Grand Union Canal Transfer

Chapter 9: Carbon

Table of Contents

Tables

9. Carbon

9.1 Introduction

9.1.1 This Preliminary Environmental Information (PEI) Report chapter presents the preliminary assessment of likely significant environmental effects arising from the Proposed Development in relation to carbon and other Greenhouse Gases (GHG).

9.1.2 In line with the GHG Protocol (Ref. 1), the GHG assessment is reported as tonnes of carbon dioxide equivalent (tCO_2e). It considers the seven Kyoto Protocol gases:

a. Carbon dioxide (CO2);
b. Methane (CH4);
c. Nitrous oxide (N2O);
d. Sulphur hexafluoride (SF6);
e. Hydrofluorocarbons (HFCs);
f. Perfluorocarbons (PFCs); and
g. Nitrogen Trifluoride (NF3).

9.1.3 These gases are collectively referred to in this PEI Report as 'GHG', expressed as tonnes of carbon dioxide equivalent (tCO_2e) or megatonnes ($MtCO_2e$). The term GHG is used throughout this chapter and refers collectively to all seven Kyoto Protocol gases. Carbon is also used to refer to the same term when referring to external policy or tools e.g. the UK's Carbon Budgets.

9.1.4 This preliminary assessment follows the methodology outlined within the Environmental Impact Assessment (EIA) Scoping Report and Scoping Opinion (provided in **Appendices 5-PD-1** and **5-PD-2** in PEI Report **Volume 4**) and is based on the environmental information obtained to date and the description of the Proposed Development as presented in **Chapter 3: The Proposed Development** in PEI Report **Volume 2.** Further review of the potential for significant GHG effects will be undertaken at the ES stage.

9.1.5 In the EIA Scoping Report, the GHG and Climate assessments were reported together in a single chapter called Climate. Within this PEI Report, the climate assessment is presented separately in **Chapter 10: Climate** in PEI Report **Volume 2.** This is due to the two different assessment methodologies making it more appropriate to report them separately.

9.1.1 To align with the requirements set out in the Institute of Sustainability and Environmental Professionals (ISEP)[1] guidance for Assessing Greenhouse Gas Emissions and Evaluating their Significance (Ref. 2), this chapter presents a Greenhouse Gas Assessment that considers the whole life cycle of the Proposed Development. The assessment evaluates GHG emissions associated with the construction and operational phases to understand the overall GHG impact of the Proposed Development and to identify opportunities for emission reduction and mitigation where appropriate.

9.1.2 There are no supporting appendices or figures for this chapter.

9.1.3 There are interrelationships between the potential effects on GHG and other environmental topics. Therefore, please also refer to **Chapter 21: Traffic and Transport** and **Chapter 18: Materials and Waste** in PEI Report **Volume 2**, which provide assessments of the potential significant effects arising from the construction and operation of the Proposed Development relating to transportation, and materials and waste.

9.2 Legislation, Policy and Guidance

9.2.1 Legislation, policy[2], standards and guidance relevant to the scope and method of the GHG assessment and potential mitigation measures are listed in the following sections.

Legislative Framework

9.2.2 Relevant legislation comprises:

a. Climate Change Act 2008 (Ref. 3) and The Climate Change Act 2008 (2050 Target Amendment) Order 2019 (Ref. 4);

b. United Nations Framework on Climate Change Paris Agreement (Ref. 5);

c. The Carbon Budgets Order 2009 (Ref. 6);

d. The Carbon Budget Order 2011 (Ref. 7);

[1] Formerly the Institute of Environmental Assessment and Management (IEMA).

[2] For the purposes of this PEI Report an overview of relevant policy is provided to show how relevant policy has informed scope, method and in some cases mitigation. It is not the purpose of the PEI Report (or the Environmental Statement [ES]) to present a review of the compliance of the Proposed Development with the requirements of policy. The Planning Statement, to be submitted with the Development Consent Order (DCO) application, will present an assessment of the extent to which the Proposed Development accords with policy.

e. The Carbon Budget Order 2016 (Ref. 8); and

f. The Carbon Budget Order 2021 (Ref. 9).

National Policy

9.2.3 National policy considered includes:

a. National Policy Statement (NPS) for Water Resources Infrastructure (the relevant national policy statement that has effect in relation to the Proposed Development) ((Ref. 10);

b. National Planning Policy Framework (NPPF) (Ref. 11); and

c. Carbon Budget Delivery Plan (CBDP) (Ref. 12).

Local Policy

9.2.4 Local policy considered includes relevant Local Plans (both adopted and emerging) and other adopted policy documents attributed with the ten local authorities that the Proposed Development is situated within. More detail is provided in Table 1-4 in **Chapter 1: Introduction** in PEI Report **Volume 2**.

National Guidance

9.2.5 National guidance considered comprises Planning Practice Guidance – Climate Change (Ref. 13).

Other Guidance

9.2.6 Other guidance to be considered includes:

a. ISEP: Assessing Greenhouse Gas Emissions and Evaluating their Significance. (Ref. 2);

b. The GHG Protocol (World Resources Institute and World Business Council for Sustainable Development (WRI & WBCSD)) (Ref. 1);

c. Publicly Available Standard (PAS) 2080:2023 Carbon management in buildings and infrastructure (Ref. 14); and

d. UK Water Industry Research: Supporting Whole Life Carbon Reduction (Ref. 15).

9.3 Consultation

9.3.1 This section provides an overview of consultation undertaken to date in relation to GHGs.

Phase One Public Consultation

9.3.2 One topic was raised from Phase One Public Consultation undertaken between 11 September to 25 October 2024 which relates to low water flows and the release of GHGs.

9.3.3 While water flows may be lower in the future, the Proposed Development is not considered to exacerbate this impact. In fact, the Proposed Development will help to regulate water flows and could itself mitigate this impact. As there are not expected to be any adverse impacts on low water flows as a result of the Proposed Development, this has not been included in the GHG assessment.

EIA Scoping

9.3.4 No comments were raised in the EIA Scoping Opinion (provided in **Appendix 5-PD-2** in PEI Report **Volume 4**) in relation to the proposed scope of the GHG assessment.

Other consultation

9.3.5 There has been no further consultation that has taken place outside of Phase One Public Consultation in relation to the GHG assessment.

9.4 Scope of Assessment

9.4.1 This section identifies the scope of the GHG assessment following EIA Scoping, design refinement, surveys / studies and assessment.

Amendments to Scope Following EIA Scoping

9.4.2 No amendments have been made to the scope outlined in the EIA Scoping Report.

Scope of Assessment

9.4.3 **Table 9-1** provides a summary of the matters scoped into and out of the GHG assessment on the basis of whether they were considered to have the potential to result in significant effects during the EIA Scoping process.

a. In = refers to likely effects that are considered potentially significant and therefore do require further assessment in the EIA.

b. Out = refers to likely effects that are not considered potentially significant and therefore do not require further assessment in the EIA.

c. n/a = refers to where there is no prospect of an effect from a particular Proposed Development Part(s), either due to the particular nature or location of the Proposed Development Part

and/or the absence of a receptor within the study area for that particular Proposed Development Part.

Table 9-1: Summary of GHG assessment scope

Likely significant effect	Receptor(s)	Parts of the Proposed Development					
		1a	1b	2	3	4a	4b
Greenhouse Gass (GHG) Impact Assessment							
GHG Emissions	The Proposed Development will generate GHG emissions over its lifecycle, as such a GHG impact assessment has been scoped into the EIA. The following lifecycle stages for civil engineering works set out within the PAS 2080:2023 Guidance (Ref. 14) have been scoped into the assessment: • Pre-construction; • Product stage; • Construction process stage; and • Operation stage. The receptor for these GHG emissions is the global atmosphere.	In	In	In	In	In	In
Decommissioning	An assessment of decommissioning GHG effects was scoped out of the EIA Scoping Report.	Out	Out	Out	Out	Out	Out

9.5 Assessment Methodology

9.5.1 This section presents the methodology used to assess the potential effects of GHG emissions during the pre-construction, construction and operational phases of the Proposed Development.

Defining the Study Area

9.5.2 This section sets out the study areas adopted for the Proposed Development as a whole for the GHG assessment.

9.5.3 When determining the significance of the GHG emissions impact, the GHG assessment considers the Proposed Development as a single entity rather than assessing individual components or projects phases. This approach reflects that the receptor for GHG emissions is the global climate, rather than site specific or local receptors. Accordingly, emissions are assessed collectively and contextualised against relevant UK and sectoral GHG budgets to determine the overall significance of the Proposed Development's GHG impact.

9.5.4 The study area for the GHG assessment includes:

a. Direct GHG emissions arising from demolition and site clearance / remediation, construction and operation of the Proposed Development within the Preliminary Order Limits; and

b. Indirect GHG emissions attributed to the Proposed Development occurring outside the Preliminary Order Limits, including embodied emissions in materials, transport, upstream processes (such as extraction and manufacture of fuels and chemicals), and downstream processes (such as wastewater treatment, waste management and recycling).

Determining Baseline Conditions

9.5.5 For the purposes of the GHG Assessment, the baseline represents a Business as Usual (BAU) scenario where the Proposed Development does not proceed. It has been defined qualitatively, reflecting the level of information available at this preliminary stage.

9.5.6 In line with ISEP guidance (Ref. 2), the baseline assumes that existing land uses and assets within the Preliminary Order Limits remain unchanged, identifying current sources and sinks[3] of GHG emissions within these limits

[3] A carbon sink is a system that absorbs and stores more GHG emissions from the atmosphere than it emits.

to provide a consistent basis for comparison across both construction and operational phases.

9.5.7 While the baseline emissions occurring as a result of all existing activities occurring within the Preliminary Order Limits have not been specifically calculated, the GHG assessment only includes the GHG impact of activities that are in addition to the baseline scenario. Therefore, the baseline emissions are inherently included and accounted for within the GHG assessment methodology.

9.5.8 It was not possible to quantify baseline GHG emissions at this preliminary assessment stage. A precautionary baseline of zero emissions has therefore been applied to represent a worst-case scenario and avoid underestimating the potential effects of the Proposed Development.

9.5.9 **Table 9-2** provides an overview of the baseline studies and surveys undertaken to inform the carbon assessment. The table uses the following coding:

✓ = Completed; and

O = To be completed for the ES.

Table 9-2: Summary of baseline carbon studies and surveys

Study / survey	Overview	Date completed	Part of the Proposed Development					
			1a	1b	2	3	4a	4b
Desktop review	In the absence of activity data to support a quantitative baseline, a high level qualitative baseline has been developed for the PEI Report to identify potential existing emission sources and their likely magnitude.	September 2025	✓	✓	✓	✓	✓	✓

Assessment of Effects

9.5.10 This section sets out how the scoped in effects are assessed.

9.5.11 To identify the magnitude of GHG impacts over the life cycle of the Proposed Development, emissions have been calculated in accordance with the GHG Protocol (Ref. 1) and reported in line with the principles set out in PAS 2080:2023 Guidance (Ref. 14). GHG emissions from construction activities, embodied emissions in materials, and the operation of the Proposed Development have been quantified in this PEI Report using a calculation-based approach consistent with the GHG Protocol (Ref. 1):

Activity data x GHG emissions factor = GHG emissions

9.5.12 Activity data is a quantifiable measure of activity, such as plant operating hours or quantity of concrete used. Emission factors convert activity data into GHG emissions. Activity data is sourced from information provided by the Applicant.

9.5.13 The assessment adopts a project lifecycle approach to identify ‘hot spots’ of GHG emissions (i.e., the project stages likely to generate the largest emissions) and enables priority areas for mitigation to be identified. This approach is consistent with the principles set out in ISEP guidance (Ref. 2).

9.5.14 **Table 9-3** summarises the likely GHG emission sources associated with the Proposed Development for each life cycle stage, in accordance with the reporting structure set out in PAS 2080:2023 Guidance (Ref. 14).

Table 9-3: Potential GHG emissions sources

Life cycle stage	PAS 2080:2023 Module	PAS 2080:2023 Sub-Module	Primary emission sources
Pre-construction	A0	Land and associated fees / advice	Activities within A0 include, but are not limited to, non physical processes undertaken prior to construction, such as preliminary studies, impact and risk assessments, stakeholder engagement, design and technical studies, product and material testing, site surveys, and land acquisition.
Product stage	A1 – A3	Raw material extraction and manufacturing of products that are required to build the equipment for the Proposed Development. Transportation of materials for such processes / manufacturing (where available).	Embodied GHG emissions from energy use in the extraction of materials and manufacture of components and equipment. GHG emissions from the transportation of products and materials during their processing and manufacture.
Construction process stage	A4	Transportation of construction materials to the Preliminary Order Limits.	Transport of construction materials is included under the construction process stage, where these are not included in embodied GHG emissions.
	A5	On site construction activities. Transport of construction workers. Disposal of waste generated during the construction processes.	GHG emissions from energy (electricity, fuel, etc.,) consumption for plant and vehicles, and generators on site. GHG emissions from fuel use for worker commuting.

Life cycle stage	PAS 2080:2023 Module	PAS 2080:2023 Sub-Module	Primary emission sources
			GHG emissions from fuel consumption for the transportation and disposal of waste. Land use change during construction.
Operation stage	B1 – B8	Energy use from operation of the Proposed Development. Maintenance activities. Manufacture and use of chemicals in the water treatment process.	GHG emissions from the use of grid electricity and fuel during operation. GHG emissions associated with maintenance activities (e.g., replacement components and fuel use). GHG emissions associated with chemical use during the water treatment process. Process emissions of methane and nitrous oxide from on site activities. GHG emissions are associated with the transportation of workers from operational sites.

9.5.15 As detailed in the EIA Scoping Report, emissions associated with decommissioning have been scoped out of the GHG assessment.

9.5.16 The resulting GHG footprint has been compared with the baseline conditions to determine the impact of the Proposed Development.

9.5.17 Where project specific data is currently unavailable, assumptions and industry benchmarks have been applied to address data gaps. Where quantification was not possible, a qualitative approach has been adopted in line with ISEP guidance (Ref. 2). All assumptions and exclusions used in the GHG assessment are set out in **Table 9-6**.

9.5.18 In the absence of detailed material quantities and activity data at this preliminary assessment stage, the GHG assessments and reporting undertaken to support the Regulators' Alliance for Progressing Infrastructure Development (RAPID) Gate 3 submission was used. The GHG assessment for Parts 1a and 1b of the Proposed Development was undertaken by Jacobs (Ref. 16) and for Parts 2, 3 and 4a and 4b of the Proposed Development was undertaken by WSP (Ref. 17).

9.5.19 Outputs from both assessments were combined to produce a single integrated assessment, providing an overview of the likely whole life GHG emissions associated with the Proposed Development.

9.5.20 A more detailed assessment will be undertaken and reported in the ES when more detailed activity data will be available.

GHG Assessment Approach

9.5.21 The GHG assessment for Parts 1a and 1b was undertaken using the Severn Trent (ST) Carbon Tool, informed by project data and supported by datasets such as the University of Bath's Inventory of Carbon and Energy (ICE) Database, Version 3 (Ref. 18). For Parts 2, 3 and 4a and 4b, the Affinity Water (AfW) Carbon Tool was used, informed by project data, industry benchmarks, proxies, and professional judgment. The results of the assessment are presented collectively in this chapter, representing the GHG impact of Proposed Development as a single entity.

9.5.22 Both of these assessments modelled emissions over an 80-year appraisal period, comprising nine years for construction and 71 years for operation. However, to align with other preliminary assessments presented in the PEI Report, the emissions modelled have been adjusted to a 100-year operational lifespan, with a 4-year construction period. Any impact on the preliminary GHG assessment as a result are not expected to have a material impact on the outcome of the assessment.

9.5.23 Embodied emissions were estimated by applying emission factors to key asset types within the Proposed Development, based on indicative material quantities and design dimensions. This provides a proportional estimate of

embodied emissions. The ST Carbon Tool estimates embodied emissions for each asset using emissions benchmarks built into the modelling tool. The AfW Carbon Tool applies equivalent asset level emission factors to estimate embodied emissions.

9.5.24 Operational emissions were calculated by applying emission factors to activity data for energy, fuel, and chemical consumption during treatment processes. Annual emissions for each utility and chemical were extrapolated over the operational period to estimate total emissions.

Sensitivity of Receptors

9.5.25 The global climate has been identified as the receptor for the purposes of the GHG assessment. The sensitivity of the climate to GHG emissions is ‘high’. The rationale is as follows:

a. GHG emission impacts could compromise the UK’s Carbon Budget Delivery Plan (Ref. 12) sectoral construction and Net Zero Pathways and, therefore, the ability to meet its future carbon reduction trajectory;

b. Any additional GHG impacts could compromise the wider UK’s ability to reduce its GHG emissions and, therefore, the ability to meet its future legally binding carbon budgets;

c. The extreme importance of limiting global warming to below 2°C above industrial levels, while pursuing efforts to limit such warming to 1.5°C as set out in the Paris Agreement (Ref. 5) and a recent report by the Intergovernmental Panel on Climate Change (IPCC) (Ref. 19) highlighted the importance of limiting global warming below 1.5°C; and

d. Disruption to the global climate already has diverse and wide-ranging impacts on the environment, society, economic and natural resources. Known effects of climate change include increased frequency and duration of extreme weather events, temperature changes, rainfall and flooding, and sea level rise and ocean acidification. These effects are largely accepted to be negative, profound, global, likely, long-term to permanent, and are transboundary and cumulative from many global actions.

9.5.26 As the effects of GHG emissions are not geographically constrained, the global climate is considered the receptor, and the UK’s carbon budgets are used as a proxy to help determine significance.

Magnitude of Impacts

9.5.27 In GHG accounting, it is considered good practice to contextualise emissions against relevant pathways to net zero, such as pre-determined carbon budgets. In line with ISEP guidance (Ref. 2), emissions resulting from the

Proposed Development has been contextualised against the UK carbon budgets (see **Table 9-4**) as proposed by the Climate Change Committee (CCC), agreed by Government, and ratified by Parliament. This contextualisation is applied in terms of both the sensitivity of the receptor and the magnitude of potential impacts, as appropriate.

9.5.28 The UK carbon budgets restrict the amount of GHG emissions the UK can legally emit in each five-year period. The Third, Fourth, and Fifth Carbon Budgets reflected the previous 80% reduction target by 2050 (Ref. 6, Ref. 7, Ref. 8). The Sixth Carbon Budget is the first to align with the legislated UK Government 2050 net zero commitment (Ref. 4). The Seventh Carbon Budget, published by the CCC on 26 February 2025, sets out the recommended UK emissions limits for 2038–2042 (Ref. 20). The UK Government is expected to adopt the CCC's recommendations for the Seventh Carbon Budget in 2026.

9.5.29 To assess the Proposed Development's trajectory towards net zero by 2050, the CCC's Balanced Net Zero Pathway has been used post 2042, in the absence of any formally published carbon budgets beyond the Seventh Carbon Budget. Beyond 2050, the UK is legally required to maintain net zero emissions.

9.5.30 The Balanced Net Zero Pathway is divided into five-year periods post 2042 to align with the structure of the previous seven legally binding carbon budgets. These indicative periods represent the Eighth and Ninth budget periods up to 2050, consistent with the UK's 1.5 degree (°C) trajectory as outlined in **Table 9-4**.

Table 9-4: UK Carbon Budgets and Indicative Carbon Budgets Based Upon the CCC's Balanced Net-Zero Pathway

Carbon budget period	UK Carbon Budget ($MtCO_2e$)	Indicative Carbon Budgets based upon the CCC's Balanced Net-Zero Pathway ($MtCO_2e$)[4]	Industry Sectoral Carbon Budget based upon the Seventh Carbon Budget ($MtCO_2e$)	Resources and Waste Sectoral Budget based upon the Seventh Carbon Budget ($MtCO_2e$)
5th (2028-	1,725	-	158	95

[4] It should be noted that the sectoral carbon budgets reported in the Seventh Carbon Budget exclude removals, whereas the CCC Balanced net-zero Pathway incorporates removals within its projections. As a result, the

Carbon budget period	UK Carbon Budget ($MtCO_2e$)	Indicative Carbon Budgets based upon the CCC's Balanced Net-Zero Pathway ($MtCO_2e$)[4]	Industry Sectoral Carbon Budget based upon the Seventh Carbon Budget ($MtCO_2e$)	Resources and Waste Sectoral Budget based upon the Seventh Carbon Budget ($MtCO_2e$)
2032)				
6th (2033-2037)	965	-	103	62
7th (2038-2042)	535[5]	-	54	42
8th (2043-2047)	-	220	28	30
9th (2048-2050)	-	23	11	16

9.5.31 The carbon budgets beyond 2037, including the Seventh Carbon Budget, have not yet been formally adopted by the UK Government or ratified by Parliament. They should therefore be treated as indicative reference points for contextualising the Proposed Development's alignment with the national net zero trajectory.

9.5.32 To assess construction phase emissions, the industry sectoral budget published in the Seventh Carbon Budget (Ref. 20) was used. This was considered the most appropriate comparator, as it primarily reflects emissions from raw material production. Given that most construction phase emissions arise from material and component manufacture, it provides a relevant benchmark for this assessment.

9.5.33 For the operational phase, emissions are expected to span multiple sectors; however, the majority are anticipated to arise from water treatment processes. Therefore, the Resource and Waste sectoral carbon budget published in the UK's Seventh Carbon Budget (Ref. 20) was used to provide

sectoral budgets do not directly align with the totals reported for the Balanced Pathway.

[5] At the time this PEI Report was produced, the levels set in the Seventh Carbon Budget are only considered as advice from the CCC. These will not become legally binding until they are passed through Parliament, which is expected to happen in 2026.

additional context for this assessment, as this is considered the most relevant to water treatment.

Significance of Effects

9.5.34 The ISEP guidance (Ref. 2) notes that there are currently no universally agreed methods to evaluate quantified levels of GHG significance, and that the application of standard EIA significance criteria is not considered appropriate for GHG assessments. Instead, professional judgement is required to contextualise a project's GHG emission impact. ISEP guidance (Ref. 2) further recommends that mitigation should be considered from the outset and throughout the lifetime of a project, supporting the delivery of proportionate EIA. Once the magnitude of GHG emissions is determined, appropriate mitigation measures should be proposed.

9.5.35 Furthermore, the ISEP guidance (Ref. 2) sets out five distinct levels of significance, as shown in **Table 9-5**. These are not based solely on whether a project emits GHG emissions, but on how the project contributes, positively or negatively, towards achieving a science based, 1.5°C aligned transition to net zero. The significance levels are plotted against the UK's net zero compatible trajectory to evaluate the likely significance of the Proposed Development.

9.5.36 The effect of the Proposed Development may shift from significant to non-significant where mitigation measures are incorporated that substantially improve upon a business-as-usual scenario and align with, or exceed, the science based emissions trajectory of ongoing but declining emissions towards net zero.

Table 9-5: Definition of Levels of Significance

Significance Level	Effects	Description	Example in the ISEP guidance (Ref. 2)
Significant	Major adverse	A project that follows a 'business as usual' or 'do minimum' approach and is not compatible with the UK's net zero trajectory or accepted aligned practice or area-based transition targets. It is down to the practitioner to differentiate between the 'level' of significant adverse effects e.g., 'moderate' or 'major' adverse effects.	The project's GHG impacts are not mitigated or are only compliant with do minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.
	Moderate adverse		The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
Not significant	Minor adverse	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. It may have residual emissions but is doing enough to align with and contribute to the relevant transition scenario, keeping the UK on track towards net zero by 2050 with at least a	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.

Significance Level	Effects	Description	Example in the ISEP guidance (Ref. 2)
		78% reduction by 2035, thereby potentially avoiding significant adverse effects.	
	Negligible	A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory and has minimal residual emissions. This project is playing a part in achieving the rate of transition required by nationally set policy commitments.	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.
Significant	Beneficial	A project that causes GHG emissions to be avoided or removed from the atmosphere. Only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.	The project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

Assumptions, Limitations and Uncertainties

9.5.37 In cases where specific information about energy usage, materials, or the GHG emissions of important asset components is unavailable, assumptions have been made and are outlined below. These are based on industry estimates, professional best practice, and information provided by the Applicants.

9.5.38 In the absence of detailed material quantity and activity data, the GHG assessments prepared at Gate 3 were used to inform this preliminary GHG assessment undertaken for the PEI Report. These Gate 3 assessments were undertaken in accordance with the RAPID Guidance on undertaking GHG assessments at Gate 3 (Ref. 21).

9.5.39 The assumptions and data within these Gate 3 assessments underpin this preliminary assessment, providing a high-level view of the likely whole life GHG emissions associated with the Proposed Development.

9.5.40 For Parts 1a and 1b of the Proposed Development, the ST Carbon Tool was used to estimate GHG emissions. For Parts 2, 3 and 4a and 4b of the Proposed Development, the assessment was undertaken using the AfW Carbon Tool, which estimates both capital (A1–A5) and operational (B6) emissions, including those associated with chemical use. The assessment has produced an estimate of the major emission sources based on the benchmarks and modelling built into these tools, rather than producing a detailed estimate based on specific material quantities. This approach is appropriate for estimating the GHG impact at the PEI Report stage.

9.5.41 Some uncertainty remains compared with assessments based on detailed material quantities and activity data. However, this is considered to be the most accurate methodology to calculate emissions given the data available at the time of undertaking this preliminary GHG assessment. The GHG assessment will be reviewed for the ES, and a more detailed assessment will be undertaken. Any differences between the methodologies are not expected to affect the outcome of the GHG assessment.

9.5.42 Operational emissions reported by both the AfW and ST Carbon Tools are based on current UK grid electricity intensities and do not account for future decarbonisation, as this functionality is not built into these tools. Consequently, the results represent a precautionary, indicative upper bound estimate of likely operational GHG emissions. The GHG assessment will be reviewed for the ES, and decarbonisation of the grid will be accounted for where possible.

9.5.43 Canal boat traffic represents a source of GHG emissions within the Preliminary Order Limits, as most vessels are powered by diesel engines.

However, these are not included within the assessment as such activities are not expected to change materially as a result of the Proposed Development

9.5.44 The GHG assessment will be further refined to incorporate detailed material quantities and activity data as these become available and will be reported in the ES.

9.5.45 Key assumptions applied in the GHG assessment are presented in **Table 9-6**. The life cycle modules are labelled in accordance with PAS 2080:2023 Guidance (Ref. 14).

Table 9-6: Key assumptions applied to the GHG Assessment

Life cycle module		Emission Source	Key assumptions
A: Before Use Stage	A0 Preconstruction Stage	A0 Emissions from site surveys, design, and business travel.	Currently, there is no robust methodology for calculating A0 emissions. However, they are expected to be minimal, contributing less than 1 % to the total GHG emissions of the Proposed Development. This is based on professional expertise and established best practises, drawing on experience from comparable projects. According to the ISEP Guidance (Ref. 2), GHG emissions anticipated to be below 1 % of the total project emissions can be excluded from the assessment. Therefore, emissions from A0 have been excluded on this basis.
	A1-3 Product Stage	A1-3 Raw materials supply and manufacture	The Gate 3 GHG assessments use national and international databases, including the Civil Engineering Standard Method of Measurement, Fourth Edition (CESMM4) Carbon and Price Book (Ref. 23) and the ICE Database v3.0 (Ref. 18), were used to inform the A1–A3 impacts, covering raw material extraction, processing, and manufacturing.
	A4-5 Construction Process Stage	A4 Material transport	For the Gate 3 assessment of Parts 2, 3 and 4a and 4b, isochrone and iso-distance maps were used to determine transport distances for construction materials, and standard factors were applied. For Parts 1 and 2, the Gate 3 GHG assessment relied on assumptions built into the ST Carbon Tool to calculate the transportation of materials to site.
		A5 Construction Installation process	Detailed CESMM4 Carbon and Price Book (Ref. 23) benchmark-based items were applied to estimate construction emissions where available (e.g., pipelines), while approximate estimates were used

Life cycle module		Emission Source	Key assumptions
			for elements with limited data (e.g., mechanical and electrical installations). Emission factors were based on representative construction conditions and typical asset types, providing benchmark values appropriate for projects of a similar scale and nature. Although not specific to the Proposed Development, this approach was considered appropriate for the preliminary assessment reported in this chapter. Construction worker commuting was not considered in either of the Gate 3 GHG assessments. These emissions are expected to be minor relative to overall construction phase emissions, and their omission is not anticipated to materially affect the outcome of the assessment.
B: Use Stage	B1-8 Use Stage	Maintenance, repair, replacement, refurbishment & Operational Energy Usage (B1-B8)	B4 emissions were derived from the predefined service life of the materials and assets used in the assessment. For the Gate 3 GHG assessment for Parts 2, 3 and 4a and 4b, GHG emissions calculated for A1–A5 were combined with predefined asset renewal periods to estimate replacement impacts (B4). In both GHG assessments, B6 emissions were estimated using UK Government emission factors that assume a constant electricity grid intensity over time; therefore, expected future reductions in grid carbon intensity were not considered in the absence of the required functionality within the carbon tool. This will be reviewed for the ES, however as the decarbonisation of the grid is managed by UK government and outside factors, the assumption of no decarbonisation in the grid intensity does not affect the conclusions of this assessment in terms of alignment with policy.

Life cycle module		Emission Source	Key assumptions
			Consumption of chemicals for treatment works was also accounted for using the emissions factors built into the AfW and ST Carbon Tools used.

9.6 Environmental Design, Standards and Management

9.6.1 This section outlines embedded environmental design, standards and/or management measures in relation to GHGs that are relevant for the whole Proposed Development. Where embedded environmental design, standards and/or management measures are specific to a Proposed Development Part(s), these have been identified.

Construction Phase

9.6.2 The DCO application will be accompanied by an Outline Construction Environmental Management Plan (Outline CEMP) that will describe the commitments that the undertaker and its contractors are required to follow during the construction phase. The aim of the Outline CEMP is to reduce impacts from construction activities.

9.6.3 The Outline CEMP will secure and monitor GHG reduction measures during construction, serving as the principal mechanism for implementing construction related GHG mitigation on site. A preliminary Outline CEMP is included in **Appendix 24-PD-2** in PEI Report **Volume 4**.

9.6.4 Embedded mitigation secured through the Outline CEMP will be accounted for in the GHG assessment undertaken for the ES.

Operational Phase

9.6.5 Energy efficiency and recovery have been embedded into the design and operation of the Proposed Development to minimise energy demand, reducing GHG emissions associated with treatment and discharge processes. If feasible and deliverable, the outfall structure will be designed to provide micro hydro power recover, which will be used to power site operations. Bypass structures will also be designed to allow the potential installation of hydroelectric power generation.

9.6.6 The Outline Operational Environmental Management Plan (Outline OEMP) to be submitted with the DCO application will secure and monitor GHG reduction measures during operation, serving as a mechanism for securing further operation related GHG mitigation on site.

9.7 Baseline Conditions

9.7.1 This section describes the baseline environmental characteristics with specific reference to GHGs.

9.7.2 The lifecycle GHG emissions included within this assessment are those that are considered to be additional to this baseline scenario, in accordance with the methodology described in section 9.5.

Existing Baseline

9.7.3 The existing baseline is defined as the ‘BAU’ case, in which the Proposed Development does not proceed and the existing infrastructure within the Study Area continues to operate. The baseline comprises existing carbon stock and sources of GHG emissions within the boundary of the existing site activities.

9.7.4 At Minworth Wastewater Recycling Centre (WwRC), emissions arise from energy use to power pumps, blowers, and treatment equipment, from the use and manufacture of treatment chemicals, and from process emissions such as nitrous oxide and methane released during biological treatment and sludge handling. Backup generators and site vehicles also produce small quantities of emissions through fuel use.

9.7.5 Across the canal network, emissions result from the energy needed to operate existing pumping systems and control structures, fuel use associated with dredging, vegetation management and other maintenance activities, and material use for towpath and bank repairs.

9.7.6 Canal boat traffic represents a further source of emissions, as most vessels are powered by diesel engines. However, these are not included within the assessment as such activities are not expected to change materially as a result of the Proposed Development with boat movements likely to remain the same.

9.7.7 At Daventry and Drayton Reservoirs, operational emissions are expected to be minimal and primarily associated with routine water supply processes and occasional maintenance activities.

Future Baseline

9.7.8 The future baseline is defined as the projected ‘BAU’ case in which the Proposed Development is not constructed, and existing infrastructure continues to operate. This considers the likely evolution of emissions in the absence of the Proposed Development, including planned efficiency improvements and expected changes in demand.

9.7.9 At Minworth WwRC, energy use and process emissions would continue broadly in line with current operations, with gradual reductions possible as efficiency improvements and decarbonisation initiatives are implemented over time. Chemical use and associated supply chain emissions would remain necessary for ongoing treatment, although incremental improvements in chemical efficiency may slightly reduce their impact.

9.7.10 Maintenance activities across the canal network and at the reservoirs would continue, with emissions from dredging, pumping, and towpath maintenance remaining at current levels.

9.7.11 In the wider water supply system, forecast growth in population and water demand in AfW's supply area would still need to be addressed. In the absence of the Proposed Development, alternative options such as additional groundwater abstraction or bulk imports may be implemented, which could require additional pumping energy or treatment infrastructure, resulting in an overall increase in emissions compared to current levels.

9.7.12 The UK water sector is expected to decarbonise over time in line with its net zero target of 2030. Whilst these impacts cannot currently be quantified this would likely have an impact on the future baseline which will be considered qualitatively and explored at ES stage.

9.8 Assessment of Effects and Significance

9.8.1 This section provides the preliminary assessment of likely significant effects, including determining the level of significance, for the Proposed Development as a whole. Where applicable, the requirement for additional mitigation measures and/or monitoring is identified to avoid, prevent, reduce, or if possible, offset, any identified significant adverse effects on the environment.

Construction Phase

9.8.2 For the purposes of the GHG assessment, the construction phase of the Proposed Development is assumed to run from 2028 to 2032, with an anticipated duration of four years.

9.8.3 The emissions associated with the construction phase of the Proposed Development have been calculated in line with the methodology, assumptions and limitations detailed in section 9.5. The results are provided in **Table 9-7**. The life cycle modules are labelled in accordance with PAS 2080:2023 Guidance (Ref. 14).

Table 9-7: Construction phase GHG emissions

Life Cycle Module		**GHG Emissions (tCO_2e)**
A: Before Use Stage	Product Stage, Transport & Construction – Installation process (A1 - A5)	201,246
Total tCO_2e over the construction period		**201,246**

9.8.4 The total emissions attributed to the construction phase of the Proposed Development are estimated to be 201,246 tCO_2e, as shown in **Table 9-7**. Based on the outputs of the Gate 3 GHG reporting, embodied emissions from raw materials are anticipated to represent the largest contributor to construction phase impacts across the Proposed Development. This reflects the use of intensive materials such as concrete, steel, and major electrical components.

9.8.5 The second largest source of emissions is expected to arise from the transport of materials to site, which is influenced by material quantities, haulage distances and delivery requirements. Additional construction related emissions are associated with site preparation and installation activities, including fuel use by construction plant, as well as waste generation and handling during the construction phase.

9.8.6 To contextualise this impact, these construction GHG emissions are compared to the UK carbon budgets, which coincide with the construction phase. This comparison is presented in **Table 9-8**. For additional context, the Proposed Development has also been contextualised against the industry sectoral budget. These are presented in **Table 9-9**.

9.8.7 The potential construction GHG emissions of the Proposed Development are estimated to contribute less than 0.1272 % of any carbon budget reported below in **Table 9-8** and **Table 9-9**. For this comparison, the construction GHG emissions are assumed to be distributed evenly across the years of the construction period.

Table 9-8: Comparison of construction phase GHG emissions with UK carbon budgets

UK Carbon Budget Period	UK Carbon Budget (tCO_2e)	Construction GHG Emissions (tCO_2e)	% of Carbon Budget
5th (2028 – 2032)	1,725,000,000	201,246	0.01 %

Table 9-9: Comparison of construction phase GHG emissions with the Industry Sectoral Budget

UK Carbon Budget Period	Sector Specific Carbon Budget (tCO_2e)	Construction GHG Emissions (tCO_2e)	% of Carbon Budget
5th (2028 – 2032)	158,190,000	201,246	0.13 %

9.8.8 As discussed above, the GHG impact of the Proposed Development during construction has been assessed against the relevant carbon budgets. The construction impacts are consistent with the NPS for Water Resources Infrastructure (paragraphs 4.4.15 and 4.4.16) (Ref. 25), which requires water infrastructure projects to minimise GHG emissions and demonstrate alignment with the UK's legally binding target to achieve net zero by 2050. The Proposed Development supports these objectives by integrating low carbon design and construction practices where feasible, improving resource and energy efficiency, and reusing existing infrastructure such as the Grand

Union Canal to transfer water, thereby reducing the need for additional water transfer infrastructure and avoiding associated emissions.

9.8.9 Following implementation of the mitigation measures outlined in section 9.6 and those secured through the Outline CEMP, the construction impacts of the Proposed Development are considered to align with existing and emerging policy requirements, as well as good practice design standards for projects of this type.

9.8.10 In accordance with ISEP guidance (Ref. 2) (see section 9.5), the GHG emissions associated with construction are assessed as Minor Adverse and Not Significant. A project with 'Not Significant' effects is considered to be consistent with the measures necessary to achieve the UK's net zero trajectory.

9.8.11 Based on the above, there is likely to be an indirect, permanent, long-term, adverse effect which is considered to be minor and not significant.

Additional Mitigation, Enhancement and Monitoring

9.8.12 In addition to the construction related mitigation presented in section 9.6, the following potential measures will be considered to further reduce the Proposed Development's impact on GHGs during the construction stage:

a. Adopt low emission transport solutions, optimise construction sequencing to reduce transport demand, and prioritise local sourcing of materials and labour to lower associated emissions. Specific measures to reduce vehicle emissions will be outlined in the Construction Traffic Management Plan (CTMP), to be submitted alongside the ES;

b. Reduce construction waste through efficient material use, reuse, and recycling, supported by landfill diversion targets;

c. Limit off-site disposal of materials by applying suitable treatment and recovery techniques, supported by landfill diversion targets;

d. Efficient routeing and siting of infrastructure and temporary works to minimise material requirements, reduce construction activities, and thereby lower associated GHG emissions;

e. Promote efficient resource management by repurposing excavated materials where feasible and identifying synergies with nearby projects; and

f. Investigate low carbon steel options, including electric arc furnaces with higher scrap content and emerging hydrogen-based production methods to reduce embodied emissions;

g. Prioritise steel procurement from UK or European manufacturers with verified low carbon processes by specifying steel with higher recycled

content and sourcing from suppliers certified for low carbon intensity, such as those aligned with SteelZero[6] or ResponsibleSteel[7];

h. Adopt low carbon concrete solutions by incorporating supplementary cementitious materials (e.g., limestone or calcium sulphoaluminate cements) to reduce reliance on energy-intensive clinker, using blends with reduced or zero Ordinary Portland Cement (OPC) content, and exploring alternative reinforcement materials such as fibre or basalt systems;

i. Apply recognised benchmarking frameworks, such as the Institution of Civil Engineers' Low Carbon Concrete Group (LCCG), and explore innovative concrete technologies (e.g., bio-cements and performance-enhancing admixtures) to promote lower carbon specifications, enhance durability, and reduce material demand;

j. Expand the use of alternative composite materials, such as glass reinforced plastic (GRP) and fibre-reinforced plastic (FRP), where technically feasible, to reduce reliance on traditional steel and concrete components;

k. Incorporate low carbon asphalt and pavement materials for access and service roads to reduce embodied emissions;

l. Use Renewable Energy Guarantees of Origin (REGO) backed electricity and transition to electric tools, equipment, and low emission generators powered by hydrogen; and

m. GHG KPIs to be part of contract selection process for construction to ensure environmental performance.

Residual Effect

9.8.13 The residual effect is as reported above. There is likely to be an indirect, permanent, long-term, adverse residual effect which is considered to be minor and not significant. The potential additional mitigation measures above are unlikely to change this overall conclusion but will further reduce the GHG emissions impact of the Proposed Development.

Operational Phase

9.8.14 For the purposes of the GHG assessment a reference operational period of 100 years was assumed, in accordance with asset lifespans.

---

[6] SteelZero is a global initiative led by The Climate Group and ResponsibleSteel that brings together organisations committed to procuring and using 100% net-zero steel by 2050 to accelerate the decarbonisation of the steel industry.

[7] ResponsibleSteel is a non-governmental organisation that advocates for and sets standards for low-carbon steel production.

9.8.15 GHG emissions associated with the operational phase of the Proposed Development have been calculated in line with the methodology, assumptions and limitations detailed in section 9.5. The results are provided in **Table 9-10**. The life cycle modules are labelled in accordance with PAS 2080:2023 Guidance (Ref. 14).

Table 9-10: Operation phase GHG emissions

Life cycle Module	Emission Source	GHG Emissions (tCO_2e)	GHG emissions (%)
B: Use Stage	Maintenance, repair, replacement, refurbishment (B2 – B5)	355,304	27
	Other operational processes (B1, B6 – B8)	963,555	73
Total tCO_2e over the Operational phase		**1,318,859**	**100**

9.8.16 The total GHG emissions associated with the Proposed Development in the operational phase are estimated to be 1,318,859 tCO_2e, as shown in **Table 9-10**. The largest contributor is energy use and chemical consumption at the Minworth Advanced Water Treatment Plant (AWTP) and Galley Water Treatment Works (WTW), together with the electricity demand from the pumping stations for transfer of water through the two pipelines and at the pumped lock bypasses and abstraction from the canal. The other main source of operational emissions is maintenance, repair, and replacement activities, which are anticipated to contribute approximately 355,304 tCO_2e over the lifetime of the Proposed Development.

9.8.17 The operational emissions presented in **Table 9-10** do not account for the future decarbonisation of the UK electricity grid or the expected decarbonisation of material and chemical supply chains. Consequently, GHG emissions may be higher than anticipated due to an overestimation of electricity related emissions, while the impacts of other factors, such as embodied emissions, chemical usage, and maintenance activities, may also be understated.

9.8.18 To contextualise this impact, these operational GHG emissions are compared to the UK carbon budgets which coincide with the operational phase. This comparison is presented in **Table 9-11**. For additional context, the Proposed Development has also been compared against the Resources and Waste sectoral carbon budget. This is comparison is presented in **Table 9-12**.

9.8.19 The potential operational GHG emissions of the Proposed Development are estimated to contribute less than 0.2473% of any carbon budget reported in **Table 9-11** and **Table 9-12**. However, as noted above, UK grid decarbonisation has not been factored into the assessment, which may lead to an overestimation of operational emissions and, consequently, the reported carbon budget percentage contributions. Decarbonisation of the grid will be accounted for within the GHG assessment presented in the ES where possible.

9.8.20 For the purposes of comparison, operational emissions are assumed to be distributed evenly across the years of the operational period. As discussed in section 9.5, the UK is legally required to remain net zero after 2050.

Table 9-11: Comparison of operational phase GHG emissions with UK carbon budgets.

UK Carbon Budget Period	UK Carbon Budget (tCO_2e)	Operational GHG Emissions (tCO_2e)	% of Carbon Budget
5th (2028 – 2032)	1,725,000,000	13,189	0.0008 %
6th (2033 – 2037)	965,000,000	52,754	0.0055 %
7th (2038 – 2042)	535,000,000	65,943	0.0123 %
8th (2043 – 2047)	220,000,000	65,943	0.0300 %
9th (2048 – 2050)	23,000,000	39,566	0.1720 %

Table 9-12: Comparison of operational phase GHG emissions with the Resources and Waste Sectoral Budget.

UK Carbon Budget Period	Sector Specific Carbon Budget (tCO_2e)	Operational GHG Emissions (tCO_2e)	% of Carbon Budget
5th (2028 – 2032)	95,000,000	13,189	0.0139 %
6th (2033 – 2037)	62,000,000	52,754	0.0851 %
7th (2038 – 2042)	42,000,000	65,943	0.1570 %

UK Carbon Budget Period	Sector Specific Carbon Budget (tCO_2e)	Operational GHG Emissions (tCO_2e)	% of Carbon Budget
8th (2043 – 2047)	30,000,000	65,943	0.2198 %
9th (2048 – 2050)	16,000,000	39,566	0.2473 %

9.8.21 Although the Proposed Development will result in increased GHG emissions compared to the without project baseline, these must be considered in the context of the UK's policy commitments to achieve net zero by 2050. This policy framework is an important reference point when assessing the significance of the Proposed Development's GHG impact.

9.8.22 The UK Government has set a target for a fossil fuel-independent electricity system by 2035, as outlined in the Powering Up Britain: Net Zero Growth Plan (Ref. 26). While this trajectory was not reflected in the assessment, it provides important context for understanding how future grid decarbonisation may reduce operational emissions over the lifetime of the Proposed Development.

9.8.23 Mitigation measures to limit GHG emissions during operation will be secured through the Outline OEMP, which serves as the implementation framework for relevant mitigation controls. While the Outline OEMP is not a mitigation measure in itself, it contains and secures the actions necessary to reduce operational GHG emissions.

9.8.24 As discussed above, the GHG impact of the Proposed Development during operation has been compared against the relevant carbon budgets. The Proposed Development's operational impacts are consistent with the NPS for Water Resources Infrastructure (Ref. 25), which requires water infrastructure projects to minimise GHG emissions and demonstrate alignment with the UK's legally binding target to achieve net zero by 2050.

9.8.25 The Proposed Development supports these objectives by incorporating energy efficient systems, enabling the use of renewable electricity, and improving the overall efficiency of the water transfer network. Following implementation of the mitigation measures outlined in section 9.6, the operational impacts are considered to align with applicable existing and emerging policy requirements, as well as good practice design standards for projects of this type. In accordance with IESP guidance (see section 9.5), the GHG emissions associated with operation are assessed as Minor Adverse and Not Significant.

9.8.26 Based on the above, there is likely to be an indirect, permanent, long-term, adverse effect which is considered to be minor and not significant.

Additional Mitigation, Enhancement and Monitoring

9.8.27 In addition to the operation related embedded mitigation presented above in section 9.6, the following potential opportunities will be considered further to reduce the Proposed Development's operational impact on GHGs:

a. Optimising pumping systems to reduce operational energy use;
b. Assessing the potential for on-site renewable energy generation to reduce reliance on grid electricity;
c. Making use of energy efficient lighting and smart controls and electrifying heating systems with renewable energy; and
d. Applying circular economy principles to extend the service life of equipment, minimising the need for replacements.

Residual Effect

9.8.28 The residual effect is as reported above. There is likely to be an indirect, permanent, long-term, adverse residual effect which is considered to be minor and not significant. The potential additional mitigation measures above are unlikely to change this overall conclusion but will further reduce the Proposed Development GHG emissions.

Summary

9.8.29 **Table 9-13** summarises the residual GHG effects of the Proposed Development.

Table 9-13: Summary of residual effects – Project-Wide

Description of effect	Sensitivity of receptor	Nature of effect / geographic scale	Magnitude of impact	Initial classification of effect (with embedded control)	Additional mitigation, enhancement and/or monitoring	Residual effect significance
Construction Phase						
GHG Emissions	High	Adverse, Long-term, Global	High	Minor Adverse	No additional mitigation is required to avoid a significant adverse effect, but consideration will be given to measures that will further reduce the Proposed Development's emissions.	Minor Adverse (Not Significant)
Operational Phase						
GHG Emissions	High	Adverse, Long-term, Global	High	Minor Adverse	No additional mitigation is required to avoid a significant adverse effect, but consideration will be given to measures that will further reduce the Proposed Development's emissions.	Minor Adverse (Not Significant)

9.9 Summary and Next Steps

9.9.1 The preliminary assessment of effects has identified that the GHG impacts of the Proposed Development would be minor adverse and not significant for both the construction and operational phases.

9.9.2 The information provided in this PEI Report is preliminary, with the final assessment of likely significant effects to be reported in the ES.

9.9.3 Further work to support the assessments presented in the ES will include refining the GHG assessment to incorporate detailed material quantities and activity data as these become available. It will also include further consideration of the potential additional mitigation measures referred to in section 9.8.

9.10 References

Ref. 1 World Resources Institute & World Business Council for Sustainable Development. (2004). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition).

Ref. 2 Institute of Sustainability and Environmental Professionals (ISEP) (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance.

Ref. 3 UK Government (2008). Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/contents [Accessed 07/10/2025].

Ref. 4 UK Government (2019). The Climate Change Act 2008 (2050 Target Amendment) Order 2019. Available at: https://www.legislation.gov.uk/ukdsi/2019/9780111187654 [Accessed 07/10/2025].

Ref. 5 United Nations Framework Convention on Climate Change (UNFCCC). (2015). Paris Agreement. United Nations Framework Convention on Climate Change. Retrieved from https://unfccc.int/sites/default/files/english_paris_agreement.pdf [Accessed 07/10/2025].

Ref. 6 UK Government (2008). The Carbon Budgets Order 2009. Available at: https://www.legislation.gov.uk/uksi/2009/1259/contents/made [Accessed 07/10/2025].

Ref. 7 UK Government (2011). The Carbon Budget Order 2011. Available at: https://www.legislation.gov.uk/uksi/2011/1603/made#:~:text=This%20Order%20sets%20the%20carbon,the%20Climate%20Change%20Act%202008 [Accessed 07/10/2025].

Ref. 8 UK Government (2016). The Carbon Budget Order 2016. Available at: https://www.legislation.gov.uk/uksi/2016/785/contents/made. [Accessed 07/10/2025].

Ref. 9 UK Government (2021) The Carbon Budget Order 2021. Available at: https://www.legislation.gov.uk/ukdsi/2021/9780348222616. [Accessed 07/10/2025].

Ref. 10 Department for Environment, Food & Rural Affairs (Defra). (2025). National Policy Statement for Water Resources Infrastructure. Available at: https://assets.publishing.service.gov.uk/media/6874ca77c831dea2b152cfe9/E03400114_National_Policy_Statement_for_Water_Resources_Web_Accessible.pdf [Accessed 07/10/2025].

Ref. 11 Ministry of Housing, Communities and Local Government, Ministry of Housing, Communities & Local Government (MHCLG). (2018 to 2021) and Department for Levelling Up, Housing and Communities (DLUHC). (2025). National Planning Policy Framework – Last updated 7th February 2025. Available at: https://assets.publishing.service.gov.uk/media/675abd214cbda57cacd3476e/NPPF-December-2024.pdf [Accessed 07/10/2025].

Ref. 12 Department for Energy Security and Net Zero. (2023). Carbon Budget Delivery Plan. Available at: https://www.gov.uk/government/publications/carbon-budget-delivery-plan [Accessed 07/10/2025].

Ref. 13 DLUHC and MHCLG. (2019). Planning Practice Guidance: Climate Change. Available at: https://www.gov.uk/guidance/climate-change [Accessed 07/10/2025].

Ref. 14 British Standards Institution. (BSI). (2023). PAS 2080: Carbon Management in Buildings and Infrastructure.

Ref. 15 UK Water Industry Research. (2024). Supporting Whole Life Carbon Reduction.

Ref. 16 Severn Trent. (2024). Minworth SRO Gate Three Carbon Report. Available at: https://www.severntrent.com/content/dam/sros-gate-3-documents/minworth/minworth-sro-gate3-annex-a5-carbon-report-redacted.pdf. [Accessed 07/10/2025].

Ref. 17 Affinity Water. (2024). Grand Union Canal Strategic Resource Option: Detailed Feasibility and Concept Design – Annex A1 - Engineering. Available at: Gate 3 Documents | Strategic Resource Options | Affinity Water Have your say. [Accessed 07/10/2025].

Ref. 18 University of Bath. (2019). Inventory of Carbon and Energy (ICE), Version 3.0.

Ref. 19 International Pannel on Climate Change (IPCC). (2018). Global warming of 1.5°C. Available at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf [Accessed 05/03/2025].

Ref. 20 Climate Change Committee. (2025). The Seventh Carbon Budget. Available at: https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf [Accessed 07/10/2025].

Ref. 21 The Regulators' Alliance for Progressing Infrastructure Development (RAPID). (2024). Strategic regional water resource solutions guidance for gate three. Version 3. Available at: https://www.ofwat.gov.uk/wp-content/uploads/2024/01/January-2024-Gate-Three-Guidance-Version-3.pdf [Accessed 07/10/2025]

Ref. 22 University of Manchester. (2011). Carbon Calculations over the Life Cycle of Industrial Activities (CCalC v2.0 - User guide. [Accessed 07/10/2025]

Ref. 23 Mott MacDonald. (2013). CESMM4 Carbon & Price Book 2013. Available at: https://library2.nics.gov.uk/pdf/dof/2023/PDF230058.pdf [Accessed 07/10/2025]

Ref. 24 Department for Energy Security and Net Zero (DESNZ) 2024. Greenhouse Gas Reporting: Conversion Factors 2024. UK Government. Available from: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024 [Accessed 07/10/2025].

Ref. 25 Department for Environment, Food & Rural Affairs (DEFRA). (2025). National Policy Statement: Water Resources Infrastructure. Available at: https://www.gov.uk/government/publications/national-policy-statement-water-resources-infrastructure [Accessed: 10/10/2025].

Ref. 26 Department for Energy Security and Net Zero (DESNZ). (2023). Powering Up Britain: Net Zero Growth Plan. London: HM Government. Available at: https://www.gov.uk/government/publications/powering-up-britain/powering-up-britain-net-zero-growth-plan [Accessed 07/10/2025].