

Appendix: Supporting Technical Information

Annex 1: Greenhouse Gas Emissions Report

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BROAD STREET MALL

GHG Emissions Assessment

Broad Street Mall (Inception (Reading) Sarl)

December 2018

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	RELEVANT LEGISLATION, POLICY & GUIDANCE	3
3.0	METHODOLOGY	4
4.0	GHG EMISSIONS ASSESSMENT	8
5.0	ASSESSMENT OF SIGNIFICANCE & MITIGATION	12
6.0	RESIDUAL EFFECTS	ERROR! BOOKMARK NOT DEFINED.
7.0	ON-GOING ASSESSMENT	16
	APPENDIX A: SUMMARY OF RELEVANT LEGISLATION, POLICY & GUIDANCE	17
	APPENDIX B: GHG EMISSION DATA SOURCES	20
	APPENDIX C: REFERENCES	21

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GREENHOUSE GAS EMISSIONS ASSESSMENT

1.0 Introduction

1.1 Project Overview

- 1.1.1 This Greenhouse Gas (GHG) Emission Assessment report has been prepared by Adapt Sustainability Consulting Limited for Broad Street Mall on behalf of Inception (Reading) Sarl (Development Management).
- 1.1.2 The assessment was carried out to provide GHG emission information to inform a full planning application for the redevelopment of an area of land ('Broad Street Mall' (the 'site')). The site is located within the administrative boundary of Reading Borough Council (RBC) and includes a shopping centre (retail units), office space, car parking and some internal thoroughfares.
- 1.1.3 The scheme proposal (the 'Proposed Development') is for the construction of four new blocks on top of the existing Broad Street Mall shopping centre, and the extension and refurbishment of Quadrant House in Reading. The Proposed Development will provide for a residential led mixed-use development including residential and retail space.

1.2 EIA & GHG Emissions

- 1.2.1 The EIA Directive was amended in 2014 (2014/52/EU), with member states required to transpose it into national legislation from the 16th May 2017. The amendments include a requirement for a description of the likely significant effects of a project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of a project to climate change.
- 1.2.2 GHG emissions contribute to climate change by causing global warming, and increasing global temperatures are predicted to have severe adverse environmental, social and economic effects. To reduce the likely effects of climate change, the UK Government has set a target to reduce GHG emissions by 80% against 1990 levels by 2050.
- 1.2.3 The built environment is a major contributor to GHG emissions, and according to the Committee on Climate Change, buildings were responsible for 19% of the UK's GHG emissions in 2016. Historically within the built environment sector emphasis has been placed upon reducing GHG emissions arising from the operational use of electricity and gas. However, to meet the target set by the UK Government, a more comprehensive approach is needed to understand better how to reduce the life-cycle and embodied impacts of new and existing buildings.
- 1.2.4 The inclusion of an assessment of GHG emissions within an EIA allows for a greater understanding of the extent of GHG emissions arising from a project and to support the identification of opportunities to optimise performance.

1.3 GHG Emission Assessment of Proposed Development

- 1.3.1 In September 2018 an EIA Scoping Report submitted to Reading Borough Council. This set out the potential key environmental impacts and likely significant effects to be considered as part of the EIA for the Proposed Development. The undertaking of a GHG Emission Assessment was included within the scope of the EIA.

1.3.2 This report presents an assessment of GHG emissions for the Proposed Development. The assessment has been undertaken in line with the IEMA guide to 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2017) which recommends a framework of five steps to prepare a robust, appropriate and consistent assessment;

1. Define goal and scope of GHG emission assessment;
2. Set study boundaries;
3. Determine assessment methodology;
4. Collect the necessary calculation data; and
5. Calculate the GHG emission inventory.

1.3.3 The prepared GHG emission inventory has informed the decision-making process in identifying mitigation measures for the Proposed Development.

2.0 Relevant Legislation, Policy & Guidance

2.1 [Introduction](#)

2.1.1 The following legislation, policy, and guidance are relevant to this assessment and provide context to the overarching aim and approach taken to determine and mitigate GHG emissions. Further information for the referenced legislation, policy and guidance is provided in Appendix A.

2.2 [National Legislation & Policy](#)

- The Climate Change Act (2008)
- National Planning Policy Framework (NPPF) (2018)
- Part L of the Building Regulations (2013) Conservation of Fuel & Power

2.3 [Local Policy & Guidance](#)

- Reading Borough Council (2008); Reading Borough Local Development Framework: Core Strategy
 - Policy CS1: Sustainable Construction and Design
- Reading Borough Council (2009); Reading Borough Local Development Framework: Reading Central Area Action Plan
- Reading Borough Council (2017) Draft Local Plan
 - Policy CC2 Sustainable Construction and Design
 - Policy CC3 Adaption to Climate Change
 - Policy CC4 Decentralised Energy
- Reading Borough Council (2018) Hosier Street Area; Outline Development Framework: Reconnecting with Reading's Historic Town Centre (out for public consultation)
- Reading Borough Council (2011) Local Development Framework; Supplementary Planning Document: Revised Sustainable Design and Construction
- Reading Borough Council (2008) Reading Tall Building Strategy

2.4 [Industry Guidance](#)

- BSI (2012) EN 15804:2012 Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.
- BSI (2011) EN 15978:2011 Sustainability of Construction Works. Assessment of Environmental Performance of Buildings.
- BSI (2012) EN 15804:2012 Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.
- European Commission (2013) Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment.
- IEMA (2014) Position Statement on Climate Change and Energy.
- IEMA (2017) Assessing Greenhouse Gas Emissions and Evaluating their Significance.
- PAS 2080 (2016) Guidance Document on Carbon Management in Infrastructure
- RICS (2014) Methodology to Calculate Embodied Carbon.
- RICS (2017) Whole Life Carbon Assessment for the built environment (1st edition).
- UKGBC (2017) Embodied Carbon: Developing a Client Brief.
- WRAP (2011) Cutting Embodied Carbon in Construction Projects. WRI & WBSCD (2005) The Greenhouse Gas Protocol for Project Accounting.

3.0 Methodology

3.1 Introduction

3.1.1 This section describes the methodology applied to completing this GHG emissions assessment. It has been undertaken in line with the IEMA guide to ‘Assessing Greenhouse Gas Emissions and Evaluating their Significance’ (2017) and with other industry guidance referenced in sub-section 2.5. It is important to note that there is no singular industry approach to assessing GHG emissions and that there are many different approaches associated with the built environment sector. The IEMA guidance does not specify a particular approach, but rather sets out advice as to the key components necessary to deliver a robust, appropriate and consistent assessment.

3.2 Goal & Scope

3.2.1 The goal of this assessment is to complete a proportionate GHG emissions assessment of the Proposed Development, to determine any likely significant effects arising from GHG emissions and the requirement for any appropriate mitigation.

3.2.2 The Proposed Development includes the construction of four new blocks on top of the existing structure on-site and the extension and refurbishment of one existing blocks.

- Block 1: 22 storey (on top of the existing mall and therefore 25 storeys in total) development providing up to 180 residential units with amenity space and parking;
- Block 2: 18 storey (on top of the existing mall and therefore 21 storeys in total) development providing up to 150 residential units, with amenity space and parking;
- Block 3: 15 storey (on top of the existing mall and therefore 18 storeys in total) development providing up to 115 residential units, with retail unit;
- Block 4: Refurbishment and extension of existing office floors, with two additional floors proposed above. There will therefore be three levels of residential, within a 5-storey block, providing up to 35 residential units; and
- Block 5: Provision of up to 50 residential units above the existing retail parade, along with enhancements to the existing shop fronts.

3.2.3 The GHG emissions inventory will include Scope 1, 2 and 3 emissions. A definition of each scope is provided below (adapted from the WBCSD WRI (2015): GHG Protocol: A Corporate Accounting and Reporting Standard):

- Scope 1 Emissions: Direct GHG emissions arising from energy use (combustion) on site.
- Scope 2 Emissions: Indirect GHG Emissions arising from the use of purchased electricity, heat or steam.
- Scope 3 Emissions: Other indirect (embodied) GHG emissions arising from third-party services and the production of materials, transportation, and disposal of waste.

3.3 Assessment / Study Boundaries

3.3.1 A detailed and complete GHG emissions assessment typically covers all life cycle stages of development. Figure 1 sets out the modular approach of the life cycle stages to be included. This is a simplified presentation of the modular approach provided by IEMA (2017) and is based on the BS EN 15978 standard.

3.3.2 It is recognised that covering all GHG emissions associated to a project is challenging, particularly in the earlier design stages, and therefore IEMA (2017) place emphasis upon

undertaking a proportionate and appropriate assessment to inform decision making and avoid undue burden to developers and regulators. Further information on the assumptions and limitations of the methodology are presented in sub-section 3.5.

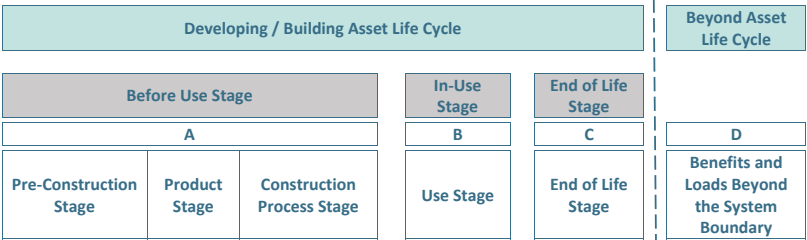


Figure 1: Modular approach to life cycle stages and modules for EIA GHG emissions assessment (adapted from IEMA (2017))

3.3.3 Module A is classified as the ‘Before Use Stage’ and includes emissions associated with pre-construction activities, products and the construction process.

3.3.4 Module B is classified as the ‘Use Stage’ and includes emissions associated with the operation of the Proposed Development.

3.3.5 Module C is classified as the ‘End of Life Stage’ and includes emissions associated with the de-construction and demolition of the Proposed Development.

3.3.6 Module D is classified as the ‘Beyond Asset Life Cycle’ and includes emissions associated with activities beyond the project boundary and life cycle of the Proposed Development. Module D is classified as an optional consideration as it relates to the repurposing of discarded building elements or any energy recovered from beyond the project’s lifecycle. It is not included in this assessment, as data to quantify this impact is limited until more detailed specifications and manufacturer information are available.

3.3.7 The assessment will consider the building components and works related to the project, including external works within the site boundary. For the purposes of this assessment, the site boundary remains consistent with that stated within the EIA. For further information on the Proposed Development and the site boundary, refer to **ES Chapter 1: Introduction (Volume 1)**.

3.3.8 The Reference Study Period (RSP) for the assessment is 60 years. This RSP is the most commonly referenced within industry guidance including within the RICS (2017) Whole Life Carbon Assessment for the built environment (1st edition) and BS EN 15978 (2011).

3.3.9 The RSP will be considered in conjunction with the demolition, and construction programme of the Proposed Development. In summary, the enabling works, demolition and construction will take circa 2 and a half years to complete.

3.4 Calculation Methodology

3.4.1 The quantification of GHG emissions for an EIA can be either measured or calculated or a combination of both. Within this assessment, emissions have been calculated as the exercise is taking place in advance of any supply chain mobilisation or construction works associated with the Proposed Development.

3.4.2 The calculation for determining GHG emissions is based upon the multiplication of relevant emission factors with the activity producing the GHG emissions.

For example:

Electricity consumed (kWh) x electricity emission factor (tCO₂e per kWh) = total tCO₂e

3.4.3 GHG emissions will be reported using the following units: tonnes of carbon dioxide equivalent (tCO₂e).

3.4.4 A universal database is not available for the sourcing of GHG emission factors and benchmarks. Therefore, a range of industry sources are used to compile the inventory. References to the sources for emission factor data are provided within Appendix B.

3.4.5 A summary of the GHG emissions data considered in this assessment is provided below.

Module A: Before Use-Stage

- Pre-construction & Construction Stage:
 - Estimated emissions associated with the treatment and transport of waste arising from the enabling works and construction
 - Estimated emissions associated with energy use on-site activities
- Product Stage:
 - Cradle to gate assessment of construction materials

Module B: In-Use Stage

- In-Use Stage:
 - Estimated emissions associated with the operational energy consumption (regulated and unregulated emissions included)
 - Estimated emissions associated with operational waste arisings
 - Estimated emissions associated with operational water use
 - Estimated emissions associated with vehicles/transport including servicing and visitors

Module C: End of Life

- End of Life Stage:
 - Estimated emissions associated with demolition activities
 - Estimated emissions associated with the treatment and transport of demolition

3.5 Limitations of the Assessment

3.5.1 This assessment has been undertaken at RIBA Stage 2, typically referred to as the 'Concept Design' stage. During this stage, outline proposals for the structural design, building services systems, outline specifications and preliminary cost information is produced. Therefore, this assessment is based on the indicative information available at this stage of the project. This reduces the level of accuracy of the assessment. However, by using industry benchmarks and preliminary modelling results, the results of the assessment can provide insight as to the priority areas for reducing the GHG emissions impact of the Proposed Development.

3.5.2 Emissions associated with the transport of the delivery of goods to the site are typically a material consideration for residential developments. At this early stage of the project, it is challenging to determine a meaningful calculation of these transports emissions as a greater understanding of where these goods originate from is required (e.g., the distance from the supplier's 'gate' to site). It is recommended that this assessment is regularly reviewed throughout the later stages of the design to replace benchmark and estimated data with the actual design and product information.

3.5.3 Within the 'Baseline' and 'In-Use' calculations current carbon factors have been used to determine the GHG emission impact of predicted energy usage. However, future energy projections indicate that the carbon intensity of energy generated by the National Grid may reduce as cleaner energy sources replace more carbon-intensive methods such as coal-based generation. In line with the guidance provided by EN 15978 (2011), current emission factors have been applied to 'In-Use' energy calculations in an effort to limit uncertainty factors. As further technical design information is made available during RIBA stage 3 & 4, future scenario models could be undertaken to compliment the GHG emission assessment.

3.5.4 The current car park on site is known as 'NCP Broad Street Mall' and comprises 700 car-parking spaces spread across three floors. The Proposed Development will retain the current car park facilities on the first and podium floors, whilst the car parking on the second floor will be decreased in size (by a total of 60 car parking spaces) due to the introduction of the building footprints. It is expected that GHG emissions will arise from vehicles utilising these spaces. The Proposed Development will provide 24 accessible parking spaces, emissions associated with these vehicles are not considered to be material and are therefore not included in this assessment at this stage.

4.0 GHG Emissions Assessment

4.1 Baseline

Current Baseline

4.1.1 Within the context of this GHG emissions assessment, the baseline is a reference point against which the impact of the Proposed Development can be compared against. The baseline for the GHG emissions assessment is a business-as-usual scenario whereby the Proposed Development does not go ahead.

4.1.2 The GHG emission from the existing Site include the operations of the current businesses and therefore predominantly relate to electricity usage and heat demand. Due to the nature of the existing operations, where there are multiple tenants operating within the Site, comprehensive information to calculate the actual GHG emissions is not available. An estimation of energy use has been calculated using the Chartered Institute of Building Services (CIBSE) Energy Benchmarks TM46:2008 for the retail shopping centre and office areas. Based on this calculation, the annual baseline emissions are estimated to be 2,712 tCO₂e.

4.1.3 Emissions associated to the NCP Car Park have not been calculated as floor area data has not been made available at this stage. However, the GHG emissions anticipated to arise from the car park are expected to be minimal compared to the other operational buildings (approximately 20kWh per m² per annum) due to there being no heating demand and low electrical demand for lighting purposes.

4.2 Module A: Before Use Stage

Demolition & Construction Stage

4.2.1 GHG emissions will arise from activities to prepare the site for the Proposed Development. Equipment will be installed on-site to support enabling and construction activities. As a result of these activities, emissions will arise from energy used for site equipment and from the transport and treatment of waste materials.

4.2.2 To calculate the GHG emissions relating to energy use for on-site equipment, an industry benchmark has been used. The benchmark is published in the Constructing Excellence '2018 UK Construction Key Performance Indicators (KPI) Report' and is based on the typical median energy usage and resulting carbon emissions per £100k of project value. Using this benchmark, it is estimated 358 tCO₂e will arise from energy used to supply site equipment.

4.2.4 Estimations of the waste that will arise from the demolition activities are provided in **ES Chapter 5 Demolition and Construction (Volume 1)**. During the pre-construction and construction stage, approximately 26,056 tonnes of material is expected to be produced.

4.2.5 Emission factors for the expected waste streams have been sourced from the UK Government (2018) GHG Conversion Factors and have been selected based upon the expected treatment of the waste material e.g. reclaimed, recycled or diverted to landfill. The waste will be transported from site and emissions will arise from these vehicle movements. It is estimated that 65 tCO₂e will arise from the treatment and transport of waste.

Product Stage

4.2.5 At an early stage of a project, GHG emissions arising from the manufacture of construction products/materials, often referred to as embodied emissions, can be calculated using the RICS

(2014) benchmark. The benchmark is based on industry case studies and accounts for 'cradle-to-gate' emissions.

4.2.6 'Cradle-to-gate' are emissions those that arise from the energy used in extracting materials, refining them (i.e., primary manufacture), transporting and processing them to produce a finished product.

4.2.7 Within the RICS methodology benchmark emission factors are provided for different building use-types. To calculate the product stage emission for the Proposed Development, the most appropriate benchmark has been determined for the development. This was determined by splitting the building GIA into different typologies; High Street Retail, High Rise, Medium Rise and Low-Rise apartments and multiplying the emission factor for each typology by the associated Gross Internal Floor Area (GIA). The estimated GHG emissions arising from products/materials to be used in the Proposed Development are calculated as 36,637tCO₂e.

4.2.6 Increasingly, product/material manufacturers are producing reports detailing actual 'cradle-to-gate' emissions and also produce industry recognised Environmental Product Declarations (EPD). It is recommended that as the technical design and specification of the Proposed Development progresses, more accurate information should be sought from suppliers to determine to replace the use of benchmarks.

4.3 Module B: In-Use Stage

Energy Use

4.3.1 Once operational, GHG emissions will arise from the Proposed Development as a result of energy being used for technical building services including heating, cooling, hot water, and ventilation, as well as for occupier equipment such as cooking appliances, computers and, refrigeration for example.

4.3.2 An Energy Strategy has been prepared for the Proposed Development to support the planning application process. The Energy Strategy includes Standard Assessment Procedure (SAP) modelling to demonstrate compliance with Building Regulations Part L1A 2013, and it includes a description of the design considerations to meet the energy requirements set out in the Reading Borough Council Core Strategy (2008). Energy used for technical building services is referred to as regulated energy and energy used for uncontrolled occupier equipment is referred to as unregulated energy.

4.3.3 The results of the energy modelling for domestic buildings within the Proposed Development are presented in Table 2.

	Carbon Dioxide Emissions (tCO ₂ per year)			
	Domestic		Non-Domestic	
	Regulated	Unregulated	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	873.02	640.63	22.61	9.86
Predicted Performance After Proposed Savings	373.94	274.37	22.61	9.86

Table 2: Predicted annual regulated and unregulated carbon emissions for domestic buildings in the Proposed Development

- 4.3.4 Figure 2. presents the cumulative emissions associated with energy use over the proposed study period of 60 years. These figures have been calculated by multiplying the predicted energy consumption, reported in the Energy Strategy, by the UK 2018 GHG conversion factors for electricity. The 'high' scenario represents the baseline where no energy savings are realised, and the 'low' scenario represents where energy saving measures are applied. On this basis the total predicted 'In-Use' emissions, assuming the Proposed Development is operational for 60 years are 38,898 tCO₂ (low scenario) or 90,819 tCO₂ (high scenario).

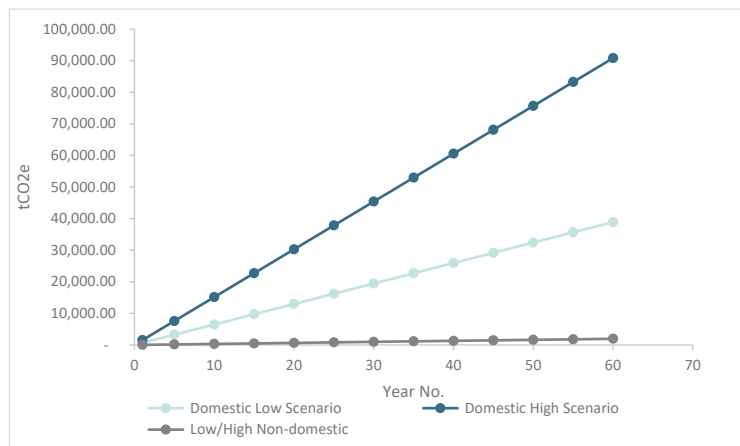


Figure 2. Cumulative tCO₂e during use stage

Water Use

- 4.3.5 It is estimated that when the complete development is fully operational the annual water consumption will be 44,750m³. Assuming that the Proposed Development is operational for 60 years the predicted emissions associated to water consumption are 2,555 tCO₂e.

4.4 Module C: End-of-Life Stage

- 4.4.1 When the Proposed Development has reached the end of its life and will no longer be in use (assumed this will be in Year 60), GHG emissions will arise from the decommissioning, stripping out, disassembly, deconstruction and demolition activities, as well as from the transport, processing and disposal of materials of the built assets.
- 4.4.2 In the absence of specific material information that will arise from the demolition at the end-of-life stage and how these materials will be treated at the point of disposal, the RICS (2017) guidance recommends and provides benchmark values.
- 4.4.3 Table 4 provides a summary of the end-of-life GHG emissions:

End-of-Life Stage	tCO ₂ e
Site demolition activities	125
Waste treatment / disposal & transportation	178

Table 4. Estimated end-of-life emissions for the Proposed Development

- Emissions arising from on-site demolition activities and the disposal and transportation of demolition waste have been calculated using the RICS (2017) benchmark (refer to Appendix B).

4.5 Summary of Estimated GHG Emissions

- 4.5.1 The total estimated GHG emissions for the Proposed Development from Pre-Construction Stage to End-of-Life Stage are 80,763 tCO₂e. This calculation is based on the low 'In-Use' scenario.

- 4.5.2 Table 5 presents a breakdown of GHG emissions by stage.

Stage	tCO ₂ e
Before Use Stage	37,060
In-Use Stage	43,401
End of Life	302
Total	80,763

Table 5: Proportion of Estimated GHG Emissions by Module/Stage (based on low 'In-Use Scenario')

5.0 Assessment & Mitigation

5.1 Assessment

5.1.1 It is widely accepted that an EIA should focus on a Proposed Development's significant impacts. The IEMA (2017) guidance advocates that GHG emissions are always considered and reported but at varying degrees of detail depending on the EIA project. Furthermore, in the absence of significance criteria and on the basis that GHG emissions will contribute to climate change, and climate change being recognised as the largest inter-related cumulative environmental effect, IEMA recommend that any GHG emissions arising from a project are to be considered as 'significant'.

5.1.2 A comparison of the estimated GHG emissions arising from the Proposed Development with the UK National Carbon Budgets is presented. Table 6 presents the relevant UK carbon budget data. The current UK carbon budgets are projected to 2032. Emissions associated to the 'Before Use' stage (enabling and construction works) will fall within the third carbon budget and 'In-use' stage emissions will also fall within the third budget.

Carbon Budget	Carbon Budget Level (MtCO ₂ e)	Estimated GHG Emissions Arising from Proposed Development (tCO ₂ e)	% of Carbon Budget
3 rd 2018-2022	2,544	38,464	0.002%
4 th 2023-2027	1,950	2,893	0.0001%
5 th 2028-2032	1,725	2,893	0.0002%

Table 6: UK National Carbon Budgets

5.2 Mitigation

5.2.1 Reducing emissions can be best achieved by considering a hierarchal approach as illustrated in Figure 3. This hierarchy is adapted from the IEMA (2014) 'Position Statement on Climate Change and Energy' and starts with first avoiding or reducing emissions where practical, before suggesting offset or sequester strategies beyond this. The practical outcomes of applying these principles will differ depending on the attributes of the project. However, to make a notable positive impact, the hierarchy needs to be considered in the early decision-making stages of a project.

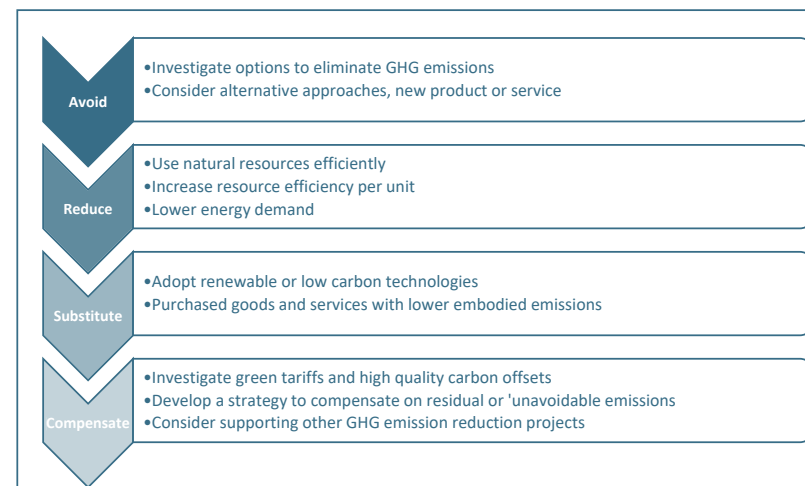


Figure 3: The Greenhouse Gas Management Hierarchy (Adapted from IEMA (2014) Position Statement on Climate Change and Energy)

5.2.2 Throughout the early stages of the design (RIBA Stages 1- 2), mitigation measures to reduce the environmental impact and specifically the GHG emission impact of the Proposed Development have been considered by the Design Team. The mitigation measures are summarised in Table 7. Further detail on these measures can be found in the **Hoare Lea (2018- Rev. B) Broad Street Energy Strategy**.

Stage	Mitigation Measures
Before Use Stage	Materials with Low Embodied Impact: A building lifecycle assessment will be undertaken in accordance with BREEAM criteria.
	Designing for durability: The design will consider the specification of materials and products that are robust in order to reduce the likelihood of replacement over the building's life cycle.
	Construction Site & Resource Management Plan: The completion of a Resource Management Plan that will focus on opportunities for material re-use, increasing recycling rates and avoiding diversion to landfill. The Proposed Development will aim to generate less than 3.2 m3 of waste per 100m2 of GIFA.
	Pre-Demolition Audit: The completion of a pre-demolition audit of any existing buildings, structures or hard surfaces to determine whether refurbishment or reuse is feasible and, in the case of demolition, to maximise the recovery of material for subsequent high grade or value applications.
In-Use Stage	Fabric Design: Improved insulation level beyond Part L minimum targets to meet the fabric efficiency target and reduce heat losses.
	Energy Efficient Ventilation: The use of Mechanical Ventilation Heat Recovery (MVHR) in each dwelling helps to reduce energy consumption by utilising the internal air to pre-heat the incoming fresh air.
	Energy Efficient External Lighting: All external light fittings are automatically controlled for prevention of operation during daylight hours and presence detection in areas of intermittent pedestrian traffic.

	<u>Water Monitoring and Efficient Appliances:</u> A water meter with a pulsed output will be installed on the mains supply to each building/unit. A leak detection system will be installed which is capable of detecting a major water leak on the mains water supply within the building and between the building and the utilities water meter
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Table 7: Planned Mitigation Measures

6.0 Conclusion

6.1 Conclusion

6.1.1 The IEMA principles on climate change mitigation and EIA identify climate change as one of the defining environmental policy drivers of the future, and that action to address GHG emissions is essential.

6.1.2 The principles are based on the following considerations:

1. All projects create GHG emissions that contribute to climate change;
2. Climate change has the potential to lead to significant environmental effects; and
3. There is a carbon budget that defines a level of dangerous climate changes whereby any GHG emission within that budget can be considered as significant.

6.1.3 As a result, IEMA (2017) recommend that all GHG emissions, including any residual emissions following adoption of any mitigation measures, are to be determined as significant. However, as demonstrated in Section 5 the arising GHG emissions represent a small proportion of the regional GHG emissions and by the adoption of mitigation measures, as well as continuing decarbonisation of the energy network, it is anticipated that emissions will be minimised over time.

6.1.4 As stated in Section 4.5, the total estimate of GHG emissions for the Proposed Development over the 60-year RSP the 80,763 tCO₂e. This calculation is based on the low 'In-Use' scenario.

6.1.5 Table 5 demonstrate that GHG emissions associated with In-Use stage is the largest contributor to GHG emissions throughout the lifecycle of the Proposed Development.

7.0 On-going Assessment

7.1 Updating the GHG Assessment

- 7.1.1 This assessment is reflective of the design information available at RIBA stage 2. Additional detail in the design and specification of the Proposed Development will become available as the project progresses. For example, during the tender process, a Principal Contractor may identify and suggest alternative construction materials or methodologies that may reduce or increase the emission impact. It is therefore recommended that the GHG emission assessment is updated at each RIBA stage to account for any changes and allow for the identification/adjustment of mitigation activities where appropriate.

7.2 Operational Performance

- 7.2.1 In 2016 Innovate UK carried out a study to evaluate the building performance in domestic projects, the study provides strong evidence that GHG emissions from new homes are two or three times higher than design estimates, often referred to as the 'performance gap'. It is recommended that the anticipated energy and GHG emission performance is reviewed at each RIBA stage throughout the design and delivery programme. On completion, an assessment of as-built performance should be undertaken to identify any commissioning issues that may be resulting in higher energy usage. Furthermore, carrying out this review could lead to a better understanding of any performance gap and inform the design of future projects.

Appendix A: Summary of Relevant Legislation, Policy & Guidance

National Legislation & Policy

The Climate Change Act (2008)

The Climate Change Act (2008) is the basis for the UK's approach to tackling and responding to climate change. Through the Climate Change Act, a target to significantly reduce the UK Greenhouse Gas emissions by 2050 has been set. The Act commits the UK Government by law to reduce GHG emissions by at least 80% of 1990 levels by 2050. It also establishes a framework to deliver these requirements.

National Planning Policy Framework (NPPF) (2018)

The National Planning Policy Framework (NPPF) came into force with the aim of making the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The government states that at the heart of the National Planning Policy Framework is a presumption in favour of sustainable development, which should be seen as a principle thread running through both plan-making and decision-taking.

▪ Chapter 9. Promoting sustainable transport

- Transport issues should be considered from the earliest stages of plan-making and development proposals, so that:
 - a) the potential impacts of development on transport networks can be addressed;
 - b) opportunities from existing or proposed transport infrastructure, and changing transport technology and usage, are realised – for example in relation to the scale, location or density of development that can be accommodated;
 - c) opportunities to promote walking, cycling and public transport use are identified and pursued;
 - d) the environmental impacts of traffic and transport infrastructure can be identified, assessed and taken into account – including appropriate opportunities for avoiding and mitigating any adverse effects, and for net environmental gains; and
 - e) patterns of movement, streets, parking and other transport considerations are integral to the design of schemes, and contribute to making high quality places.

▪ Chapter 14. Meeting the challenge of climate change, flooding and coastal change

- Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:
 - a) take account of advice from lead local flood authority
 - b) have appropriate proposed minimum operational standards
 - c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development
 - d) where possible, provide multifunctional benefits

▪ Chapter 15. Conserving and enhancing the natural environment

- Planning policies and decisions should contribute to and enhance the natural and local environment by:
 - a) minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;
 - b) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and
 - c) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.
- Planning policies and decisions should ensure that a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);
- Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development.

Part L of the Building Regulations (2013) Conservation of Fuel & Power

Part L of the Building Regulations (2013) Conservation of Fuel & Power provides guidance on how to comply with the energy efficiency requirements of the Building Regulations. It requires that reasonable provision shall be made for the conservation of fuel and power in buildings by:

- Limiting heat gain and losses -
 - through thermal elements and other parts of the building fabric; and
 - from pipes, ducts and vessels used for space heating, cooling and hot water services;
- Providing fixed building services which -
 - are energy efficient
 - have effective controls; and
 - are commissioned by testing and adjusting as necessary to ensure they use no more fuel or power than is reasonable in the circumstances.

Regional Policy & Guidance

Local Policy

Reading Borough Council (2008); Reading Borough Local Development Framework: Core Strategy

The Reading Borough Local Development Framework sets out how planning and development will achieve the Reading 2020 Vision for the town. The Core Strategy includes a number of policies designed to provide a planning framework for implementing the Strategy for sustainable growth. It includes targets for sustainable construction and design. A brief summary of policies relating to this report is provided below:

- **Policy CS1: Sustainable Construction and Design**
 - All new housing is required to meet the most up to date Eco-Homes 'Very Good' as a minimum standard, and all new commercial developments are required to meet the most up to date BREEAM 'Very Good' as a minimum standard.
 - On larger developments of more than 10 dwellings or 1,000 m² of floorspace, ensure that 50% of the provision meets the most up to date Eco-Homes and BREEAM 'Excellent' standards;

Reading Borough Council (2009); Reading Borough Local Development Framework: Reading Central Area Action Plan

The Reading Central Area Action Plan (RCAAP) is the comprehensive planning framework needed to achieve the significant change in the central area until 2026, without compromising those features of the centre that make it what it is.

Reading Borough Council (2017) Draft Reading Borough Local Plan

The Reading Borough Draft Local Plan provides guidance for development in Reading up until 2036. It includes targets for sustainable construction and design. A brief summary of policies relating to this report is provided below:

- **Policy CC2: Sustainable Construction and Design**
 - All new major non-residential developments are required to meet the most up-to-date BREEAM 'Excellent' standards, where possible
 - All new minor non-residential developments are required to meet the most up-to-date BREEAM 'Very Good' standard as a minimum;
- **Policy CC3: Adaptation to Climate Change**
 - New buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;
 - Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, etc;
 - Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help to connect habitat, designed with plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions
- **Policy CC4: Decentralised Energy**
 - Any development of more than 20 dwellings and/ or non-residential development of over 1,000 sq. m shall consider the inclusion of a CHP plant, or biomass-fuelled heating scheme, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable or feasible for this form of energy provision.
 - Where there is existing decentralised energy provision, including a CHP plant or a district energy network present within the vicinity of an application site, further developments of over 10 dwellings or non-residential development of 1,000 sq. m will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

Reading Borough Council (2018) Hosier Street Area; Outline Development Framework: Reconnecting with Reading's Historic Town Centre (out for public consultation)

Sets out a framework and principles for promoting the development of the area to ensure a co-ordinated, high quality, comprehensive development creating a multi-purpose urban quarter in Central Reading.

Reading Borough Council (2008) Reading Tall Building Strategy

This strategy informs the development of tall buildings policy and of specific guidelines for individual sites and areas that are documented within the Reading Central Area Action Plan. It acknowledges that tall buildings are inherently energy intensive and covers opportunities that should be exploited to ensure that tall buildings meet the requirements of the Core Strategy.

Reading Borough Council Sustainable Design and Construction

This supplementary document provides an opportunity to clarify and interpret the Core Strategy policy in the context of the continuing evolution of advice and best practice.

Industry Guidance

BSI (2012) EN 15804:2012 Sustainability of Construction Works. Environmental Product Declarations

Provides guidance around core product category rules relating to Environmental Product Declarations (EPDs) for construction products and services.

BSI (2011) EN 15978:2011 Sustainability of Construction Works. Assessment of Environmental Performance of Buildings.

Focuses on the calculation method to assess the environmental performance of a building, based on life cycle assessment (LCA) for both new and existing buildings. Providing a description of the object of assessment, system boundaries applicable at the building level, procedures used for inventory analysis, a list of indicators and procedures for calculation, reporting and data requirements.

PAS 2080 (2016) Guidance Document on Carbon Management in Infrastructure

PAS 2080 shows a more systematic way for managing whole life carbon in infrastructure delivery. By joining up the value chain, a new culture of challenge and innovation is encouraged to help drive down carbon and cost. The PAS2080 Guidance Document can be used to accelerate the understanding and use of the PAS.

IEMA (2017) Assessing Greenhouse Gas Emissions and Evaluating their Significance.

Best practice guidance in assessing GHG emissions and evaluating their significance in EIA projects

RICS (2017) Whole Life Carbon Assessment for the built environment (1st edition).

This guidance note provides a framework of practical guidance for quantity surveyors on how to calculate embodied carbon emissions associated with their projects.

RICS (2014) Methodology to Calculate Embodied Carbon.

Methodology to calculate the total carbon emitted for a building, known as embodied carbon, across the entire property lifecycle from construction through to demolition.

The European Commission (2013) Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment

The aim of this guidance is to improve the consideration of climate change and biodiversity issues in strategic environmental assessments (SEAs) carried out across the EU Member States.

UKGBC (2017) Embodied Carbon: Developing a Client Brief.

This guide is designed for those who need to write effective briefs for commissioning their first embodied carbon measurements, but who may be at an early stage of embodied carbon knowledge.

WRAP (2011) Cutting Embodied Carbon in Construction Projects.

A guidance document produced by WRAP for construction clients and designers to help identify basic, cost-effective actions to reduce the carbon impact of the materials used in construction projects.

WRI & WBCSD (2005) The Greenhouse Gas Protocol for Project Accounting

The GHG Protocol for Project Accounting (Project Protocol) provides specific principles, concepts, and methods for quantifying and reporting GHG reductions.

Appendix B: GHG Emission Data Sources

Activity	Emission Factor	Unit	Source
Baseline			
Electricity	0.28307	kgCO ₂ e per kWh	UK Government (2018) GHG Conversion Factors for Company Reporting
Natural gas	0.18396	kgCO ₂ e per kWh	UK Government (2018) GHG Conversion Factors for Company Reporting
Module A: Before Use-Stage			
Waste Disposal: Concrete (Demolition)	1.1092	kgCO ₂ e per tonne	UK Government (2018) GHG Conversion Factors for Company Reporting
Waste Disposal: General / Mixed construction waste	1.1092	kgCO ₂ e per tonne	UK Government (2018) GHG Conversion Factors for Company Reporting
Transport of waste via road	0.93372	kgCO ₂ e per km (diesel, <17 tonnes rigid)	UK Government (2018) GHG Conversion Factors for Company Reporting
Product 'Cradle to Gate' emissions High Rise Apartments (16-25 storey)	1180	kgCO ₂ e per m ² GIA	RICS (2014) Methodology to Calculate Embodied Carbon.
Product 'Cradle to Gate' emissions Medium Rise Apartments (11-15 storey)	970	kgCO ₂ e per m ² GIA	RICS (2014) Methodology to Calculate Embodied Carbon.
Module B: In-Use Stage			
Electricity	0.233 -	kgCO ₂ e per kWh	Hoare Lea (2018) Broad Street Energy Strategy
Water Supply	0.344	kg CO ₂ e m ³	UK Government (2018) GHG Conversion Factors for Company Reporting
Water Treatment	0.708	kg CO ₂ e m ³	UK Government (2018) GHG Conversion Factors for Company Reporting
Module C: End-of-life			
On-site energy usage	3.4	kgCO ₂ e per m ² GIA	RICS (2017) Whole Life Carbon Assessment for the built environment (1st edition).
Demolition waste treatment/disposal	0.013	kgCO ₂ e per kg	RICS (2017) Whole Life Carbon Assessment for the built environment (1st edition).
Transport of waste via road	0.93372	kgCO ₂ e per km (diesel, <17 tonnes rigid)	UK Government (2018) GHG Conversion Factors for Company Reporting

Appendix C: References

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