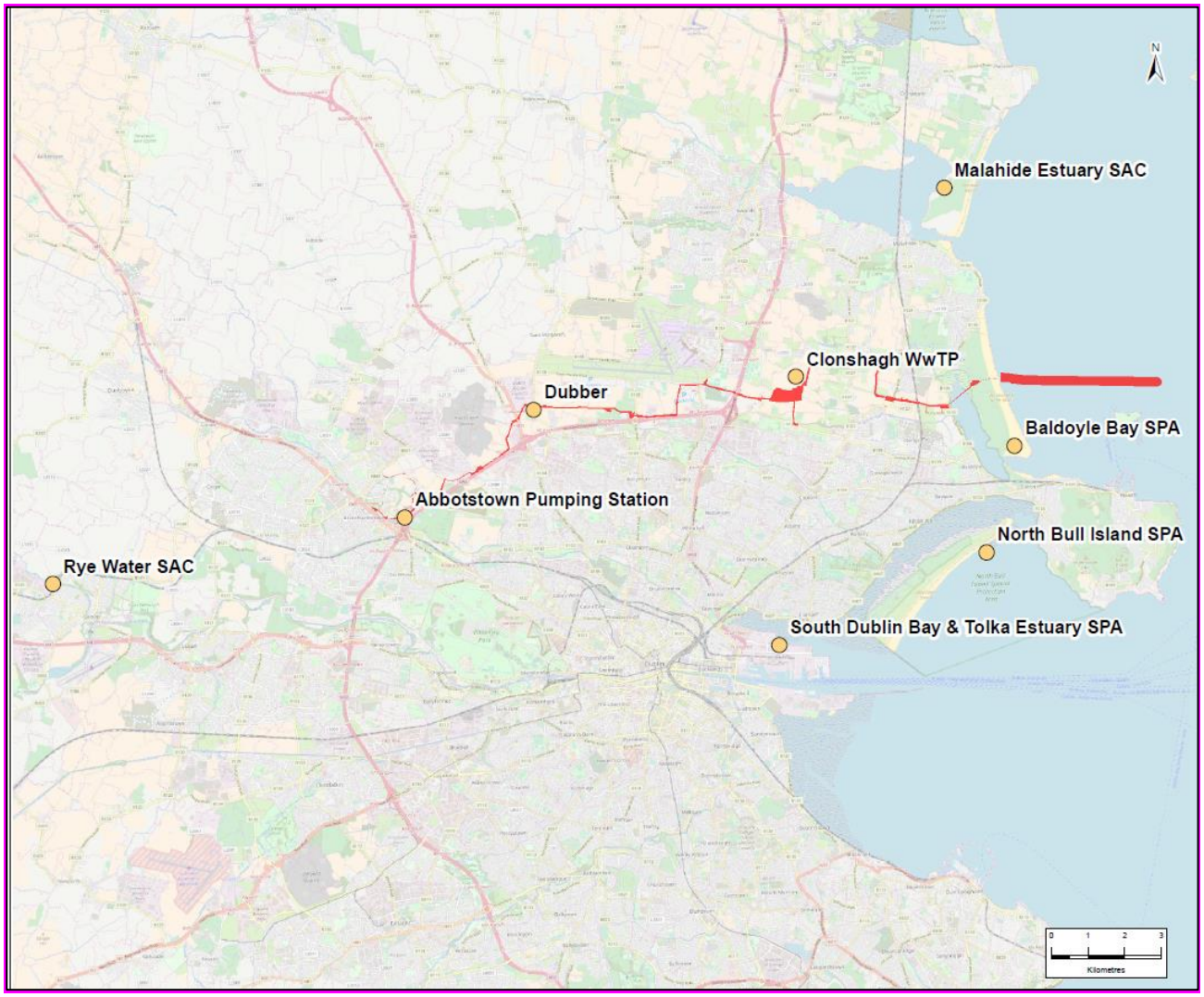
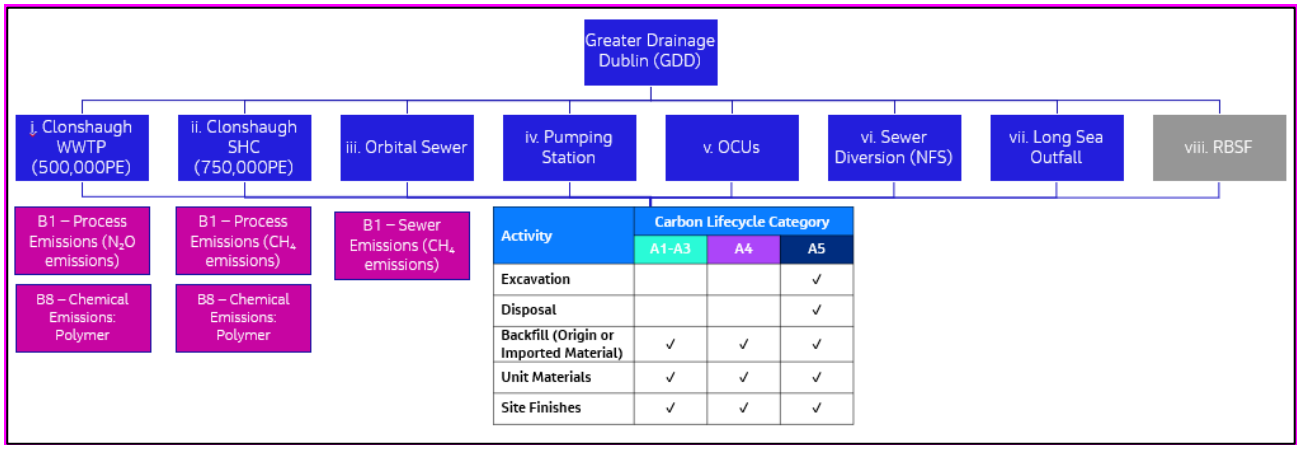


Image 2.1: Project Boundary for the GHG Emissions Assessment from the Proposed Project's Infrastructural Elements

2.1.1 System Boundary

The system boundary relevant for this GHG assessment includes all material emissions, direct or indirect, generated during the life cycle stages of the Proposed Project. Annual emissions, in addition to the overall lifetime of the Proposed Project are considered. The system boundary for the GHG emissions assessment for the Proposed Project aligns with those presented in BS EN 15987 Sustainability of construction works (BSI 2011) and in PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023) which represents good practice for life cycle carbon quantification in infrastructure projects.

A model-based scenario quantification approach was adopted to assess the impact of emissions from within the system boundary. A purpose-built model was created to calculate the anticipated GHG emissions from both the Construction (including embodied carbon) and Operational Phases of the Proposed Project using a series of calculations, industry standard emissions factors and assumptions to calculate a carbon footprint for the Proposed Project, details of which are provided in Appendix B of this Appendix. The carbon footprint takes account of all anticipated GHG emissions including CO_2, CH_4, and N_2O, which are normalised and reported as t CO_2e. Image 2.2 indicates the infrastructural element, project lifecycle stage and primary emissions sources included in the model (based on the life cycle carbon assessment methodology in BS EN 15987 Sustainability of construction works (BSI 2011) and in PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023)).



Activity	Carbon Lifecycle Category		
	A1-A3	A4	A5
Excavation			✓
Disposal			✓
Backfill (Origin or Imported Material)	✓	✓	✓
Unit Materials	✓	✓	✓
Site Finishes	✓	✓	✓

Image 2.2: System Boundary Included Within Purpose-Built Emissions Assessment Model

While all updated elements to the Proposed Project (i.e., the inclusion of ultraviolet (UV) treatment and the River Mayne culvert extension as outlined in Chapter 4A (Description of the Proposed Project) in Volume 2A Part A of this EIAR Addendum) have been considered within the system boundary, it should be noted that activities that do not significantly change the result of the assessment (where expected emissions are less than 1% of total emissions and do not exceed a maximum total of 5% of total emissions as per the IEMA GHG Guidance (IEMA 2022), are excluded from the scope of the assessment. This includes these new proposed elements.

2.1.2 Temporal Boundary

A reference study period of 50 years was selected for the GHG emissions assessment based on the typical design working life (DWL) for permanent buildings and structures in accordance with IS EN 1990 Basis of structural design (Eurocode). This study period incorporates both the Before-Use Stages (A1-A5) and the Use Stage (B1-B9) modules based on BS EN 15987 Sustainability of construction works (BSI 2011) and in PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023) assessment life cycle information as detailed in section (a) and has been selected to assess the anticipated GHG emissions which may potentially influence the objectives of the 2021 Climate Act in relation to achieving net zero carbon by 2050.

2.2 Relevant Guidelines, Policy and Legislation

Since the submission of the planning application in 2018, there has been considerable movement regarding climate-related government policy, EIA legislation, GHG assessment guidance and best practice that are recognised in this Appendix.

The GHG assessment has been undertaken with reference to the most appropriate guidance documents relating to climate change which are set out in the following sections. In addition to specific climate guidance documents, the updated EPA Guidelines (EPA 2022a) were considered and consulted in the preparation of the updated GHG assessment.

The GHG 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 include:

- The 2021 Climate Act;
- CAP 2023 (Government of Ireland 2022b);
- EIA Directive;
- Project Ireland 2040 – National Planning Framework (hereafter referred to as the NPF) (Government of Ireland 2020a);

- Water Quality and Water Services Infrastructure. Climate Change Sectoral Adaptation Plan (prepared under the NAF) (Government of Ireland 2019a);
- Department of Transport, Tourism and Sport (DTTAS) Transport - Climate Change Sectoral Adaptation Plan (prepared under the NAF) (Government of Ireland 2019b);
- Fingal County Council (FCC) Climate Change Action Plan 2019 – 2024 (FCC and Codema 2019);
- Fingal Development Plan 2017 – 2023 (FCC 2017);
- Fingal Development Plan 2023 – 2029 (FCC 2023);
- 2030 Climate and Energy Policy Framework (European Commission 2014);
- The Sustainable Energy Authority of Ireland (SEAI) IS399 Energy Efficient Design Management - Business & Public Sector (SEAI 2014);
- Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (European Commission 2013);
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC;
- The Department of the Environment, Climate and Communications (DECC) General Scheme of the Climate Action Amendment Bill (hereafter referred to as the General Scheme Bill) (DECC 2021);
- IEMA GHG Guidance (IEMA 2022);
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020) (IEMA 2020a);
- GHG Management Hierarchy updated for net-zero (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);
- Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (as amended) (hereafter referred to as the Urban Wastewater Treatment Directive (UWWTD)); and
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (hereafter referred to as the Water Framework Directive (WFD)).

2.2.1 International and National Guidelines, Policy and Legislation

Ireland is a party to the United Nations Framework Convention on Climate Change (UNFCCC 1992), and the Kyoto Protocol (UNFCCC 1997). Together with the Paris Agreement (UNFCCC 2015), which entered into force in 2016, these provide the international legal framework for addressing climate change. It requires all signatories to strengthen their climate change mitigation efforts to keep global warming to well below 2°C this century and to pursue efforts to limit global warming to 1.5°C. The aim is to limit global GHG emissions to 40 gigatonnes as soon as possible whilst recognising that peaking of emissions will take longer for developing countries.

Contributions to GHG emissions were based on Nationally Determined Contributions (NDC's) which formed the foundation for climate action after 2020. Significant progress was also made in the Paris Agreement on elevating climate adaptation in response to climate change onto the same level as action to cut and curb emissions.

In order to meet the commitments under the Paris Agreement, the European Union (EU) enacted Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas 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 GHG Regulation). The GHG Regulation aims to deliver, collectively by the EU in the most cost-effective manner possible, reductions in GHG emissions from the 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 emissions of larger industrial emitters (e.g., electricity generation and cement manufacturing). The non-ETS sector includes all domestic GHG emitters, which do not fall under the ETS including GHG emissions from transport, residential, commercial buildings, public sector and agriculture.

The purpose of Number 46 of 2015 - Climate Action and Low Carbon Development Act 2015 (hereafter referred to as the 2015 Climate Act), was to enable Ireland '*to pursue, and achieve, the transition to a low carbon, climate resilient and environmentally sustainable economy the end of the year 2050*'. This is referred to in the 2015 Climate 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, instead referring to both the former Climate Action Plan 2019 (hereafter referred to as the 2019 CAP) (Government of Ireland 2019c) and a series of National Long-Term Climate Action Strategies.

The Climate Act Adaptation Plan, referred to as the National Climate Change Adaptation Framework (DCCAE 2018), which is required to be submitted to the Government for approval every 5 years, outlines a range of objectives to:

- Specify the national strategy for adaptation measures in different sectors which reduce the vulnerability of the state to the negative effects of climate changes that may occur; and
- Take account of any existing obligation if the State under the law of the EU or any international agreement.

The first Climate Action Plan (CAP) was the 2019 CAP and this outlined the status across key sectors including electricity, transport, public service, industry and agriculture and included broadscale measures required for each sector to achieve ambitious decarbonisation targets. An updated CAP was published in 2021 (Government of Ireland 2021a) and a subsequent update published in 2023 (i.e. CAP 2023) (Government of Ireland 2023).

The CAP 2023 (Government of Ireland 2022b) 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.

In May 2019, Ireland declared a climate and biodiversity emergency and in November 2019 the European Parliament approved a resolution declaring a climate and environment emergency in Europe. Following on from the publication of the General Scheme Bill by the Government in 2021, the 2021 Climate Act was published in July 2021 giving statutory effect to the core objectives stated within the 2019 CAP. In relation to climate, the Programme for Government – Our Shared Future (Government of Ireland 2020b) committed 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.

The 2021 Climate 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. In addition, the 2021 Climate Act states that:

> '*A carbon budget, consistent with furthering the achievement of the national climate objective, shall be proposed by the Advisory Council, finalised by the Minister and approved by the Government for the period of five years commencing on the 1 January 2021 and ending on 31 December 2025 and for each subsequent period of five years (in this Act referred to as a 'budget period').*'

2.2.2 Regional Policy and Guidelines

As outlined, FCC (with Codema) developed a Climate Change Action Plan 2019 – 2024 in 2019 (FCC and Codema 2019), with considerations to International, European, and National agreements, legislation and regulations including the 2015 Climate Act, NAF (DCCAE 2018) and the NPF (Government of Ireland 2020a). Under the NAF, sectoral adaptation plans were required to be prepared and submitted to the government for approval by 30 September 2019. The implementation, monitoring and future iterations of the Fingal Climate Change Action Plan 2019 – 2024 will be consistent with approved sectoral adaptation and currently sets out goals to mitigate GHG emissions and plans to prepare for and adapt to climate change.

The Climate Change Action Plan 2019 – 2024 sets out the current and future climate change impacts and GHG emissions levels in Fingal, through the development of adaptation and mitigation baselines and examines the future impacts that climate change may have on the region, setting out the first iteration of actions that will be used to reduce the source and effect of these impacts. The Climate Change Action Plan 2019 – 2024 focuses on two key approaches required to tackle climate change, namely, mitigation, consisting of actions to reduce current and future GHG emissions and, adaptation, which consists of actions to reduce impacts already happening (and that are projected to happen in the future) from climate change. The Climate Change Action Plan 2019 – 2024 considers the particular risks to impact areas including critical infrastructure (e.g., wastewater infrastructure), which includes assets such as treatment plants and pumping stations and notes that sea level rise and flooding have the greatest future risk when both the likelihood and consequence are evaluated. This GHG emissions reduction objective was also recognised in the Fingal Development Plan 2017-2023 (FCC 2017), Two Year Progress Report in relation to Energy and Climate Change objectives (specifically Objective EN23).

2.3 Carbon Budgets and Sectoral Emissions Ceilings

As noted in Section 1.1, the 2021 Climate Act outlines a series of specific actions to provide for carbon budgets and sectoral emissions ceilings for different sectors of the economy. These carbon budgets are to 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 (refer to Table 2.1). In September 2022, the Government adopted Sectoral Emissions Ceilings (Government of Ireland, Sectoral Emissions Ceilings September 2022) for each relevant sector within the limits of each carbon budget and, against which the impact of the Proposed Project is evaluated. The Sectoral Emissions Ceilings published for 2030 are outlined in Table 2.1.

Table 2.1: Carbon Reduction Required for the Next Thee 5-Yearly Periods Commencing with 2021 to 2025

Budget Period	Reduction Required (Mt CO_{2e})[1]	2018 Emissions (Mt CO_{2e})
2021 - 2025	295	Reduction in emissions of 4.8% per annum for the first budget period
2026 - 2030	200	Reduction in emissions of 8.3% per annum for the second budget period
2031 - 2035	151	Reduction in emissions of 3.5% per annum for the third budget period

Note 1: Source (Department of Taoiseach 2022)

For the Construction Phase of the Proposed Project, the relevant sector emissions ceiling which applies is the 'Industry' sector which has a 35% reduction required by 2030 and an emissions ceiling of 4Mt CO_{2e} (or 4,000kt (kilotonnes) CO_{2e}).

The sector emissions ceiling which applies to the Operational Phase of the Proposed Project is 'Other' (sub-category 'Waste'), which has a 50% reduction required by 2030 and an emissions ceiling of 1Mt CO_{2e} (or 1,000kt CO_{2e}). Within the 'Other' sector, the sub-category of 'Waste' has an emissions ceiling of 0.6Mt CO_{2e} (or 600kt CO_{2e}).

Table 2.2: Sectoral Emissions Ceilings and Total Amount of Permitted GHG Emissions Per Sector to 2030 Compared to 2018 Emissions Baseline (Sectoral Emissions Ceilings, Government of Ireland 2022)

Sector	Baseline (Mt CO_{2e})	Carbon Budgets (Mt CO_{2e})		2030 Emissions (Mt CO_{2e})	Indicative Emissions % Reduction in Final Year of 2025-2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Transport	12	54	37	6	50
Electricity	10	40	20	3	75
Built Environment - Residential	7	29	23	4	40
Built Environment - Commercial	2	7	5	1	45
Agriculture	23	106	96	17.25	25
LULUCF[1]	5	xxx	xxx	xxx	Xxx
Industry	7	30	24	4	35
Other (F-gases, waste, petroleum refining)	2	9	8	1	50
Unallocated Savings	-	7	5	-5.25	-
Total	**68**	**xxx**	**xxx**	**-**	**-**
Legally Binding Carbon Budgets and 2030 Emission Reduction Targets	**-**	**295**	**200**	**-**	**51**

Note 1: LULUCF – Land Use, Land-Use Change and Forestry

In 2021, the European Commission published the Commission Notice - Technical guidance on the climate proofing of infrastructure in the period 2021 – 2027 (hereafter referred to as the Technical Guidance on Climate) (European Commission 2021), in order to improve climate considerations in infrastructure projects by integrating climate change mitigation and adaptation measures into the development of infrastructure projects. The Technical Guidance on Climate 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 Technical Guidance on Climate recognises the impact that most projects will have on carbon emissions, compared to the baseline, through the project life cycle (from construction to end-of-life) and through indirect activities that occur because of the project. The Technical Guidance on Climate recognises that while a certain specific project may not have an individual net carbon reduction effect, the delivery of the project is integral to an overall plan that reduces emissions.

Ireland's first national adaptation strategy, published by the former Department of the Environment, Community and Local Government (DECLG) in December 2012, titled the National Climate Change Adaptation Framework - Building Resilience to Climate Change (hereafter referred to as the NCCAF) (DECLG 2012), was the first step in developing a national policy in Ireland to address the anticipated impacts of climate change through a structured programme of action on adaptation. This non-statutory framework was replaced in January 2018 by the NAF (DCCAE 2018). The NAF identified 12 sectors which must prepare sectoral adaptation plans including for water services infrastructure. The NAF requires that local authorities (31 county and city county councils nationally) develop long-term local climate change adaptation strategies and integrate these strategies into plans and policies that come under their remit (development plans etc.).

The government's long-term overarching 'Project Ireland 2040' strategy to build a more sustainable and resilient future aligns investment planning with stated National Strategic Objectives (Government of Ireland National Planning Framework 2018). The NPF (Government of Ireland 2020a) and Project Ireland 2040 - National Development Plan 2021 – 2030 (hereafter referred to as the NDP) (Government of Ireland 2021b) combine to form 'Project Ireland 2040'. The NPF sets the vision and strategy for national development to 2040, with the NDP providing the enabling investment to implement the strategy. The NDP includes the Proposed Project as one of the NSOs under 'Sustainable Management of Water and Other Environmental Resources'. In a Circular Economy, and under the Whole of Government Circular Economy Strategy 2022 – 2023 'Living More, Usual Less' (hereafter referred to as the Circular Economy Strategy) (Government of Ireland 2021c), a national policy framework is set out to support the transition to a circular economy in which the '*inherent value of products, materials and our natural resources is maintained for as long as possible'*. The NDP states that

'*while the overall focus of Government waste policy is on prevention and waste minimisation, investment in indigenous waste treatment capacity remains critical to our environmental and economic well-being*'.

The NDP sets out Sectoral Strategies (Water) including the Water Services Policy Statement 2018 – 2025 (hereafter referred to as the WSPS) (Government of Ireland 2020c) which outlines the Government's expectations for the delivery and development of water and wastewater services in the years ahead against the strategic objective themes of Quality, Conservation and Future Proofing. The WSPS sets out and prioritises the investment requirements to meet environmental obligations under the UWWTD and the WFD mandated River Basin Management Plans. The NDP includes the Proposed Project as a Strategic Investment Priority which will deliver critical outcomes for consumers and communities by continuing to prioritise investment to improve water and wastewater quality through significant capital projects and delivery of national programmes, in addition to meet changing legislative and regulatory requirements and, future economic, housing and population demands.

2.4 Data Collection and Collation

2.4.1 Baseline Data Collection

The climate impact assessment completed for this Appendix comprised desk-based tasks between December 2022 and August 2023, and research data and relevant publications from the following organisations were reviewed:

- FCC;
- Department of Housing, Planning and Local Government (DHPLG);
- DCCAE;
- EPA;
- SEAI;
- Intergovernmental Panel on Climate Change (IPCC); and
- IEMA.

The data and publications listed are discussed and referenced in Section 1.1, Section 2 and Section 3.

Predictions of GHG emissions from the Proposed Project, for both the Construction and Operational Phases, were prepared using the emission factors derived from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019), Civil Engineering Standard Method of Measurement 2019 (CESMM4 Revised) (Institute of Civil Engineers 2019), The Inventory of Carbon and Energy (ICE) database (BG10/2011) (BSRIA and Bath University 2011), and using the project phases and activity data set out in the British Standard institute (BSI) British Standard (BS) BS EN 15987 Sustainability of construction works (BSI 2011):

- Project Activity Data forming the basis of the emissions calculations as detailed in Section 2.4.2, was sourced from the documents referenced in Section 1 and the Proposed Project Planning Drawings included in the 2018 planning application, in addition to the updated Planning Drawings which form part of the Addendum; and
- Reference sources for GHG emission factors per unit of activity are included in Appendix B.

As noted in Section 2.1, the assessment of the Construction Phase embodied carbon was undertaken using a purpose-built model. A comparison of this model has been undertaken with the recently published online TII Carbon Assessment Tool (2023) to verify that the most recent emission factors and guidance have been incorporated into the model, which has been purpose built to assess the emissions from the Proposed Project.

All inclusions, exclusions, assumptions, and uncertainties of the data are detailed in Appendix A.

2.4.2 Impact Assessment Data Collection

Detailed data used in the assessment of traffic related emissions for the Construction and Operational Phases of the Proposed Project was sourced from Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 13A (Traffic and Transport) in Volume 3A Part A of this EIAR Addendum.

2.5 Appraisal Method for Assessment of Impacts

The impact assessment appraisal method reported in this Section considers the total volume of carbon anticipated to be used in the construction and operation of the Proposed Project. The IEMA GHG 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 assessment aims to 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 GHG Guidance does not recommend a particular approach for this due to variations of situations, but instead, it sets out advice for the key common components necessary for undertaking a GHG emissions assessment. During the assessment, IEMA recommend the use of a reasonable worst-case scenario rather than an absolute worst-case scenario. The IEMA GHG Guidance states that GHG emissions assessment should incorporate the six steps (detailed in Section 2) into any climate assessment.

The method used to calculate the GHG emissions (or removal value) associated with the Proposed Project, in accordance with IEMA GHG Guidance, is as follows:

GHG emission factor x Activity data = GHG emission or removal

Details of the GHG emissions inventory, activity data and emissions factors applied are provided in Appendix B. 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 the IEMA GHG Guidance.

Mitigation has taken a leading role within the IEMA GHG Guidance compared to the previous edition published in 2017 (2017 IEMA guidance on Assessing Greenhouse Gas Emissions and Evaluating their Significance). Early engagement is key and therefore the mitigation measures which were considered from the outset of the Proposed Project (and to be continued throughout the Proposed Project's lifetime in order to maximise GHG emissions savings) are detailed in Section 5.

When considering the cumulative assessment, all global cumulative GHG sources are relevant to the effect on climate change and the assessment approach is outlined in Section 2.1.

The specific appraisal methods utilised in order to complete the assessment in accordance with the IEMA GHG Guidance are detailed in Section 2.5.1 and Section 2.5.2. In addition to the IEMA GHG Guidance, the Guidance from the United Kingdom Highway Agency (UKHA) Design Manual for Roads and Bridges (DMRB) - LA 114 Climate (hereafter referred to as LA114 Climate) (UKHA 2019) was consulted and this outlines a recommended approach for determining the significance of both the Construction and Operational Phase carbon effects for a large (highways) infrastructure project. Using this approach, the proposed methodology considers the overall volume of emissions (from all of the different sources of emissions set out) for the Construction Phase and the Operational Phase and provides an overall determination on whether that would be a significant effect. 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 are conducted in the same manner as for highways, rail, housing or commercial projects and developments.

The approach is based on comparing the current baseline scenario and the net project GHG emissions to the relevant carbon budgets. The sectoral carbon budgets which were published in July 2022 are detailed in Table 2.1 and Table 2.2 in Section 2.3, with an overall target of 51% reduction by 2030 and can be used for impact assessment alongside Ireland's non-ETS 2030 emissions target. A detailed discussion of the input data and appraisal methodology for both the Construction and Operational Phases is detailed in Section 2.5.1 and Section 2.5.2.

The GHG systems boundary for assessment and life cycle stages scoped in are discussed in the Section 3 and Section 4. At a high level, they include pre-construction, products utilised in construction, the construction activities, maintenance of materials during the design life of the Proposed Project, and the use of, or Operational Phase. Given the extent of the Operational Phase, LA 114 Climate states that decommissioning should be excluded from the boundary of the climate assessment. This approach is replicated in the Transport Infrastructure Ireland (TII 2022) Climate Guidance for National Roads, Light Rail, and Rural Cycleways (Offline & Greenways) – Overarching Technical Documents) (hereafter referred to as the TII Climate Guidance) (TII 2022), where it is noted that the temporal boundary of the assessment should be appropriate to the type of infrastructure being developed. In the case of the Proposed Project, the expected design life in accordance with the IS EN 1990 Basis of structural design (Eurocode) is 50 years.

2.5.1 Construction Phase Appraisal Method

2.5.1.1 Embodied Emissions During the Construction Phase

Section 3.13 of LA114 Climate (UKHA 2019) recommends that, when calculating GHG emissions for a project's life cycle, '*an industry recognised carbon calculation tool(s)*' should be used. The embodied construction emissions for the Proposed Project were calculated using the purpose-built model described in Section 2.1 and compared to the format of the online TII Carbon Tool (TII 2023). Both the purpose-built model and the TII Carbon Tool use emission factors from recognised sources including the Carbon and Price Book database (CESSM 2013). In addition, emission factors relevant to the assessment of wastewater treatment infrastructure was included, namely, the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019), CESMM4 Revised (Institute of Civil Engineers 2019), The Inventory of Carbon and Energy (ICE) database (BG10/2011) (BSRIA and Bath University 2011) and using the project phases and activity data set out in BS EN 15987 Sustainability of construction works (BSI 2011). 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 as detailed in Section 2.5. It should be noted that the online TII Carbon Tool (TII 2023) has been commissioned by TII to assess GHG emissions associated with infrastructure projects using Ireland-specific emission factors and data, and which have been adopted for the assessment of the Proposed Project emissions.

The assessment commences with the pre-construction (site clearance) stage, followed by the assessment of the embodied carbon associated with all materials used in the construction of the Proposed Project (based on the engineering design schedule of materials and quantities), the emissions during the Construction Phase activities and emissions related to waste generated during the Construction Phase.

The Construction Phase of the Proposed Project will result in GHG emissions from various sources, as detailed in Table 2.3. Embodied carbon refers to GHGs emitted during the manufacture, transport, construction and installation of building materials and equipment. As part of the Proposed Project, Construction Phase embodied GHG emissions are assessed under the following headings:

- Land Use Change;
- Manufacture of materials and transport to site;
- Construction and installation works (including excavations, construction, water usage, personnel travel); and
- Construction waste material including off site transport.

Detailed information for the Proposed Project including predicted construction material volumes were provided by the design team for the Proposed Project. The infrastructure associated with the Proposed Project is expected to have a construction and commissioning period of approximately 48 months and an expected

design life of 50 years. Standard maintenance required during the operation of the Proposed Project is considered. Given the extent of the Operational Phase (50 years), decommissioning should be excluded from the climate assessment based on references previously cited.

Table 2.3: Sources and Life Cycle Stages for the Proposed Projects Potential GHG Emissions

Emission Stage	Lifecycle Sub-Stage	Potential Sources of Emissions (Not Exhaustive)
Construction Phase	Material (Product) Embodied Emissions: including raw material supply and manufacture	• Concrete (of various compositions / grades) • Steel (of various compositions/grades/finishes) and • High Density Polyethylene (HDPE) (in process piping) • Imported virgin backfill is required (assumed generally as a gravel type aggregate).
	Transportation to Site Emissions	Transportation of construction materials to and from site including laden and unladen Heavy Goods Vehicle (HGV) movements.
	Construction Activity Emissions	• Plant machinery operation in the installation of the proposed asset. • Excavation and disposal of excavated material. • Aggregate backfilling and emissions associated with the quantity of backfill. • Laying of hardstanding areas (e.g., footpaths and road areas).
	Land Use Change	Emissions mobilised from vegetation or soil loss during construction
Operational (Use-Phase)	Fugitive Emissions	Emissions associated with the use / operation of the proposed treatment assets, and in the case of wastewater and sludge treatment the process and fugitive emissions. Examples of emissions sources include: • Operational process emissions generated via the treatment of wastewater (e.g., N_2O emissions). • Fugitive emissions, predominantly CH_4, associated with the treatment of wastewater sludges using a Thermal Hydrolysis Process (THP).
	Maintenance and Repair Emissions	Emissions associated with expected regular maintenance and repair activities and covers the materials, energy and / or chemicals used in ongoing and regular maintenance and repair activities.
	Capital Replacement Emissions	Emissions associated with regular replacement of assets / components (e.g., Mechanical, Electrical, Instrumentation, Controls, Automation (MEICA) equipment).
	Energy Emissions	Emissions associated with the operational energy requirements of proposed process and operation hours (fuel / electricity consumption).
	Chemical Emissions	Emissions associated with the required chemical consumption throughout the operation of the Proposed Project. Chemical requirements based on assumed dosage rates and approved Uisce Éireann suppliers are selected and respective transportation distances for chemical sources determined.
Opportunities for Reduction	GHG emissions potential of recovery including reuse and recycling	Emissions reduction associated with heat and energy recovery through implementation of Thermal Hydrolysis Process (THP) Reduction in emissions associated with biosolids production through use of THP and for indigenous and imported sludges Reduced chemical demand aligned with reduced biosolid production volume

2.5.1.2 Traffic Emissions during Construction Phase

The use of heavy goods vehicles (HGVs) and traffic related to transportation to site during Construction Phase activities, as set out in Table 2.3, is expected to be a source of emissions at and near the Proposed Project site, with the emission of CO_2 as the principle GHG of concern.

Due to the scale of the Proposed Project, traffic modelling was undertaken to determine the projections of HGV traffic generated during the Construction Phase as part of the EIAR in the 2018 planning application (refer to Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, supplemented by Chapter 13A (Traffic and Transport) in Volume 3A Part A of this EIAR Addendum, for detailed methodology and definition of scope of assessment) and based on the likely number of deliveries of construction materials, the removal of waste materials from the Proposed Project and the arrival and departure of workers and staff.

The change in GHG emissions due to the Construction Phase traffic impacts of the Proposed Project have been assessed based on emissions derived using the United Kingdom (UK) Government Greenhouse gas reporting: conversion factors 2022 (UK Government 2022) and Developing CO_2 Baselines – A Step-by-Step Guide for Your Local Authority (Codema 2017). The emission factors used to convert traffic-related energy use to CO_2 emissions are based on typical fuel types used for Irish infrastructure construction projects.

2.5.1.3 Land Use Changes

The land use change associated with the Construction Phase of the Proposed Project has also been assessed using the approach outlined in Table 2.3. Trees are a natural carbon sink and absorb 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 assessed using the methodology outlined in the IPCC 'Guidelines on National GHG Inventories – Chapter 4: Forest Land' (IPCC 2006) and as supplemented by the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019).

2.5.2 Operational Phase Appraisal Method

The most significant potential sources of GHG emissions for the Operational Phase of the Proposed Project are related to emissions of CO_2 associated with electricity power demand of the proposed Abbottstown pumping station, the proposed WwTP and the SHC.

In addition to electricity-related emissions, there is also the potential for fugitive process emissions of N_2O from the proposed activated sludge treatment process and, CH_4 from the anaerobic digestion and thermal hydrolysis processes.

There is also the potential for road traffic related emissions associated with the Operational Phase of the Proposed Project, including from the delivery of consumables and the import of sludges to the site, the removal of waste and solids residuals for further treatment and disposal, and workers accessing the site. Standard maintenance and repair and capital replacement required over the Operational Phase have also been considered as part of the Operational Phase emissions.

2.5.2.1 Operational Phase Power Requirements

The CO_2 (which is a GHG) generated due to the electricity power demand of the proposed Abbottstown pumping station and the proposed WwTP and SHC, 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 Energy in Ireland 2022 Report (SEAI 2022) states that the carbon intensity of electricity was 348gCO_2/kWh (grams of carbon dioxide per kilowatt hour) in 2021 which was based on Ireland's renewable energy share in electricity (RES-E) was 36.4%under the second Renewable Energy Directive (REDII) Directive (EU) 2018/2001 (recast) on the promotion of the use of energy from renewable sources. The 2021 CAP originally set a national target of up to 80% of electricity demand by renewables by 2030 for the national grid which is considered in this assessment in determining the GHG emissions and resulting impact from the Operational Phase of the Proposed Project. It is anticipated that by 2030 the carbon intensity of the national gird electricity will be 66gCO_2/kWh (Statement by CEO Electricity

Supply Board 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 pumping and aeration activities can be compared against the waste sector's carbon budget, the details of which are referred to in Section 2.3.

2.5.2.2 Operational Phase Process Emissions

The Operational Phase accounts for emissions associated with the use / operation of the proposed treatment assets, and in the case of wastewater and sludge treatment this includes both process and fugitive (direct) emissions.

This assessment accounts for the following emissions sources:

- **Liquid stream process/fugitive emissions** generated as a result of the treatment and aeration of wastewater. The Proposed Project is designed as an Activated Sludge Process (ASP) to reduce both biological and chemical oxygen demand within the wastewater and remove total suspended solids. While the plant has not been designed for nutrient removal, recent studies have indicated that the emission of N_2O may occur as a by-product of the biological treatment process. The latest 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019) indicated that the emissions factor for N_2O from secondary treatment processes is 0.016kgN_2O-N/kg N (kilograms of nitrous oxide nitrogen per kilogram of nitrogen), representing a fourfold increase on the previous factor (2006 IPCC Guidelines for National Greenhouse Gas Inventories). In addition, a factor for methane (CH_4) emitted from wastewater treatment processes has been included in this assessment based on the most recent date included in the IPCC 2019 Refinement ; and
- **Sludge stream process/fugitive emissions**, Methane (CH_4) emissions associated with the treatment of wastewater sludges are considered within the assessment using 2006 IPCC emissions factor (with now change to the emission factors in the 2019 IPCC Refinement). Within the assessment, fugitive emission associated with anaerobic digestion, biogas production, unintentional losses/leaks and sludge thickening and storages are considered.

For the purposes of this assessment, the fugitive emissions for treated effluent have been quantified based on current IPCC factors for N_2O and CH_4. They have not, however, been included in the assessment of emissions within the System Boundary (refer to Section 2.1.1) as these emissions arise as a consequence of the wastewater generated by the increasing population and will be emitted regardless of the delivery of the Proposed Project.

The system boundary applied for quantifying emissions associated with biosolids does not extend beyond transportation of the biosolids from the SHC to a further treatment location.

In relation to emissions from biosolids, the assessment includes emissions generated as a result of biological treatment of wastewater from the 500,000 PE (population equivalent) processed at Clonshaugh WwTP, and emissions generated from the treatment of 750,000 PE of biosolids at the SHC which includes 500,000 PE of indigenous biosolids from the Clonshaugh wastewater treatment process and biosolids from an additional 250,000 PE and imported from satellite plants in the region served by the Clonshaugh sludge hub.

Emissions associated with transportation of the digested dewatered sludge (both indigenous and imported) to the proposed RBSF have been included in the emissions assessment.

2.5.2.3 Traffic Emissions during Operational Phase

Estimates of the amount of HGV traffic to be generated during the Operational Phase of the Proposed Project were based on the likely quantities of waste materials that will be removed from the site (e.g., sludge, solids residuals, fats, oils and grease), and the quantity of consumables (e.g., chemicals, spares) that will be delivered to the proposed WwTP site, in addition to the arrival and departure of workers and staff. Projections of traffic generated during the Operational Phase were completed in Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 13A (Traffic and

Transport) in Volume 3A Part A of this EIAR Addendum and are considered within the traffic emissions during the Operational Phase. A detailed inventory of inclusions and exclusions is included in Appendix A.

2.6 Impact Assessment Criteria

2.6.1 Construction and Operational Phase Significance Criteria

An assessment is not solely based on whether a project emits GHG emissions alone, but how it makes a relative contribution towards achieving a science based 1.5°C aligned transition towards net zero (IEMA 2022). This updated assessment considers the significance of the predicted GHG emissions from the Proposed Project, the extent to which the emissions align with Ireland's GHG trajectory to net zero by 2050.

LA114 Climate (UKHA 2019) outlines a recommended approach based on comparing the 'Do Something' scenario and the *net* project GHG emissions to the relevant carbon budgets (Government of Ireland 2022), where available. It further 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 the Government to meet its carbon reduction targets*'.

Following the publication of the 2021 Climate Act (July 2021), sectoral carbon budgets were published by the Government of Ireland in July 2022 and are used for comparison with the net CO_2 GHG emissions from the Proposed Project in this assessment. In the case of the Proposed Project, the GHG emissions from the Construction Phase will be compared to the 'Industry' sector carbon budget and GHG emissions from the Operational Phase will be compared to the 'Other (Waste)' sector carbon budget as detailed in Section 2.3.

When considering the aspect of significance, there are three overarching principles which are particularly relevant in the IEMA Principles Series: 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, and 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 IEMA GHG 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 involves a two-stage process that defines both the magnitude of the impacts and the sensitivity of the receptors.

Following the Irish Government's declaration of a climate and biodiversity emergency in May 2019 and considering that Ireland is currently failing to meet its binding targets under the GHG Regulation, consideration regarding the **sensitivity** of the receptor is based on the approach recommended in the IEMA GHG Guidance. This approach states that the assessment of the cumulative effects of GHG emissions differs from that for other environmental topics (e.g., odour emissions or dust), as GHG emission impacts and the resulting effects

cannot be evaluated within a geographically bounded study area. All global cumulative GHG sources are relevant to the effect on climate change, and this is considered when defining the receptor (i.e., the receptor is the atmospheric concentration of GHGs, which is considered to be of 'high' sensitivity to further emissions given the severe consequences of global climate change and the cumulative contributions of all GHG emission sources). Effects of GHG emissions from specific cumulative projects in the GDA are therefore not individually assessed in this Appendix.

In relation to climate, there is no project specific assessment criteria, but determining the significance (**magnitude**) of the effects of the Proposed Project takes into account the recommended IEMA GHG Guidance which considers any embedded or committed mitigation measures that form part of the design. The levels of significance considered are:

- **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 trajectory by 2050 (i.e., when anthropogenic emissions of GHGs to the atmosphere are balanced by anthropogenic removals over a specified period) or a sectoral based transition to net zero targets, would result in a significant adverse effect. This assessment differentiates between the 'level' of significant adverse effects (e.g., 'moderate' or 'major' adverse effects) and considers the need for the Proposed Project in the context of meeting broader sustainability and environmental objectives (e.g., providing resilience, and compliance with the UWWTD). A project's impact can shift from significant adverse to non-significant effects by incorporating mitigation measures that substantially improve on 'business-as-usual' and meet or exceed the science-based emissions trajectory of ongoing but declining emissions towards net zero. Meeting the minimum standards set through existing policy or regulation cannot necessarily be taken as evidence of avoiding a significant adverse effect. This is particularly true where policy lags behind the necessary levels of GHG emission reductions for a science based 1.5°C compatible trajectory towards net zero;
- **Minor Adverse 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, would have 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 (i.e., when anthropogenic emissions of GHGs to the atmosphere are balanced by anthropogenic removals over a specified period irrespective of the time period or magnitude of offsets required) 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 substantially surpass the reduction trajectory, or substantially surpass existing and emerging policy that is compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant. It should be noted that these impacts will be reported as *Neutral* within this document; and
- **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.

Furthermore, the criteria for determining the significance of effects in this assessment are set out in TII's recent Climate Guidance document PE-ENV-01104 (TII 2022a) which ensures consistency with the terminology contained with Figure 3.4 of the updated EPA Guidelines (EPA 2022a). The significance of GHG effects set out in PE-ENV-01104 is based on IEMA GHG Guidance which is also consistent with the terminology contained within Figure 3.4 of the updated EPA Guidelines. TII (TII 2022a) states that professional judgement must be considered when contextualising and assessing the significance of a project's GHG impact. In line with IEMA GHG Guidance, TII state that the crux of assessing significance is:

> '*not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050*'.

Significance is determined using the criteria outlined in Table 2.4 (derived from Table 6.7 of PE-ENV-01104 (TII 2022a)) along with consideration of the following two factors:

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

Table 2.4: TII Greenhouse Gas Assessment (GHGA) Significance Criteria

Effects	Significance Level Description	Description
Significant Adverse	Major adverse	The project's GHG impacts are not mitigated
		The project has not compiled with d0-minimum standards set through regulation, nor provided reductions required by local or national policies
		No meaningful absolute contribution to Ireland's trajectory towards net zero.
	Moderate adverse	The project's GHG are partially mitigated
		The project has partially compiled with do-minimum standards set through regulation, and have not fully complied with local or national policies
		Falls short of full contribution to Ireland's trajectory towards net zero.
Not Significant	Minor adverse	The project's GHG emissions are mitigated through 'good practice' measures.
		The project has complied with existing and emerging policy requirements
		Fully in line to achieve Ireland's trajectory towards net zero
	Negligible	The project's GHG impacts are mitigated beyond design standards
		The project has gone well beyond existing and emerging policy and requirements
		Well 'ahead of the curve' for Ireland's trajectory towards net zero.
Beneficial	Beneficial	The project's net GHG impacts are below zero and it causes a reduction in atmosphere GHG concentration
		The project has gone well beyond existing and emerging policy and requirements
		Well 'ahead of the curve' for Ireland's trajectory towards net zero, provides a positive climate impact

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 that 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 (i.e., non-ETS emissions), are subject to Regulation (EU) 2023/857 amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement, and Regulation (EU) 2018/1999 (hereafter referred to as the 2023 Effort Sharing Regulation). The previous Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas 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 previous Effort Sharing Regulation) had set a specific target for Ireland of a 30% reduction in GHG emissions by 2030 for non-ETS emissions compared to 2005 levels.

The 2023 Effort Sharing Regulation set new national targets for Member States, revising the national GHG emission reduction target from 30% by 2030 (compared to 2005 levels) to 42% by 2030 (compared to 2005 levels). The revision was adopted as part of a package of proposals aimed at reducing the EU's emissions by 55% by 2030 (compared to 1990 levels) and alignment with the European Green Deal in order to limit warming to 1.5 degrees Celsius and align with the goal of the Paris Agreement. From CAP 2023 (Government of Ireland

2023) and in line with EU ambition, the Programme for Government – Our Shared Future (Government of Ireland 2020b) commits to achieving a 51% reduction in Ireland's overall GHG emissions from 2021 to 2030, and to achieving net-zero emissions no later than 2050.

As noted in Section 2.3 (and as recommended in the TII Climate Guidance (TII 2022)), the assessment must use sectoral, local, or national carbon budgets to contextualise the Proposed Project's GHG impact. Ireland's national and sectoral carbon budgets are used in this assessment to contextualise the magnitude of GHG emissions from the Proposed Project for both the Construction and Operational Phases, in order to demonstrate the level of impact of additional GHG emissions on Ireland's ability to meet its reduction targets.

At this stage of the Proposed Project, it should be noted that the origin of all products and materials to be procured is not known. It has been assumed, therefore, that the emissions arising from materials assessed may potentially contribute to Ireland's carbon budget thereby representing a conservative approach, which is reflected within the limitations of the assessment.

3. Baseline Environment

3.1 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'.

GHGs have different efficiencies in retaining solar energy in the atmosphere and different lifetimes in the atmosphere. 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 a 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 25 units of CO_2, and N_2O has a GWP100 of 298.

For the purposes of this assessment, the definition outlined in Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC for GHGs has been used.

In 'Annex V, C. Methodology Point 5', GHG are defined as CO_2, CH_4 and N_2O. Emissions quantities for each of these GHGs are normalised to calculate the total GHG emissions and are reported as a CO_2 'equivalent' (or CO_2e) based on the applicable GWP multiplier outlined above.

In Ireland's National Inventory Report 2023 – Greenhouse Gas Emissions 1990-2021 (hereafter referred to as the 2023 EPA GHG Inventory) (EPA 2023a), the total emissions of GHG in Ireland for 2022 (including indirect emissions from solvent use without LULUCF) were reported as 60.76 million tonnes of carbon dioxide equivalent (Mt CO_2e).

Ireland's latest emissions data is sourced from the EPA website (EPA 2023b). The data presents provisional 1990 to 2022 Inventory data (updated in July 2023) and the EPA's latest 2022 to 2030 projections estimate (updated June 2023). Ireland's latest GHG emissions (1990 to 2022) are provisional figures based on the SEAI's energy balance provided in June 2023. The figures presented hereunder represent the provisional 1990 to 2022 Inventory data updated in July 2023. From the EPA's latest emissions data, CO_2 accounted for 60.4% of total GHG emissions, while CH_4 and N_2O accounted for 29.0% and 9.4%, respectively.

The main source of CH_4 and N_2O in Ireland is from the agricultural sector with 'waste' accounting for 1.8% of the overall total N_2O emissions and 4.5% of the overall total CH_4 (EPA 2023a). In relation to emissions from wastewater treatment and discharge (category 5.D), Section 7.5 of the 2023 EPA GHG Inventory states that:

> '*the IPCC Level 3 emission source categories relevant under 5.D Wastewater Treatment and Discharge in 2021 are 5.D.1 Domestic Wastewater (CH_4) and (N_2O). Total CH_4 and N_2O emissions from these activities amounted to 156.0 kt CO_2e in 2021*'.

3.2 Existing GHG Emissions Baseline

The IEMA GHG Guidance (IEMA 2022) identifies baseline emissions as the existing and future emissions within the assessment boundary without construction and operation of the project. 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.

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*'.

Given the circumstances of Ireland's declaration of a climate and biodiversity emergency in May 2019 and the November 2019 European Parliament approval of a resolution declaring a climate and environment emergency in Europe, in conjunction with Ireland's current failure to meet its EU binding targets in the Regulation (EU 2018/842), changes in GHG emissions either beneficially or adversely are of more significance than previously viewed prior to these declarations. Thus, the baseline climatic environment should be considered a highly sensitive environment for the assessment of impacts.

The previous Effort Sharing Regulation was amended in April 2023 by the 2023 Effort Sharing Regulation and Ireland's new national target is to limit its GHG emissions by at least 42% by 2030. This new national target for Ireland will contribute to an emission reduction at EU level, in the Effort Sharing sectors, of 40% compared to 2005 levels. This revision was adopted as part of a package of proposals aimed at reducing the EU's emissions by 55% by 2030 (compared to 1990 levels) and deliver the European Green Deal.

According to projections from the EPA in relation to Ireland's Greenhouse Gas Emissions Projections 2020 – 2040 (EPA 2021), Ireland has exceeded its 2020 annual limit set under EU's Effort Sharing Decision (Decision No. 406/2009/EC on the effort of member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020) by 7.07 million tonnes CO_2eq (Mt CO_2e).

For 2022, the total national emissions were 60.76 Mt CO_2e (excluding LULUCF), as shown in Table 3.1. This represents a 1.9% decrease compared to 2021 figures. The sector with the highest emissions is agriculture at 38.4% of the total, followed by transport at 19.1%. GHG emissions from the 'Waste' sector increased by 4.9% in 2021 (0.87Mt CO_2e).

Table 3.1: Total National GHG Sectoral Emissions in 2021 and 2022 and Percentage Change

MtCO2e[1]	2021	2022	% Total 2022	% Annual Change
Agriculture	23.63	23.34	38.4	-1.2
Transport	10.98	11.63	19.1	6.0
Energy Industries	10.26	10.08	16.6	-1.8
Residential	6.99	6.11	10.0	-12.7
Manufacturing Combustion	4.61	4.29	7.1	-7.1
Industrial Processes	2.48	2.29	3.8	-7.5
F-Gases	0.74	0.74	1.2	-0.5
Commercial Services	0.76	0.77	1.3	0.2
Public Services	0.67	0.66	1.1	-1.9
LULUCF	7.34	7.31		
Waste	0.83	0.87	1.4	4.9
National Total	61.95	60.76		-1.9
National Total including LULUCF	69.29	68.07		-1.8

Note 1: Reproduced from Latest emissions data on the EPA website (EPA 2023a)

The 2022 EPA GHG Inventory (EPA 2022b) reported, under IPCC Level 3 emission source category '*5.D Emissions from Wastewater Treatment and Discharge*', that total CH_4 and N_2O emissions from these activities amounted to 160.2kt CO_2e in 2020 (it should be noted that CO_2 emissions from wastewater were not considered in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019) because these are of biogenic origin and should not be included in national total emissions).

4. Potential Impacts

In the context of the Proposed Project, the potential impact on climate change related emissions on the surrounding environment must be considered for each of two distinct phases:

- Construction Phase; and
- Operational Phase.

During the Construction Phase, the potential impacts on climate emissions are considered with respect to the embodied carbon used for the construction of the Proposed Project. This impact has been assessed using a purpose-built model to calculate emissions from a wastewater and sludge treatment facility and is based on the online TII Carbon Assessment Tool (TII 2023), as outlined in Section 2.4.2. In addition, the impact of GHG emissions due to Construction Phase traffic movements on the climate have been included in the model.

For both the Construction and Operational Phases, the following impact scenarios have been assessed:

- **Do Nothing** (DN) – In this scenario the Proposed Project is not constructed;
- **Do Something, Scenario A** – In this scenario, both the unmitigated and mitigated GHG emissions associated with the Proposed Project are quantitatively assessed, including all elements detailed in Chapter 4 (Description of the Proposed Project) in Volume 2 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 4A (Description of the Proposed Project) in Volume 2A Part A of this EIAR Addendum, and considering the study area and boundary detailed in Section 2.1; and
- **Do Something, Scenario B** – In this scenario the GHG emissions associated with a number of the reasonable alternatives considered is qualitatively evaluated in comparison to the Proposed Project, incorporating the committed mitigation measures.

4.1 Construction Phase

4.1.1 Do Nothing

Without the construction of the Proposed Project, the GHG emissions associated with the Construction Phase of the Proposed Project would not occur and the GHG emissions experienced within the study area would remain largely unchanged, resulting in a Not Significant impact, as no construction related emissions will occur.

However, it is noteworthy that, while GHG emissions will not occur within the study area if the Proposed Project is not constructed, GHG emissions will still occur somewhere because wastewater treatment infrastructure must be provided to cater for existing and future wastewater treatment requirements, in accordance the UWWTD.

4.1.2 Do Something (Proposed Project)

During the Construction Phase of the Proposed Project, works will be undertaken to construct and install both above and below ground infrastructure. The construction activities and phasing for the Construction Phase of the Proposed Project are described in greater detail in both the Outline CEMP and the Engineering Design Report submitted in the 2018 planning application, as supplemented by the Outline CEMP Addendum and Engineering Design Report Addendum in this remittal application. While the total Construction Phase period will be approximately 48 months, including a 12-month commissioning period to the final Operational Phase, individual activities will have shorter durations. The programme detailed in the Outline CEMP Addendum identifies the estimated duration of works at each sub-section. Works are envisaged to proceed concurrently on multiple work-fronts to minimise the overall construction duration.

The Construction Phase construction activities will predominately involve site clearance, earthworks and excavation, transportation of materials to and from site, construction of temporary construction compounds, trenching, horizontal directional drilling, construction of access and internal roads, foundation laying, reinforced concrete works, erection of structural frames, buildings, and tanks.

During the Construction Phase, all of these activities will have the potential to generate GHG emissions on-site.

4.1.2.1 Construction Phase Carbon Calculations

To quantify the Construction Phase embodied carbon for the Proposed Project, a purpose-built model was created (refer to Section 2.1), including Ireland-specific emission factors and data, where available.

In the purpose-built carbon assessment model, embodied carbon for the Construction Phase has been assessed based on project life cycle stages identified in BS EN 15978 Sustainability of Construction Works (BSI 2011) and the construction activities associated with each stage. Detailed project information, including tonnage of material, excavation volumes, maintenance and repair requirements, was used in the assessment of embodied carbon (refer to Appendix B (Carbon Assessment Model) of this Appendix for details of model inputs to the carbon calculations model).

The Proposed Project is estimated to result in total Construction Phase CO_2e emissions of 23.1kt embodied carbon over an estimated 48-month period, equivalent to an annualised total of 5.8kt CO_2e. As shown in Table 4.1, the assessment indicates that the key stages for GHG emissions generation are associated with the embodied carbon of the construction materials which account for 83.5% of all carbon emissions for the Construction Phase. Construction activities and transportation to (and from) site are expected to account for almost 15% of Construction Phase emissions.

Table 4.1: Construction Phase t CO_2e Emissions for the Proposed Project

Construction Phase – Stage Description	Construction Phase – Stage BS EN 15978:2011 Reference)	kt CO_2e / Total	kt CO_2e – Annualised for 48 Months	% of Total
Embodied Carbon Product Stage	A1 – A3	19.3	-	83.5
Construction Transportation	A4	1.5	-	6.5
Construction Activities	A5	1.9	-	8.3
Maintenance and Repair Allowance[NOTE1]	B2 – B3	0.4	-	1.7
Total	**-**	**23.1**	**5.8**[NOTE2]	**100**

Note 1: Includes annualised maintenance and repair allowance 2% of B2 – B3 in carbon assessment calculations.
Note 2: Annualised GHG emissions from passenger cars included in Transportation Emissions value (0.18kt CO_2e per year)

The predicted annualised embodied carbon emissions averaged over the full Construction Phase were directly compared with Ireland's annual emissions budgets and targets, namely:

- Total national GHG emissions in Ireland for 2022 (60.76 t Mt CO_2e (EPA Ireland's Latest Emissions Data updated April 2023)) (refer to Section 4.1.2.1); and
- Ireland's non-ETS 2030 target of 33,381kt CO_2e (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 2018/842 of the European Parliament and of the Council) (refer to Section 4.1.2.1).

4.1.2.2 Construction Phase Traffic

As noted in Section 2.5.1.2, due to the scale of the Proposed Project, traffic modelling was undertaken to determine the projections of construction traffic generated during the Construction Phase as part of the EIAR in the 2018 planning application (refer to Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 13A (Traffic and Transport) in Volume 3A Part A of this EIAR Addendum, for detailed methodology and definition of scope of assessment).

For the carbon assessment, the emission factors used to convert traffic-related energy use for the Construction Phase to CO_2 emissions are based on typical fuel types used for Irish infrastructure construction projects and have been assessed based on emission factors derived using both the Greenhouse gas reporting: conversion

factors 2022 (UK Government 2022) and Developing CO_2 Baselines – A Step-by-Step Guide for Your Local Authority (Codema 2017).

GHG emissions associated with expected HGV movements (principally CO_2 from fuel combustion) required to transport the materials extracted and delivered to site(s) are included within the Embodied Carbon (A1 – A3 Life Cycle Stages) assessment (refer to Appendix B of this Appendix). In addition, GHG emissions associated with passenger car journeys for construction staff travelling to and from construction sites over the entire Construction Phase period, are also included in the carbon assessment.

Passenger car emission estimates are based on predictions of the total number of two-way vehicle movements over the period as a worst-case scenario, as detailed in Chapter 13 (Traffic and Transport) in Volume 3 Part A of the EIAR in the 2018 planning application, as supplemented by Chapter 13A (Traffic and Transport) in Volume 3A Part A of this EIAR Addendum. This assumes the use of an average sized diesel car, therefore representing a highly conservative worst-case scenario. The unmitigated GHG emissions associated with passenger vehicle movements annualised for the Construction Phase are estimated at 0.18kt CO_2e per year. In the Do Something scenario, where the Proposed Project is constructed, the impact would be Moderate Adverse, Significant and Short-Term.

4.1.3 Land Use Change

For the Proposed Project, the land take will predominantly be from agricultural land to facilitate the installation of the proposed orbital sewer route and outfall pipeline route, Abbotstown pumping station, treatment facilities and temporary construction compounds. 2010/335/: Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC state that the carbon sequestration value for agriculture land (or crop land) is zero tonnes of carbon per hectare (a value which is also used in the TII Carbon Assessment Tool (TII 2023), for land principally occupied by agriculture. As the carbon sequestration value for agricultural land is zero, the land take required is not considered to impact carbon sequestration. Overall, in relation to land use change, there will be a Minor Adverse impact on carbon sequestration as a result of the Construction Phase of the Proposed Project leading to a Not Significant impact on climate.

In the Do Something scenario, where the Proposed Project is constructed, the land use change impact would be Minor Adverse, Not Significant and Short-Term.

4.1.4 Contextualisation of Construction Phase Emissions

4.1.4.1 Compatibility with National GHG Emissions and Non-ETS Targets

As calculated using the purpose-built carbon assessment model, the Proposed Project will result in total Construction Phase GHG emissions of 23.1kt CO_2e over a four-year period, equivalent to an annualised total of 5.8kt CO_2e, or 0.017% of Ireland's non-ETS 2030 target or 0.0095% of the national GHG emissions (in 2022). Over the predicted 50-year design life, the annualised emissions due to the initial Construction Phase and ongoing maintenance of the Proposed Project will reach at most 0.0014% of Ireland's non-ETS 2030 emissions target.

4.1.4.2 Compatibility with Sectoral Budgets

In 2022, the Irish Government introduced a 2030 'Industry' sector carbon budget emissions cap of 24Mt CO_2e which has been determined as being compatible with net zero and international climate commitments. The 24Mt CO_2e carbon budget for the five-year period between 2026 and 2030 aligns with the Construction Phase of the Proposed Project, which equates to an emission ceiling of 4.8Mt CO_2e per year (or 4,800kt CO_2e per year). The percentage contribution of the annualised carbon emissions from the Proposed Project is estimated to be 0.12% of Ireland's 2030 'Industry' sector carbon budget.

4.1.5 Do Something (Alternatives Considered)

In accordance with the UWWTD, wastewater treatment infrastructure must be provided to cater for both current and projected future demand. GHG emissions will occur as a result of the Construction Phase activities required to construct the assets. Chapter 5 (Consideration of Alternatives) in Volume 2 Part A of the EIAR submitted in the 2018 planning application, as supplemented by Chapter 5A (Consideration of Alternatives) in Volume 2A Part A of this EIAR Addendum, looked at feasible alternatives taking a balanced approach with respect to buildability, land take and disruption during construction. The complexity associated with constructing some of the alternative options considered (e.g., the provision of approximately 850 new, small scale WwTPs to provide an equivalent level of treatment), would necessitate greater land take, greater quantities of materials, higher volumes of traffic distributed across a wider area and would lose the benefits of constructing a larger, regional facility.

For each of the comparable large scale alternative scenarios considered, the materials and activities necessary to construct the infrastructure would be the same but would differ principally in the location where the assets are constructed. Therefore, a comparison of the GHG emissions from the Proposed Project relative to the alternative solutions is considered to be the same with no quantifiable difference in the GHG emissions from the various configurations.

In the Do Something scenario, where alternatives to the Proposed Project are constructed, the impact would be Moderate Adverse, Significant and Short-Term.

4.1.6 Summary of Construction Phase Potential Impacts

Based on the current design details, the sum of the total Construction Phase related unmitigated GHG emissions, including future maintenance, is 23.1kt CO_2e. Over the predicted 50-year design life, the annualised emissions due to the initial Construction Phase and ongoing maintenance of the Proposed Project are estimated to be 0.0014% of Ireland's non-ETS 2030 emissions target or 0.12% of the 'Industry' sector carbon budget. A conservative approach has been taken in assessing the construction materials that will be used for the Proposed Project.

The Proposed Project represents a significant wastewater infrastructure project, and the embodied carbon emissions are indicative of construction activity related emissions for projects of this scale. The relative impact of the Construction Phase for the alternative scenarios considered for the Proposed Project is considered to be the same since the principal activities would remain the same and there would be no quantifiable difference in the GHG emissions for the different configurations.

Considering the aspect of significance, the IEMA GHG Guidance approach (IEMA 2022) states that GHG emissions have a combined environmental effect that is approaching a scientifically defined limit, and as such, any GHG emissions or reductions from a project may be considered as significant. The IEMA GHG Guidance further advises that the significance criteria for impacts must be taken from the project as a whole over its life cycle rather than from individual elements.

Therefore, the potential impact to climate of the Construction Phase of the Proposed Project, prior to mitigation, will be Moderate Adverse, Significant and Short-Term.

Mitigation will nonetheless be implemented in order to minimise the contribution of the embodied carbon due to construction materials and transportation activities (refer to Section 5.2).

4.2 Operational Phase

For the Operational Phase, the potential unmitigated and mitigated impact scenarios referred to in Section 4.1 have been considered. The Proposed Project is expected to have a design life of 50-years and will provide centralised wastewater treatment for 500,000PE and a sludge treatment facility for 750,000PE capable of recovering heat and energy to produce renewable electricity on-site.

4.2.1 Do Nothing

Should the Proposed Project not proceed, the Do Nothing scenario represents a scenario whereby the GHG emissions related to the Operational Phase would not occur. Under this scenario, the GHG emissions experienced within the study area will remain largely unchanged based on the current population figures.

However, as the population within the agglomeration increases, aligned with forecasted growth, the volume of wastewater generated will increase concurrently. Even with embedded planning commitments to upgrade the eight existing WwTPs within the agglomeration to their ultimate capacity, it is anticipated that projected population growth will exceed the committed upgrade capacity by 2025. This additional wastewater load will place undue pressure on existing infrastructure, posing a risk to optimal operation and consistent compliance. Where untreated wastewater enters surface waters, GHGs are emitted as organic material breaks down and releases N_2O and CH_4.

In the absence of the Proposed Project, the following would not be provided:

- Resilient infrastructure aligned with the aims of the Greater Dublin Strategic Drainage Strategy (GDSDS) (Dublin Drainage Consultancy 2005) to provide an environmentally sustainable Regional Drainage Strategy consistent with the WFD;
- Compliance with the requirements of the UWWTD; and
- Assistance to the completion of Action AD/23/14 (Chapter 22 Adaptation of CAP 2023 (Government of Ireland 2023)) to improve the resilience of Ireland's water infrastructure to the impacts of climate change.

Chapter 5 (Consideration of Alternatives) in Volume 2 Part A of the EIAR submitted in the 2018 planning application, as supplemented by Chapter 5A (Consideration of Alternatives) in this EIAR Addendum, details five Major Negative impacts under Environmental Objectives including Biodiversity, Population and Human Health, Water, Air Quality and Material Assets, in the absence of the Proposed Project.

In the Do Nothing scenario, in the absence of the Proposed Project, the climate impact would be Major Adverse, Significant and Long-Term.

4.2.2 Do Something (Proposed Project)

The Proposed Project includes Anaerobic Digestion (AD), a Thermal Hydrolysis Process (THP) and a Combined Heat and Power (CHP) unit for the generation of renewable power through the recovery of heat and energy from the sludge treatment process. To reduce the impact on the climate, the Proposed Project comprises embedded design measures which minimise GHG emissions from the Operational Phase. This Section outlines both the unmitigated and mitigated operational emissions to exemplify the benefits of the Proposed Project design. To reduce the impacts of the Proposed Project a centralised sludge treatment option has been selected as a measure to optimise regional sludge management presenting an opportunity to provide an advanced treatment processes which produces less biosolids and maximises energy recovery potential. The Proposed Project therefore provides a high quality advanced THP system which benefits from economies of scale and is designed to maximise the production and recovery of biogas from both the indigenous and imported biosolids produced.

4.2.2.1 Emissions in the Absence of Embedded Design Measures

The operational carbon in the absence of embedded design measures has been assessed for the Proposed Project based on the purpose-built calculation tool described in Section 2.5. The operational carbon in the absence of embedded design measures represents a scenario without either advanced sludge pre-treatment (THP and AD) or on-site heat and energy recovery. The breakdown of the emission sources for this scenario is shown in Table 4.2. The assessment indicates that GHG emissions from both process and fugitive emissions (CH_4 and N_2O) account for over 94% of emissions in the absence of embedded design measures.

Table 4.2: Operational Phase t CO_2e Emissions for the Proposed Project in the Absence of Embedded Design Measures

Operational Phase – Stage Description	Operational Phase – Stage (BS EN 15978:2011 Reference)	kt CO_2e / 50 Years	kt CO_2e – Annualised for 50 Years	% of Total
Process / Fugitive (Direct) Emissions	B1	706.34	14.1	94.5
Energy	B6	23.41	0.5	3.1
Chemical Usage	B8	18.15	0.4	2.4
Total	**-**	**747.90**	**15.0**	**100**

The assessment of direct (process and fugitive) emissions for the Proposed Project are based on emission factors for N_2O emitted due to biological treatment (i.e., 1.6%N_2O-N/$TN_{incoming}$) and is assumed as per the current IPCC factor in Table 6.8A of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019), which is considered to be aligned with available global science. As calculated using the purpose-built tool, the Proposed Project, in the absence of embedded design measures will result in Operational Phase emissions of 747.90kt CO_2e over its 50-year design life, which is equivalent to an annualised total of 0.05% of Ireland's non-ETS 2030 target, based on annualised emissions of 15.0kt CO_2e.

In the Do Something scenario, where the Proposed Project is operational in the absence of embedded design measures, the impact would be Moderate to Major Adverse, Significant and Long-Term.

4.2.2.2 Emissions with the Inclusion of Embedded Design Measures

In order to minimise the contribution of the operational carbon from the Operational Phase of the Proposed Project, design measures have been embedded within the selected option to reduce the impact of the anticipated emissions.

As noted in Section 4.2.2, the Proposed Project consists of a centralised sludge treatment option (SHC), co-located with the proposed WwTP facility in Clonshagh. This option has been selected to facilitate the provision of an advanced sludge treatment and renewable energy facility benefitting from the economies of scale provided by treating sludge generated by a population equivalent of 750,000PE (including a 250,000PE imported sludge capacity).

The provision of an AD, THP and CHP process would be considered best practise for a treatment works at the scale of the Proposed Project. The key emissions benefit for the Proposed Project are achieved through the provision of advanced and sustainable sludge treatment (through the implementation of the SHC), and heat and energy recovery, for the sludges imported from municipal wastewater sludge and domestic septic tanks generated in Fingal which would otherwise have a lower level of sludge treatment most likely without energy recovery. A comparison between the emissions in the absence and presence of embedded design measures is shown in Table 4.3.

Table 4.3: Operational Phase tCO_2e Emissions (With and Without Embedded Design Measures) Over the Proposed Project 50-Year Design Life

Operational Phase – Stage Description	Impact Source	kt CO_2e / 50 Years
Without Embedded Design Measures	Process / Fugitive (Direct) Emission	706.34
With Embedded Design Measures		646.9
Emission Reduction		-59.5
% Change		-8.42%
Without Embedded Design Measures	Energy (Indirect) Emissions	23.4
With Embedded Design Measures		16.8
Emission Reduction		-6.6
% Change		-28.2
Without Embedded Design Measures	Chemicals (Indirect) Emissions	18.15
With Embedded Design Measures		13.6
Emission Reduction		-4.55
% Change		-25.1%
Without Embedded Design Measures	Total	747.90
With Embedded Design Measures		677.3
Emission Reduction		-70.6
% Change		-9.4%

As outlined in Table 4.3, the indirect emissions associated with energy use will reduce by an estimated 28% as a result of the benefits of recovering heat and power from the treatment process. Over half of the Proposed Project's energy demand will be met through on-site generation, which will reduce demand on the national grid. In addition, the application of sludge pre-treatment, consisting of the THP with AD, will result in a 50% reduction in the volume of biosolid mass (tonnes of dried solids produced) resulting in a proportional reduction of direct emissions from the thickening and storage of sludge on-site.

In the Do Something scenario, where the Proposed Project is operational with embedded design measures, the impact would be Moderate Adverse, Significant and Long-Term.

4.2.3 Land Use Change

In the Do Something scenario, where the Proposed Project is operational, the land use change impact would be Minor Adverse, Not Significant and Long-Term.

4.2.4 Contextualisation of Operational Emissions

At present, an estimated 80% of the population in Ireland is connected to the public wastewater sewer network, which equates to a population equivalent of 4,024,000PE. The Proposed Project infrastructure will provide treatment capacity representing an estimated 10% of the national connected load by 2050, based on Central Statistics Office (CSO) moderate projections for 2051 (CSO 2016).

4.2.4.1 Compatibility with National GHG Emissions and Non-ETS Targets

As calculated using the purpose-built carbon assessment model, the Proposed Project (with the inclusion of embedded design measures) will result in total Operational Phase GHG emissions of 677.3kt CO_2e over a 50-year period, equivalent to an annualised total of 13.5kt CO_2e, or 0.04% of Ireland's non-ETS 2030 target or 0.022% of the national GHG emissions (in 2022).

4.2.4.2 Compatibility with Sectoral Budgets

In 2022, the Irish Government introduced a 2030 'Other (Waste)' sectoral carbon budget emissions cap of 4Mt CO_2e, which has been determined as being compatible with net zero and international climate commitments. The 4Mt CO_2e carbon budget for the five-year period between 2026 to 2030 aligns with the commencement

of the Operational Phase of the Proposed Project, which equates to an emission ceiling of 0.6Mt CO_2e per year (or 600kt CO_2e per year) by 2030. The percentage contribution of the annualised carbon emissions from the Proposed Project are estimated to be 2.25% of Ireland's 2030 'Other (Waste)' sectoral carbon budget.

As noted in Section 2.5.2.2, the N_2O emissions from the reduction of total nitrogen in the discharged treated wastewater is not included in the system boundary assessment (as the emissions are likely to occur beyond the study area). However, these emissions have been quantified in order to understand the whole life cycle carbon emissions associated with the discharged treated wastewater. The inclusion of the annualised emissions relating to the N_2O emitted from discharged treated wastewater will increase the contribution to an estimated 2.5% of Ireland's 2030 'Other (Waste)' sectoral carbon budget.

As noted in Section 4.2.4, the Proposed Project will provide capacity for the treatment of municipal wastewater for an estimated 10% of the national connected load.

4.2.5 Do Something (Alternatives Considered)

As noted in Section 4.1.5, wastewater treatment infrastructure must be provided to cater for both the current and projected future demand in accordance with the UWWTD, to a level of secondary treatment for agglomerations above a threshold of 10,000PE. Alternative design solutions to the Proposed Project were considered and are detailed in Chapter 5 (Consideration of Alternatives) in Volume 2 Part A of the EIAR submitted in the 2018 planning application, as supplemented by Chapter 5A (Consideration of Alternatives) in Volume 2A Part A of this EIAR Addendum.

It is noteworthy that regardless of the configuration of the preferred option (i.e., whether the option comprises multiple small scale or a single centralised large scale facility), both embodied and operational GHG emissions would be emitted. The quantity of GHG emissions from each alternative would be similar, as the emissions are related to both construction and operational activities necessary to treat wastewater and sludge from a defined population equivalent (which remains unchanged across all alternatives considered).

Each of the larger scale feasible alternatives considered included the provision of a single, regional WwTP, the provision of an orbital sewer with a raw water pumping station, a centralised secondary treatment plant, a SHC with capability for heat and energy recovery and a marine discharge pipeline.

For each of the comparable large scale alternative scenarios considered, the principal wastewater and sludge treatment processes were similar but would potentially differ in relation to configuration. In relation to efficiencies at scale, the provision of a large scale centralised system for wastewater and sludge treatment was considered the most advantageous option to maximise the opportunity to recover heat and energy from the process, reduce the volume of biosolids produced and reduce the resultant transport and disposal vehicle movements. Therefore, the provision of a centralised, regional option would generate lower GHG emissions from the Operational Phases

The operational emissions for each of the large scale alternatives considered are comparable to the Proposed Project as the energy demand, process emissions and biosolids production rates are based on the relative emissions per population unit served.

In the Do Something scenario, where alternatives to the Proposed Project are operational, the impact would be Moderate Adverse, Significant and Long-Term.

4.2.6 Summary of Operational Phase Potential Impacts

The potential GHG emissions from both direct and indirect emissions for the Operational Phase of the Proposed Project have been assessed.

During the Operational Phase of the Proposed Project the dominant source of GHGs will be as a result of direct emissions (predominantly process and fugitive emissions of CH_4 and N_2O). Additionally, GHGs will be indirectly emitted (as CO_2) resulting from the plant's energy and chemical demand.

4.2.6.1 Process / Fugitive Emissions

The proposed WwTP has been designed as a secondary treatment process with a tertiary disinfection stage (ultraviolet treatment) to achieve an effluent quality standard of 25mg/l (milligrams per litre) BOD (Biochemical Oxygen Demand), 35mg/l total suspended solids and 125mg/l of COD (Chemical Oxygen Demand), discharging to a marine environment and without a nutrient removal requirement. The science base continues to grow in the understanding of N_2O emissions from secondary treatment processes. As the proposed WwTP is not designed to nitrify (i.e., removal of nutrients), it is described as a carbonaceous plant. Theoretically, carbonaceous plants should not nitrify or emit N_2O, but evidence shows that carbonaceous plants can inadvertently nitrify. Adopting a conservative (worst-case) approach, therefore, the emission factor for N_2O emitted due to secondary treatment is assumed as per the current IPCC factor in Table 6.8A in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019). This assumption is considered to be aligned with available global science but recognises the risk that exists as the proposed WwTP is brought into service with the potential to partially nitrify. While recognised as a risk, an opportunity also exists to provide the operational and process flexibility to support a carbonaceous-only WwTP in accordance with regulatory requirements (refer to Section 5.3 for details of mitigation measures to minimise N_2O emissions from the secondary treatment process).

4.2.6.2 Energy Emissions

Indirect emissions associated with the energy usage for the Proposed Project have been directly reduced by the inclusion of heat and energy recovery capacity which can satisfy over 50% of the facility energy demand. The renewable energy produced on-site by an enhanced energy recovery process (AD, THP and CHP units) will provide some offset in relation to electricity demand. To maximise the benefit of heat and energy recovery, the Proposed Project is designed to treat both indigenous sludge (500,000 PE from the Clonshagh agglomeration) and imported dewatered sludges for an additional 250,000PE from surrounding satellite facilities.

In addition, to reduce energy demand, the plant equipment, buildings and systems associated with the Proposed Project will be designed, equipped, operated and maintained in such a manner to ensure a high level of energy performance with efficient use of energy. The Proposed Project complies with the requirements set out in IS399 Energy Efficient Design Management (SEAI 2014) and will account for the requirements of the proposed amendments to the Energy Performance of Buildings Directive by way of Revised Directive 2023/1791 came into effect on 10 October 2023 which are aimed at ensuring buildings are categorised as zero-emission buildings by 2030 for new builds and 2050 for existing buildings. This update will be considered at the next phase of the design of the Proposed Project.

The energy recovery process units have been sized to accommodate 750,000PE of sludge. Energy included in biogas produced by the installation will be partly consumed (approximately 35%) to maintain the temperature for the THP, and partly (approximately 65%) to produce heat and electricity in the CHP units. Hence, the use of biogas produced on-site will eliminate the need for a natural gas supply and will reduce the demand on grid energy providing both energy and emissions benefits. In addition to the on-site production of heat and power, based on the timeline for the decarbonisation of the national grid, it is anticipated that the associated electricity emission factors will reduce to 0.066kgCO_2e/kWh (kilograms of carbon dioxide per kilowatt hour) by 2030 [source: statement by ESB Chief Executive at EPA Climate Conference 2023]. This reduced emissions factor has been assumed within the carbon model and applied to the anticipated emissions from year-one of the Operational Phase for the design life of the Proposed Project.

4.2.6.3 Biosolids Emissions

In addition to emissions from the secondary treatment process, direct emissions will also be generated from the sludge treatment processes and storage. Using enhanced sludge pre-treatment processes (i.e. THP with AD), the volume of biosolids produced can be reduced up to 50% (based on tonnes of dried solids produced). A reduction in sludge production will result in a consequential reduction in associated process and fugitive emissions, a reduction in the embodied emissions resulting from chemical demand and a reduction in emissions from the transportation of the final biosolids product to the final destination for storage (i.e., the

RBSF). As outlined in Table 4.3, a reduction of emissions associated with chemical demand by almost 25% can be achieved using the sludge pre-treatment processes (THP with AD).

4.2.6.4 Overall Operational Phase Emissions Potential Impacts

As outlined in Table 4.3, a comparison between the unmitigated and mitigated scenarios, reported as kt CO_2e, indicates a potential 9.4% decrease in total emissions for the Operational Phase of the Proposed Project, equating to 1.4kt CO_2e per annum.

Based on the contribution of each of the key sources of GHG emissions from the Proposed Project as outlined in Section 4.2.6.1 to Section 4.2.6.3, the potential impact to climate of the Operational Phase of the Proposed Project, prior to mitigation, will be Moderate to Major Adverse, Significant and Long-Term.

5. Mitigation and Monitoring Measures

The mitigation measures which will reduce GHG emissions, formulated for both the Construction and Operational Phases of Proposed Project, are differentiated within this Section, as follows:

- Committed embedded design measures within the Proposed Project design (refer to Section 4.2.2.2 and Section 4.2.6.1 to Section 4.2.6.3);
- Mitigation measures formulated for the Construction and Operational Phases of the Proposed Project included as part of the EIAR submitted in the 2018 planning application; and
- Additional mitigation measures recommended as part of the assessment completed for this EIAR Addendum.

It is key to note that some of the mitigation measures detailed in Chapter 24 (Summary of Mitigation Measures) included in Volume 3 Part A of the EIAR in the 2018 planning application already support the reduction of carbon emissions from the Proposed Project.

In addition, Chapter 9 of the GDD Engineering Design Report (included as a standalone document in the 2018 planning application), as supplemented by the Addendum to the Engineering Design Report included as a standalone document in this Addendum, details some of the sustainable design elements which are already integrated into the Proposed Project and support the reduction of carbon emissions in the Construction and Operational Phases. The sustainable design elements are detailed in the following sections.

5.1 Embedded Design Measures

The Proposed Project will incorporate a number of committed embedded design measures with respect to the Construction and Operational Phases which will contribute to the reduction of its impact on climate related GHG emissions.

The embedded design measures incorporated within the Proposed Project design are detailed in Section 4.2.2.2, and Section 4.2.6.1 to Section 4.2.6.3 of this Appendix.

5.2 Construction Phase Mitigation Measures

The embodied carbon of construction materials, transportation and activities will be the dominant source of GHG emissions as a result of the Construction Phase of the Proposed Project.

5.2.1 Embodied Carbon

The main source of GHG emissions from the Construction Phase will be the embodied carbon of the construction materials, activities and waste emissions associated with the Proposed Project.

5.2.1.1 Mitigation Measures (Included in the EIAR in the 2018 Planning Application)

The following mitigation measures were included in the EIAR in the 2018 planning application and will be incorporated into the Proposed Project to support the reduction of embodied carbon associated with the Construction Phase:

- At the next stage of design, measures will be taken to optimise the use of materials and select low carbon materials;
- Materials will be reused as much as possible (including excavated rock, topsoil) within the extent of site(s); and
- Sections of the proposed orbital sewer route which have the potential to result in significant waste generation will be constructed using trenchless methods.

5.2.1.2 Additional Mitigation Measures for this EIAR Addendum

The following additional mitigation measures will be incorporated into the Proposed Project and will support the reduction of embodied carbon associated with the Construction Phase:

- A whole-life Carbon Management Plan will be implemented and will be aligned to the revised PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023). Through carbon management planning, emissions reduction actions can be identified early to inform design solutions with low embodied carbon and that are aligned with targets set in Chapter 13 Industry, Table 3.5 Key Metrics to Deliver Abatement in Industry of the CAP 2023 (Government of Ireland 2022b);
- Lifecycle assessments for major asset components will be undertaken and recommendations will be implemented to influence the procurement of low carbon / sustainable / locally sourced materials and equipment, where possible; and
- Materials procured for major asset components will have verified Environmental Product Declarations (EPDs).

5.2.2 Traffic Emissions Mitigation Measures

The construction traffic GHG emissions associated with the Construction Phase of the Proposed Project will be short-term and temporary in nature. Construction vehicles, staff transport and Construction Phase generators will give rise to the majority of emissions of CO_2 or N_2O, the assessment of which is included in the Construction Phase carbon assessment for stages A1 to A5 (refer to Table 4.1) of the Proposed Project.

5.2.2.1 Mitigation Measures (Included in the EIAR in the 2018 Planning Application)

The following mitigation measures included in the EIAR in the 2018 planning application will be implemented and will support the minimisation and reduction of emissions:

- All construction vehicles will switch off engines when not active;
- All plant and machinery will be maintained and serviced regularly;
- Movement of construction traffic around Proposed Project sites will be minimised; and
- The appointed contractor(s) will organise shuttle / minibuses to reduce the number of passenger cars required for construction staff workers travelling to and from site (refer to Chapter 13 (Traffic and Transport) of the EIAR in the 2018 planning application). In addition, the appointed contractor(s) will prepare a Construction Traffic Management Plan (CTMP) to minimise traffic impacts and associated increased emissions during the Construction Phase.

5.2.2.2 Additional Mitigation Measures for this EIAR Addendum

The following additional mitigation measures will be incorporated into the Proposed Project and will support the reduction of transport emissions associated with the Construction Phase:

- The appointed contractor(s) will comply with the latest EU regulations relating to CO_2 emission performance standards for new passenger cars and new light commercial vehicles for Construction Phase activities. The most recent standards in force at the time of writing for emissions from on-road vehicles, including passenger vehicles and shuttle buses for staff transportation, is Regulation (EU) 2023/851 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2019/631 as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition.

5.2.3 Summary of Construction Phase Impacts Following the Implementation of Mitigation Measures

The GHG emissions associated with the Construction Phase of the Proposed Project will be short-term and temporary in nature. The appointed contractor(s) will update and finalise the CEMP and CTMP to recognise and include the need to manage GHG emissions during the Construction Phase. An Outline CTMP and CEMP

were included in the 2018 planning application, and the Outline CEMP has been supplemented by the Addendum to the Outline CEMP in this Addendum. Based on annualised GHG emissions and considering the mitigation measures described in Section 5.2.1 and Section 5.2.2 of this Appendix, the predicted impacts to climate across the timeframe of the Proposed Project due to the Construction Phase will be Minor Adverse, Not Significant and Short-Term.

Table 5.1: Summary of Predicted Construction Phase Impacts Following the Implementation of Mitigation Measures

Assessment Topic	Potential Impact (Pre-Mitigation)	Predicted Impact (Post-Mitigation)
Embodied Carbon	Moderate Adverse, Significant and Short-Term	Minor Adverse, Not Significant and Short-Term
Traffic Emissions	Moderate Adverse, Significant and Short-Term	Minor Adverse, Not Significant and Short-Term
Combined Construction Emissions	Moderate Adverse, Significant and Short-Term	Minor Adverse , Not Significant and Short-Term

5.3 Operational Phase Mitigation Measures

As outlined in Section 4.2.6, the key sources of emissions during the Operational Phase will be related to direct (process and fugitive) emissions, energy use and chemical demand.

5.3.1 Mitigation Measures

5.3.1.1 Mitigation Measures (Included in the EIAR in the 2018 Planning Application)

The following mitigation measure was included in the EIAR in the 2018 planning application and will be implemented to mitigate operational carbon, and is as follows:

- It is recommended that advanced anaerobic digestion be utilised in the sludge treatment process to recover energy from the sludge and reduce the volume of the sludge, following which the material can be dewatered and treated to produce a biosolid end product suitable for reuse in agriculture. The biogas produced during the treatment process will be used on-site for energy recovery.

5.3.1.2 Additional Mitigation Measure for this EIAR Addendum

The following additional mitigation measures will be incorporated into the Proposed Project and will support the reduction of emissions associated with the Operational Phase:

- A whole-life Carbon Management Plan will be implemented and will be aligned to the Revised PAS 2080:2023 Carbon Management in Buildings and Infrastructure (BSI 2023) to inform the operation of the Proposed Project using a purpose built carbon assessment tool and aligned to an industry adopted and verified assessment tool such as TII's online Carbon Assessment Tool (TII 2023);
- Net zero for operational emissions in relation to both process and energy related emissions will be supported through energy demand reduction, increased energy efficiency, maximisation of energy recovery, implementation of a carbonaceous-only biomass control mode and implementation of process control optimisation to reduce the volume of biosolids production;
- Provision of operational and process flexibility to support a carbonaceous only WwTP in accordance with regulatory requirements will be catered for. This will focus on the optimisation of both design and operational processes which will facilitate a low sludge retention time, minimising the risk of nitrification. This measure represents a significant opportunity to reduce process emissions from the wastewater treatment process. By operating the treatment process in a carbonaceous mode, the risk of inadvertent production of N_2O gas will be reduced;
- A comprehensive Operational Commissioning Plan will be developed by the appointed contractor, as is normal practice, and implemented to demonstrate that the proposed WwTP is brought online in a carbonaceous mode (BOD removal only to intentionally avoid nitrification);

- The fugitive emissions will be minimised via design technologies and will be managed by Uisce Éireann and its site operator during the Operational Phase; and
- Scheduled capital replacement and regular planned maintenance will minimise the potential for unintentional releases and leaks from process units, pipework and fittings.

In line with the NPF (Government of Ireland 2020a), the Proposed Project will deliver a renewable energy use solution through on-site energy recovery and power generation. This is in alignment with National Policy Objective 55 (referred to in Section 11.2.3 and Section 12 of the Climate Action Plan 2023 (Government of Ireland 2023)) seeking to meet national objectives towards achieving a low carbon economy.

In addition, the Proposed Project will support National Policy Objective 56 to sustainably manage waste generation and support circular economy principles by providing an enhanced sludge treatment process (THP) which will reduce the volume of biosolids produced by 50%, resulting in the reduction of both transportation and chemical demand associated with the management of the biosolid produced. The biosolid produced will further support both circular and bioeconomy processes by producing a biosolid fertiliser which can replace the demand for and use of petrochemically based fertiliser products, manufactured outside of Ireland.

5.3.2 Summary of Operational Phase Emissions Impacts following Mitigation

On 27 October 2022, following consultation with stakeholders and the general public, the European Commission published its proposal for a revised Urban Wastewater Treatment Directive (the Recast Directive). The Recast Directive proposes to bring in changes to increase the standard of wastewater treatment required across the EU, and support the transition forwards a circular economy and energy neutrality by 2040. The Recast Directive proposes amongst other matters, to add the objective of nutrient recovery, and tighten phosphorus removal requirements for sewage works. The Recast Directive is still in draft form and likely to be subject to further debate and revision before it is adopted and comes into force on a phased basis. Precisely what will be required and by when is therefore unknown at this point in time. Uisce Éireann has, as part of its site selection process, sought to ensure that the site selected for the proposed WwTP (at Clonshagh) is sized so as to allow for such expansion or adaptation as may be required in the future. The Proposed Project site will likely be sufficient to accommodate any additional treatment infrastructure required to meet the requirements of the Recast Directive. Once those requirements are known and in force, a separate planning application, supported by an EIAR and NIS as needed, will be made for any consequential works required including at the proposed WwTP.

Table 4.3 of Section 4.2.2.2 details the annual GHG emissions from the Proposed Project based on emission factors detailed in Appendix B of this Appendix. The annualised GHG emissions for the Operational Phase including mitigation measures are 13.8ktCO_2e and represent a 9.5% reduction compared to the unmitigated GHG emissions. These emissions have been compared with the estimated total GHG emissions in Ireland in 2021, Ireland's non-ETS emissions for 2030 and the 'Waste' sectoral carbon budget for 2030 (refer to Section 4.2.4).

The predicted impacts to climate over the lifetime of the Proposed Project due to the Operational Phase, following the implementation of mitigation measures, will be Moderate Adverse, Significant and Long-Term.

Table 5.2: Summary of Predicted Operational Phase Impacts Following the Implementation of Mitigation Measures

Assessment Topic	Potential Impact (Pre-Mitigation)	Predicted Impact (Post-Mitigation)
Process / Fugitive Emissions	Major Adverse, Significant and Long-Term	Moderate, Significant and Long-Term
Energy Emissions	Moderate Adverse, Significant and Long-Term	Minor Adverse, Not Significant and Long-Term
Biosolids Emissions	Moderate Adverse, Significant and Long-Term	Minor to Moderate, Significant and Long-Term
Chemical Emissions	Moderate Adverse, Significant and Long-Term	Minor to Moderate, Significant and Long-Term
Combined Operational Phase	Moderate to Major Adverse, Significant and Long-Term	Moderate Adverse, Significant and Long-Term

The potential impact assessment reflects the GHG emissions which shall arise as a result of the significant population growth projected to 2040. In accordance with the UWWTD, the provision of secondary (biological) wastewater treatment is required as a minimum for agglomerations of the scale of the Proposed Project. Process emissions (from N_2O), generated as a consequence of wastewater and sludge treatment, have high emission factors and alternatives to treat wastewater volumes at similar scales are not currently available.

While the GHG emissions from the Proposed Project are predicted to be generally significant, the co-benefits of the Proposed Project extend beyond the impact of the emissions. Providing resilient sanitation infrastructure which is designed to meet both current and future wastewater demands, with capacity to recover energy and produce a circular biosolid fertiliser product, represents a sustainable development approach.

6. Residual Impacts

6.1 Construction Phase

The Proposed Project is estimated to result in total Construction Phase GHG emissions of 23.1kt CO_2e over a 48 month construction and commissioning period, equivalent to an annualised total of 0.0014% of Ireland's non-ETS 2030 emissions target and 0.12% of Ireland's carbon sectoral ('Industry') budget for 2030. The embodied carbon emissions associated with the Construction Phase of the Proposed Project will be short-term and temporary in nature. Nevertheless, the impact on the climate, following the implementation of mitigation measures, as outlined in Table 5.1 will be Minor Adverse, Not Significant and Short-Term. The mitigation measures proposed will have the effect of reducing carbon emissions during the Construction Phase.

6.2 Operational Phase

The Proposed Project is estimated to result in total Operational Phase GHG emissions of 677.3kt CO_2e over a 50 year operational period, equivalent to an annualised total of 0.04% of Ireland's non-ETS 2030 emissions target and 2.25% of Ireland's carbon sectoral ('Waste') budget for 2030. The Proposed Project will provide treatment for municipal wastewater and sludge for a population equivalent representing over 10% of the national connected load to the public sewerage infrastructure.

The GHG emissions associated with the Operational Phase of the Proposed Project will be long-term and significant in nature. Nevertheless, there are considerable co-benefits of providing a regional secondary and tertiary treatment process (with capacity for municipal wastewater to 500,000PE and a sludge treatment to a capacity of 750,000PE), heat and energy recovery capacity, on-site power generation and minimised biosolids production, extend to supporting:

- The key WFD objectives (Article 4 of the WFD);
- The NAF (DCCAE 2018);
- The objectives of the Planning and Development Act 2000 (as amended), and
- The Policy objective PM30 of the Fingal Development Plan 2017 – 2023 which encourages '*the production of energy from renewable sources*', including CHP (this is now policy CAP13 in the recently published Fingal Development Plan 2023 – 2029 (FCC 2023)).

Mitigated operational emissions will be 0.04% of Ireland's non-ETS 2030 target and 2.25% of the sectoral carbon budget for 'Waste'. As previously noted, a further opportunity exists at detailed design stage to provide operational and process flexibility to support a carbonaceous only WwTP in accordance with regulatory requirements. If the plant can be designed in a way that supports carbonaceous treatment only (with low sludge retention times which minimise the risk of nitrification), this would result in a process capable of producing lower emissions.

Based on the analysis outlined above, the GHG emissions in kt CO2e associated with the Operational Phase of the Proposed Project, following the implementation of mitigation measures, will be Moderate Adverse, Significant and Long-Term.

7. Difficulties Encountered in Compiling Information

Throughout this assessment, efforts have been made to make conservative estimates in relation to volumes and types of materials to be used, thereby representing the most likely scenario for the assessment of embodied carbon.

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Directives and Legislation

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Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (as amended)

Decision No. 406/2009/EC on the effort of member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

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

Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast)

Number 32 of 2021 – Climate Action and Low Carbon Development (Amendment) Act 2021

Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas 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

Regulation (EU) 2023/857 amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement, and Regulation (EU) 2018/1999

Appendix A. Model Assumptions, Inclusions and Exclusions

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Appendix A: Assumptions, inclusions and exclusions for each project phase:		
Emission Stage	BSEN 15978:2011 (and PAS 2080:2016) Lifecycle Stages	Assessment Methodology
Construction	A1 – A3: Material Embodied Emissions	This lifecycle stage accounts for emissions associated with the production of the materials used within the proposed treatment assets. Examples include concrete (of various compositions/grades), steel (of various compositions/grades/finishes) and HDPE (in process piping). In some instances, imported virgin backfill is required and this is assumed generally as a gravel type aggregate. The Proposed Project design Activity Schedule details quantified information on asset size and material usage. The Activity Schedule provides sufficient detail to assess the Bill of Quantities (BoQ) of the proposed assets allowing for estimation of volume/mass of the construction materials detailed above. In each case, appropriate emissions factors (EFs) obtained from the ICE v3 Database, Highways England Carbon Tool v2.3 or the BEIS UK Government GHG Conversion Factors for Company Reporting v2 shall be used. These emission factors shall be applied to the previously calculated BoQs to determine the embodied emissions associated with each asset listed in the Activity Schedule. Where sufficient asset design information is unavailable, Uisce Eireann design specifications and/or standards shall be consulted in conjunction with accepted industry design assumptions. Material emissions associated with the proposed sewer mains installation have been determined using a Water Mains Carbon Calculator that was developed, by Jacobs, on behalf of Uisce Eireann. This tool also uses data sources as detailed above and approved Uisce Eireann mains installation specification and practices. In the assessment of process buildings, the London Energy Transformation Initiative (LETI) Climate Energy Design Guide has been used to determine the A1-A3, A4, A4 and B1-B5 carbon emissions associated per m² of building.
	A4: Transportation to Site Emissions	This lifecycle stage accounts for emissions associated with the transportation of construction materials to and from site. The assessment shall use the calculated BoQ as detailed in the A1-A3 lifecycle stage to determine the number of laden and unladen HGV movements. For each material type, a transportation distance from production source has been assumed. Transportation emissions account for 1 No. 100% laden HGV journey and 1 No. 100% unladen return journey. Where material excavation is required, as is included within the Activity Schedule description, transportation emissions associated with disposing the material to landfill shall also be included.
	A5: Construction Activity Emissions	This lifecycle stage accounts for emissions associated with plant machinery operation in the installation of the proposed asset. Emissions are predominantly associated with excavation and disposal of excavated material. Additionally, where aggregate backfilling is required, emissions associated with the quantity of backfill shall be determined. Emissions associated with the laying of hardstanding areas (e.g., footpaths and road areas) shall be determined based on hot asphalt rolling. The Civil Engineering Standard Method of Measurement (CESMM) 4 for Earthworks provides emissions factors associated with such activities and shall be used in this assessment.
Operational	B1: Fugitive Emissions	This lifecycle stage accounts for emissions associated with the use/operation of the proposed treatment assets, and in the case of wastewater and sludge treatment the process and fugitive emissions. This assessment identified the following as B1 emissions sources: i. Operational process emissions generated via the treatment of wastewater. During the operation of Activated Sludge Processes (ASP), nitrification or nitrification-denitrification processes may result in substantial nitrous oxide (N_2O) emissions[1]. A carbonaceous wastewater

[1] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge

Appendix A: Assumptions, inclusions and exclusions for each project phase:

<table>
<tr><th>Emission Stage</th><th>BSEN 15978:2011 (and PAS 2080:2016) Lifecycle Stages</th><th>Assessment Methodology</th></tr>
<tr><td></td><td></td><td>treatment process is proposed within the PP, however recent studies have indicated plants which are not designed for nitrification can also result in the emission of N_2O. These emissions shall be included within this assessment.

ii. Fugitive emissions, predominantly methane (CH_4), associated with the conveyance of wastewater via sewer mains. Whilst this is an identified source of GHG emissions, it shall not be accounted for within this assessment for the following reasons;
a. It is not currently accounted for in the globally recognised accounting methodologies, such as the IPCC.
b. Emissions factors that can be applied at a high-level have not yet been developed and further work is required to accurately estimated and validate this[2].

iii. Fugitive emissions, predominantly methane (CH_4), associated with the treatment of wastewater sludges using a Thermal Hydrolysis Process (THP). In this assessment, the Carbon Accounting Workbook (CAW) emissions factor for methane gas emissions from THP processes shall be used which is equivalent to a minimum of 2% loss from total methane production[3].</td></tr>
<tr><td></td><td>B2 & B3: Maintenance & Repair Emissions</td><td>This lifecycle stage accounts for emissions associated with expected regular maintenance & repair activities and covers the materials, energy and/or chemicals used in ongoing and regular maintenance and repair activities.

Expectedly, there is no proposed maintenance regime for the PP given the early stage of design, therefore an allowance of a minimum of 2% of each assets' A1-A3 emissions shall be used for this lifecycle stage.</td></tr>
<tr><td></td><td>B4: Replacement Emissions</td><td>This lifecycle stage accounts for emissions associated with regular replacement of assets/components. In this assessment, complete asset replacement shall be projected based on the following Minimum Design Life expectations shown in the table below:

<table>
<tr><th>Element</th><th>Minimum Required Design Life (Years)</th></tr>
<tr><td>Concrete Structures/Civil Engineering Structures</td><td>120</td></tr>
<tr><td>External/Internal Steel Walkways, Gantries, Miscellaneous Metal Work</td><td>50</td></tr>
<tr><td>Underground services (including all underground pipes)</td><td>50</td></tr>
<tr><td>Overground pipe supports</td><td>50</td></tr>
<tr><td>Piping (overground)</td><td>50</td></tr>
<tr><td>Piping (underground)</td><td>50</td></tr>
<tr><td>Roads and Footpaths</td><td>40</td></tr>
<tr><td>All MEICA equipment</td><td>20</td></tr>
<tr><td>Wearing parts other than consumable items</td><td>5</td></tr>
</table>

In this lifecycle carbon assessment, B4 emissions will be associated with MEICA equipment only, given the replacement frequency is 15 - 20 years (depending on equipment design life). B4 emissions shall be determined assuming a like-for-like replacement resulting in the same A1-A3, A4 and A5 emissions i.e. emissions factors shall not be modified to reflect new or alternative production or installation processes.</td></tr>
</table>

[2] IWA Scientific and Technical Report Series No. 26, Quantification and Modelling of Fugitive Greenhouse Gas Emissions from Urban Water Systems, Chapters 5 and 8
[3] UKWIR Quantifying and Reducing Direct Greenhouse Gas Emissions (2020), Report ref. No. CL/01/E/201

Appendix A: Assumptions, inclusions and exclusions for each project phase:		
Emission Stage	BSEN 15978:2011 (and PAS 2080:2016) Lifecycle Stages	Assessment Methodology
	B5: Refurbishment Emissions	This lifecycle stage accounts for emissions associated with planned alteration or improvement of the physical characteristics of the asset in order for it to cater for the desired future function identified and quantified at the outset[4]. Thus, given the design horizon and industry standard expected life cycle of the proposed assets, carbon emissions associated with refurbishment activities will not be included within this assessment.
	B6: Energy Emissions	This lifecycle stage accounts for emissions associated with the operational energy requirements of proposed process and operation hours. The Activity Schedule details assumed daily energy requirements which shall be used to determine the associated emissions using electricity emission factors for the design period. To provide greater assessment accuracy, additional consideration has been given to the fact the design connected load (of 500,000 PE for the WWTP and 750,000 PE for the SHC) shall reflect the loading profile in Table 3.5 of Appendix B_Appendix A14.1_Final Draft. Therefore, there will be less connected PE load from the first year of operation. Additionally, there will be some projected degree of electricity grid decarbonisation that will impact the yearly electricity emissions over the design period. Thus, the following process has been followed to provide greater calculation accuracy for this lifecycle stage: i. Using the estimated population growth figures for the Greater Dublin area, the connected load has been as per the loading profile in Table 3.5 of Appendix B_Appendix A14.1_Final Draft. ii. Applying corresponding yearly estimated electricity emissions factors based on the UK Government Green Book Guidance for Energy Use Valuation Note, the approach within this lifecycle stage is to assess the total energy demand of the PP to determine baseline emissions. A further assessment has been completed to understand the proposed renewable energy generation that will reduce the overall emissions of the PP. This assessment is included within the bespoke model.
	B8: Chemical Emissions	This lifecycle stage accounts for emissions associated with the required chemical consumption throughout the PP operation. Chemical requirements shall be based on assumed dosage rates for the projected design horizon. Similarly to the B6 energy demand assessment, chemical requirements will be prorated based on the projected load profile (as per B6(i)). Appropriate emissions factors shall be applied for the chemical production stage. Additional emissions associated with the transportation of specific chemicals to site will be determined. Approved Irish Water suppliers shall be selected and respective transportation distances for chemical sources will be determined.
Decommissioning	C1 – C4: End of Life Emissions	This lifecycle stage accounts for emissions associated with decommissioning of the PP assets. This accounts for deconstruction, transportation of plant machinery and waste disposal. Given the design horizon of the PP, C1-C4 lifecycle emissions will not be included within this assessment.

[4] Royal Institute of Chartered Surveyors (RICS) Whole Life Carbon Assessment for the Built Environment 1st Edition (2017)

Appendix B. Carbon Model

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Project Title: Greater Dublin Drainage Addendum
Client Name: Uisce Eireann
Project No.: 321120
Doc. Title: Greater Dublin Drainage (GDD) Carbon Assessment for Proposed Project
Doc. Reference: 321120-CALC-001
Date: 09.11.23
Rev: 3

Project Description

Purpose

Jacobs have been asked to provide an addendum to the 2018 EIAR Vol 3 Part A Chapter 14 Air Quality, Odour and Climate, reconsidering the climate aspects of the Proposed Project (PP) as a response to the advancement in the EIA process and evolving climate legislation since 2018. These advancements are primarily driven by the accelerating impacts of climate change and the introduction by the Irish Government of Net Zero targets by 2050 for the public sector and the introduction of legally binding GHG reduction targets.
A&L Goodbody (legal representatives) have requested the preparation of an updated EIAR Climate chapter (the addendum) which aligns with current legislation and guidance, in relation to the area of greenhouse gas (GHG) emissions.
As significant changes in climate assessment requirements have emerged since 2018, and are likely to continue to change, Jacobs recommended that IW take a proactive approach which re-examines the environmental impact of GHG emissions from the Proposed Project through the lens of the current and emerging guidance and (net zero) emissions targets.

Requirements

A phased approach was proposed which will allow a reasonable quantification of GHG emissions to be made in 2 phases to quantify and mitigate the environmental impact of the Proposed Project by firstly:

- Phase 1: Developing an updated methodology and indicative model to re-evaluate the GHG emissions from each key project element and stage and then quantifying the overall impact of the project emissions on climate change.
- Phase 2: Conduct a deeper-dive by examining reduction opportunities associated with key carbon emissions “hot-spots” that can be adopted as the project progresses e.g., use of low carbon materials, location of site compounds, use of local suppliers. These reduction opportunities can be captured and implemented within subsequent design and procurement stages of the project.

Scope of the Proposed Project

In 2018 , the scope of the planning application and EIAR submitted for the Greater Dublin Drainage Scheme (referred here as the Proposed Project, PP) is to provide wastewater infrastructure in the north and north-west of the Ringsend agglomeration to meet the drainage and treatment requirements to 2050 design horizon. The PP consists of the following main elements:

i.Proposed 500,000PE capacity activated sludge Wastewater Treatment Plant (WWTP) at Clonshaugh, Fingal
ii.Sludge Hub Centre to be co-located at same site in Clonshaugh (750,000PE capacity)
iii. Proposed orbital sewer route from Blanchardstown to Clonshaugh site
iv. Proposed pumping station at Abbottstown in grounds of the National Sports Centre
v. Odour control units at transition point between rising main from Abbottstown and gravity main to WWTP
vi. Diversion of North Fringe Sewer (NFS) to the proposed WWTP
vii. Proposed outfall pipeline from WWTP consisting of a land-based section and a marine section
viii. Regional Biosolids Storage Facility (RBSF) By others - not in scope of this assessment

All planning, design and environmental details of the PP can be found at the GDD Planning Application website:
https://www.gddapplication.ie/planning-documents/

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Document Description

The following tasks are required for Phase 1:

- Review original indicative model and scope to which the climate/emissions assessment applied.
- Define the Study Area (red line boundary of the PP)
- Establish the scope and inputs to the revised model to which the updated impact assessment will apply i.e., elements of the proposed projects to be included, project life cycle stages (from PAS2080), sources of emissions etc.
- For construction phase include all elements within red-line boundary of project and use project description, costing sheets and Construction Environmental Management Plan (CEMP) to establish construction phase activities and materials.
- For operational phase consider emissions associated with electricity demand, chemical use, transport and treatment of sludge, possible fugitive emissions etc.
- Review the updated guidance in relation to best approach for conducting carbon assessments for infrastructure projects:
- IEMA guidance, PAS2080, TII guidance document (approach likely to be adopted in Ireland as a common national approach for large public sector infrastructure projects)
- Establish the baseline conditions from which the net emissions can be determined. The task here will be to consider the net emissions which are a balance between the emissions that will be avoided using the PP design in comparison to the emissions that would be generated either by “no project” or an equivalent plant with no energy or thermal recovery provided.
- Prepare an updated methodology to outline the calculations to estimate the PP net emissions across all project phases. Specify the emission factors to be used and sources/references
- Quantify the emissions of the PP based on the updated model (see indicative model from 2018 EIAR below). Prepare visual representation of updated model inputs and outputs (based on PAS2080 and other recent guidance).
- Based on emissions assessment from the model, provide a commentary om impact of net emissions from the PP on the climate.
- Prepare a commentary on mitigation measures included in 2018 planning application and potential mitigation opportunities to be further evaluated in Phase 2.

Checking and Approval Section

	Name	Date
Prepared by:	Chris Kyne/Evelyn McAuliffe	18.04.23
Checked by:	Chris Kyne/Amanda Lake	30.06.23
Reviewed by:	Evelyn McAuliffe	25.07.23

Project Title:	Greater Dublin Drainage Addendum
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Approved by: Evelyn McAuliffe 09.11.23

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1. Model Assumptions

1. Proposed Project Assessment Boundary

The Proposed Project (PP) consists of 8 No. individual main elements as shown in Figure 1.1 below. At this time of assessment, the boundary excludes the Regional Biosolids Storage Facilty (RBSF) and any associated carbon emission associated with the construction/installation of plant, operation of plant and emissions associated wih the transportation and the derivatives of raw or treated sludge.

The assessment boundary shall assess the carbon emissions (embodied and operational) associated with each individual PP main element. This method enables the consideration of renewable energy sourcing and alternative energy source emissions across each element. The outputs of the overall assessment shall accumulate the total life cycle carbon associated with the PP.

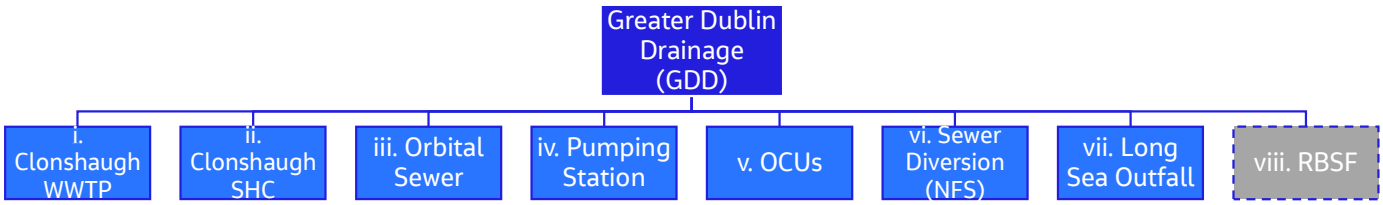

Figure 1.1 - Proposed Project (PP) Assessment Boundary Elements

2. Assessment Scope (refer to schematic below)

3. Design Assumptions

3.1 Excavation: Assume quoted footprint of asset x quoted asset depth.

4.4 Data Sources

4.1 Indicative PP Costs and Equipment/Material Summary: GDD - Phase 1 Civil & ME Capex Estimate - ASP_171023.xlsx
4.2 Greater Dublin Population Growth Figures: Table 3.3, Chapter 4 - Descriptions of the Proposed Project, EIAR: Vol 2 Part A of 6, June 2018.
4.3 UK Electricity Emission Factors: UK Government Green Book Guidance for Energy Use Valuation
4.4 Irish Water Sludge Specification
4.5 Glass Lined Steel (GLS) Tank Specification: American Water Works Association (AWWA) D103a-14 Standard for Factory-Coated Bolted Carbon Steel Tanks for Water Storage)
4.6 EPA Ireland National Inventory Report 2022 Greenhouse Gas Emissions 1990-2020 (April 2022), ISBN 978-1-80009-037-8
4.7 UKWIR Report Quanitfying and Reducing Direct Greenhouse Gas Emissions, CL/01/E/201, 2020
4.8 Regional Biosolids Storage Facility for Greater Dublin, Engineering Design Report Rtev 0, May 2018
4.9 RBSF GDD Planning Drawings (see folder)

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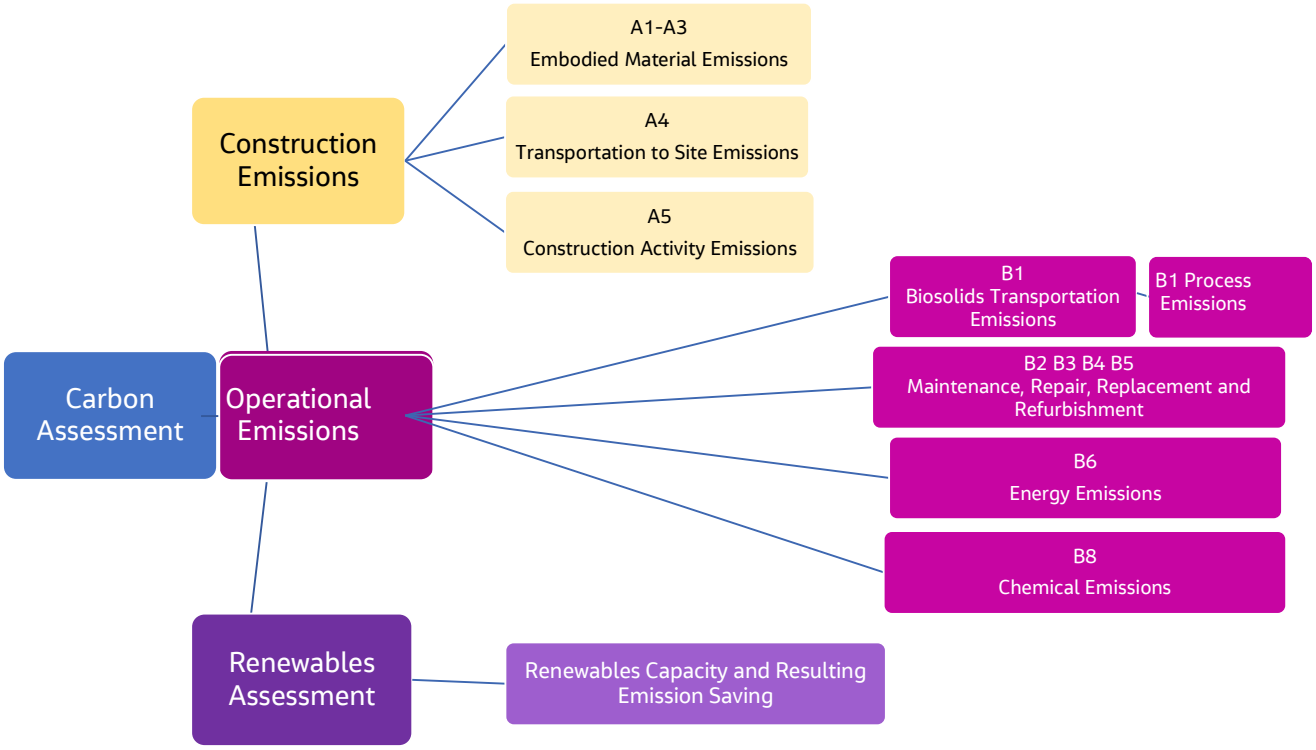
(2. Assessment Scope Diagram)



Assessment Overview, Calculation Methodology, Assumptions and References

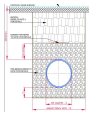
Carbon Lifecycle Category	Ref.	Details
A1-A3	1.01	Embodied A1-A3 emissions associated with; backfill material, pipeline material & associated valves and surface finishing.
	1.02	Urban mains installation: assumed 100% gravel aggregate removal. See Ref. T.01 & T.02 for information on gravel aggregate emission factor and material density information.
	1.03	Field/verge mains installation: assumed 100% soil aggregate. See Ref. T.03 & T.04 for information on gravel aggregate emission factor and material density information.
	1.04	Open cut mains installation excavation (see Figure 1 for reference): i) Trench width is dependent on pipe nominal diameter as shown in Ref. T.03. ii) Trench bedding depth is dependent on pipe nominal diameter as shown in Ref. T.04. iii) Minimum depth of cover is dependent on pipe nominal diameter and installation location type (e.g. road or field) as shown in Ref. T.05.
	1.05	Pipe bedding material: IW Trench Backfill drawing requires granular material 14mm to 5mm graded aggregate or 10mm or 14mm single sized aggregate to IS EN 1324 to comply with WIS 4-08-02 AND IGN 4-08-01. For the purposes of this assessment, it has been assumed a gravel aggregate emission factor (Ref. T.01) will be representative of the mix of bedding materials used.
	1.06	Backfill material: assumed to be same as excavated/however imported.
	1.07	Resurfacing: for urban main installation, assummed a 300mm concrete hardstanding road/footpath installation over the total trench footprint (see Ref. T.08 and T.09).
	1.08	Pipeline material can be user selected based on HDPE or concrete. As per Carbon First approach, Iron and HDPE use same EF as conservative value.
	1.09	HDPE Density = 0.97 t/m³ [Source: Highways England Carbon Tool v2.3]
	1.10	HPDE Pipeline diameters and corresponding wall thicknesses obtained from the Highways England Carbon Tool v2.3 (see Ref. T.06)
	1.11	Concrete Pipeline: Assumed precast concrete circular pipework. Pipeline diameters and corresponding pipeline densities obtained from the Highways England Carbon Tool v2.3 (see Ref. T.46)
	1.12	Topsoil depth: 300 mm
A4	2.01	Emissions associated with transportation of materials to and from construction location.
	2.02	Assumed the use of laden and unladen (average) HGV which can accommodate a maximum load of 30m³ (see Ref. T.05 and T.06).
	2.03	Assumed the standard flatbed trailor length is 15m. For simplicity, it is assumed that pipes cannot be stacked. This is used to determine the number of pipe transportation to and from site (1000/15).
	2.04	Transportation distance to site can be user defined.
A5	3.01	Emissions associated with construction activities and construction waste emissions (e.g. landfilling etc).
	3.02	Emissions associated with construction activities have been obtained from the Civil Engineering Standard Method of Measurement (CESMM) 4 for Earthworks which provide carbon emissions for excavation, preparation and filling activities envisaged within a water mains installation.

Technical Factors and Assumptions

T.01	Aggregate of gravel type Emission Factor:	0.005	tCO2e/t [Source: ICE v3.0 (Nov 2019)]
T.02	Aggregate of gravel type Material Density:	2.24	t/m³ [Source: ICE v3.0]
T.03	Concrete (Grade 32/40) Emission Factor:	0.138	tCO2e/t [Source: Highways England Carbon Tool v2.3]
T.04	Concrete (Grade 32/40) Material Density:	2.4	t/m³ [Source: Highways England Carbon Tool v2.3]
T.05	Laden HGV emission factor:	0.000961	tCO2e/t.km [Source: UK Government GHG Conversion Factors for Company Reporting v2. June 20221
T.06	Unladen HGV emission factor:	0.000645	tCO2e/km 0% Laden Articulated Diesel HGV (>3.5-33t) [Source: UK Government GHG Conversion Factors for Company Reporting v2. June 20221
T.07	Bedding Excavation emission factor:	1.060	kgCO2e/m³ [Source: (CESMM4) for Earthworks. E4.2.5
T.08	Bedding (tip distance 15km) emission fa	8.492	kgCO2e/m³ [Source: (CESMM4) for Earthworks. E5.3.2.02
T.09	Bedding (stored for re-use) emission fac	1.132	kgCO2e/m³ [Source: (CESMM4) for Earthworks. E5.3.2.03
T.10	HDPE pipework emission factor:	2.52	tCO2e/t [Source: ICE v3.0 (Nov 2019)]
T.11	General Asphalt material density:	1	t/m³ [Source: ICE v3.0 (Nov 2019)]
T.12	General Asphalt (Asphalt & Bitumen)	0.055	tCO2e/t General Asphalt [Source: ICE v3.0 (Nov 2019)]
T.13	Imported Bedding:	1.444	kgCO2e/m³ [Source: (CESMM4) for Earthworks. E6.3.5]
T.14	Excavated Bedding:	0.824	kgCO2e/m³ [Source: (CESMM4) for Earthworks. E6.3.4
T.15	Galvanised Steel Staircase Mass:	400	kg [Assumed based on Sussellar Info. URL: https://www.ostairs.co.uk/products/external-galvanised-steel-staircase-kit?variant=34428707799172]
T.16	Galvanised Steel Emission Factor:	2.760	tCO2e/t [Source: ICE v3.0 (Nov 2019) - Hot dipped galvanised steel]
T.17	Commercial Building Emission Factor:	600	kgCO2e/m² [Source: London Energy Transformation Initiative (LETI) Climate Energy Design Guide. 'How new buildings can meet UK climate change targets'. pa 301
T.18	Process Building Energy Usage Factor:	0.002	MWh/m²/yr [Source: Jacobs Reslica PD GHG Calculator. converted from MWh/sf/yr]
T.19	Bitumen Emission Factor:	0.191	tCO2e/t Straight-run Bitumen [Source: ICE v3.0 (Nov 2019)]
T.20	Dense Asphalt Hot Rolling:	0.017	tCO2e/m² Hot rolled asphalt base 100mm thick [Source: (CESMM4) Carbon and Pricing Section R3.1 (R3.1.4.021]
T.21	(Thick) Dense Asphalt Hot Rolling:	0.024	tCO2e/m² Hot rolled asphalt base 150mm thick [Source: (CESMM4) Carbon and Pricing Section R3.1 (R3.1.4.021]
T.22	WWTP N2O Emissions Factor:	0.016	kgN2O-N/kg N Influent [Source: CAW17]
T.23	Raw Sewage Nitrogen Loading:	12.000	gN/PE/d Typical Per Capita Contribution (PCC)
T.24	N_2O to CO_2e Conversion:	298.000	kgCO2e/kg N2O [Source: CAW17]
T.25	CH_4 to CO_2e Conversion Factor	25.000	kgCO2e/kgCH4
T.26	Polymer Chemical Emission Factor:	1.713	tCO2e/tonne polymer [Source: Reslica PD Greenhouse Gas Calculator]
T.27	Glass Emissions Factor:	3.590	kgCO2e/m² of 1mm Thick Glass [Source: ICE v3.0 (Nov 20191
T.28	Steel (general) Density:	8.000	t/m³ [Source: Highways England Carbon Tool v2.31
T.29	Natural Gas Emission Factor:	2.016	kgCO2e/m³ [Source: UK Government GHG Conversion Factors for Company Reporting v2. June 20221
T.30	HDPE Plastic Pipe Density:	0.970	t/m³ [Source: Highways England Carbon Tool v2.3]
T.31	EF N2O Effluent	0	kgN2O-N/kg N discharged to the receiver [Source: 2019 Refinement to the 2006 IPCC Guidelines Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge and CAW 17]
T.32	BOD Loading:	60.000	gBOD/PE/d Typical Per Capita Contribution (PCC)
T.33	EF CH4 Effluent	0.000	kgCH4/kg BOD discharged to the receiver [Source: 2019 Refinement to the 2006 IPCC Guidelines Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge]
T.34	TN removal (TNrem)	0.500	% removal [Source Jacobs process team]
T.35	Sludge storage and thickening EF	1.500	kgCH4/t rawDS [Source: UKWIR GHG Process Emissions Report "Quantifying and Reducing Direct Greenhouse Gas Emissions", 2020]
T.36	EF CH4 in the ASP	0.018	kgCH4/kgBOD influent [Source: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge]
T.39	BOD removal	0.950	% removal [Source Jacobs process team]
T.40	CH4 emission from sludge management and biogas production (AD, CHP etc)	2.000	%
T. 41	Biogas yield (AD with THP)	410.000	m3/t rawDS [Source: UKWIR GHG Process Emissions Report "Quantifying and Reducing Direct Greenhouse Gas Emissions", 2020]

T.42 Trench width requirements based on pipeline diameter [Source: IW Trench Backfill/Bedding & Reduced Cover Protection Slab Detail, Dwg. No - STD-LD-21 Rev 0, June 2022].

Pipeline Diameter (mm)	Trench Width (mm)
350	850
400	900
500	1000
600	1200
700	1400
800	1600
900	1800
1000	1900
1200	2200



T.43 Bedding depth requirements based on pipeline diameter [Source: IW Trench Backfill/Bedding & Reduced Cover Protection Slab Detail, Dwg. No - STD-LD-21 Rev 0, June 2022].

Pipeline Diameter (mm)	Bedding Depth (mm)
≤ 500	150
> 500	200

T.44 Minimum cover depth based on pipeline diameter and installation location [Source: IW Trench Backfill/Bedding & Reduced Cover Protection Slab Detail, Dwg. No - STD-LD-21 Rev 0, June 2022].

Pipeline Diameter (mm)	Cover Depth (Roads) (mm)	Cover Depth (Fields) (mm)
350 to 900	1200	900
1000 to 120	1200	1000

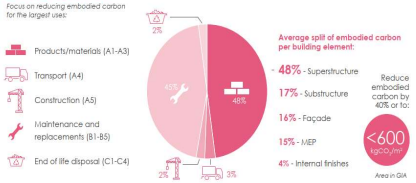
T.45 HDPE Pipeline Diameters and corresponding wall thicknesses (Ref. 1.10):

Pipeline Diameter (mm)	Pipe Wall Thickness (mm)	Pipeline Density (t/m)
150	5	0.002
225	6	0.004
300	8	0.008
450	8	0.011
600	11	0.020
900	16	0.045
1200	20	0.074
1500	25	0.116
1800	30	0.167

T.46 Concrete harstanding emission factor: 0.912 tCO2e/t Average CEM I, Ordinary Portland Cement (OPC) [Source: ICE v3.0 (Nov 2019)]

T.47 Precast concrete circular pipework diameter and corresponding density (Ref. 1.11)

Pipeline Diameter (mm)	Pipeline Density (t/m)
225	0.088
300	0.128
450	0.288
600	0.488
900	0.888
1200	1.404
1500	1.796
1800	2.860
2100	3.448
2400	3.873



T.48	Precast concrete sitework emission fact	0.15	tCO2e/t [Source: ICE v3.0 (Nov 2019)]
T.49	Fuel (Diesel) Consumption Rate (Constr	0.121	m^3/m^3 fuel [Source: Jacobs GHG Calculator]
T.50	Diesel fuel emission factor:	2.699	$tCO2e/m^3$ [Source: UK Government GHG Conversion Factors for Company Reporting v2. June 20221
	Topsoil Excavation emission factor:	0.731	$koCO2e/m^3$ [Source: (CESMM4) for Earthworks. E4.1.1
	Disposal of Excavated Material:		
	Topsoil (to distance 15km) emission fac	8.492	$koCO2e/m^3$ [Source: (CESMM4) for Earthworks. E5.3.1.02
	Topsoil (stored for re-use) emission fact	1.131	$koCO2e/m^3$ [Source: (CESMM4) for Earthworks. E5.3.1.03
	Filling emission factors:		
	Excavated Topsoil:	0.471	$koCO2e/m^3$ [Source: (CESMM4) for Earthworks. E6.3.1
	Imported Topsoil:	1.444	$koCO2e/m^3$ [Source: (CESMM4) for Earthworks. E6.3.2
T.51	Tunnel Excavation:		
	Tunnels in generally soft material	0.081	$tCO2e/m^3$ [Source: (CESMM4) for Earthworks. E6.3.1
T.53	Passenger car emissions (average)	0.00017	$tCO2e/m^3$ [Source: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-20221

T8.3.4	**Drilling and flushing to stated diameter**							
T8.3.4.01	40mm diameter; not exceeding 20m deep	m	0.17	8.01	17.76	-	**25.77**	45.318
T8.3.5	**Re-drilling and flushing**							
T8.3.5.01	Generally	m	0.17	8.01	17.76	-	**25.77**	45.318
T8.3.6	**Injection of grout materials of stated composition**							

1 Model inputs for assessment of WWTP, SHC and Orbital Sewer Civil Works

MODEL INPUTS	Selection:		Carbon Lifecycle
Concrete Source Distance:	50	km	Concrete A4
Concrete HGV Load Capacity:	30	m^3	Concrete A4
Excavation Material Stockpiling:	Yes		Excavation A5
Distance to Disposal:	50	km	Excavation A5
Imported Backfill Proportion:	50%		PP Backfill A1-A3
Imported Backfill Source Distance:	50	km	PP Imported Backfill A4
Process Piping Source Distance:	50	km	Process Piping A4
Maintenance and Repair Allowance:	2%		B2-B3

2 Model inputs for assessment of WWTP, SHC and Orbital Sewer Mechanical and Electrical Works

MODEL INPUTS	Selection:	Carbon Lifecycle
MEICA Replacement Frequency:	3	MEICA B4
Maintenance and Repair Allowance:	2%	MEICA B2-B3

Treatment Capacity in GDA

Table 3.3: Projected Treatment Capacity Requirements[1] in Catchments of Existing WwTPs (Updated)

WwTP	2022 Installed Capacity	Ultimate Design Capacity[1]	Population Equivalent Load 2022[2]	Projected Treatment Capacity Required (PE) 2025	Projected Treatment Capacity Required (PE) 2031	Projected Treatment Capacity Required (PE) 2050
Ringsend[4]	1,640,000[1]	2,400,000	1,839,660	1,946,425	2,446,574	2,763,104
Shanganagh Bray	186,000	250,000	134,240	165,417	176,255	205,362
Osberstown[5]	130,000	130,000	99,966	102,100	108,300	124,800
Leixlip[3]	150,000	150,000	140,458	92,420	98,094	113,331
Portrane	65,000	65,000	35,740	44,305	47,283	55,280
Malahide[7]	27,000	27,000	21,520	22,231	23,725	27,735
Balbriggan and Skerries[5]	70,000	70,000	43,442	53,854	57,473	67,193
Swords	70,000	90,000	59,101	72,777	77,531	90,298
Total	2,338,000	3,182,000	2,374,127	2,499,529	3,035,235	3,447,103

Note 1: Expressed as average day PE.
Note 2: The PE Load stated at 2022 for the Ringsend WwTP is the annual mean organic load. All other loads are peak week loads. (source: Uisce Éireann 2023)
Note 3: All projected loadings include a 20% headroom allowance. Uisce Éireann are currently considering a partial diversion of flow and load out of this catchment and into the Ringsend catchment.
Note 4: The projected growth in the Ringsend catchment includes for a diversion of flow and load out of the Leixlip and Malahide catchment.
Note 5: The SAPMAP data was originally used to provide loading from towns. This data is currently unavailable for 2022 loadings as full Census 2022 data has not been released.
Note 6: The WwTP projections have been rounded to the nearest 100.
Note 7: Uisce Éireann are currently considering a partial diversion of flow and load out of this catchment and into the Ringsend catchment.

Loading profile for GDD WWTP to 2050

Table 3.5: Development of Required Treatment Capacity at the Proposed Wastewater Treatment Plant (Updated)

	Design Year			
	2025	2031	2040	2050
9C Sewer, including Load Transferred from Leixlip WwTP	243,304	380,104	396,959	416,561
NFS Sub-Catchments West of proposed WwTP	66,169	80,604	85,755	91,745
Total Treatment Capacity Required	309,473	460,708	482,714	508,306

Table 1:

	Process Emissions $ktCO_2e$			Energy $ktCO_2e$					
	tCO_2e/50yr	$ktCO_2e$/50yr	$ktCO_2e$/yr	kWh/day	MWh/yr	Convert to tCO_2e / yr	tCO_2e / 50yr	$ktCO_2e$ / 50yr	$ktCO_2e$ / yr
WWTP	538792	539	11	46627	17019	528	26379	26	1
SHC	108086	108	2	9459	3453	107	5351	5	0.11
Combined [B1]	646877	647	13		20471	635	31731	32	1
Offset				34912	12743	395	19751	20	0.40
Balance					7729	240	11979	12	0.24
% Reduction					62.2				

Table 2:

Energy Demand Met by Advanced Energy and Heat Recovery (AD/THP/CHP)			
	Electricity consumption [kW/d]	Electricity production [kW/d]	Est. Coverage of energy demand [%]
WwTP	46627		
SHC	9459	34912	
RBSF	0		
Total	56085	34912	62.25

Table 3:

	GHG Emissions Reduction $ktCO_2e$ associated with a 50% reduction in Biosolids Production				
	(UNMITIGATED) Without AD+THP tCO_2e/50yr	(MITIGATED) With AD+THP tCO_2e/50yr	Emissions Avoided $ktCO_2e$/50yrs	Emissions Avoided $ktCO_2e$/yr	Emissions Avoided tCO2e/yr
HGV	1972	986	1	0.019721355	20
Chemical	25260	12,630	13	0.252600196	253
Fugitive	59190	29,595	30	0.591903207	592

Table 4:

GHG EMISSIONS - Mitigated vs Unmitigated										
			Operational Emissions - Unmitigated (750kPE - See Note 1)	Operational Emissions Adjustment - Unmitigated (Reasonable worst case scenario)	Annual (unmitigated) GHG Emissions	Mitigated Whole Life Cycle Emissions (Construction + Operation)	Mitigated Construction Phase Emissions	Operational Emissions - Mitigated (750kPE)	Annual (mitigated) GHG Emissions	Operational Emissions Δ (unmitigated - mitigated)
Life Cycle Stages BS EN 15978 (2011)	Description	UNITs	Total $ktCO_2e$ (50 yr operational phase)	Total $ktCO_2e$ (50 yr operational phase)		Total $ktCO_2e$	Total $ktCO_2e$ (for 4 yr construction phase)	Total $ktCO_2e$ (50 yr operational phase)	Total $ktCO_2e$ / annum	$ktCO_2e$
A1-A3	Embodied Carbon					19.3	19.3			
A4	Transportation					1.5	1.5			
A5	Construction Activities					1.9	1.9			
B1	Fugitive and Process		825.3	706.34	14.1	646.9		647	12.9	59.5
B2-B4	Maintenance and Repair					0.4	0.4			
B5	Refurbishment					0.0				
B6	Energy		36.6	23.41	0.5	16.8		16.8	0.3	6.6
B8	Chemicals		27.2	18.15	0.4	13.6		13.6	0.3	4.5
TOTALS			**889.1**	**747.90**	**15.0**	**700.4**	**23.1**	**677.3**	**13.5**	**70.6**
			Unmitigated			**Mitigated**				**Savings**