University College School, Hampstead

Whole Life Carbon and Circular Economy Statement

Planning Submission

15th December 2023

MAX FORDHAM

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ISSUE HISTORY

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P01	24/10/23	Draft
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1.0 INTRODUCTION

1.1 DEVELOPMENT SUMMARY

The description of the development is as follows and Planning Permission is sought for the following:

The project is the partial demolition of the existing Giles Slaughter wing, retaining some of the structural elements, and the erection of a new 2-storey building in its' place, a one-storey extension, re-provision of tennis courts on the roof, external plant equipment and enclosures, external landscaping works.

1.2 Site Location

The current site consists of the Giles Slaughter Wing, Fives building, two outdoor tennis courts, and grounds located on the University College School Campus in Hampstead, London Borough of Camden.

The site is located on the East side of the campus, set back from the road and backs onto residential area.

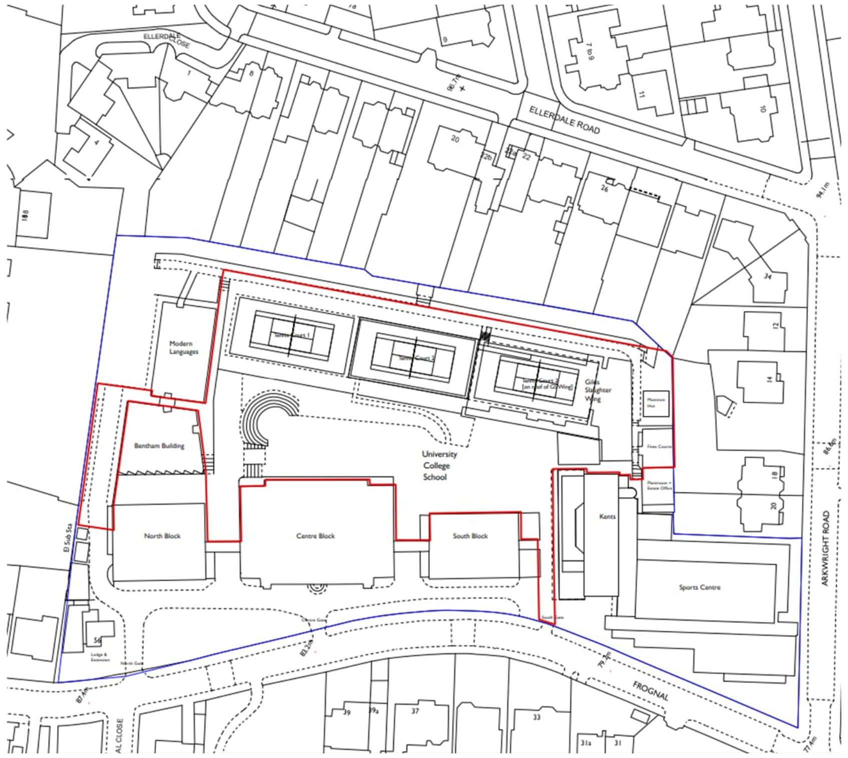


Figure 2 Site Location Plan

1.3 WHOLE LIFE CARBON

Whole Life Carbon (WLC) emissions are those associated with the building materials and products including production, construction, replacement, demolition, disposal and in-use energy consumption. Whole Life Carbon comprises of the lifecycle assessment (LCA) components as shown in Figure 1.

- Upfront Carbon (A1-A5) – Carbon emissions associated with the construction of a building. These are the carbon emissions that a project team can most directly control through modelling the upfront carbon and choosing low-carbon construction materials and processes coupled with leaner material use.
- Embodied Carbon (A1-C4, excl. B6-7 & D) – Carbon emissions associated with the construction, maintenance, repair and end-of-life of a building. Considering embodied carbon, in addition to Upfront Carbon, allows the project team to identify material choices that have a low upfront carbon cost, but avoid high ongoing carbon emissions associated with maintenance and repair.
- Whole Life Carbon (A1-C4, incl. D) – As above, but including the carbon emissions associated with the operational energy expenditure of the building and water usage. Additionally, this metric also reports Module D benefits - i.e. benefits beyond the scope of the building's lifetime such as reuse potential, recovery and recycling.

This report presents the strategies and options reviewed for minimising upfront carbon emissions (A1-A5) and the overall embodied carbon emissions (A1-C4) at RIBA stage 2 and 3.

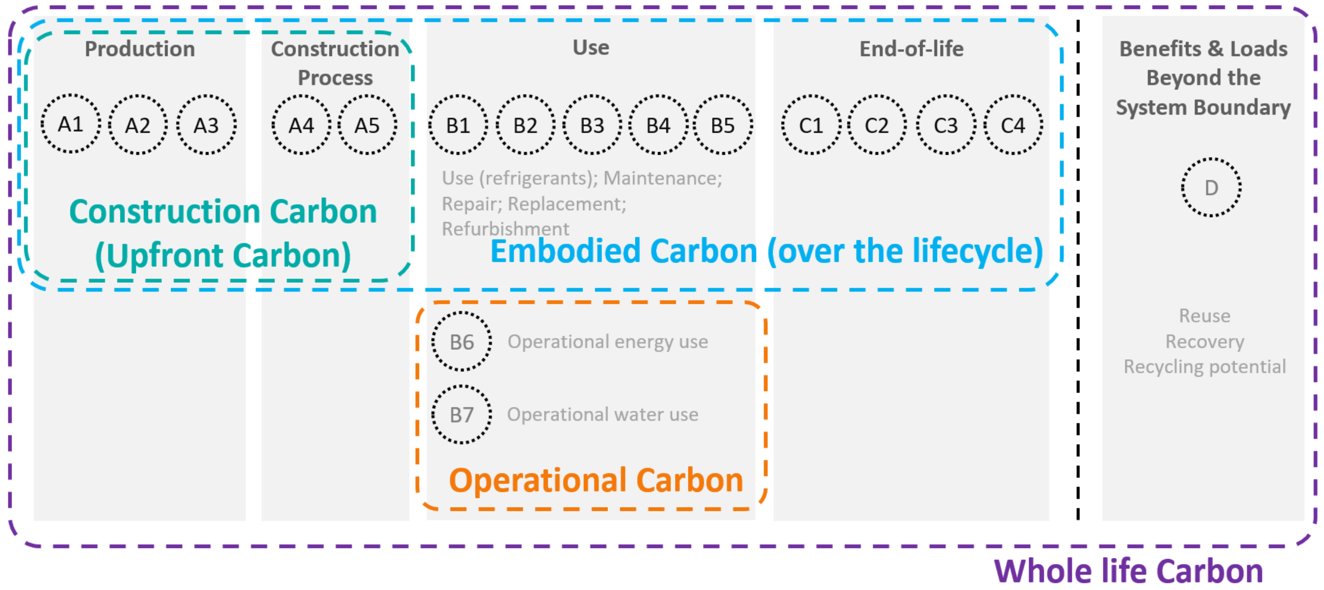


Figure 1 Whole Life Cycle Carbon assessment stages

1.4 CIRCULAR ECONOMY

A Circular Economy is one where building materials are retained in use at their highest value for as long as possible and are then reused or recycled, leaving a minimum of residual waste.

This means the assets are designed so that whole buildings, and materials, components and parts can be continually and easily recycled.

Through optimising material use embodied carbon can be significantly reduced, supporting the delivery of net zero carbon developments.

1.5 INDUSTRY BENCHMARKS

The *Embodied Carbon Target Alignment* document[1] advises that users should consult 3rd party resources such as those published by RIBA and/or LETI to determine suitable project targets.

Upfront Carbon (A1-A5) - LETI Upfront Embodied Carbon Target
LETI provide the following targets for the upfront construction (A1-A5) embodied carbon stages (excl. sequestration).

- <500 kgCO_2e/m² of GIA (A1-A5), for buildings constructed around 2020.
- <300 kgCO_2e/m² of GIA (A1-A5), for buildings constructed around 2030.

Whole Life Cycle Carbon (A1-C4, excl. B6,B7) - RIBA Life Cycle Embodied Carbon Target
The RIBA Climate Challenge provides a life cycle embodied carbon target (A1-C4, excl. B6,B7 that relates to operational carbon) including sequestration of:

- <540 kgCO2e/m² of GIA (A1-C4, excl. B6,B7), for buildings constructed around 2030.

Figure 3 shows published data of LETI design targets and RIBA 2030 Build Target against GLA benchmarks for Education buildings.

Upfront Embodied Carbon, A1-5 (exc. sequestration)

	Band	Office	Residential (6+ storeys)	Education	Retail	
	A++	<100	<100	<100	<100	
	A+	<225	<200	<200	<200	
LETI 2030 Design Target	A	<350	<300	<300	<300	
	B	<475	<400	<400	<425	GLA Aspirational Benchmark
LETI 2020 Design Target	C	<600	<500	<500	<550	
	D	<775	<675	<625	<700	GLA Typical Benchmark
	E	<950	<850	<750	<850	
	F	<1100	<1000	<875	<1000	
	G	<1300	<1200	<1100	<1200	

Life Cycle Embodied Carbon, A1-5, B1-5, C1-4

	Band	Office	Residential (6+ storeys)	Education	Retail	
	A++	<150	<150	<125	<125	
	A+	<345	<300	<260	<250	
	A	<530	<450	<400	<380	
RIBA 2030 Build Target	B	<750	<625	<540	<535	GLA Aspirational Benchmark
	C	<970	<800	<675	<690	
	D	<1180	<1000	<835	<870	GLA Typical Benchmark
	E	<1400	<1200	<1000	<1050	
	F	<1625	<1400	<1175	<1250	
	G	<1900	<1600	<1350	<1450	

Figure 3 LETI & RIBA Industry Benchmarks against GLA WLC requirements

1 LETI/RIBA/WLCN/IStructE - Embodied Carbon Alignment, 2022

1.6 PLANNING POLICY AND GUIDANCE – GLA WLC & CE

2.1 LONDON PLAN (2021)
The London Plan published in March 2021, forms the statutory development plan for Greater London over the next 20-25 years. A number of policies directly related to material resource efficiency, embodied carbon and circular economy within buildings and sites form an integral part of the London Plan.

London Plan Policy SI 2 Minimising Green House Gas Emissions
The policy sets out a requirement for development proposals to calculate and reduce WLC emissions as part of a WLC assessment. A supporting assessment guidance and a WLC assessment template has been produced by the GLA, formally adopted in March 2022. Applicants are required to report whole life embodied carbon by each life cycle stage at planning and post-construction. Local authorities are encouraged to secure the post-construction stage WLC assessment through a planning condition with the applicant.

London Plan Guidance: Whole Life Cycle Assessments (March 2022)
GLA requirements are reported in Table 1.

Table 1 – GLA Education Benchmarks from Whole Life Cycle Carbon Assessments - London Plan Guidance

	GLA Benchmark ($kgCO_2e/m^2$ GIA)	Aspirational Benchmark ($kgCO_2e/m^2$ GIA)
Upfront Carbon (A1-A5, excl. sequestration)	<750	<500
In-use and End of Life Carbon (B-C, excl. B6, B7)	<250	<175
Whole Life Carbon (A-C excl. B6, B7, incl. sequestration)	<1000	<675

London Plan Policy SI7 - Reducing Waste and Supporting the Circular Economy
Resource conservation, waste reduction, increases in material re-use and recycling, and reductions in waste going to disposal shall be achieved. Referable applications should promote circular economy outcomes and aim to be net zero-waste. Some key overarching targets set out in this policy are as follows:

- Zero biodegradable or recyclable waste to landfill by 2026;
- 65% of municipal waste recycled by 2030;
- 95% of construction and demolition waste reused/recycled/recovered;
- 95% of excavation waste put to beneficial use;

London Plan Guidance: Circular Economy Statement Guidance & Primer (March 2022)
In support of Policy SI7, projects shall demonstrate how their development, including any public realm and supporting infrastructure, will incorporate circular economy measures into all aspects of the design, construction and operation process. Projects shall ensure that their designs:

- Consider strategies to facilitate the transition towards a circular built environment;
- Recognise opportunities to benefit from greater efficiencies that can help to save resources, materials and money;
- Report against targets that will facilitate monitoring of waste and recycling.

London Plan Policy SI 8 Waste capacity and net waste self-sufficiency
In order to manage London's waste sustainably, the policy requires an equivalent of 100 per cent of London's waste to be managed within London (i.e. net self-sufficiency) by 2026. The Mayor is committed to sending zero biodegradable or recyclable waste to landfill by 2026.

London Plan Policy SI 10 Aggregates
The policy aims to achieve an adequate supply of aggregates to support construction in London by:

1) encouraging reuse and recycling of construction, demolition and excavation waste within London (incl. on-site)
2) extracting land-won aggregates within London
3) importing aggregates to London by sustainable transport modes.

2.2. WESTMINSTER CITY PLAN (2019-2040) AND ENVIRONMENTAL SUPPLEMENTARY PLANNING DOCUMENT (2022)
Westminster City Council's Local Plan sets out the following relevant policies relating to sustainability and climate change, in particular with respect to embodied carbon and circular economy.

Policy 32 Air quality
CONSTRUCTION IMPACTS

A. Developments are required to minimise demolition and construction impact by complying with Westminster's Code of Construction Practice (CoCP).
B. Modern methods of demolition and construction that minimise negative local environmental impacts will be encouraged.

The City Plan requires air quality assessments to be submitted with applications for major developments. The assessments should include Construction assessment including Construction traffic inclusion and mitigation of impacts, as per the GLA SPG on control of dust and emissions from demolition and construction.

Policy 36 Energy
Major development proposals, including shell and core schemes, should include a detailed energy assessment to demonstrate how energy use and carbon emissions have been reduced for the development in accordance with policy requirements, as per the London Plan.
Policy 36B also requires major development to be net zero carbon and demonstrate this target is achieved as per the UK Green Building Council's Framework Definition of Net Zero1 as follows: Net Zero Carbon: Construction: "When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."

Policy 37 Waste Management
The council will promote the Circular Economy and contribute to the London Plan targets for recycling and for London's net self-sufficiency by 2026.

B. All new developments (including extensions and change of use) must provide appropriate facilities for the storage of separate waste streams which are safe and convenient to access for deposit and collection, with sufficient capacity for current and projected future use.

Developers are required to demonstrate through a Circular Economy Statement, Site Environment Management Plan and/or associated Site Waste Management Plan, the recycling, re-use, and responsible disposal of Construction, Demolition and Excavation waste in accordance with London Plan targets and the council's Code of Construction Practice (CoCP).
Existing waste management facilities will be protected. Any proposals for new waste management facilities will be assessed against the criteria set out in the London Plan and national policy. The council will continue to collaborate with other Waste Planning Authorities in the management of its waste and monitor its waste exports.

Policy 38 Design Principles
SUSTAINABLE DESIGN

D. Development will enable the extended lifetime of buildings and spaces and respond to the likely risks and consequences of climate change by incorporating principles of sustainable design, including:

- use of high-quality durable materials and detailing;
- providing flexible, high quality floorspace;
- optimising resource and water efficiency;
- enabling the incorporation of, or connection to, future services or facilities; and
- minimising the need for plant and machinery.

E. Applicants will demonstrate how sustainable design principles and measures have been incorporated into designs, utilising environmental performance standards.

Environmental Supplementary Adopted 2022 Planning Document (2022), states that to align with Policy 38 on sustainable design, all major developments which include substantial demolition are also required to meet the WLC standard. Substantial demolition includes total demolition of a building, façade retention redevelopment schemes and other redevelopment schemes where only the superstructure is being retained

2.0 EMBODIED CARBON STRATEGIES

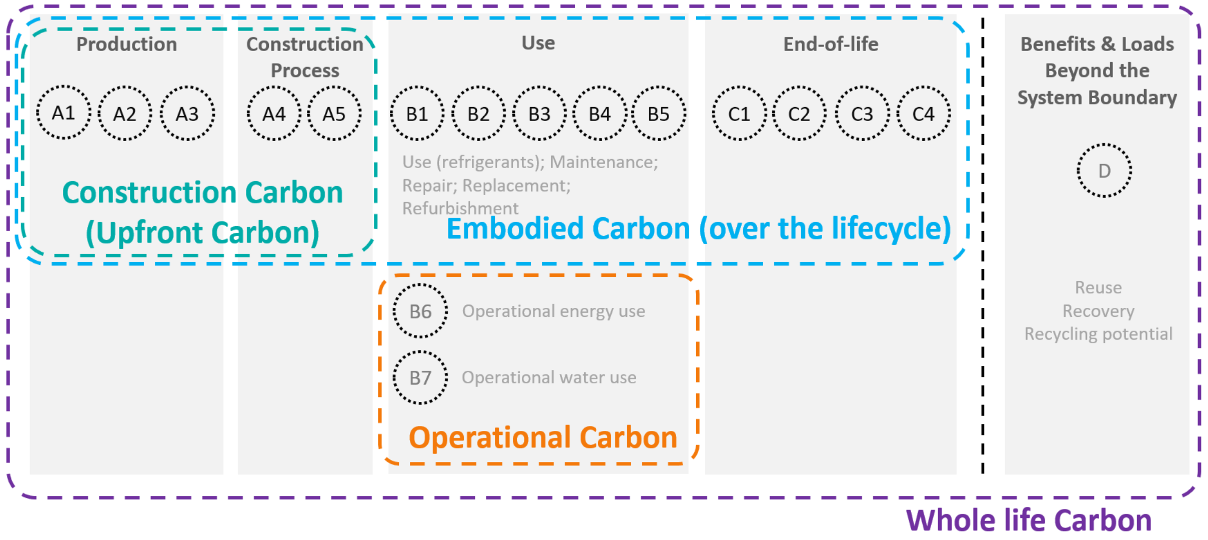
2.1 WHOLE LIFE CARBON DESIGN PRINCIPLES

WLC reduction principles		Key benefits	WLC reduction principles applied in the scheme
1	Reuse and retrofit of existing buildings	Significant retention and reuse of structures is carbon efficient and reduces construction costs.	• 100% of existing raft foundation and 50% of retaining wall to be reused • A pre-demolition audit has been carried out. A survey of opportunities for on-site/off-site reuse of existing internal and external elements identified. To be implemented by the main contractor
2	Use repurposed or recycled materials	Reduces waste and carbon emissions.	As part of design development the project aims to: • Reduce ceiling finishes through exposed ceiling • Specify floor finishes such as carpets with higher recycled content and re-use floor boards from the existing building • Options for higher recycled content aluminium frame for windows and glazing to be proposed by the main contractor
3	Material selection	Appropriate material choices are key to carbon reduction. Ensuring that materials are selected with consideration of the planned life expectancy of the building reduces waste, the need for replacements and the in-use costs.	Proposed development adopts a modular solution using Steel frame and pre-cast concrete planks; leading to reduction in on-site construction waste, construction related transport emissions and steel frames could be disassembled for reuse at end of life.
4	Minimise operational energy use	A 'fabric first' approach should be prioritised to minimise energy demand and reduce carbon and in-use costs.	Operational energy performance is optimised through high fabric standards to provide low operational energy and comfortable internal learning environment.
5	Minimise the carbon emissions associated with operational water use	Choice of materials and durability of systems, which help to avoid leakage and subsequent building damage, contribute to reducing the carbon emissions of water use.	Water efficiency targets as per BREEAM guidance.
6	Disassembly and reuse	Designing for future disassembly ensures that products do not become future waste and that they maintain their environmental and economic value.	Steel frames could be disassembled for reuse at end of life.
7	Building shape and form	Compact efficient shapes help minimise both operational and embodied carbon emissions from repair and replacement for a given floor area. This leads to a more efficient building overall resulting in lower construction and in use costs.	The form of the building is determined by the site constraints and functional needs of the space. Irrespective of the limitations, the proposed build form is compact and efficient to build.
8	Regenerative design	Removing carbon emissions from the atmosphere through materials and systems absorbing it makes a direct contribution to carbon reduction.	N/A
8	Designing for durability and flexibility	Durability means that repair and replacement is reduced which in turn helps reduce life-time building costs. A building designed for flexibility can respond with minimum environmental impact to future changing requirements and a changing climate, thus avoiding obsolescence which also underwrites future building value.	The classrooms are conceived to be a flexible internal space, with no load bearing internal walls and higher ceiling height, to allow future lay out changes.
10	Optimisation of the relationship between operational and embodied carbon	Optimising the relationship between operational and embodied carbon contributes directly to resource efficiency and overall cost reduction.	The span/depth of the building has been optimised to enable as much daylighting into classrooms as feasible, reducing the amount of lighting load as well as the steel framing depth required.

WLC reduction principles		Key benefits	WLC reduction principles applied in the scheme
11	Building life expectancy	Defining building life expectancy gives guidance to project teams as to the most efficient choices for materials and products. This aids overall resource efficiency, including cost efficiency and helps future proof asset value.	The service life of the proposed scheme is as per the Eurocodes, 50 years.
12	Local sourcing	Sourcing local materials reduces transport distances and supply chain lengths and has associated local social and economic benefits.	At procurement stage options for distance and mode of transport involved in sourcing various elements will be considered. For the purpose of embodied carbon estimates RICS whole life carbon guidance recommended distance have been assumed. • Locally manufactured e.g. concrete, aggregate, earth - 50km by road • Nationally manufactured e.g. plasterboard, blockwork, insulation - 300km by road • European manufactured e.g. CLT, façade modules, carpet - 1,500 km by road • Globally manufactured e.g. specialist stone cladding - 200 km by road, 10,000km by sea
13	Minimising waste	Waste represents unnecessary and avoidable carbon emissions. Buildings should be designed to minimise construction waste, and to ease repair and replacement with minimum waste, which helps reduce initial and in-use costs.	Proposed construction follows a modular construction approach requiring minimal on-site works, resulting in less wastage.
14	Efficient construction	Efficient construction methods (e.g. modular systems, precision manufacturing and modern methods of construction) can contribute to better build quality, reduce construction phase waste and reduce the need for repairs in the post completion and the defects period (snagging).	Proposed development adopts a modular solution using Steel frame and pre-cast hollow-core concrete planks; this is determined by site constraints and the requirement to provide roof top tennis courts. Existing raft foundation has been reused & extended for the new build.
15	Lightweight construction	Lightweight construction uses less material which reduces the carbon emissions of the building as there is less material to source, fabricate and deliver to site.	
16	Circular economy	The circular economy principle focusses on a more efficient use of materials which in turn leads to carbon and financial efficiencies.	See Section 3.0

2.2 PROPOSED SCHEME EMBODIED CARBON

Whole Life Carbon (WLC) emissions are those associated with the building materials and products including: production, construction, replacement, demolition, disposal and in-use energy consumption. Whole Life Carbon comprises of the lifecycle assessment (LCA) components as shown in the figure below.



Upfront Carbon (A1-A5) - Carbon emissions associated with the construction of a building. These are the carbon emissions that a project team can most directly control through modelling the upfront carbon and choosing low-carbon construction materials and processes coupled with leaner material use.

Embodied Carbon (A1-C4, excl. B6-7 & D) – Carbon emissions associated with the construction, maintenance, repair and end-of-life of a building. Considering embodied carbon, in addition to Upfront Carbon, allows the project team to identify material choices that have a low upfront carbon cost, but avoid high ongoing carbon emissions associated with maintenance and repair.

Whole Life Carbon (A1-C4, incl. D) – As above, but including the carbon emissions associated with the operational energy expenditure of the building and water usage. Additionally, this metric also reports Module D benefits - i.e. benefits beyond the scope of the building's lifetime such as reuse potential, recovery and recycling.

The results are then compared to the following industry targets for Education structures:

- LETI 2030 Design Target: This is a metric for comparing Upfront Carbon, excluding sequestration, and is used to inform Offset Payments.
- RIBA 2030 Built Target: This is a metric for comparing Embodied Carbon, including sequestration.
- GLA WLC Benchmark: The is a metric for both Upfront and Embodied Carbon

General approach
WLC carbon modelling has been carried following the methods set out in RICS Whole Life Carbon Assessment for The Built Environment V1.0 and using the One Click LCA Software, by Bionova. The software tool makes use of several databases of materials, building products, Environmental Product Declarations (EPDs) and in-house environmental data.

Assumed building lifetime

For the purpose of embodied carbon analyses, a hypothetical building lifetime of 60 years is used. In reality, elements of the building will likely last longer (for example the structure). 60 years is chosen to be able to compare predicted performance to benchmarks. 60 years is the basis of the RICS Whole life carbon assessment guidance.

Embodied carbon materials and products data
In general, the One Click data (such as EPDs) is to be at a minimum ISO 14040/44 compliant and the study associated with material/product must have been conducted no more than 10 years ago. The EPDs issued in Europe are commonly also EN 15804 compliant and in that case valid 5 years from the issue date. Wherever appropriate, suitable product specific EPDs have been used in preference to generic data for material/product GWP data.

Lifecycle stages
The scope of this WLC Carbon analysis includes upfront construction carbon (stages A1-A5), impacts from maintenance, repair, replacements and refurbishment (B1 -B5) and demolition and disposal at end of life (C1-C4). Operational Carbon (B6) and water use (B7) is addressed separately as part of the operational energy modelling.

A 10% contingency factor has been applied to the results to account for the typical carbon increase resulting in greater detail available in later design stages.

Accuracy and certainty
The WLC carbon modelling result can only ever be considered an approximation. There are many factors that influence this, including the following:

- Limited scope: it is not possible to include all individual components and elements of a building.
- Uncertainty in estimating quantities
- Uncertainty in the embodied carbon rates for materials and products. The availability of embodied carbon data for specific products is very limited. In many cases generic data or proxy products need to be used. Different data sources (or methodological choices) can have very different embodied carbon values for equivalent or similar products.
- Uncertainty in design aspiration compared to actual as-built products / strategies

Within the UCS scheme, the following key assumptions have been made:

- Steel modelled with UK Average consumed factors (A1-A3 = 1.74 kgCO2e/kg)
- Concrete generally modelled with carbon factors relating to around 25% GGBS replacement. This is not intended to be an intent to use GGBS but rather be a carbon placeholder for an achievably low carbon mix for concrete of that strength grade.
- Secant Piled Walls and Concrete Walls are considered External Retaining Walls i.e. External Works
- Wall, Floor and Ceiling finishes are based off internal benchmark data from previous projects
- Building services has been partially modelled (Mat01 scope) and an uplift applied to match internal benchmark data
- Recital Roof structure estimated from MXF assumptions

Results
When comparing to RIBA and LETI benchmarks, the following categories are excluded: non-fixed FF&E, external works outside the building footprint, and renewable electricity generation.

	Upfront Carbon A1-A5 (kgCO$_2$e/m^2)
LETI 2030 design target	<300
GLA WLC Benchmark	<750
University College School *(excl. Ext Works/FF&E)*	795
University College School *(all elements)*	1012

	Embodied Carbon A1-C4 (kgCO$_2$e/m^2)
RIBA 2030 design target	<540
GLA WLC Benchmark	<1000
University College School *(excl. Ext Works/FF&E)*	1110
University College School *(all elements)*	1342

Short Building Penalty
Certain building typologies suffer from inherent penalties to embodied carbon metrics due to the impact of roof structure. Given that carbon rates are fundamentally counted, then divided by GIA, the roof represents a ‘penalty’ in as much as it requires structure but doesn’t provide GIA. For a very tall building, the penalty is ‘spread’ over many floors and has a relatively modest impact. For a short building of the same footprint, the same structure can be the majority of the buildings carbon, as is the case with UCS.

Stage 2 Optioneering
During Stage 2, comprehensive optioneering was carried out to satisfy BREEAM Mat01 requirements. The table of options can be seen below. For full detail on the results, see the Stage 2 Mat01 Report.

SUPERSTRUCTURE OPTIONS - FOR BREEAM LCA (Up to 6 credits)

	Option 1	Option 2	Option 3	Option 4
Frame	GS Raft Precast + Steel	GS Raft Precast + Steel	GS Raft Steel	GS Raft Steel + Steel Ties
Slab	Precast Hollowcore Composite	Precast Hollowcore Non-composite	Coffered Slab - classrooms Precast Hollowcore	Tie- Vault - classrooms Precast Hollowcore
Roof/Terraces	Tennis Court / General Play Zinc Standing Seam Green Roof	Tennis Court / General Play Zinc Standing Seam Green Roof	Tennis Court / General Play Copper Standing Seam Green Roof	Tennis Court / General Play Green Roof Green Roof
Stairs and ramps	Steel access	Concrete Stairs external	Steel access	Concrete Stairs external
External walls	West - Red Brick (non standard) Rockwool Block East - Glazed Ceramic Tiles Insulation - Rockwool Block	West - Red Brick (Waste Brick) Hemp SFS East - Glazed Ceramic Tiles Insulation - Rockwool Block	West - Red Brick (K-Briq) Wood fibre SFS East - Glazed Ceramic Tiles Insulation - Rockwool Block	West - Red Brick (non standard) Rockwool Block East - Glazed Ceramic Tiles Insulation - Rockwool Block
Windows and external doors	Alu/Timber Comp Double	Double	Double	Alu/Timber Comp Double

SUBSTRUCTURE - FOR BREEAM LCA (1 credit)

	Option 1	Option 2	Option 3
Foundations	New raft + reuse of existing raft	New raft + reuse of existing raft	New raft + reuse of existing raft
Basement - Retaining	Secant (hard - soft piles) + Liner	Secant + Liner	Sheet pile wall (quiet sheet piling) + Liner
Ext Retaining	Partially retained existing contig wall	Partially retained existing contig wall	Partially retained existing contig wall

MEP SERVICES OPTIONS - FOR BREEAM LCA (1 exemplary credit)

	Option 1	Option 2	Option 3
Heat Source	2-pipe ASHP R32 (2No. 180kW)	4-pipe ASHP 454B	ASHP (R290)
Heating and Cooling	FCU/Fan-Rad	UFH & FCUs	Chilled Beams & FCUs
Ventilation	AHU/MVHR/Nat Vent	AHU/MVHR	AHU/MVHR/Nat Vent
	Galv Steel Ductwork	Phenolic	Carboard Duct

3.0 CIRCULAR ECONOMY STRATEGIES

The project aim is to showcase a circular approach to demolition by adopting a proactive strategy following the waste preference hierarchy:

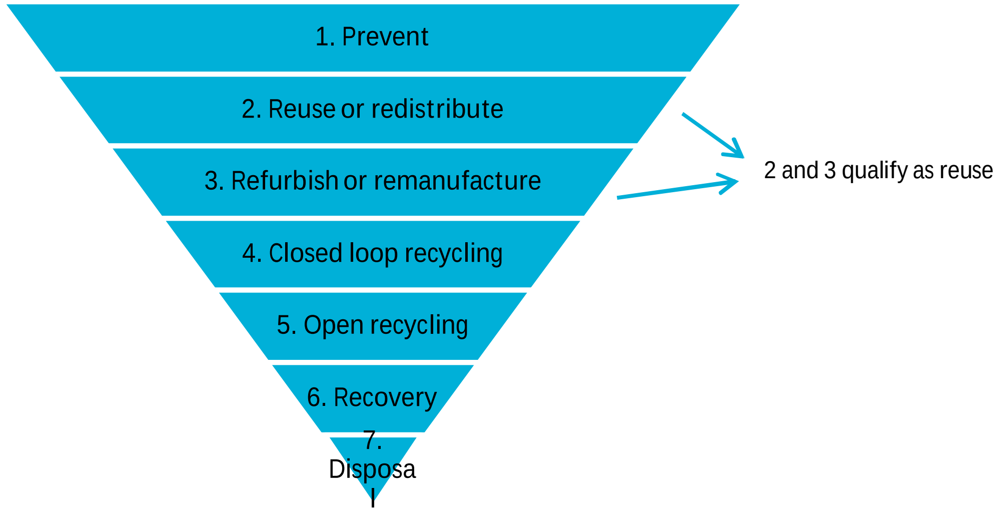


Figure 4 Waste Hierarchy

3.1 EXISTING BUILDINGS DEVELOPMENT APPROACH

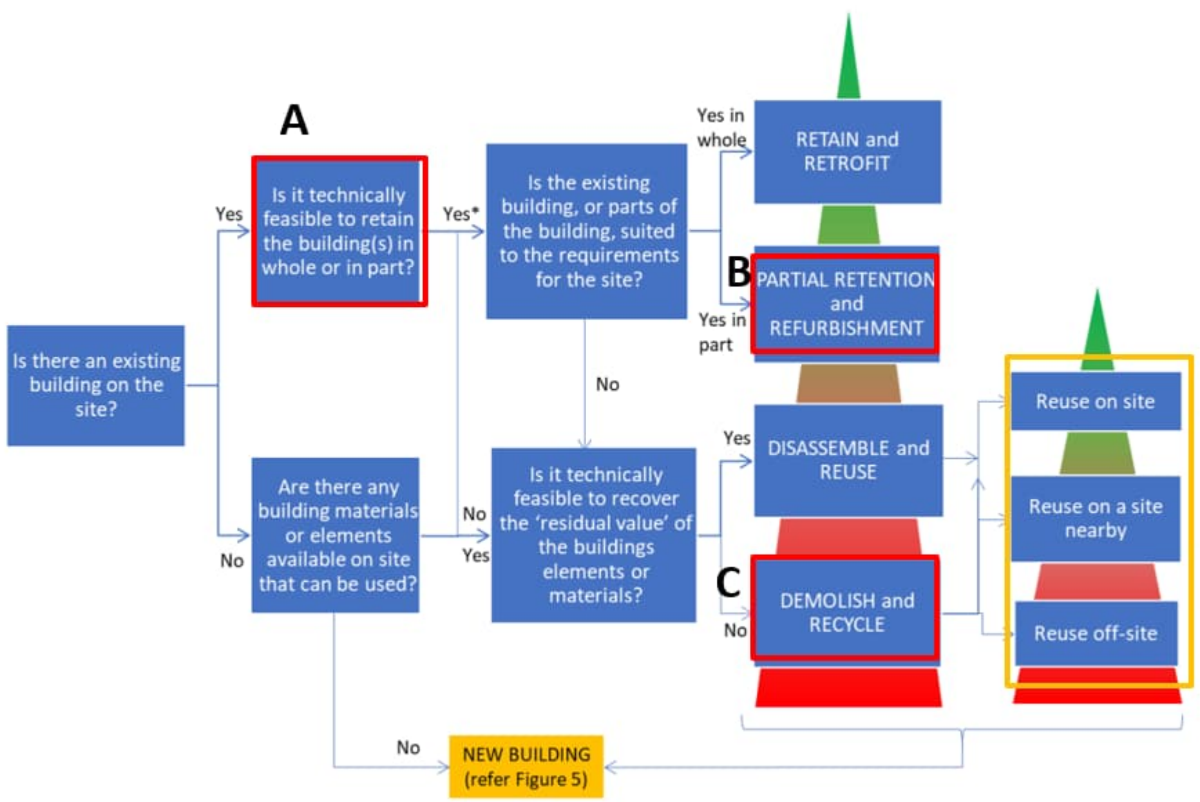


Figure 5 GLA CE Guidance – Decision making tree for design approaches to existing buildings.

The London Plan Circular Economy guidance requires project teams to use the flow chart in Figure 5 to demonstrate how the proposed scheme has considered the options for retaining the existing built structures totally or partially before considering substantial demolition.

The existing building GIA is 926m^2. Five different development options were evaluated at early design in developing the proposed scheme; the pros and cons of each are outlined below:

Options	Pros	Cons
Full demolition of GS Wing, GS Wing retaining wall, Fives and Maintenance Hut, with basement plantrooms	Creation of space that delivers all of the project brief requirements	Higher embodied carbon and significant demolition
Full retention of GS Wing, GS Wing retaining wall, Fives and Maintenance Hut	Lower embodied carbon as no new structure will be provided	Existing structure is of poor thermal performance, issues with waterproofing of the fabric and inadequate building services; poor daylighting. Does not meet the teaching standards
Partial retention of GS Wing – partial demolition of GS Wing, full demolition of GS Wing retaining wall, Fives and Maintenance Hut	Reuse of part of the existing building	Limited access from courtyard; reduced development footprint due to root protection zone, challenging levels and matching slab heights; lack of space to meet key design brief for the music Recital Room, Cafeteria and Drama Studios
Full retention of GS Wing deep ground slab - partial demolition of GS Wing [superstructure only], full demolition of GS Wing retaining wall, Fives and Maintenance Hut, with basement plantrooms	Creation of space that delivers all of the project brief requirements	Higher embodied carbon from full basement Superstructure demolition impact
Partial retention of GS Wing & retaining wall – partial demolition of GS Wing and retaining wall, full demolition of Fives and Maintenance Hut	Basement omitted; re-use of the ground floor slab and 50% of the existing GS Wing retaining wall Creation of space that delivers all of the project brief requirements	Superstructure demolition impact

As illustrated in the flow chart in Figure 5 the development approach considered within the constraints of the existing site is outlined below:

- *Stage A - Is it technically feasible to retain the building in whole or part? Yes, in part*
  Retention of the existing building is feasible. However, retention of the buildings will not meet the requirements of the site. The project development brief requires the capacity of sites to be optimised and requires the provision of additional commercial accommodation, and improved ground floor accommodation. Those requirements could not be met by a development that would involve retention of the whole building. See Circular economy - Assessment of existing buildings, included as part of the Design and Access Statement.
  However, it is possible to retain elements of the existing building as outlined in subsequent sections.

- *Stage B - Is the existing building or parts of the building, suited to the requirements for the site? Yes, in part*

The Applicant team therefore concluded retention of the entire building was not practical and considered an alternative approach. This partial retention option involves Partial retention of GS Wing & retaining wall – partial demolition of GS Wing and retaining wall, full demolition of Fives and Maintenance Hut. This approach, whilst prioritising the retention of the existing structure, can deliver the intensification and development of the site whilst providing floorspace to a higher standard. The following structural elements will be retained:

Raft/foundations

Existing raft/foundation (all to be retained), 800mm thick, area of 1220m^2. This equates to avoiding sourcing new reinforced concrete (RC) volume of 976m^3 i.e 2,342,400kg of concrete and 87,840kg of steel (reinforcement)

Retaining contiguous wall

52% of the existing contiguous wall has been retained, avoiding sourcing new concrete amounting to a total volume of around 123m^3 of RC i.e. 296,227kg of concrete and 13,577kg of steel (reinforcement).

- *Stage C - Is it technically feasible to recover the residual value of the buildings, elements or materials? Yes*

A Pre-demolition audit was carried out by the project team to identify a list of potential items for reuse and recycling. The proposed scheme is aiming for BREEAM Excellent rating. A Pre-demolition audit is required for meeting BREEAM Wst 01 credit requirements. The audit reported a total estimated waste arisings (Key Demolition Products) of 1,255 tonnes, which is equivalent to 1.35tonnes/m2 of demolition waste arising per m^2 GIA. See P200-Pre-Demo-KaN-Final Issue (pre demolition Audit) for a copy of the pre-demolition audit report outlining the detailed waste arisings.

A diversion of waste from landfill target of 95% (by weight). The table below outlines the reuse opportunities to recover the residual value of some of the elements and materials:

	Proposed reuse to recover the residual value of materials on-site
Bricks	A small proportion of recovered bricks from the site will be re-used for façade and perimeter wall in the proposed development
Timber and timber products	Timber floorboards to be re-used on-site and a potential end user sports charity has been identified for the maintenance shed to be reused off-site
Plastics (Astro turf)	A potential end user sports charity has been identified for the Astroturf to be reused off-site
Stone	About half of the stone cladding and slabs will be used as external paving and seating in the proposed development

3.2 DESIGN PRINCIPLES WITHIN THE PROPOSED SCHEME

The London Plan Circular Economy guidance requires the project teams to use the flow chart in Figure 5 and illustrate how the proposed scheme has embedded CE design approaches. The following also satisfy BREEAM 'Mat 06 Material efficiency' and 'Wst 06 Design for disassembly' credit requirements.

Design out waste

- Main structure will be steel with pre-cast concrete and will be modular.
- Masonry walls will be designed to modular brick dimensions which will avoid waste of material.
- Common areas will be finished using standard size materials where feasible, e.g. plasterboard partitions, ceiling tiles and carpet tiles.
- Efficient building fabric specification and optimised service run to reduce heat loss for low operational energy
- Exposed soffit reducing ceiling finishes.

Designing for Longevity

- The project general is not intended to allow an increase in pupil numbers. The design is in accordance with the school's requirements.
- Design life of the proposed scheme is a minimum of 50 years

Designing for adaptability or flexibility

- The whole building is a structural frame with no internal load bearing walls.
- The single storey building is extremely adaptable for teaching spaces and admin spaces and all partitions are drylined.
- Accessible and flexible services

Designing for disassembly

- Structural steel frames to have bolted connections to allow future reuse
- External brick to be laid in lime mortar enabling future reuse

3.3 CIRCULAR ECONOMY TARGETS

Waste diversion from landfill
Minimum policy target is 95% diversion of construction, demolition and excavation waste from landfill.

Estimated demolition waste is 1,255 tonnes of which the project will aim to recycle, and or reuse, 95% of this waste stream. This shows that in terms of material arising, the most significant elements are :

1. Concrete - 711 tonnes (57%)
2. Plastics (astroturf) - 261 tonnes (21%)
3. Bricks - 191 tonnes (15%)

The demolition and main contractor will be required to monitor waste generation and destinations, and report percentages to reuse,/recycling/landfill in each report, producing a summary report at the end.

Reuse of site won materials
The proposed development is targeting between 15-20% by weight of demolished and strip-out materials to be reused either on-site and/or off-site. P200-Pre-Demo-KaN-Final Issue (Pre-demolition Audit) to be reviewed and actions to be implemented by the project team and the main contractor.

Materials	Estimated waste arising (tonnes)	% reuse on-site/off-site (as per pre-demolition audit)	Tonnes of materials reuse on-site/off-site
Stone	6.5	46%	2.99
Brick	191	6%	11.46
Timber	16	30%	4.8
Plastic (Astroturf)	261	99%	258.39
Total estimated reused materials on-site/off-site			277.64
Total demolition waste, estimate as per Pre-demolition audit	1255		22%

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Managing the construction impacts

The main contractor will be contractually required to deliver responsible construction and reduce environmental impacts during construction. This will be implemented by main build contractors, such as registering the scheme with Considerate Construction Scheme, aiming for a 4 star or above rating, adopting responsible Construction Practices. This to be delivered in line with the BREEAM Man 03 'Responsible Construction Practices'.

Recycled content

The London Plan requires schemes to meet a minimum target of 20% recycled or reused content, by value of a scheme. This will be a challenging target to meet for a steel framed, precast hollow core slab scheme. The project aspiration is to review inclusion of the following element specification.

- Concrete specification to incorporate a minimum of 20% recycled aggregates and lower carbon cement specification (as informed by embodied carbon model) to enable higher recycled content by value.
- Main contractor to propose options to deliver the following:
  - Façade window aluminium frame with higher recycled content e.g. Hydro CIRCAL.
  - Glass with >30-40% recycled content.