Whole Life Carbon Assessment

9D The Grove, Highgate, London, N6 6JU

Iceni Projects Limited on behalf of
Charlton Brown Architects Ltd.

October 2021

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1. EXECUTIVE SUMMARY

1.1 Iceni Projects Ltd was commissioned by Charlton Brown Architects Ltd to produce a Whole Life Carbon Assessment for the proposed redevelopment of 9D The Grove, Highgate, London, N6 6JU.

1.2 This document outlines the whole life carbon (WLC) associated with both a potential retrofit option for the existing dwelling, and the proposed replacement dwelling, as required following comments from the London Borough of Camden Council in December 2020.

1.3 The development proposal is for the demolition of the existing dwelling on the site to provide a replacement family dwelling.

1.4 The Whole Life Carbon Assessment (WLCA) for the proposed development has been undertaken using the Greater London Authority's (GLA) methodology set out within the Whole Life-Cycle Carbon Assessments guidance, prepared for consultation in April 2020. This approach is consistent with that required by the London Plan Policy SI2, and therefore represents best practice in meeting the required standards of whole life carbon assessment and reduction.

1.5 A summary of the estimated whole life carbon emissions is provided below.

Table 1.1 Estimated Whole Life Carbon Emissions

Building Element	Option 1: Retrofit of Existing Building ($kgCO_2e$)	Option 2: Proposed Replacement Dwelling ($kgCO_2e$)
0 Demolition	-	1,481
1 Substructure	19,912	13,170
2.1 – 2.4 Superstructure	13,165	24,090
2.5 – 2.6 Superstructure	71,297	38,877
2.7 – 2.8 Superstructure	169	11,846
3 Finishes	12,979	37,626

4 Fittings, furnishings & equipment	-	-
5 Services (MEP)	24,903	47,486
6 Prefabricated buildings and building units	-	-
7 Work to existing building	6,142	-
8 External works	-	-
Other materials – TOTAL	-	-
Site energy and water	254,119	217,347
TOTAL kgCO_2e	**402,686**	**391,923**

1.6 The results of this Whole Life Carbon Assessment therefore demonstrate that, when considering the embodied carbon of the proposals and taking account of the embodied carbon associated with the existing dwelling as it stands, retrofitting the existing dwelling will have a greater impact than the demolition and replacement of the existing dwelling. This is largely due to the use of more carbon intensive materials in the substructure and frame of the existing dwelling when compared to the proposed dwelling. Furthermore, when accounting for the operational energy and water usage under the two scenarios, demolishing and replacing the existing dwellings with the proposed replacement home will have a lower impact in terms of whole life carbon emissions than retrofitting the existing building due to the greater fabric efficiency associated with the proposed development. In addition, when considering the embodied carbon intensity of the two options, the proposed replacement dwelling, with an embodied carbon intensity of 6.4 kgCO_2e/m^2 per annum, is significantly lower than that of the proposed retrofit option, for which an embodied carbon intensity of 17.3 kgCO_2e/m^2 per annum has been calculated.

1.7 An additional study considering the projected decarbonisation of the national grid has also been undertaken. Under both options, it has been assumed that an all-electric space and water heating system will be utilised, with an air source heat pump being employed in both scenarios. Therefore, it is expected that the carbon dioxide emissions associated with the space and water heating demand of the under both Option 1 and Option 2 will fall considerably when accounting for the expected decarbonisation of the national electricity grid. In light of this, when considering the expected decarbonisation of the national grid over the 60-year life span of the proposed development, the following whole life carbon emissions have been calculated:

Table 1.2 Estimated Whole Life Carbon Emissions Accounting for Grid Decarbonisation

	Option 1: Retrofit of Existing Building ($kgCO_2e$)	**Option 2: Proposed Replacement Dwelling ($kgCO_2e$)**
Embodied carbon	107,465	104,843
Site energy and water	140,907	132,155
TOTAL $kgCO_2e$	**248,372**	**236,998**

1.8 The findings of this Whole Life Carbon Assessment therefore demonstrate that, in terms of both embodied carbon emissions intensity, and total whole life carbon emissions, the proposed replacement dwelling will be more sustainable than the proposed retrofit option for the existing dwellings. This therefore supports the principle of demolition proposed.

2. INTRODUCTION

2.1 Iceni Projects Ltd was commissioned by Charlton Brown Architects Ltd to produce a Whole Life Carbon Assessment for the proposed redevelopment of 9D The Grove, Highgate, London, N6 6JU.

Report Objective

2.2 This document details the whole life carbon assessment undertaken to compare both the embodied and whole life carbon emissions associated with two development scenarios: Option 1 proposing a retrofit to the existing dwelling at 9D The Grove, and Option 2 proposing the demolition and replacement of the existing dwelling.

2.3 The report is structured as follows:

- Section 3 discusses the planning context and policies which are relevant to whole life carbon;
- Section 4 presents the methodology of the assessment, including the scope of the assessment and data sources;
- Section 5 presents the inputs of the whole life carbon assessment;
- Section 6 presents the results of the whole life carbon assessment;; and
- Section 7 summarises the findings of the whole life carbon assessment.

Site and Surroundings

2.4 The application site (Appendix A1) is situated within the Highgate ward of the London Borough of Camden, approximately 0.6 miles south of Highgate train station.

2.5 The site is bound by The Grove to the east, and Fitzroy Park to the north. The surrounding area is dominated by residential uses in all directions, with residences typically being detached in nature, and up to four-storeys in height.

2.6 The site is currently occupied by a detached ground plus two-storey residential dwelling, numbered 9D The Grove.

The Proposed Development

2.7 The proposal seeks to replace the existing dwelling on-site with a new family dwelling of high quality design and sustainability credentials that will serve to enhance the character and appearance of the surrounding area.

2.8 The images below show selected elevations and plans of the scheme, based on the information provided by Charlton Brown Architects in August 2021.

Figure 2.1 East elevation

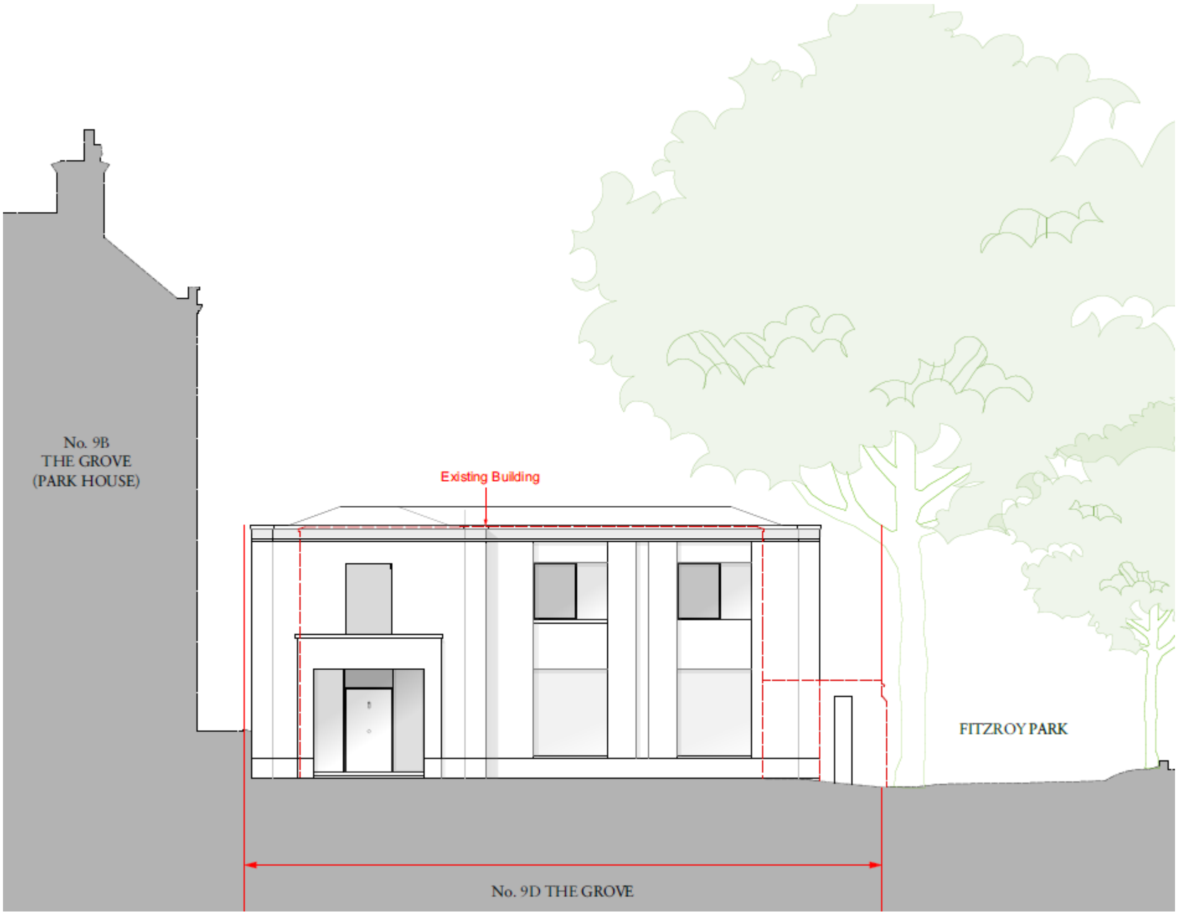


Figure 2.2 West elevation

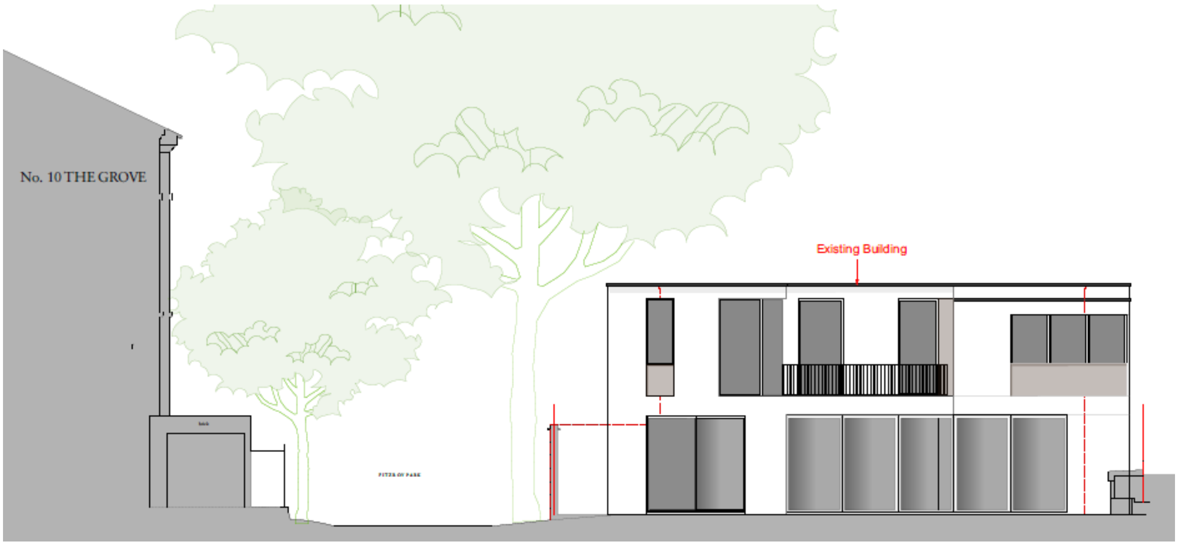


Figure 2.3 Lower ground floor plan

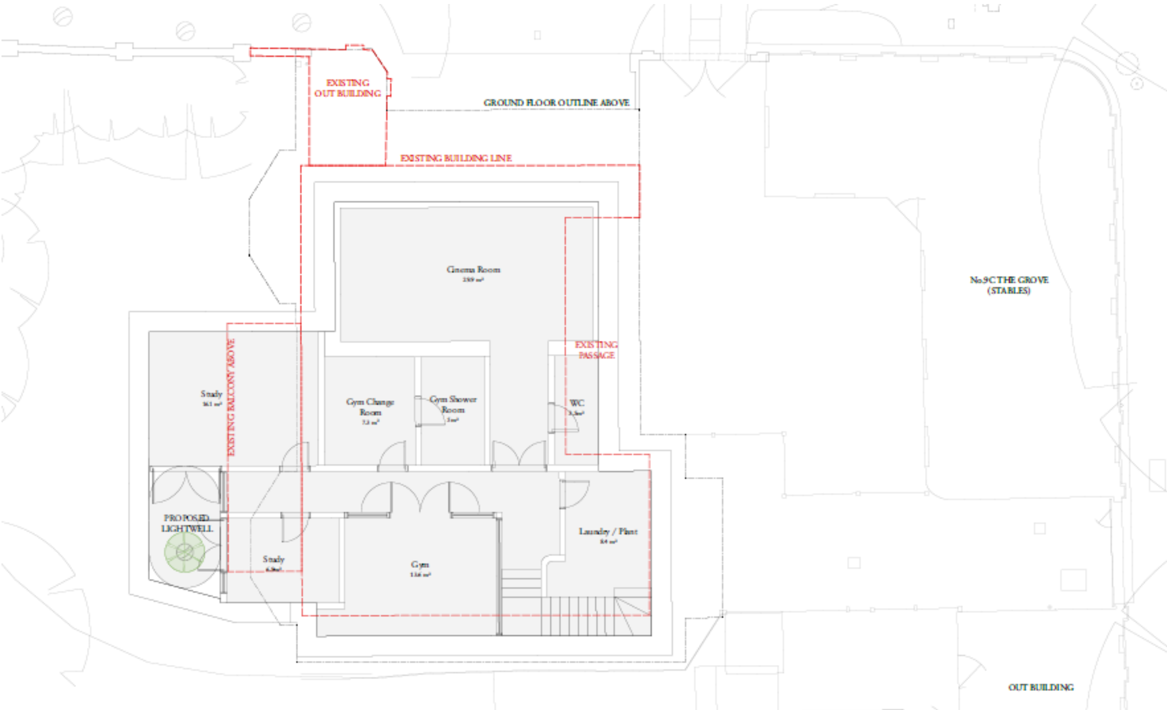


Figure 2.4 Ground floor plan

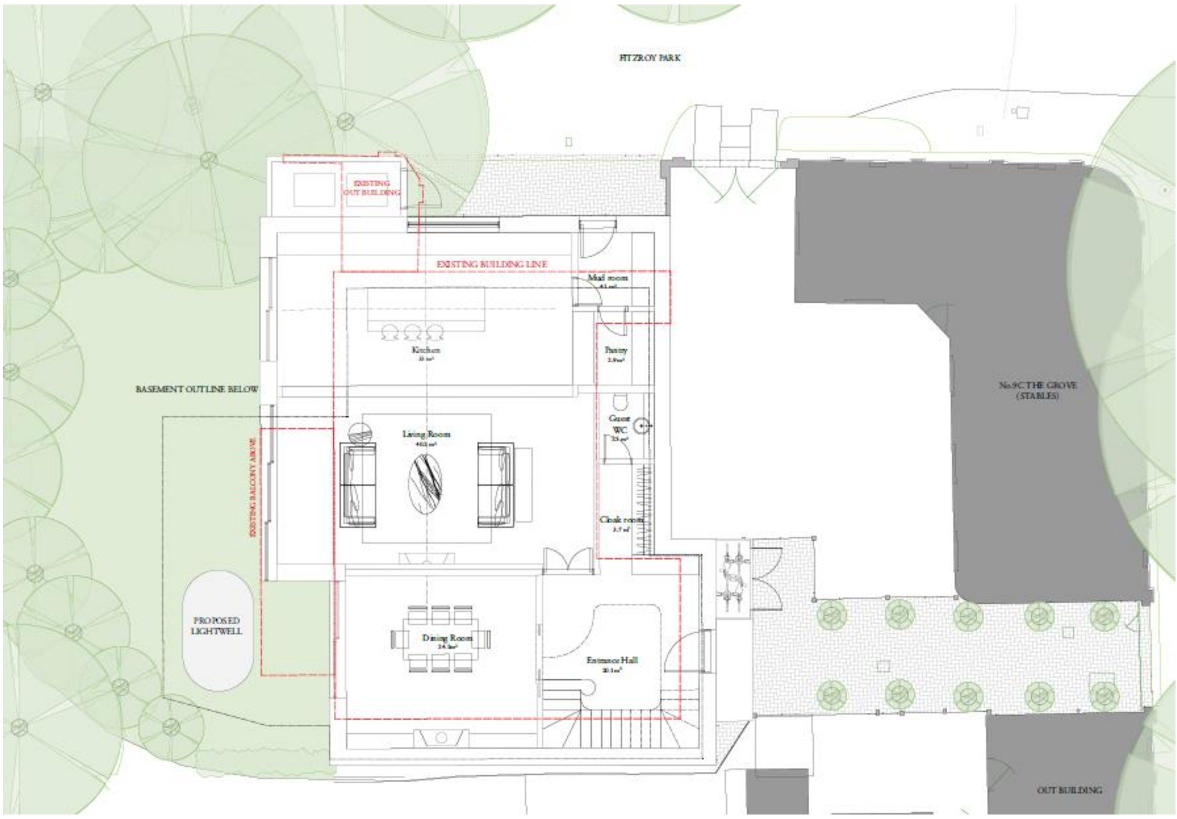
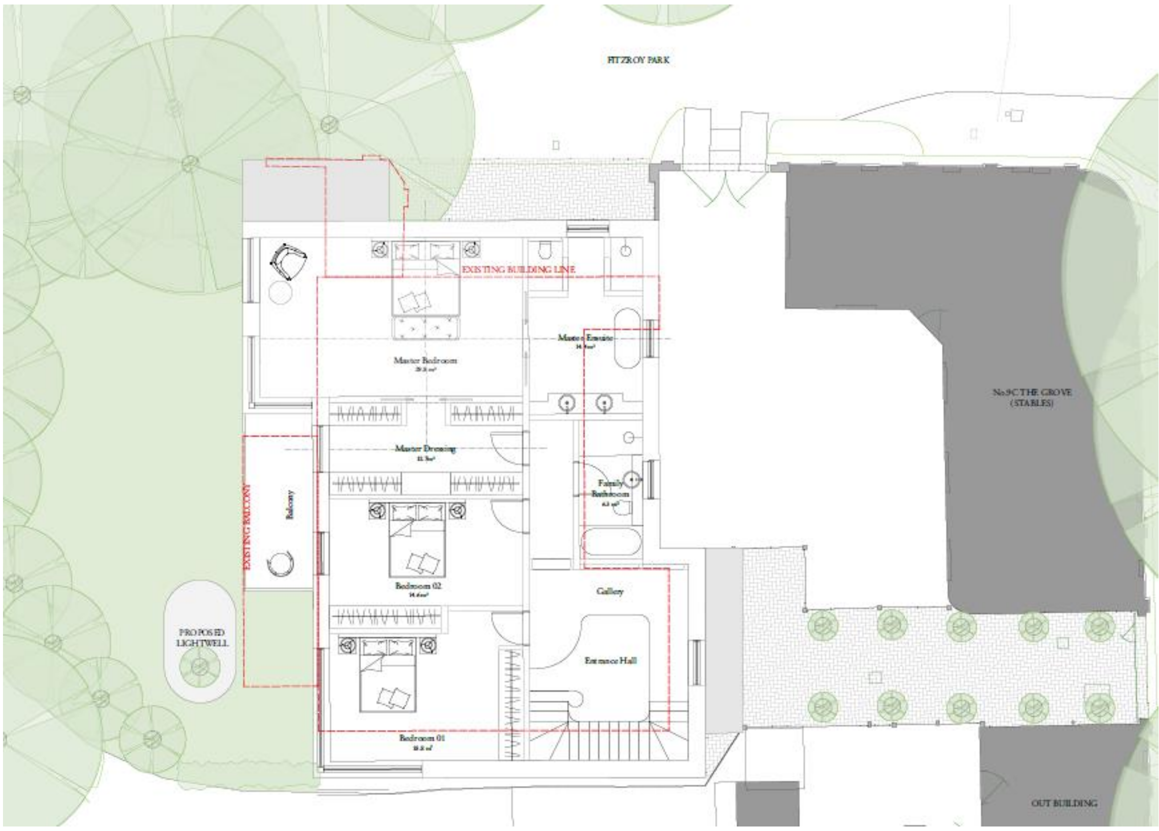


Figure 2.5 First floor plan



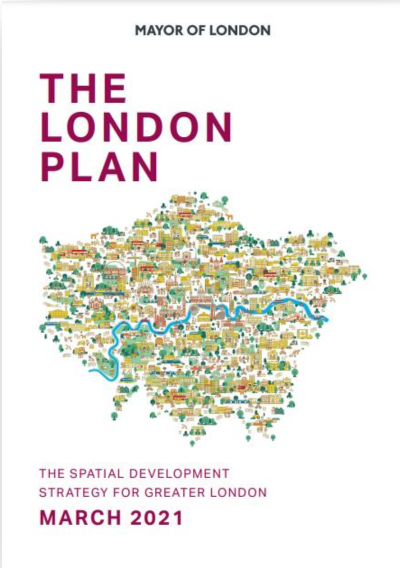
3. PLANNING AND REGULATORY CONTEXT

3.1 Built environment embodied carbon emissions are incorporated within policy and regulation at a regional and local level, as set out below.

Regional

The London Plan (March 2021)

3.2 The London Plan is the overall strategic plan for London and includes policies for sustainable development and whole life carbon within Chapter 9 (London's response to climate change). Key policies of relevance to this scheme are as follows:

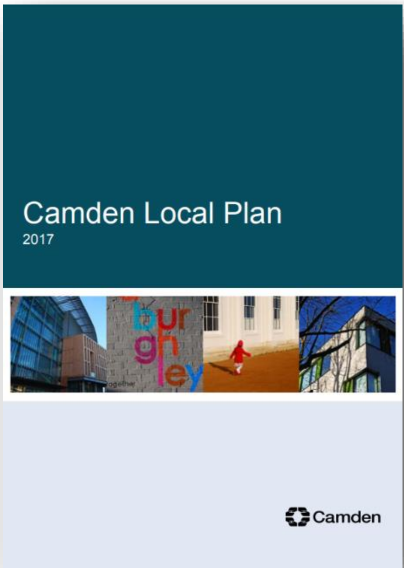


- **Policy SI2 Minimising greenhouse gas emissions.** This states that development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment, and demonstrate actions taken to reduce life-cycle carbon emissions.

  The accompanying text states that operational carbon emissions will make up a declining proportion of a development's whole life-cycle carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole life-cycle approach is needed to capture its unregulated emissions (i.e. those associated with cooking and small appliances), its embodied emissions (i.e. those associated with raw material extraction, manufacture and transport of building materials and construction), and emissions associated with maintenance, repair and replacement, as well as dismantling, demolition and eventual material disposal. Whole life-cycle carbon emission assessments are therefore required for development proposals referable to the Mayor. Major non-referable development should calculate unregulated emissions and are encouraged to undertake whole life-cycle carbon assessments. The approach to whole life-cycle carbon emissions assessments, including when they should take place, what they should contain, and how information should be reported, will be set out in guidance.

Local

Camden Local Plan (2017)



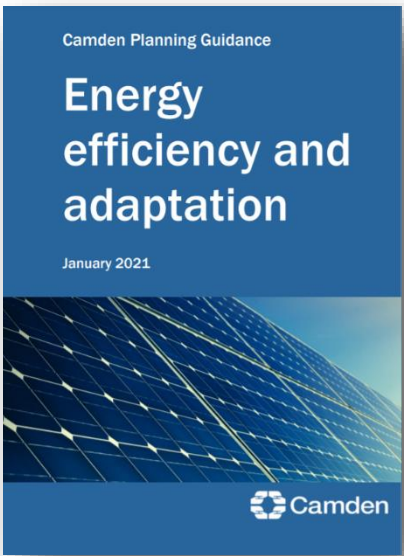
3.3 Paragraph 8.17 of the Camden Local Plan requires developments to consider the specification of materials and construction processes with low embodied carbon content.

3.4 Paragraph 8.18 goes on to state that the Council will expect all developments, whether refurbishment or redevelopment, to optimise resource efficiency by:

- Reducing waste;
- Reducing energy and water use during construction;
- Minimising materials required;
- Using materials with low embodied carbon content; and
- Enabling low energy and water demands once the building is in use.

3.5 Further to this, paragraph 8.20 states that, as part of the assessment of resource efficiency, all developments involving five or more dwellings and/or more than 500 sqm gross internal floor space are encouraged to assess the embodied carbon emissions associated with the development within the energy and sustainability statement.

Camden Planning Guidance: Energy efficiency and adaptation (2021)



3.6 The Camden Planning Guidance: Energy efficiency and adaptation provides guidance on the preparation of Whole Life Carbon Statements.

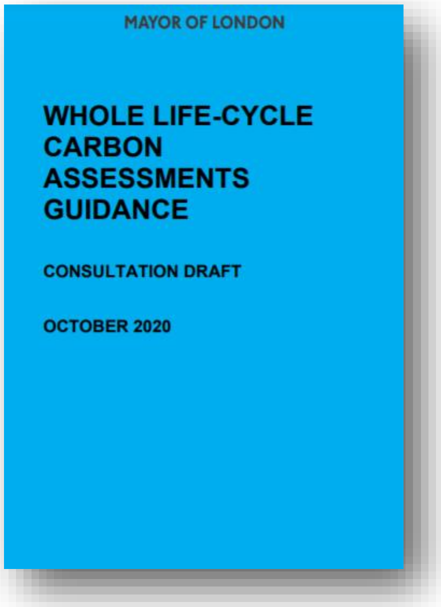
3.7 Paragraph 9.4 states that, in assessing the opportunities for retention and refurbishment, developers should assess the condition of the existing building and explore future potential of the site. The New London Plan highlights the importance of retaining the value of existing buildings with the least preferable development option of recycling through demolition, although Policy D3 of the New London Plan states the “best use of the land needs to be taken into consideration when deciding whether to retain existing buildings in a development”. The following information in the table below should help to inform decision making prior to the pre-application of a scheme. This should provide a transparent and holistic approach to assessing options that delivers the best outcomes.

Condition and feasibility studies (to understand the reuse potential of the existing building/s)	
Existing building uses	• How well does the building function? Identify operational positives/negatives. • Existing used surveys (if occupied) to understand what works / or doesn’t work
Servicing	• Summary MEP (Mechanical, Electrical, Plumbing) servicing, thermal performance and sustainability for each building component. • Identify remaining lifespan of plant and discuss pros/cons of plant upgrade.
Technical: review, with evidence and photos, of existing building, based on intrusive study	• Upgrades required to comply with current legislation. • Include a summary of existing building fabric, cladding, materials, etc. • Scaled section drawings showing slab depths, floor to ceiling dimensions, etc. • Loading capacity of structural frame, materials strength, pile testing. • Energy performance of the façade. • SBEM (Simplified Building Energy Model) energy modelling. • Details of Air Tightness, thermal bridge modelling and condensation analysis in exploration of limits to fabric upgrade in existing building. • Future projections for carbon content of electric load should incorporate latest BEIS carbon factors.
Site capacity	• What is the best use of the site? And can optimal site capacity be achieved?

Other Considerations

Whole Life-Cycle Carbon Assessments Guidance, Consultation Draft (October 2020)

3.8 The guidance note provides further detail on addressing the requirements related to Whole Life Carbon, as per Policy SI2DB of the London Plan through the provision of a Whole Life Carbon Assessment to accompany planning applications. The document explains how to calculate Whole Life Carbon emissions and the information that needs to be submitted to comply with the policy. It also includes information on design principles and Whole Life Carbon benchmarks to aid in designing buildings that have low operational carbon and low embodied carbon.



3.9 The consultation draft of the Whole Life-Cycle Carbon Assessments Guidance states that Policy SI2DB applies to planning applications which are referred to the Mayor, but that Whole Life Carbon Assessments are also supported and encouraged on major applications which are not referable to the Mayor.

Comments from the London Borough of Camden Council

3.10 The following comments were provided by the Sustainability Officer for Camden Council in December 2020:

> *"When comparing the regulated carbon you have shown the new building to be more efficient than the retrofit of the existing building (as would be expected), however no calculations of the embodied carbon have been shown. This is crucial to understand the whole life carbon (WLC) impact of the proposals and needs to be considered.*
>
> *The Local Plan Policy CC1 requires all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building. Paragraph 8.17 of the Local Plan states this should be justified in terms of optimisation of resources and energy use. As such a Whole Life Carbon assessment will be expected for all applications proposing substantial demolition.*
>
> *As such, as a minimum, there should be an assessment of the embodied carbon of the retrofit compared to the new build. This would show us whether this is more sustainable to retain and retrofit or to demolish and rebuild."*

4. METHODOLOGY

4.1 The whole life carbon assessment for the proposed development has been undertaken in line with the Greater London Authority's (GLA) methodology set out in the London Plan and associated draft guidance documents. This approach is consistent with the required by the London Borough of Camden, and therefore represents best practice in meeting the required standards for the undertaking of whole life carbon assessments.

4.2 The methodology of the whole life carbon undertaken for the proposed development is outlined below. The assessment has been undertaken in line with the GLA draft guidance for whole life carbon assessments, and is therefore in compliance with the Royal Institution of Chartered Surveyors (RICS) Professional Statement: Whole Life Carbon Assessment for the Built Environment.

Assessment Scope

4.3 The assessment of whole life carbon (WLC) emissions consists of the following sections: total operational carbon emissions (regulated plus unregulated); embodied carbon emissions; and any future potential carbon emissions 'benefits', post end-of-life, including benefits from reuse and recycling of building structure and materials.

Operational Carbon Emissions

4.4 In line with the draft GLA guidance, the operational carbon emissions have been calculated based on the Part L assessments undertaken as part of the Sustainability Statement prepared for the proposed development, and which accompanies this submission. This encompasses carbon emissions related to both regulated and unregulated energy uses, in line with the Part L definitions, across a 60-year study period.

Embodied Carbon Assessment and End-of-Life Emissions

4.5 To assess the embodied carbon for the project, a Life Cycle Assessment (LCA) tool, eTool LCD, has been employed to allocate anticipated material quantities as part of an inventory analysis. The materials are represented within the model by using materials with associated Environmental Product Declarations (EPDs). EPDs are produced by manufacturers and identify the carbon emissions of a product. By scheduling the materials proposed for the development, the overall carbon emissions can be approximated.

4.6 It should be noted, the LCA tool employed has a limited database. Therefore, where a material is not included within the database, a material of similar composition has been selected instead. It should also be noted that the LCA tool employed here the tool satisfies the criteria set out within the Whole Life-Cycle Carbon Assessments Guidance:

- It follows BS EN 15978.

- The scope covers modules A – C.

- The database from which the life-cycle assessment information is sourced is based on EPDs that reflect the country of origin of the material selected.

4.7 The LCA process and results included within this report have been carried out in accordance with BS 15978:2011 and the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment. All EPDs used as part of the assessment have been produced in line with the requirements of BS EN 15804:2012. Each material has been assessed the following lifecycles stages:

- A1 – A3 Product stage

- A4 Material transportation to site

- B4 – B5 Replacement and maintenance

- C1 – C4 End of life

4.8 The contribution of life stage A5 – Installation into the building – has also been explored separately, in order to give an estimate of the emissions related to construction.

4.9 As required by the draft GLA guidance, the following elements have been included within the assessment:

- Demolition

- Facilitating works

- Substructure

- Superstructure – including frame, upper floors, roof, stairs and ramps, external walls, windows and external doors, internal wall and partitions, and internal doors.

- Finishes

- Fittings, furnishings and equipment

- Building services

- Prefabricated buildings and building units

- Work to existing building

- External works – including hard and soft landscaping, fencing, fixtures, drainage and services

4.10 Due to the early stage in the design process, details on the internal fittings, furnishing and equipment, some internal structures including internal doors, and the external works associated with the proposed development are not available, therefore the carbon emissions associated with these building elements have not been calculated within this assessment.

4.11 At this stage of the design process, therefore, the carbon dioxide emissions associated with internal fittings, furnishings and equipment, internal doors and external landscaping have not been calculated and therefore do not contribute to the calculated embodied and whole life carbon emissions presented here. It is intended that, as the designs of the proposed development continue to be developed, and information regarding the internal fittings and structures becomes available, the calculation of the embodied and whole life carbon associated with the proposed development will be updated to reflect these changes in the information available, should this be required by Camden Council.

Life Cycle Assessment Impacts

4.12 A building LCA considers a range of environmental indicators that assess the relevant overall impacts of the materials selected. Whilst an LCA would ideally consider all environmental impacts associated with a product or material, this is not always possible. This is due to a lack of available information in some cases, or a lack of consensus within the industry in terms of how to calculate key performance indicators.

4.13 Standard ratios are used to convert greenhouse gas emissions into equivalent amounts of carbon dioxide (CO_2). These ratios are based on the global warming potential (GWP) of each gas, which is a relative measure of the estimated contribution a gas has to global warming over a given time period, typically set at 100 years. It is expressed relative to CO_2, which is set as the baseline against which other gases are compared, and therefore has a GWP value of 1.

4.14 This assessment reports on the embodied carbon of the development in terms of GWP, using the annotation carbon dioxide equivalent, CO_2e.

Data Sources

4.15 There are a number of approached to undertaking an LCA for a building, therefore flexibility is required when utilising a dataset of product-specific environmental product declarations and other, more generic data calculated within the LCA tool. Examples of the types of data required when undertaking an LCA are displayed in Table 4.1, below.

Table 4.1 Types of data required for a WLC Assessment

Quantity Data	Material Data	Comments
Cost Plan	Cost Plan	Cost plans can be useful for calculation of uncertain quantities which are not product specific, however an allowance is often made at early design stages that may reduce accuracy.
Architectural Drawings and Area Schedules	Architectural Build-ups	A more traditional and slower approach to determining quantity of building elements, if build-ups are available to support.

4.16 At this stage, the assessment has been based on drawings and plans provided by Charlton Brown Architects, submitted as part of the planning application for which this assessment has been undertaken, as well as plans of the existing building.

Assessment Scenarios

4.17 In line with the requirements of Camden Council, the whole life carbon assessment has been undertaken for two scenarios.

Option 1: Retrofit of the Existing Building

4.18 The first scenario calculates the whole life carbon emissions associated with a retrofit option for the existing dwelling. As part of this retrofit option, the following interventions are proposed, in line with those applied for the operations energy modelling undertaken as part of the Sustainability Statement:

- **Ground Floor:** to improve the u-value of the ground floor from 1.03 $W/m^2/K$ to 0.20 $W/m^2/K$, 200mm thick rockwool insulation beneath the existing suspended timber ground floor has been provided across the total ground floor area.

- **External Walls:** to improve the u-value of the external walls from 1.4 $W/m^2/K$ to 0.55 $W/m^2/K$, it has been assumed that a 50mm cavity is present within the wall structure, into which granulated rockwool insulation has been injected.

- **Roof:** to improve the u-value of the roof from 1.50 $W/m^2/K$ to 0.32 $W/m^2/K$, 100mm thick polyisocyanurate (PIR) insulation boards have been provided across the total roof area.

- **Glazing:** to improve the u-value of the glazing from 5.90 $W/m^2/K$ to 1.40 $W/m^2/K$, the existing single glazed windows have been replaced with double glazed windows.

4.19 The dimensions of the existing building were provided, and the proposed interventions agreed, by Charlton Brown Architects in August 2021.

4.20 It should be noted that, as the retrofitting is to be made to an existing building, the embodied carbon associated with the building as it stands has been taken into account. However, for the purposes of comparison with the proposed replacement dwelling, the embodied carbon associated with the existing structure has been accounted for over a period of 60 years only, from the point at which the retrofit takes place, until the end of the building's life, here assumed to be 60 years.

4.21 Whilst not included for within the submitted Sustainability Statement, for the purposes of this Embodied Carbon Assessment, the retrofitted dwelling has been modelled with an air source heat pump system to provide space and water heating.

Option 2: Proposed Replacement Dwelling

4.22 The second scenario calculates the whole life carbon emissions associated with the demolition of the existing dwelling on-site, and the construction of the proposed replacement family home. The dimensions of and materials proposed to be employed for the proposed dwelling were provided by Charlton Brown Architects in August 2021, in line with the information provided within the accompanying Design and Access Statement and Energy and Sustainability Assessment.

5. INPUTS TO THE WHOLE LIFE CARBON ASSESSMENT

5.1 This section presents the inputs to the whole life carbon assessment undertaken for the proposed development.

Operational Carbon Assessment

5.2 Operational carbon emissions have been estimated as part of the Energy and Sustainability Assessment, produced by Charlton Brown Architects in August 2021. The assessment of operational carbon emissions was based on the methodology set out in Part L of the building regulations, and the total regulated CO_2 emissions have been reported for the two scenarios: Option 1 retrofit of the existing building and Option 2 the proposed replacement dwelling. Both scenarios are residential in nature, and the reported CO_2 emissions have been based on SAP calculations in line with Part L1A:2013 of the building regulations.

5.3 An additional set of figures has also been used within the whole life carbon assessment for the proposed development, based on the expected decarbonisation of the electricity grid over the lifetime of the development, here assumed to be 60 years. This has been calculated for both Options 1 and 2.

Embodied Carbon and End-of-Life Assessment

5.4 Table 5.1 below lists the building elements considered as part of the whole life carbon assessment, in line with the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment. A list of the inputs to the eTool LCD tool are provided in Appendix A2.

5.5 Table 5.2 details the Life Cycle Modules considered within the Whole Life Carbon Assessment, alongside a brief commentary on the data source employed.

Table 5.1 Data used in the embodied carbon assessment – building elements

Building element group	Building element (NRM Level 2)	Basis of information
Demolition	0.1 Toxic / hazardous / contaminated material treatment.	An allowance for contaminated land removal and treatment has not been included for the proposed development at this stage of the design.
	0.2 Major demolition works	An allowance for contaminated land removal and treatment has not been included for the proposed development at this stage of the design.
0 Facilitating works	0.3 & 0.5 Temporary / enabling works	Due to the early stage of the design (RIBA Stage 2) this information is not yet available and as such has not been included in the assessment.
	0.4 Specialist groundworks	No specialist ground works were included separately, with individual ground works accounted for in the relevant substructure / external landscaping sections
1 Substructure	1.1 Substructure	The specific foundations quantity was calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element.
2 Superstructure	2.1 Frame	Material quantity and composition of the frame was calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element. The frame is calculated using the development dimensions for both the existing and proposed case and compiled in the assessment.
	2.2 Upper floors, including balconies	Material quantity and composition of the upper floor was calculated by Charlton Brown Architects, based on the estimated dimensions of each relevant building element.
	2.3 Roof	Material quantity and composition of the roof were calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element.
	2.4 Stairs and ramps	Stairs and ramps have been excluded from the assessment due to lack of available data.
	2.5 External walls	Material quantity and composition of the external walls were calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element.

	2.6 Windows and external doors	The window and door areas were calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element.
	2.7 Internal walls and partitions	Material quantity and composition of the internal partition walls were calculated by Charlton Brown Architects, based on the estimated surface area of each relevant building element.
	2.8 Internal doors	The internal doors have been excluded from the assessment due to lack of available data.
3 Finishes	3.1 Wall finishes	The wall, floor and ceiling finishes were calculated by Charlton Brown Architects for each of the proposed blocks, based on the estimated surface area of each relevant building element.
	3.2 Floor finishes	
	3.3 Ceiling finishes	
4 Fittings, furnishings and equipment (FF&E)	4.1 Fittings, furnishings & equipment including building-related and non-building-related	The FF&E have been excluded from the assessment due to lack of available data.
5 Building Services / MEP	5.1 – 5.14 Services including building-related* and non-building-related**	Calculations pertaining to the proposed building services have been calculated by the eTool LCD tool, based on assumptions built into the tool.
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units	No prefabricated elements are applicable.
7 Work to Existing Building	7.1 Minor demolition and alteration works	Minor alteration works associated with the proposed retrofit have been included based on the volumes of materials to be removed and replaced, calculated by Charlton Brown Architects.
8 External Works	8.1 Site preparation works	External works were excluded from the assessment due to lack of available data.
	8.2 Roads, paths, paving and surfacing	
	8.3 Soft landscaping and irrigation systems	

	8.4 Fencing, railings and walls	
	8.5 External fixtures	
	8.6 External drainage	
	8.7 External services	
	8.8 Minor building works and ancillary buildings	No allowance was considered for minor building works and ancillary buildings.

Table 5.2 Life-cycle modules

Module	Description	Commentary on Data Source
A1 – A3 Construction Materials	Raw material supply (A1) includes emissions generated when raw materials are taken from nature, transported to industrial units for processing and processed. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from the transport of all raw materials from suppliers to the manufacturer's production plant, as well as impacts of production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as handling of waste formed in the production processes at the manufacturer's production plants until end-of-waste state.	eTool LCD allows the reporting of timber sequestration in Modules A1 – A3, as well as timber decomposition in Module C4. eTool LCD background data follows the EN 16449 formula for biogenic carbon stored in timber elements. A comprehensive database of construction products are available within eTool LCD, meaning the carbon emissions attributable to the product stage (Modules A1 – A3) may be calculated by assigning suitable embodied carbon factors to the given elemental material quantities.
A4 Transportation to Site	A4 includes exhaust emissions resulting from the transport of building products from manufacturer's production plant to building site, as well as the environmental impacts of production of the used fuel.	Transport distances were estimated based on typical average transport distances according to material types and project location, as provided by eTool LCD.
A5 Construction / Installation Processes	A5 covers the exhaust emissions resulting from using energy during the site operations, the environmental impacts of production processes of fuel, energy and water, as well as handling of waste until the end-of-waste state.	eTool LCD allows the quantification of detailed construction processes, including the energy use of equipment and plant and the transport of equipment and plant to and from the site. eTool LCD also accounts for waste generated during Module A5, with the waste percentage being configurable, as well as the disposal method and recycling rate of the material.

B1 – B5 Maintenance and Material Replacement	The environmental impacts of maintenance and material replacements (B1 – B5) include environmental impacts related to the replacement of building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation and production of the replaced new material as well as the impacts from manufacturing the replace material and handling of waste until the end-of-waste state.	For Module B1, eTool LCD is currently limited to carbonation of concrete. For Module B2, eTool LC allows detailed accounting of maintenance and cleaning activities. eTool LCD allows for detailed accounting of repair activities under Module B3. Replacement activities under Module B4 are allowed for within eTool LCD. Reporting under Module B5 is not undertaken as standard within eTool LCD.
B6 Energy Use	The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also taken into account.	Energy consumption taken from SAP and Energy Assessment calculations undertaken for the two scenarios, in line with GLA requirements.
B7 Water Use	The considered use phase water consumption (B7) impacts include the environmental impacts of the production processes of fresh water and the impacts from wastewater treatment.	Using default eTool LCI Sources allows for both water use and treatment to be accurately quantified within eTool LCD.

C1 – C4 Deconstruction	The impacts of deconstruction include impacts for processing recyclable construction waste flows for recycling (c3) until the end-of-waste state or the impacts of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on type of material. Additionally, deconstruction impacts include emissions caused by waste energy recovery.	A range of equipment can be selected within eTool LCD to model end of life demolition activities under Module C1, and carbon emissions associated with the transport of materials arising during Module C2 are included. Within eTool LCD, it is assumed that the end of waste state for commonly recycled construction products is met before the product leaves the site. However, where processing required for a material to achieve value, the disposal method will include impacts under Module C3. For most products considered under Module C4, a range of disposal methods are available to accurately model the disposal emissions.
D External Impacts / End-of-Life Benefits	External benefits for re-used or recycled material types include the positive impact of replacing virgin-based material with recycled material and the benefits of the energy which can be recovered from the materials.	eTool LCD accounts for the following Module D benefits or burdens: - Operational Energy Exports (Module D1) - Closed Loop Recycling (Module D2) - Open Loop Recycling (Module D3) - Materials Energy Recovery (Module D4)

6. WHOLE LIFE CARBON ASSESSMENT RESULTS

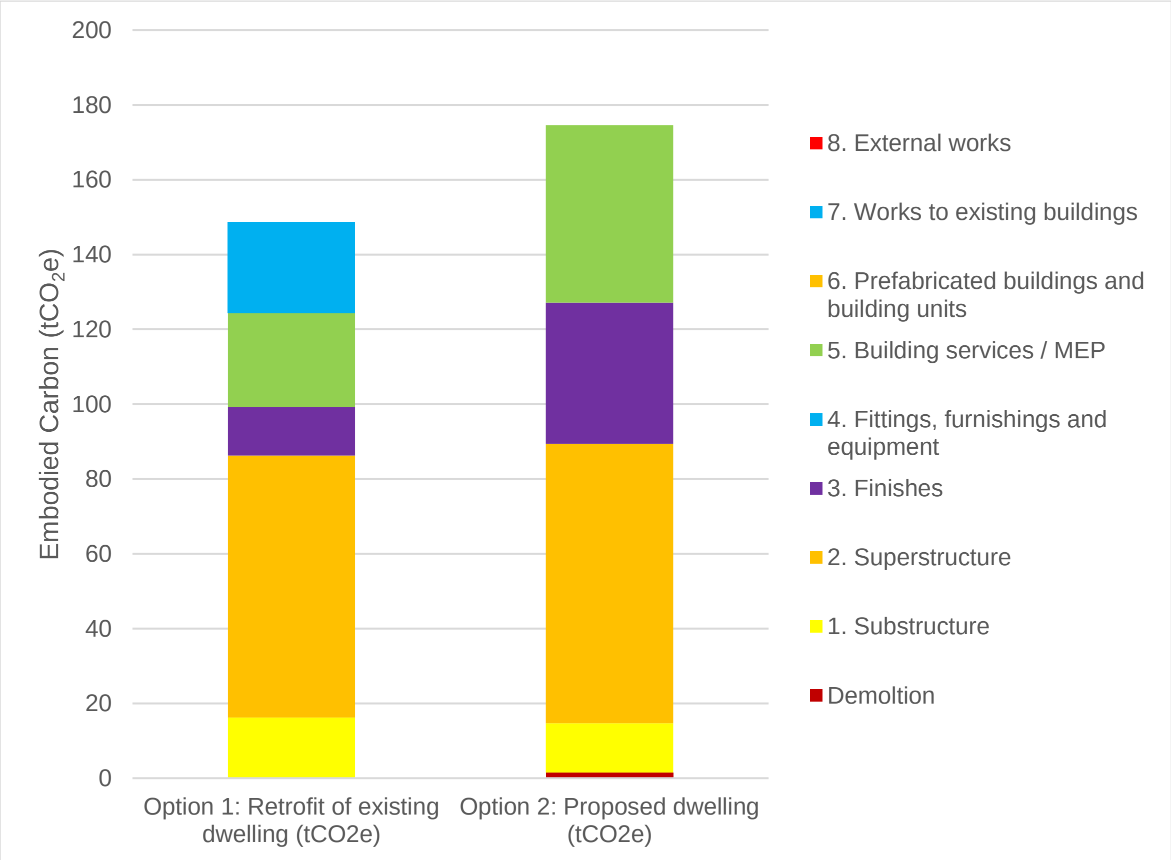
6.1 As detailed above, a Whole Life Carbon Assessment has been undertaken using the eTool LCD tool to compare the whole life carbon emissions associated with a potential retrofit solution for the existing dwelling at 9D The Grove, Highgate with those associated with the proposed replacement dwelling. This section details the results of the assessment, with the following results addressed separately:

- Embodied carbon emissions
- Operational carbon emissions
- Whole life carbon emissions

Embodied Carbon Emissions

6.2 The estimated embodied carbon emissions for both the retrofitted existing dwelling and the proposed dwelling are provided in Figure 6.1 below, broken down according to the main building element categories described above. Embodied carbon emissions across scopes A1 – A5 (Product Stage and Transport), B1 – B5 (Use Stage) and C1 – C4 (Demolition and End-of-Life) have been accounted for in the results displayed below.

Figure 6.1 Embodied carbon emissions



Operational Carbon Emissions

6.3 The total operational carbon emissions have been calculated over a 60-year study period for the two development options. The results have been based on the projected annual energy demand of the retrofitted existing dwelling and the proposed dwelling, shown in the table below.

Table 6.1 Annual energy demand

	Energy Demand (kWh/year)	
	Option 1: Retrofit of existing building	Option 2: Proposed replacement dwelling
Space heating	4,646	3,501
Hot water	2,034	2,047
Lighting	492	1,014
Auxiliary	75	1,775
Cooling	157	142
Unregulated loads	2,034	3,597

6.4 It should be noted that some elements of the energy demand of Option 2 are higher than that of Option 1 due to the fact that the proposed replacement dwelling has a greater footprint than the existing dwelling. This therefore increases the demand for lighting and auxiliary energy, as well as for unregulated demands that include cooking and electrical appliances.

6.5 The estimated total operational carbon emissions, including both regulated and unregulated energy uses, over the 60-year study period are presented in Table 6.2 below.

Table 6.2 Total operational carbon emissions

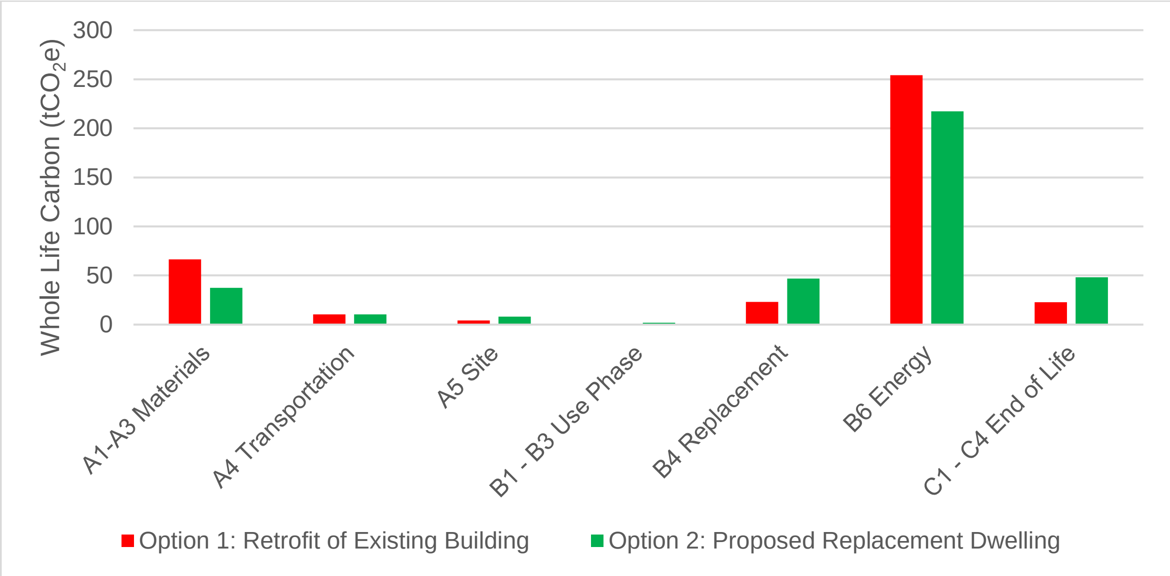
Total Operational Carbon Emissions (tCO_2)	
Option 1: Retrofit of existing dwelling	Option 2: Proposed dwelling
253	217

Whole Life Carbon Emissions

6.6 The whole life carbon emissions calculated over the 60-year study period for Option 1, which considers a potential retrofit of the existing dwelling at 9D The Grove, are provided in Table 6.3 below. The emissions calculated for Option 2, which considers the proposed replacement dwelling, are shown in Table 6.4.

6.7 Figure 6.2 below shows a breakdown of the whole life carbon emissions by life cycle stage, and compares the emissions calculated for Option 1 with those calculated for Option 2.

Figure 6.2 Total whole life carbon emissions by life-cycle stage



6.8 Figure 6.3 below shows the proportional contribution of each building element to the total whole life carbon emissions of each scenario, with the results of Option 1 shown on the left hand side, and those of Option 2 shown on the right.

Figure 6.3 Contribution of each building element to total whole life carbon emissions

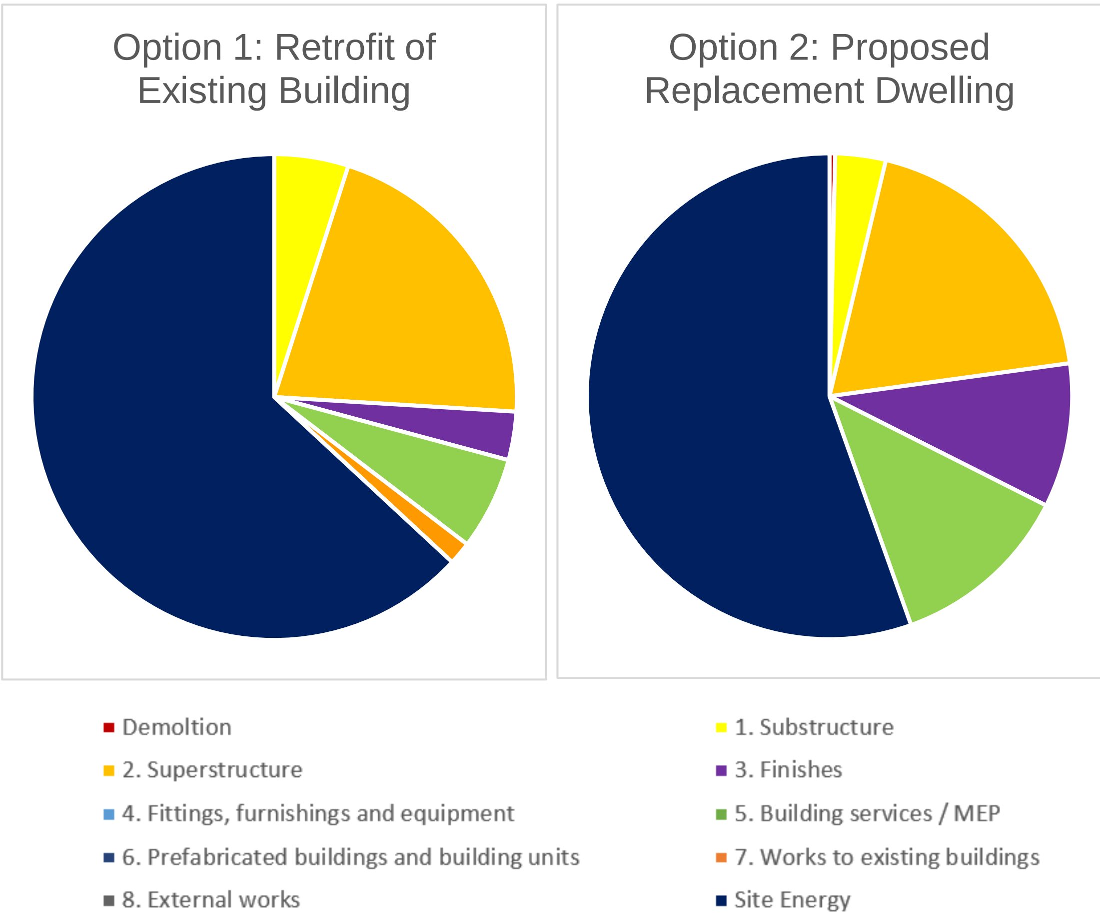


Table 6.3 Estimated whole life carbon emissions for Option 1: Retrofit of the Existing Building

	A1 – A3 Product Stage	A4 Transport to Site	A5 Site Operations	B1 Use Phase	B3 Repair	B6 Operational Energy Use	B7 Operational Water Use	C1 – C4 End-of-Life Stage	Module D External Impacts (Not included in totals)	Total $kgCO_2e$
0 Demolition										
1 Substructure	9,784	2,083	965	-	1,858			5,221	28	**19,912**
2.1 – 2.4 Superstructure	843	766	1,486	-	292			9,778	-291	**13,165**
2.5 – 2.6 Superstructure	48,557	5,830	1,114	-	9,514			6,281	-364	**71,297**
2.7 – 2.8 Superstructure	-591	80	95	-	-			586	3	**169**
3 Finishes	5,450	715	181	23	5,990			620	-3	**12,979**
4 Fittings, furnishings & equipment										
5 Services (MEP)	176	23	39	545	1,904		21,549	667	-24	**24,903**
6 Prefabricated buildings and building units										

7 Work to existing building	1,888	906	270	-	2,801			277	-813	**6,142**
8 External works										
Other materials - TOTAL										
Site, energy and water						254,119				254,119
TOTAL kgCO₂e	**66,108**	**10,404**	**4,151**	**568**	**22,359**	**254,119**	**21,549**	**23,430**	**-1,464**	**402,686**

Table 6.4 Estimated whole life carbon emissions for Option 2: Proposed Replacement Dwelling

	A1 – A3 Product Stage	**A4 Transport to Site**	**A5 Site Operations**	**B1 – B2 Use Phase**	**B3 – B4 Repair and Replace**	**B6 Operational Energy Use**	**B7 Operational Water Use**	**C1 – C4 End-of-Life Stage**	**Module D External Impacts (Not included in totals)**	**Total kgCO₂e**
0 Demolition		296	1,185							**1,481**
1 Substructure	10,202	1,148	253					1,568	281	**13,170**
2.1 – 2.4 Superstructure	-9,601	1,661	3,734		3,747			24,550	191	**24,090**
2.5 – 2.6 Superstructure	26,381	4,981	813		84			6,618	-364	**38,877**
2.7 – 2.8 Superstructure	-1,630	209	261		11,391			1,615	9	**11,846**
3 Finishes	7,037	1,740	1,725	53	16,468			10,603	48	**37,626**

4 Fittings, furnishings & equipment										
5 Services (MEP)	5,202	221	83	2,005	15,340		21,549	3,087	620	**47,486**
6 Prefabricated buildings and building units										
7 Work to existing building										
8 External works										
Other materials - TOTAL										
Site, energy and water						217,347				**217,347**
TOTAL $kgCO_2e$	**37,590**	**10,255**	**8,054**	**2,058**	**47,031**	**217,347**	**21,549**	**48,040**	**785**	**391,923**

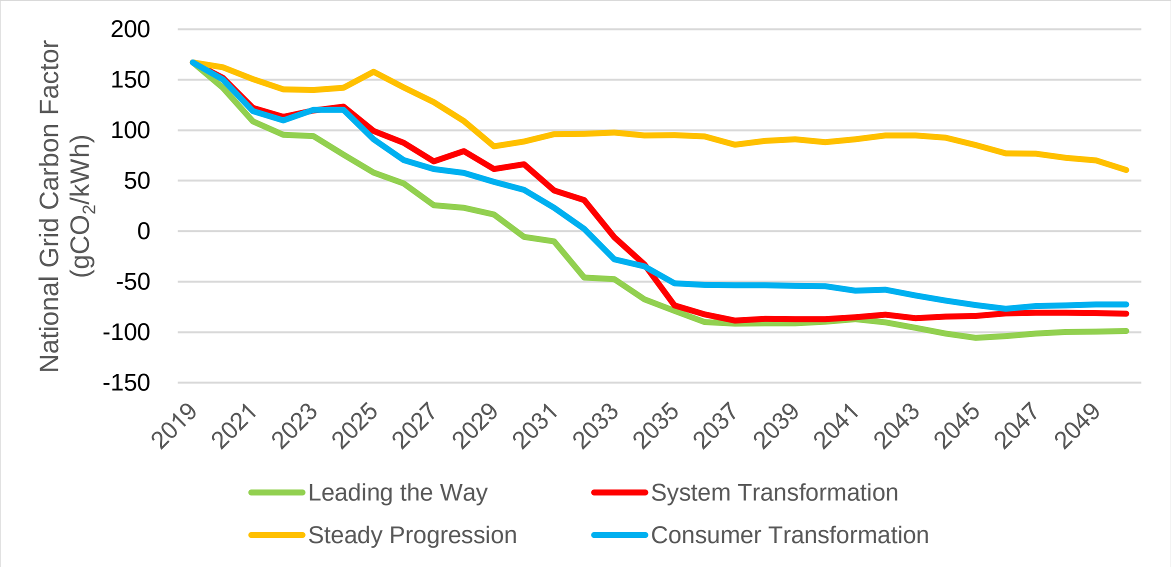
Consideration of Grid Decarbonisation

6.9 An additional scenario has been considered, taking account of the potential, longer-term decarbonisation of the electricity grid, as this should also be considered with regard to the potential impacts this may have on design decisions. Therefore an additional set of figures has been used within the whole life carbon assessment for the proposed development, based on the expected decarbonisation of the electricity grid over the lifetime of the development, here assumed to be 60 years.

6.10 The RICS (2017) and GLA (2020) guidance documents make reference to the use of the "slow-progression" scenario from the latest Future Energy Scenarios (FES) developed by the National Grid, making reference specifically to the 2015 edition of the FES.

6.11 The FES is reviewed on an annual basis, with the latest edition having been published in 2019. This accounts for more recent developments in the future performance of the National Grid. The figure below shows the projected future carbon factor for the National Grid, under four scenarios: Leading the Way; System Transformation, Steady Progression; and Consumer Transformation. The figure below is based on data taken from the National Grid 2020 Future Energy Scenarios (FES) Document.

Figure 6.4 Future projected carbon factor for the National Grid



6.12 Representing the most up-to-date future National Grid performance scenario, this whole life carbon assessment utilises the National Grid's 2020 edition of the 'steady progression' scenario, which is considered to align most closely with the Business Energy and Industrial Strategy (BEIS) department declared grid carbon projection. For the purposes of this assessment, it has been assumed that the proposed development will be fully operational from 2022, and that the carbon factor applicable post-2050 will remain at the same value as the projected carbon factor for the year 2050.

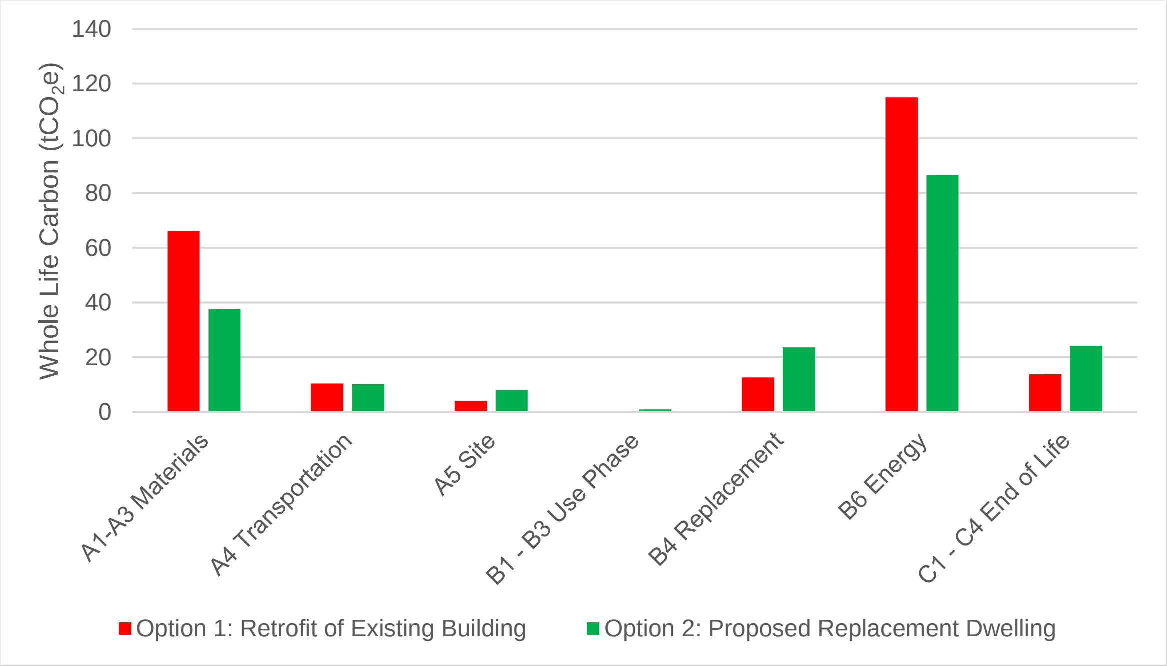
6.13 When accounting for the projected decarbonisation of the national electricity grid, the estimated total operational carbon emissions, including both regulated and unregulated energy uses, over the 60-year study period are calculated as below.

Table 6.5 Total operational carbon emissions accounting for grid decarbonisation

Total Operational Carbon Emissions (tCO_2)	
Option 1: Retrofit of existing dwelling	Option 2: Proposed dwelling
115	87

6.14 Figure 6.6 below shows a breakdown of the whole life carbon emissions by life cycle stage, and compares the emissions calculated for Option 1 with those calculated for Option 2 when accounting for the projected decarbonisation of the grid over the 60-year life span of the proposals.

Figure 6.6 Total whole life carbon emissions by life-cycle stage accounting for grid decarbonisation



6.15 This demonstrates the impact of employing an all-electric heating system within the proposed development, compared to the use of a traditional gas-fired boiler under the proposed retrofit scenario.

7. SUMMARY AND CONCLUSIONS

7.1 This Whole Life Carbon Assessment provides a comparison of the embodied and whole life carbon emissions associated with both a potential retrofit option for the existing dwelling at 9D The Grove, and the proposed replacement dwelling, as required following comments from the London Borough of Camden Council in December 2020.

7.2 The Whole Life Carbon Assessment (WLCA) for the proposed development has been undertaken using the Greater London Authority's (GLA) methodology set out within the Whole Life-Cycle Carbon Assessments guidance, prepared for consultation in April 2020. This approach is consistent with that required by the London Plan Policy SI2, and therefore represents best practice in meeting the required standards of whole life carbon assessment and reduction.

7.3 A summary of the estimated whole life carbon emissions is provided below.

Table 7.1 Estimated Whole Life Carbon Emissions

Building Element	Option 1: Retrofit of Existing Building ($kgCO_2e$)	Option 2: Proposed Replacement Dwelling ($kgCO_2e$)
0 Demolition	-	1,481
1 Substructure	19,912	13,170
2.1 – 2.4 Superstructure	13,165	24,090
2.5 – 2.6 Superstructure	71,297	38,877
2.7 – 2.8 Superstructure	169	11,846
3 Finishes	12,979	37,626
4 Fittings, furnishings & equipment	-	-
5 Services (MEP)	24,903	47,486

6 Prefabricated buildings and building units	-	-
7 Work to existing building	6,142	-
8 External works	-	-
Other materials – TOTAL	-	-
Site energy and water	254,119	217,347
TOTAL kgCO_2e	**402,686**	**391,923**

7.4 The results of this Whole Life Carbon Assessment therefore demonstrate that, when considering the embodied carbon of the proposals and taking account of the embodied carbon associated with the existing dwelling as it stands, retrofitting the existing dwelling will have a greater impact than the demolition and replacement of the existing dwelling. This is largely due to the use of more carbon intensive materials in the substructure and frame of the existing dwelling when compared to the proposed dwelling. Furthermore, when accounting for the operational energy and water usage under the two scenarios, demolishing and replacing the existing dwellings with the proposed replacement home will have a lower impact in terms of whole life carbon emissions than retrofitting the existing building due to the greater fabric efficiency associated with the proposed development. In addition, when considering the embodied carbon intensity of the two options, the proposed replacement dwelling, with an embodied carbon intensity of 6.4 kgCO_2e/m^2 per annum, is significantly lower than that of the proposed retrofit option, for which an embodied carbon intensity of 17.3 kgCO_2e/m^2 per annum has been calculated.

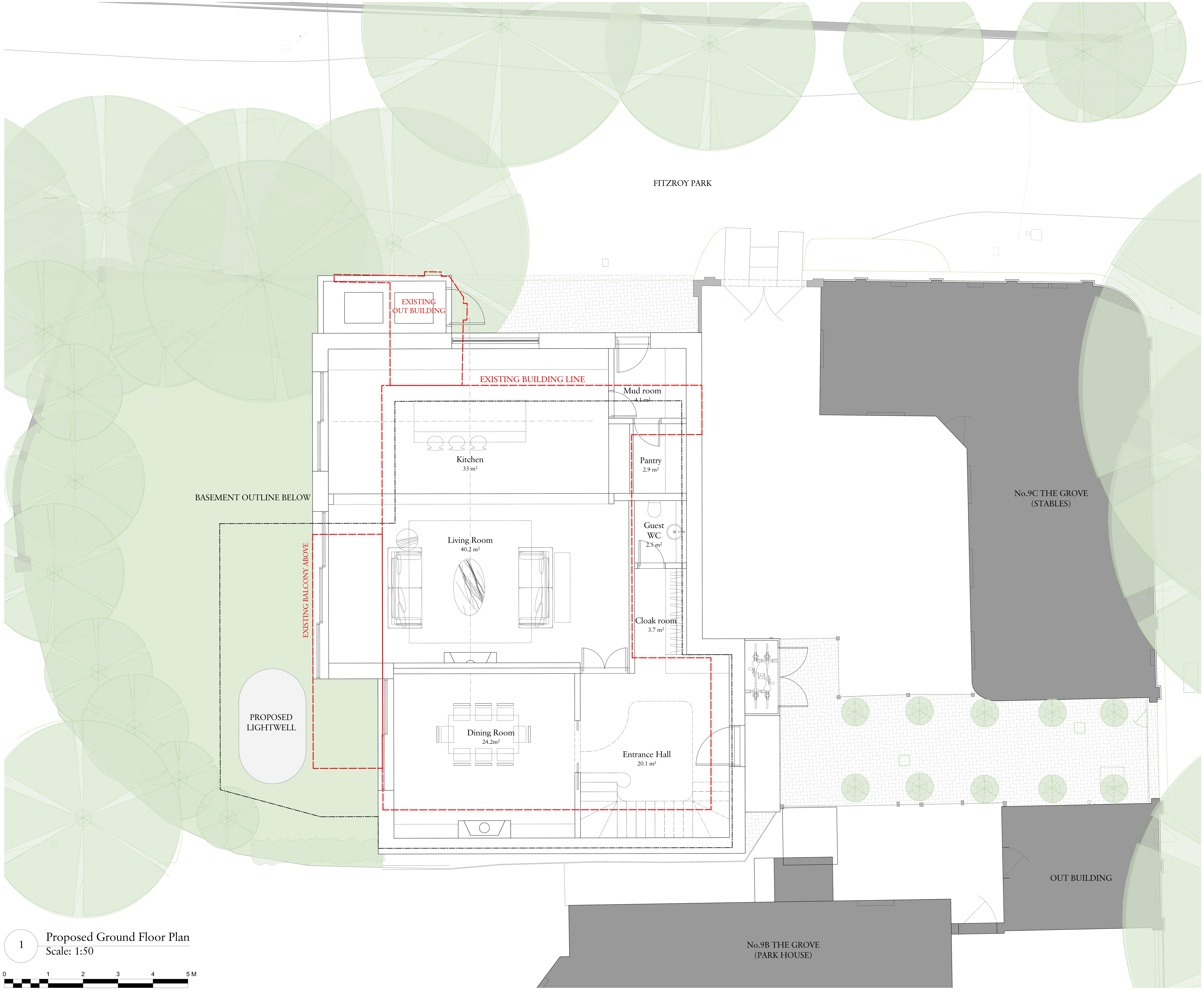
7.5 An additional study considering the projected decarbonisation of the national grid has also been undertaken. Under both options, it has been assumed that an all-electric space and water heating system will be utilised, with an air source heat pump being employed in both scenarios. Therefore, it is expected that the carbon dioxide emissions associated with the space and water heating demand of the under both Option 1 and Option 2 will fall considerably when accounting for the expected decarbonisation of the national electricity grid. In light of this, when considering the expected decarbonisation of the national grid over the 60-year life span of the proposed development, the following whole life carbon emissions have been calculated:

Table 7.2 Estimated Whole Life Carbon Emissions Accounting for Grid Decarbonisation

	Option 1: Retrofit of Existing Building ($kgCO_2e$)	**Option 2: Proposed Replacement Dwelling ($kgCO_2e$)**
Embodied carbon	107,465	104,843
Site energy and water	140,907	132,155
TOTAL $kgCO_2e$	**248,372**	**236,998**

7.6 The findings of this Whole Life Carbon Assessment therefore demonstrate that, in terms of both embodied carbon emissions intensity, and total whole life carbon emissions, the proposed replacement dwelling will be more sustainable than the proposed retrofit option for the existing dwellings. This therefore supports the principle of demolition proposed.

A1. SITE PLAN



1 Proposed Ground Floor Plan
Scale: 1:50

Rev	Date	Details	By

Charlton Brown Architecture & Interiors

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Mr N Cohen

Project
9D The Grove, Highgate, London, N6 6JU

Drawing Title
Proposed Ground Floor Plan

Date	Drawn	Checked
18/08/2021	NL	JM

Scale
1:50

Issue Status
Planning

Project Number	Drawing Number	Revision
1912	PL-00-100	

A2. INFORMATION INPUT TO ETOOL LCD

Table A2.1 Information Input for Option 1: Retrofit of the Existing Building

Template Name	Element Process Name	Lifetime Installed Mass
	Glazing | Windows | Timber Framed | Single Glaze | Domestic Fixed	2485
Demolition - Small Scale/Renovations (Work to Existing Building)	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Excavator, 15t, Diesel	
	Trade Staff (No Equipment, labour transport only), Electricity	
External Wall	Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	31844
	Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	4780
		6641
	Concrete Pump, Diesel	
	Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	37647
	Concrete | Unreinforced | Portland Cement Blends | Unspecified	5602
		78430
	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Metals (Non-Ferous) | Aluminium Unspecified	96
	Paints and Finishes | Unspecified | 1 Coat	48

		96
		191
	Paints and Finishes | Unspecified | 3 Coats	430
	Plaster and Mineral Derived Products | 100% Primary Gypsum | Plaster | Unspecified	428
		439
		4541
	Plastics | Acrylic | Unspecified	0
		57
	Plastics | High Density Polyethylene (HDPE) | Unspecified	41
		83
	Timber | Sustainably Sourced | Medium Density Fibreboard (MDF) | Unspecified	373
External Wall Insulation	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Insulation | Blankets and Batts | Mineral Wool | Blanket | Unspecified	3585
First Floor	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | General | Unspecified	3
	Offsite Manufacturing / Prefabrication Process, Electricity	
	Resins and Adhesives | Urea Formaldehyde	3
		8
	Timber | Sustainably Sourced | Glue Laminated | Unspecified	1260

	Timber | Sustainably Sourced | Plywood | Unspecified	2527
	Timber | Sustainably Sourced | Softwood | Unspecified	3750
Ground Floor Insulation	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Insulation | Blankets and Batts | Mineral Wool | Blanket | Unspecified	1022
Ground Slab	Concrete Pump, Diesel	
	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Electrical Equipment, Small with transport and tradestaff, Electricity	
HVAC Air Source Heat Pump - COP/EER 3 (operational only)	UK 2020 Grid	
HVAC Air Source Heat Pump Embodied (multi-split)	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	3
	Ferrous Metals | Steel | General | Unspecified	15
		24
	Gases | Refrigerants | R-410A (Puron, AZ-20)	5
	Insulation | Rigid Foams and Boards | Polyethylene | Polyethylene	2

	Metals (Non-Ferous) | Copper Unspecified	5
		8
	Offsite Manufacturing / Prefabrication Process, Electricity	
Roof	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	539
	Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.56mm	52
	Ferrous Metals | Steel | General | Unspecified	0
	Ferrous Metals | Steel | Stainless | Unspecified	1
	Insulation | Blankets and Batts | Polyester Batts | Unspecified	1
		82
	Metals (Non-Ferous) | Aluminium Unspecified	32
	Paints and Finishes | Unspecified | 2 Coats	80
	Plaster and Mineral Derived Products | 100% Primary Gypsum | Plasterboard | 12mm Sheets	944
	Plaster and Mineral Derived Products | Fibre Cement | Medium Density. 1250 kg/t	224
	Resins and Adhesives | Epoxy Resin	7
	Resins and Adhesives | Melamine Resin	72

	Timber | Sustainably Sourced | Softwood | Unspecified	46
		50
		1252
Roof Insulation	Insulation | Rigid Foams and Boards | Polyurethane | Polyurethane	48
	Metals (Non-Ferous) | Aluminium Unspecified	20
	Offsite Manufacturing / Prefabrication Process, Electricity	
	Resins and Adhesives | Melamine Resin	9
	Trade Staff (No Equipment, labour transport only), Electricity	
Stone Floor	Cementitious Binders | Portland Cement | Unspecified	26
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | General | Unspecified	9
	Plastics | Polyurethane | Unspecified	71
	Rock and Stone | Cut or Split | Sandstone	937
Water Consumption - UK Residential	UK Average Water Supply	
	UK Average Water Treatment	
Windows, Residential Timber frame, Double Glaze	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Glazing | Windows | Timber Framed | Double Glaze | Domestic 50% Opening	4229

Table A2.2 Information Input for Option 2: Proposed Replacement Dwelling

Template Name	Element Process Name	Lifetime Installed Mass
Basement Build Up	Concrete Pump, Diesel	
	Concrete | Unreinforced | Portland Cement Blends | 40 MPa	29738
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | Reinforcement bar | Unspecified	995
	Timber | Sustainably Sourced | Plywood | Unspecified	590
Demolition - Residential (Construction)	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Excavator, 15t, Diesel	
	Trade Staff (No Equipment, labour transport only), Electricity	
External Wall	Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	4126

	Concrete Pump, Diesel	
	Concrete | Unreinforced | Portland Cement Blends | 40 MPa	**17214**
	Concrete | Unreinforced | Portland Cement Blends | Unspecified	**67699**
	Electrical Equipment, Large with transport and tradestaff, Electricity	
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | Galvanised Structural | Unspecified	**237**
	Ferrous Metals | Steel | General | Unspecified	**93**
	Metals (Non-Ferous) | Aluminium Unspecified	**83**
	Offsite Manufacturing / Prefabrication Process, Electricity	

First Floor	**Electrical Equipment, Small with transport and tradestaff, Electricity**	
	Ferrous Metals | Steel | General | Unspecified	**4**
		13
	Offsite Manufacturing / Prefabrication Process, Electricity	
	Plastics | Polyurethane | Unspecified	**90**
	Resins and Adhesives | Urea Formaldehyde	**5**
		13
	Timber | Sustainably Sourced | Glue Laminated | Unspecified	**1959**
	Timber | Sustainably Sourced | Hardwood | Unspecified	**3722**
	Timber | Sustainably Sourced | Plywood | Unspecified	**2090**
	Timber | Sustainably Sourced | Softwood | Unspecified	**4924**
	Trade Staff (No Travel, no travel, cost only), Electricity	

Ground Floor	**Electrical Equipment, Small with transport and tradestaff, Electricity**	
	Ferrous Metals | Steel | General | Unspecified	**4**
		14
	Offsite Manufacturing / Prefabrication Process, Electricity	
	Plastics | Polyurethane | Unspecified	**95**
	Resins and Adhesives | Urea Formaldehyde	**6**
		14
	Timber | Sustainably Sourced | Glue Laminated | Unspecified	**2070**
	Timber | Sustainably Sourced | Hardwood | Unspecified	**3933**
	Timber | Sustainably Sourced | Plywood | Unspecified	**2209**
	Timber | Sustainably Sourced | Softwood | Unspecified	**5202**

	Trade Staff (No Travel, no travel, cost only), Electricity	
HVAC Air Source Heat Pump - COP/EER 3 (operational only)	**UK 2020 Grid**	
HVAC Air Source Heat Pump Embodied (multi-split)	**Electrical Equipment, Small with transport and tradestaff, Electricity**	
	Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	**3**
	Ferrous Metals | Steel | General | Unspecified	**15**
		24
	Gases | Refrigerants | R-410A (Puron, AZ-20)	**5**
	Insulation | Rigid Foams and Boards | Polyethylene | Polyethylene	**2**
	Metals (Non-Ferous) | Copper Unspecified	**5**
		8

	Offsite Manufacturing / Prefabrication Process, Electricity	
	Plastics | General | Unspecified	**9**
		15
	Rubber | Synthetic	**3**
		15
Internal Floor Cover	**Carpets and Floor Coverings | Underlay | Rubber**	**505**
	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | General | Unspecified	**20**
		39
	Plastics | Polyurethane | Unspecified	**327**
	Timber | Sustainably Sourced | Hardwood | Unspecified	**7399**
Internal Walls	**Electrical Equipment, Small with transport and tradestaff, Electricity**	
	Ferrous Metals | Steel | General | Unspecified	**2**

		3
		15
	Paints and Finishes | Unspecified | 1 Coat	6
		10
		19
		51
		77
		153
	Plaster and Mineral Derived Products | 100% Primary Gypsum | Plaster | Unspecified	1192
	Plaster and Mineral Derived Products | 100% Primary Gypsum | Plasterboard | 12mm Sheets	5825
	Timber | Sustainably Sourced | Medium Density Fibreboard (MDF) | Unspecified	599
Roof	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | General | Unspecified	5
	Timber | Sustainably Sourced | Softwood | Unspecified	1585

Solar PV System, Residential, Embodied Only	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Finished Products | Electrical Goods | Solar Inverters | Solar Inverter Generic	65
	Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	611
	Metals (Non-Ferous) | Aluminium Unspecified	306
	Metals (Non-Ferous) | Copper Wire	4
Wall, Internal, Framed, Timber Stud Plasterboard and paint finish	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Ferrous Metals | Steel | General | Unspecified	3
		5
		6
		20
	Paints and Finishes | Water Based | 1 Coat	102

		153
		307
	Plaster and Mineral Derived Products | 100% Primary Gypsum | Plasterboard | 12mm Sheets	11651
	Plastics | High Density Polyethylene (HDPE) | Unspecified	18
	Timber | Sustainably Sourced | Softwood | Unspecified	293
		293
		1171
Water Consumption - UK Residential	UK Average Water Supply	
	UK Average Water Treatment	
Windows	Electrical Equipment, Small with transport and tradestaff, Electricity	
	Glazing | Windows | Timber Framed | Double Glaze | Domestic 50% Opening	7237

A3. END-OF-LIFE SCENARIOS

Material group	End-of-life scenario	Materials included	C3 – C4, waste processing and landfilling	D, recycling benefits
Mineral building materials	Recycling for ground works	Concrete*, cement*, bricks, porcelain, plaster, clay products, stone, ceramics, asphalt	C3: Construction waste preparation for recycling	Recycling benefit from replacing the primary gravel
Metals	Metal preparation and recycling**	Aluminium, steel, stainless steel, galvanised steel copper coated, copper uncoated, brass, zinc, lead	C3: Metal waste preparation	Recycling benefits for replacing virgin metal
Biobased materials with heating value	Incineration and energy recovery	Wood, wood products	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials with heating value	Incineration and energy recovery	Plastics	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials that can be landfilled in construction waste site	Disposal / landfilling of inert material	Coatings, synthetic materials, panels and boards***, insulating materials***, glass, window and façade components***	Disposal of inert construction waste	-

* Taking into account concrete carbonatization.

** Recycling potential can only be reported for metals with shares of primary manufacturing, i.e. if a product is made of recycled material, it no longer has recycling potential. 5% of losses is assumed for recycling (the remaining 95% are recycled).

*** When not included in above groups.

A4. GENERAL NOTES

A4.1 The report is based on information available at the time of the writing and discussions with the client during any project meetings. Where any data supplied by the client or from other sources have been used it has been assumed that the information is correct. No responsibility can be accepted by Iceni Projects Ltd for inaccuracies in the data supplied by any other party.

A4.2 The review of planning policy and other requirements does not constitute a detailed review. Its purpose is as a guide to provide the context for the development and to determine the likely requirements of the Local Authority.

A4.3 No site visits have been carried out, unless otherwise specified.

A4.4 This report is prepared and written in the context of an agreed scope of work and should not be used in a different context. Furthermore, new information, improved practices and changes in guidance may necessitate a re-interpretation of the report in whole or in part after its original submission.

A4.5 The copyright in the written materials shall remain the property of Iceni Projects Ltd but with a royalty-free perpetual licence to the client deemed to be granted on payment in full to Iceni Projects Ltd by the client of the outstanding amounts.

A4.6 The report is provided for sole use by the client and is confidential to them and their professional advisors. No responsibility whatsoever for the contents of the report will be accepted to any person other than the client, unless otherwise agreed.

A4.7 These terms apply in addition to the Iceni Projects Ltd "Standard Terms of Business" (or in addition to another written contract which may be in place instead thereof) unless specifically agreed in writing. (In the event of a conflict between these terms and the said Standard Terms of Business the said Standard Terms of Business shall prevail.). In the absence of such a written contract the Standard Terms of Business will apply.