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AECOM

The Hillingdon Hospital Redevelopment

Whole Life-Cycle Carbon Assessment

The Hillingdon Hospitals NHS Foundation Trust

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Delivering a better world

Quality information

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Brief Description of the Development

This Whole Life-Cycle Carbon Assessment (WLCA) has been prepared by AECOM to accompany the hybrid planning application being submitted by the Applicant, The Hillingdon Hospitals NHS Foundation Trust, to the London Borough of Hillingdon (LBH). The proposal comprises of a full application for the new Hillingdon Hospital and multi-storey car park (hereafter referred to as the 'Hospital Redevelopment') and an outline application for a mixed-use development with a residential primary function (hereafter referred to as the 'Masterplan Development').

The hybrid application comprises the following:

- Hillingdon Hospital
- Multi-storey car park (MSCP)
- Plots P01, P02, P03, P04, and potential expansion space

This document summarises the options considered during design of the Hospital Redevelopment and Masterplan Development (hereafter referred to as the 'Proposed Development').

Scope of the Assessment

The WLCA has been conducted in accordance with BS EN 15978: 2011: (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method) using the RICS Professional Statement: Whole Life Carbon assessment for the built environment, over a 60-year study period, covering the entirety of the life-cycle modules A, B, C and D. All the building elements listed in Table 2 have been included in the WLCA, in line with the RICS Professional Statement.

The embodied carbon calculation for the WLCA has been conducted using the LCA software "OneClick LCA". For this assessment the "Whole life carbon assessment, Greater London Authority" tool was used to prepare the baseline and option studies, aligned with the RICS Professional Statement "Whole Life Carbon Assessment for the Built Environment" (2017) for service life of materials and transport distances.

The operational energy data has been produced by Building Regulations Part L (domestic and non-domestic) calculations. The scope of the operational carbon emissions in the WLC therefore includes regulated energy consumption and unregulated energy consumption based on SAPs and BRUKL report. Renewable electricity generated on-site from solar photovoltaics (PV) is also accounted for in the calculations. The operational energy consumption of the development has been calculated for a life cycle of 60 years based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project.

Whole Life-Cycle Carbon Assessment Results

The overall whole life-cycle carbon of the Proposed Development over its 60-year life cycle is 309,263 tonnes CO_2eq for the Hospital Redevelopment which corresponds to 3,013 kg CO_2eq/m² GIA, and 72,029 tonnes CO_2eq for the Masterplan Development which corresponds to 1,780 kg CO_2eq/m² GIA.

For the Hospital Redevelopment, the operational carbon is responsible for 75% of the WLC, while 25% is attributed to the embodied carbon of the building materials, facilitating works and external works. The operational carbon is analysed in the Energy Statement; therefore this document only analyses the embodied carbon. The largest share of embodied carbon (i.e. excluding operational carbon B6-B7) emissions, approximately 45% of the whole, is attributed to the product stage (life cycle stages A1-A3, also known as cradle to gate stages). Transport and construction stages (A4 – A5) contribute around 22% of total embodied carbon. The embodied carbon from recurring building elements (B1-B5) contributes approximately 30% of the total embodied carbon. The superstructure is responsible for approximately 59% of the embodied carbon, while the Services (MEP) have the second highest impact accounting for 19% of the overall embodied carbon emissions.

For the Masterplan Development, the operational carbon is responsible for 51% of the WLC, while 49% is attributed to the embodied carbon of the building materials, facilitating works and external works. The operational carbon is analysed in the Energy Statement; therefore this document only analyses the embodied carbon. The largest share of embodied carbon (i.e. excluding operational carbon B6-B7) emissions, approximately 51% of the whole, is attributed to the product stage. Transport and construction stages (A4 – A5) contribute around 19% of total embodied carbon. The embodied carbon from recurring building elements (B1-B5) contributes approximately 23% of the total embodied carbon. The superstructure is responsible for approximately 50% of the embodied carbon, while the Finishes and

FF&E have the second highest impact accounting for 29% of the overall embodied carbon emissions. These results demonstrate that in order to reduce the embodied carbon of a building, it is imperative to focus on material selection and reducing the quantities and mass of materials required.

Comparison Benchmarks

According to the GLA's Whole Life-Cycle Carbon Assessment Guidance published in March 2022, it is required that the results of the WLC are compared with the benchmarks provided in the same document. The embodied carbon results of the Hospital Redevelopment have been compared with the WLC benchmarks for Schools, Universities etc., and the results of the Masterplan Development have been compared with the WLC Residential benchmarks.

The proposed design for Hospital Redevelopment achieves GLA WLC Benchmarks for Schools, Universities etc. for Modules A1-A5 and B-C. This is due to careful selection of materials, type of substructure and superstructure and the use of 30% GGBS cement replacement for all structural elements. The proposed design is close to achieve GLA WLC Aspirational benchmarks for Schools, Universities etc for Modules A1-A5 however, is not close to achieve GLA WLC Aspirational benchmarks for Modules B-C. This is due to the services, equipment, fittings and finishes that need replacement during the lifecycle of the building. GLA WLC benchmarks for Schools, Universities etc. do not reflect hospitals design and were used due to lack of relevant benchmarks. Sitting close to GLA WLC Aspirational benchmarks for Schools, Universities etc depicts an exceptional design for such a development.

The proposed design for Masterplan Development achieves GLA Residential benchmarks for Modules A1-A5. This is due to careful selection of materials, no basement, type of substructure and superstructure selection, and the use of 30% GGBS cement replacement for all superstructure elements. The proposed design does not achieve the aspirational benchmarks for Modules A1-A5. This is due to the ground conditions being unknown at this stage and these might prevent the use of cement replacements. Thus, a more conservative approach (i.e. 0%GGBS for substructure elements) was followed. The proposed design achieves both (current and aspirational) GLA Residential benchmarks for Modules B-C (excl. B6 & B7). This is due to careful selection of services, fittings and finishes that need replacement during the lifecycle of the building.

Comparison of WLC results of all buildings of the Proposed Development with the GLA WLC Benchmarks

	Modules A1-A5 Embodied carbon per GIA ($kgCO_2eq/m^2$)	Modules B – C (excluding B6 & B7) Embodied carbon per GIA ($kgCO_2eq/m^2$)
GLA Schools, Universities etc. WLC benchmark (Hospital Redevelopment)	<750	<250
GLA Schools, Universities etc. Aspirational WLC benchmark (Hospital Redevelopment)	<500	<175
Hospital Redevelopment	514.8	249.2
GLA Residential WLC benchmark (Masterplan Development)	<850	<350
GLA Residential Aspirational WLC benchmark (Masterplan Development)	<500	<300
Masterplan Development	633.3	278.4

Recommendations

Specification of low carbon and robust materials can significantly reduce the embodied carbon of the development. It is suggested that high percentage of cement replacements are used in all concrete elements and alternative framed windows, such as timber, are used instead of aluminium.

It is recommended that the possibility for sourcing lower carbon reinforcing steel within the UK is investigated. The UK CARES programme provides EPD (environmental product declaration) carbon data for low carbon reinforcing steel products that are produced via an electric arc furnace.

Refrigerants with lower GWP should be explored if feasible, but this should be considered against the energy efficiency of the heat pump system to ensure the greatest reduction in WLC in the system.

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Post-Construction WLC

A further WLC should also be completed at Post-Construction Stage, as per the GLA's Whole Life-Cycle Carbon Assessment Guidance published in March 2022. The post-construction WLC will require an update of the information provided at the planning submission stage (RIBA Stage 2/3) and for the actual WLC carbon emission figures to be reported. The WLC calculation results should be updated for all modules, based on the actual materials, products and systems used for the construction of the Proposed Development. The evidence listed below should be provided as a minimum to support the updated results:

- Site energy (including fuel) use record;
- Contractor confirmation of as-built material quantities and specifications;
- Record of material delivery including distance travelled and transportation mode (including materials for temporary works);
- Waste transportation record including waste quantity, distance travelled and transportation mode (including materials for temporary works) broken down into material categories used in the assessment; and
- a list of product-specific EPDs for the products that have been installed. The data collected at this stage will provide an evidence base that could help inform future industry-wide benchmarks or performance ratings for building typologies.

The post-construction results will need to be compared with the WLC emissions baseline reported at planning submission stage and with the WLC benchmarks. This will need to be accompanied by an explanation for the difference, including any design changes that may have impacted on the results.

A summary of the lessons learnt that will inform future projects, will also be provided. This should include what went well and what could be improved next time to achieve WLC reductions.

1. Introduction

1.1 Background

AECOM's Sustainable Development Group has been commissioned by The Hillingdon Hospitals NHS Foundation Trust (hereafter referred to as the 'Applicant') to prepare a Whole Life-Cycle Carbon Assessment (WLCA), to accompany the hybrid planning application for the Proposed Development.

The Greater London Authority (GLA) WLCA Guidance published in March 2022[1] states:

> *"WLC emissions are the total carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions - that is, emissions associated with raw material extraction, the manufacture and transport of building materials, and construction; and the emissions associated with maintenance, repair and replacement, as well as dismantling, demolition and eventual material disposal. A WLC assessment also includes an assessment of the potential savings from the reuse or recycling of components after the end of a building's useful life. It provides a true picture of a building's carbon impact on the environment."*

This document accompanies the GLA WLC Templates, which have been developed to meet the relevant planning Policy SI 2 F of the London Plan (March 2021)[2].

The scope of this report is to:

- Outline the scope of the Whole Life-Cycle Carbon Assessment;
- Outline the methodology that was followed to complete the GLA WLC Templates;
- Present and analyse the results of the WLC of the Proposed Development;
- Compare the results of the WLC with the corresponding Benchmarks that are provided in the GLA's WLCA Guidance published in March 2022.
- Provide recommendations for carbon optimisation of the design of the Proposed Development.

The document has been produced in accordance with the GLA's WLCA Guidance published in March 2022.

1.2 Policy

London Plan

The London Plan is the statutory Spatial Development Strategy for Greater London prepared by the Mayor of London ("the Mayor"). The new London Plan was adopted on 2 March 2021 and includes the following policy in relation to the WLC:

Policy SI 2 Minimising greenhouse gas emissions

> *"F. 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."*

1.3 Description of the Development

The site is located within the London Borough of Hillingdon (LBH). The site of the Proposed Development is the site of the existing Hillingdon Hospital and is located to the south of Pield Heath Road, bound by Royal Lane to the west, and Colham Green Road to the east, hereafter referred to as the 'Site'. The new hospital is located within the footprint of existing Brunel Ward.

This hybrid application comprises of a full application for the new Hillingdon Hospital and multi-storey car park and an outline application for a mixed-use development with a residential primary function.

The Hospital Redevelopment replacement hospital building has a gross internal area (GIA) of 79,603.6 m^2 across 8 storeys (including the ground floor). The western extent of the site incorporates a linked mobility hub and multi storey car park (MSCP) of 23,034 m^2 GIA for 781 car spaces. The detailed development proposal also includes the provision of public realm in the form of a large central green open space at ground level, 161 ground level car parking spaces with the ability to cater for up to 14,000 m^2 of expansion space for future hospital expansion (if required) and new

[1] https://www.london.gov.uk/sites/default/files/lpg_-_wlca_guidance.pdf

[2] https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

bus stop arrangements with improved connections to the hospital on Pield Heath Road.

The proposed hospital will predominantly be used for clinical purposes including Accident and Emergency (A&E), maternity and neonatal wards, outpatients, operating theatres, café and retail areas, facilities management, office space and plant space.

The Masterplan Development will have a residential GIA of 31,503 m^2 which comprises of 327 dwellings. Plots P01, P02 and P04 will be mixed use blocks with supporting provision of 800 m^2 of town centre uses (Use Class E – assumed GIA of 744 m^2) at ground floor level. The outline proposal also includes the provision of up to 302 car parking spaces, 515 cycle parking spaces, improved permeability and public access routes through the site and high-quality public realm with landscaped gardens throughout the site.

The proposed outline application will predominantly be residential with café and retail areas on the ground floor of each block.

Table 1. Proposed Development's gross internal area (GIA)

	GIA (m^2)
Hospital Redevelopment	102,637.6
Masterplan Development	40,463.6[3]

The document includes contributions from a number of members of the professional team. Detailed information on these aspects of the proposal can be found in the reports referenced.

Figure 1. Illustrative bird eye view of the Proposed Development

1.4 Proposed Materials

Table 2 provides an overview of the proposed materials for the substructure and superstructure of each plot of the Proposed Development. Detailed materials tables are included in the GLA Whole Life-Cycle Carbon Assessment Template.

[3] Including dwellings, landlord's areas (e.g. corridors, plant rooms etc.), café and retail areas on the ground floor of each block (see Appendix C).

Table 2. Overview of the materials for all the buildings of the Proposed Development

Building Component	Hospital building	MSCP	Masterplan Development
Substructure	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel	Reinforced concrete C32/40 Reinforcement steel Red brick Sewage water drainage piping Synthetic membrane for waterproofing Hard foam insulation
Frame	Reinforced concrete C40/50, 30% cement replacement Reinforced concrete C50/60, 30% cement replacement Reinforcement steel	Reinforced concrete C40/50, 30% cement replacement Reinforcement steel	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel
Stairs	Precast concrete	-	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel Stainless steel
Upper Floors	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel	Reinforced concrete C30/37, 30% cement replacement Reinforced concrete C50/60, 30% cement replacement Reinforcement steel	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel Aluminium ceiling system/sheet Precast concrete
Roof	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel	-	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel Precast concrete Stainless steel
External Walls	Build-ups including brick slips, GRC, Ceramic baguettes, glass spandrels Steel framework Plasterboard	Build-ups including Brick Masonry, Architectural concrete, Metal mesh, Terracotta extrusions Steel framework Plasterboard	Reinforced concrete C30/37, 30% cement replacement Reinforcement steel Aluminium composite panels Gypsum plasterboard Particleboard Red brick Steel cladding/formwork
Windows	Triple glazed with aluminium frame Triple glazed unitised or stick façade system	Triple glazed unitised or stick façade system	Aluminium frame window (double glazed)
Hard Landscaping	Concrete pavings, timber decking, vehicle and pedestrian tarmac		Clay bricks, Resin bound, Gravel, Precast concrete, Sand
Fittings and Finishes	Various fittings, electric and sanitary equipment	-	Sanitary equipment (Bathtub, ceramic sink/toilet)
Building Services	4x GSHP 8x ASHP	-	ASHP Electricity cabling

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Building Component	Hospital building	MSCP	Masterplan Development
	8X WSHP		Elevator basic component
	Heat/drinking/drainage water network		Piping/Sprinkler/Ventilation system
	Electricity cabling		
	PV panels		

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1.5 Scope

The WLC has been conducted in accordance with BS EN 15978: 2011: (Sustainability of construction works - Assessment of environmental performance of buildings — Calculation method) using the RICS Professional Statement: Whole Life Carbon assessment for the built environment (hereafter referred to as the 'RICS PS').

The WLC covers the carbon emissions of the Proposed Development over its lifetime, accounting for:

- embodied carbon emissions
- the operational carbon emissions (regulated and unregulated)
- future potential carbon emission 'benefits', post 'end of life', including benefits from reuse and recycling of building structures and materials.

The future benefits from reuse and recycling of building structure and materials are not included in the reported results of the WLC, as they are also not included in the GLA WLC benchmarks.

1.6 Life-Cycle Modules

The WLC has followed the BS EN 15978 standard over a 60-year study period, covering the entirety of modules A, B, C and D:

- Module A1 – A5 (Product sourcing and construction stage)
- Module B1 – B7 (Use stage)
- Module C1 – C4 (End of life stage)
- Module D (Benefits and loads beyond the system boundary)

Figure 2 shows the different life-cycle modules included in the WLC as well as the difference between embodied and whole life-cycle carbon.

The GLA Whole Life-Cycle Carbon Assessment Guidance published in March 2022 states that the reference study period for the WLC should be 60 years, even in instances that the design life of a building exceeds, or is less than, 60 years.

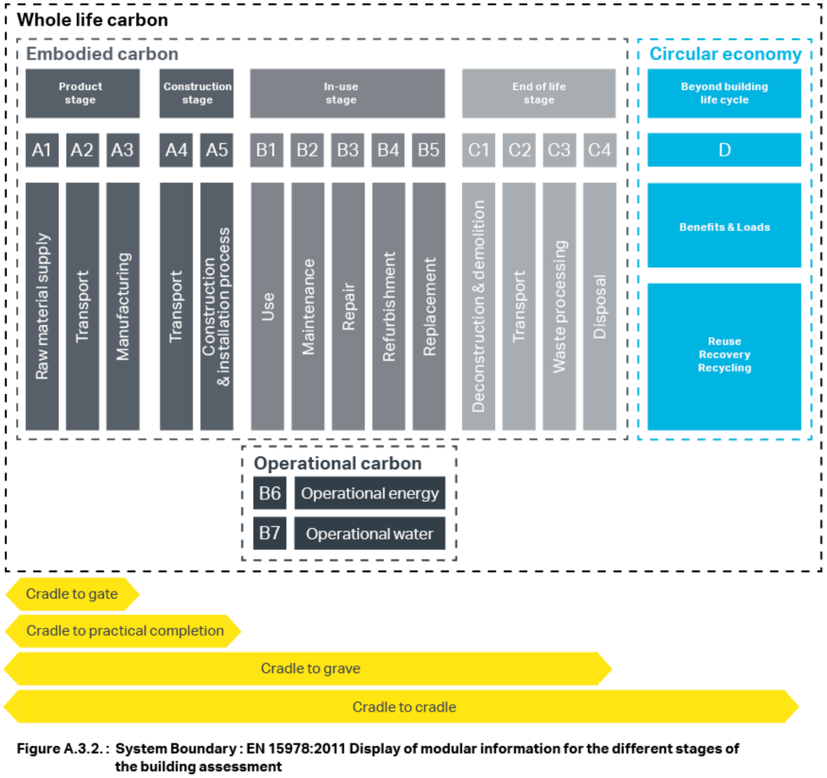

Figure 2. Whole life carbon and life-cycle modules diagram

The embodied carbon estimates from construction and materials for applicable life-cycle stages A1 – C4, otherwise known as a cradle-to-grave study, are estimated for a life cycle of 60 years. This includes embodied emissions related to the raw extraction of materials, their processing in a factory or equivalent, transport and construction on site, any replacements assumed over the study period and finally end of life disposal. Benefits and loads beyond the building life cycle, Module D, are shown in the GLA WLCA template.

The operational carbon estimate includes the carbon emissions associated with the operational energy consumption of the development. This has been calculated for a life cycle of 60 years based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project, as per the Building Regulations Part L modelling.

1.7 Building Elements

All the building elements listed in Table 3 have been included (where information was provided) in the WLC, in line with the RICS PS. The building elements are broken down according to the RICS New Rules of Measurement (NRM) classification system level 2 sub-elements.

Table 3. Building elements (RICS PS) that have been included in the WLC

Building Element Group	Building Element (NRM level 2)
Demolition	01 Toxic/hazardous/contaminated material treatment 0.2 Major demolition works
0 Facilitating works	0.3 & 0.5 Temporary/enabling works 0.4 Specialist groundworks
1.1 Substructure	1.1 Substructure
2 Superstructure	2.1 Frame 2.2 Upper floors incl. balconies 2.3 Roof 2.4 Stairs and ramps 2.5 External walls 2.6 Windows and external doors 2.7 Internal walls and partitions 2.8 Internal doors
3 Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes
4 Fittings, furnishings and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building related and non-building-related
5 Building services/MEP	5.1–5.14 Services incl. building-related* and nonbuilding-related
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units
7 Work to Existing Building	7.1 Minor demolition and alteration works
8 External works	8.1 Site preparation works 8.2 Roads, paths, paving and surfacing 8.3 Soft landscaping, planting, and irrigation systems 8.4 Fencing, railings, and walls 8.5-8.7 External fixtures, drainage, services 8.8 Minor building works and ancillary buildings

1.8 MEP Systems

The GLA WLCA guidance recognises that *"The embodied carbon emissions of MEP systems may be difficult to calculate in detail due to a lack of EPDs or other data sources. In these cases, it is recommended that applicants use the calculation methodology in CIBSE TM65 Embodied carbon in building services which provides guidance for the calculation at each life-cycle stage at product level."*

MEP systems were modelled based on the relevant GLA guidance and CIBSE TM65 guidance.

1.9 Demolition and material reuse

The GLA WLCA guidance published in March 2022 requires the assessment to:

> *"account for any carbon emissions associated with pre-construction demolition, as well as any carbon savings associated with the retention, reuse and recycling of existing structures and materials that are already on-site. Carbon emissions from pre-construction demolition should be reported… Reporting the key actions undertaken to reduce WLC emissions and the associated carbon savings, including those associated with the retention, reuse and recycling of existing structures and materials that are already on-site… To calculate the carbon emissions associated with pre-construction demolition, actual figures should be used where possible. If actual figures are not available, applicants can apply a standard assumption of 50kgCO_2e/m^2 to the GIA of the existing areas being demolished that fall within the boundary line."*

According to the Hillingdon Hospital Estate condition and survey, much of the Hillingdon Hospital site is not fit for purpose, with services scattered across the site, many in old and inappropriate facilities. 81% of the Estate, by building area, is in poor or bad condition, with key issues related to serious health and safety risks, such as failure of ventilation systems, fire spread and water leaks and water contamination. Only 8% of the Estate area is currently performing as intended. Those areas are scattered across the site, so there were no opportunities to retain existing buildings.

Pre-construction demolition emissions were calculated based on 50kgCO_2e/m^2 to the GIA of the existing areas being demolished as required by GLA WLCA guidance published in March 2022.

1.10 LCA Software and Database

The WLC has been conducted using the LCA software ‘OneClick LCA’. OneClick LCA is an industry recognised tool that produces results compliant with the international standards ISO 14044 and EN 15978 and it is certified with Quality System ISO 9001. OneClick LCA has material life-cycle inventory carbon data that is compliant with EN15804. The tool uses regionalised carbon data for the UK primarily using the Ecoinvent Database, which allows the reporting of all life-cycle modules A-D; known as ‘OneClick LCA Whole life carbon assessment, Greater London Authority’.

1.11 Operational Energy Analysis

The operational energy data has been produced by Building Regulations Part L (domestic and non-domestic) calculations. The operational energy consumption of the development has been calculated for a life cycle of 60 years (the ‘reference study period’) based on the assumption that the annual operation energy consumption will remain the same throughout the life cycle of the project, as per the Building Regulations Part L modelling.

This assessment is based on Building Regulations Part L energy calculations (i.e. BRUKL report energy estimates for Hospital Redevelopment and SAPs energy estimates for Masterplan Development). It does not include estimates from CIBSE TM54 (Evaluating Operational Energy Performance of Buildings at the Design Stage) methodology as this is not available at this stage. However, it does include estimates on unregulated energy (e.g. equipment). At the planning stage, the Building Regulations Part L modelling provide a reasonable early estimate of energy consumption for all buildings of the Proposed Development, including energy consumption for regulated and unregulated uses, as well as renewable energy generation on-site.

The outputs of the Building Regulations Part L modelling include:

- Regulated energy consumption
- Unregulated energy consumption
- Renewable electricity generated on-site (from solar photovoltaic (PV) included under regulated energy.

An overview of the regulated, unregulated and renewable of the Proposed Development is provided in Table 4.

Table 4. Overview of the Regulated and Unregulated Energy Consumption for the Hospital Redevelopment and the Masterplan Development

	Hospital Redevelopment	Masterplan Development
Regulated Consumption (kWh/year)	7,036,856.6	1,400,525.2
Unregulated Consumption (kWh/year)	9,386,946.2	1,150,210.3

1.12 Methodology

The calculation of the embodied carbon of the Proposed Development, was based on information provided by the client (The Hillingdon Hospitals NHS Foundation Trust), structural engineers (AECOM), architects (IBI Group), the quantity surveyors (Ridge and Partners), the façade engineers (AECOM) and MEP engineers (AECOM).

The embodied carbon of the materials was calculated in “OneClick LCA”, in accordance with the RICS PS. The operational carbon over a 60-year study period was added to the total embodied carbon, in order to calculate the whole life carbon of the Proposed Development. Both operational and embodied carbon were calculated using SAP10 carbon factors.

The embodied carbon results of the Hospital Redevelopment have been compared with the WLC benchmarks for Schools, Universities etc., and the results of the Masterplan Development have been compared with the WLC Residential benchmarks, provided in the GLA’s WLC Carbon Assessment Guidance published in March 2022.

Table 5. GLA Whole-life carbon benchmark targets

Benchmarks	To Practical Completion (A1-A5) $kgCO_2e/m^2$ GIA	Life Cycle 60 years + End of Life (B-C; excl. Operational) $kgCO_2e/m^2$ GIA
GLA Schools, Universities etc. WLC benchmark (Hospital Redevelopment)	<750	<250
GLA Schools, Universities etc. Aspirational WLC benchmark (Hospital Redevelopment)	<500	<175
GLA Residential WLC benchmark (Masterplan Development)	<850	<350
GLA Residential Aspirational WLC benchmark (Masterplan Development)	<500	<300

1.13 Assumptions

1.13.1 Quantities' accuracy

As per the GLA WLCA Guidance published in March 2022, for the Detailed application (Hospital Redevelopment), the total quantities for the project were used (including temporary works), as provided by the Quantity Surveyor, to inform the cost appraisal at planning application submission stage of the WLCA. This included more than 95% of the capital cost allocated to each building element category.

For the Outline application (Masterplan Development), there was no cost plan available when the modelling was undertaken and therefore, the quantities were based on information issued by the project team. Those were reviewed and cross-checked by the LCA modelling team, to ensure accuracy and robustness of the assessment. Based on information and estimates by the project team, assumptions were made with regards to some of the materials and relevant quantities, based on other projects of the same use and similar scale.

At the post-construction stage of the WLCA, the 'as built' information should be used, with quantities approved by the project Quantity Surveyor. A minimum of 95% (EN 15804) of the capital cost allocated to each building element category has been accounted for at each stage of the assessment and this should also be approved by the project Quantity Surveyor as part of the third-party review of each submission. Items excluded should each account for less than 1% of the total capital cost of that building element category.

1.13.2 Product stage (A1 – A3)

Recycled content for the steel elements is as per the RICS methodology default recommendations:

- Reinforcement steel – 97% recycled content

1.13.3 Construction process stages (A4 – A5)

Waste factors for the materials to the traditional build types have been taken from the default values provided within the software tool.

Transport distances are as per RICS methodology default figures where applicable. Where the material or building element is not included in the RICS recommendations, the default value from the dataset used has been applied.

Construction emissions have been based on carbon emissions within the LCA tool with default processes for each material/building element.

Table 6. Overview of the proposed transport distances as per RICS methodology default figures where applicable

Transport scenario	Materials	Distance	
		km by Road	km by Sea
Locally manufactured	Concrete, aggregate, earth etc.	50	-
Nationally manufactured	Plasterboard, blockwork, insulation etc.	300	-
European manufactured	CLT, façade modules, carpet etc.	1,500	-
Globally manufactured	Specialist stone cladding etc.	200	10,000

1.13.4 Use stage (B1 – B5)

1.13.4.1 Material lifespans

The in-use life stages mainly comprise of replacements to materials/building components over the 60-year study period. This is defined by the expected lifespan of each building element. Material lifespans are as per RICS methodology default figures (Table 7).

Table 7. Indicative component lifespans as per RICS professional statement and guidance document, UK 2017

Building Part	Building Element / Components	Expected Lifespan
Superstructure	Roof waterproofing	30 years
	Internal partitioning and dry lining	30 years
	Windows and external doors/Glass spandrels/ Laminate panels	30/35/10 years respectively
Finishes	Wall finishes: Plasterboard, plywood / paint, tile	30/10 years respectively
	Floor finishes: Hardwood floors / floor finishes	30/10 years respectively
	Ceiling finishes: Plasterboard / paint	30/10 years respectively
	Sanitaryware	20 years
Services	Electrical installations	30 years
	Elevator installations	20 years
	Piping and sprinkler systems	25 years
	GSHP/ASHP/WSHP	20 years
	Ventilation system	20 years
	PV panels	20 years

The maintenance emissions have been calculated based on 10 $kgCO_2e/m^2$ GIA as per GLA WLCA Guidance published in March 2022 recommendation. The repair emissions (B3) have been assumed as 25% of the total maintenance emissions (B2).

1.13.4.2 Refrigerants

The GLA WLCA Guidance published in March 2022, highlights the need to report on the environmental impact from refrigerants over the building's lifespan, due to the increasing uptake of mechanical, electrical and plumbing engineering (MEP) equipment using refrigerants, such as heat pumps.

Table 8 reports the refrigerant type, its global warming potential (GWP), initial quantity/charge, assumed annual leakage rate, and end-of-life recovery rate for all the refrigerants used in the Proposed Development.

Table 8: Refrigerants for the Proposed Development.

Refrigerant	Refrigerant GWP ($kgCO_2e/kg$)	Initial Charge (kg)	Annual leakage rate %	End of Life recovery rate %
Hospital Redevelopment - R513A	656.45	5,352	2	99
Hospital Redevelopment - R1234ze	31.01	2,400	2	99
Masterplan Development - R-410A	2,087.5	480	2	99

1.13.5 End of Life (C1 – C4) – Benefits and loads beyond the system boundary

Recycled content and recycle rates at end of life for all metals are as per RICS methodology default recommendations (Table 9). For the rest of the materials, the default values within the software tool have been used.

Table 9. Overview of the recycling rates at the end of life for steel and aluminium elements as per RICS methodology

Material	Recycling Rate

	Recovery (Reuse or Recycling)	Disposal (landfill)
Steel	96%	4%
Aluminium	96%	4%

Table 10 provides an overview of the assumption for the end-of-life scenario for different types of materials. The assumptions are based on experience and benchmarks from similar projects.

Table 10. End-of-life scenario for different types of materials of the Proposed Development

Material	End of Life Scenario	Recycling Rate
Concrete	Crushed and recycled	100%
Steel (structural, rebar, galvanised, zinc coated)	Recycled	100%
Precast concrete	Rebar separated Concrete to aggregate	2% 98%
Insulation	Landfilled	0%
Timber	Incinerated for energy	0%
Bricks and Mortar	Crushed and recycled	100%
Ceramics	Recycled	100%
Aluminium	Recycled	100%
Plasterboard	Recycled	100%
Plastics	Incineration	0%
Paints	Landfilled	0%
Glass	Recycled	80%

1.13.6 Beyond building life-cycle (D) – Circular Economy

The LCA software used, 'OneClick LCA', has default assumptions regarding the quantities of reusable and recyclable materials. The GLA WLC spreadsheet confirms the assumptions for different types of materials.

1.14 Data quality

According the GLA WLCA guidance published in March 2022, applicants and developers should adopt third-party quality assurance mechanisms to ensure accuracy in their submissions.

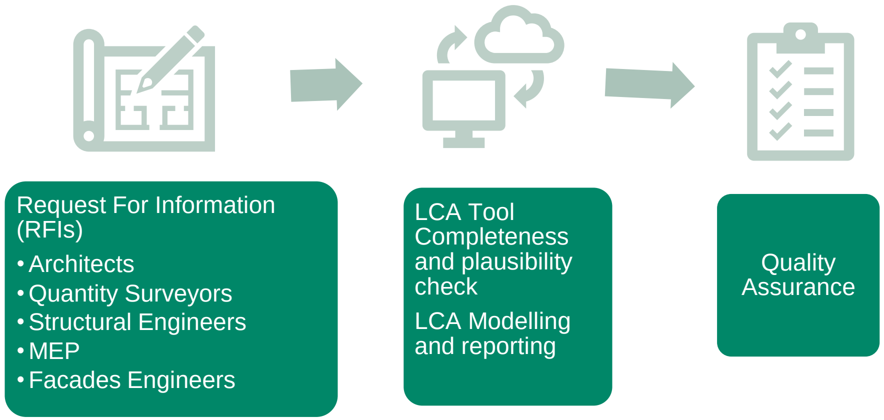

Figure 3. Process ensuring quality of the WLCA

Figure 3 presents the process used to produce the WLCA, aiming to ensure a high level of quality and accuracy. AECOM's Sustainable Development Group that was commissioned to prepare this WLCA, has requested information from multiple members of the project team, namely the architects, structural and facades engineers, the MEP team and the quantity surveyors. This enabled cross-checking figures and information using more than one sources, which improved the quality of the data used. Following completion of the WLCA using this data, the internal quality assurance process within AECOM, ensured that the WLCA and report are reviewed and verified before being issued to the applicant and submitted to the GLA.

For the post-construction assessment, allocating the team or organisation to oversee the WLC assessment, would provide consistency in reporting.

The Hillingdon Hospital Redevelopment

2. Whole Life-Cycle Carbon Assessment Results

2.1 Introduction

The purpose of this chapter is to present and analyse the results of the WLC of the Proposed Development. The results are initially presented separately for each application (detailed and outline) of the Proposed Development.

2.2 Hospital Redevelopment

Based on the information provided the overall whole life-cycle carbon of Hospital Redevelopment is 309,263,343 kgCO_2eq or 3,013 kgCO_2eq/m^2 GIA, as indicated in Table 11. The total GIA has been taken as 102,637.6 m².

Table 11. Whole Life-Cycle Carbon of Hospital Redevelopment

	GIA (m^2)	Overall Carbon (tonnes CO_2eq)	Carbon per m^2 GIA (kgCO_2eq/m^2)
WLC (A-C)	102,637.6	309,263	3,013
Embodied Carbon A1-A5		52,842	515
Embodied Carbon B-C (excluding B6-B7)		25,574	249

Table 12 shows the breakdown of the overall WLC of Hospital Redevelopment by the main life-cycle stages, over the assumed 60-year lifecycle of the Proposed Development. The total impact does not include Module D. This follows the GLA benchmarks which exclude Module D.

Table 12. Breakdown of embodied carbon of Hospital Redevelopment by life-cycle stages

Life-cycle Stage		Embodied carbon (tonnes CO_2eq)	Embodied carbon per GIA (kgCO_2eq / m^2)
Biogenic Carbon	-	-173	-2
Products	A1-A3	35,467	346
Transport	A4	8,443	82
Construction	A5	8,932	87
Recurring	B1-B5	23,195	226
Energy & Water	B6- B7	231,020	2,251
End of Life	C1-C4	2,379	23
Product Reuse	D	-49,145	-479
Total (excluding Module D and biogenic carbon)	A-C	309,436	3,015

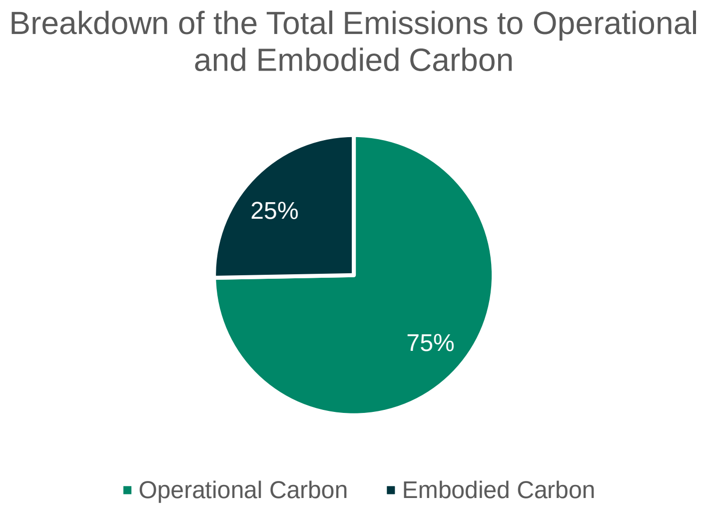

Figure 4. Breakdown of the Whole Life-Cycle Carbon of Hospital Redevelopment by operational and embodied carbon

As indicated in Figure 4, the operational carbon is responsible for 75% of the WLC carbon of Hospital Redevelopment over the 60-year study period and 25% is attributed to the embodied carbon of the building materials, facilitating works and external works.

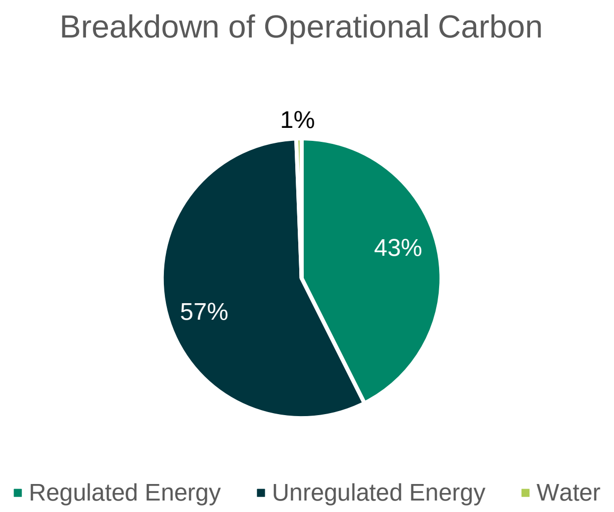

Figure 5. Breakdown of operational carbon of Hospital Redevelopment

As indicated in Figure 5, regulated energy is responsible for 43% of operational carbon and unregulated energy is responsible for 57%. Operational water accounts for the final 1% of operational energy.

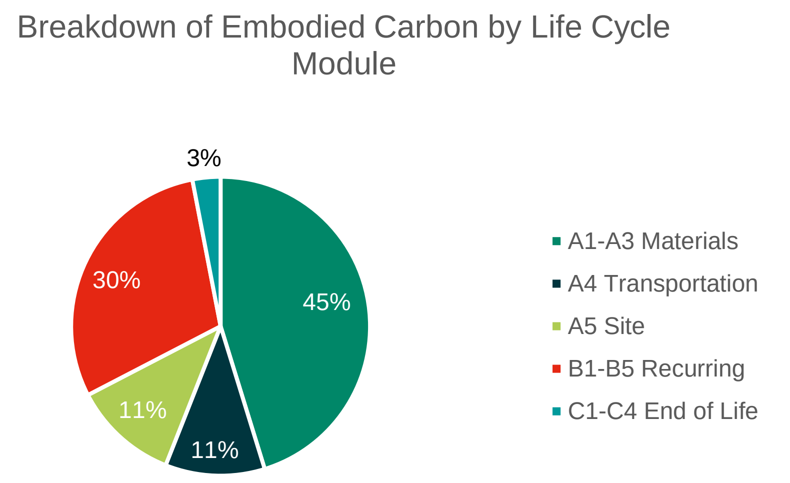

Figure 6. Breakdown of embodied carbon of Hospital Redevelopment by life-cycle module

Figure 6 shows the percentages of contribution of the different life-cycle stages to the total embodied carbon (A-C excluding B6-B7). The product stage (A1 – A3) of the building life cycle, otherwise known as the 'cradle to gate' stages (consisting of raw material extraction, transport and processing within the manufacturing of the product), is responsible for approximately 45% of the total embodied carbon. Transport and construction stages (A4 – A5) contribute around 22% of total embodied carbon. Therefore, life-cycle stages A1-A5 indicate that the embodied impact at completion of construction works accounts for 67% of the total embodied impact over the 60-year life cycle.

The embodied carbon from recurring building elements (B1-B5) contributes approximately 30% of the total embodied carbon. This is due to elements that need repairing and replacing over the 60-year life cycle of the buildings. The contribution from end of life and disposal (C1-C4) accounts for about 3% of the total embodied carbon.

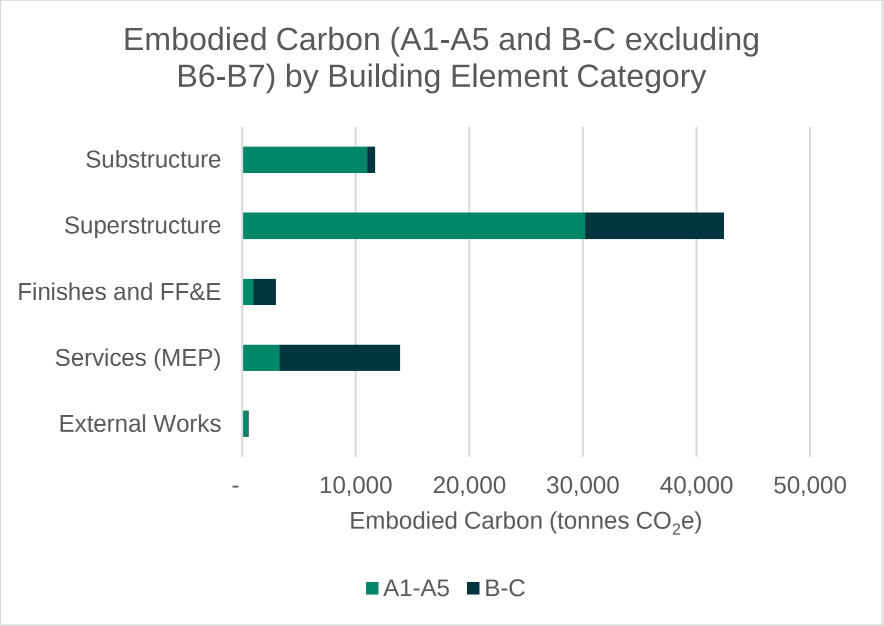

Figure 7. Breakdown of the total embodied carbon of Hospital Redevelopment by Building Element Categories

Based on Figure 7, 59% of the total embodied carbon is attributed to Superstructure, 19% to Services (MEP) and 16% to Substructure. The rest of the building categories are responsible for 6% of the total embodied carbon. For the Substructure, Superstructure and External Works categories, the highest amount of embodied carbon is attributed to Module A. However, modules B-C (excluding B6-B7) contribute to a high proportion of the embodied carbon of the Services, and the Finishes and FF&E.

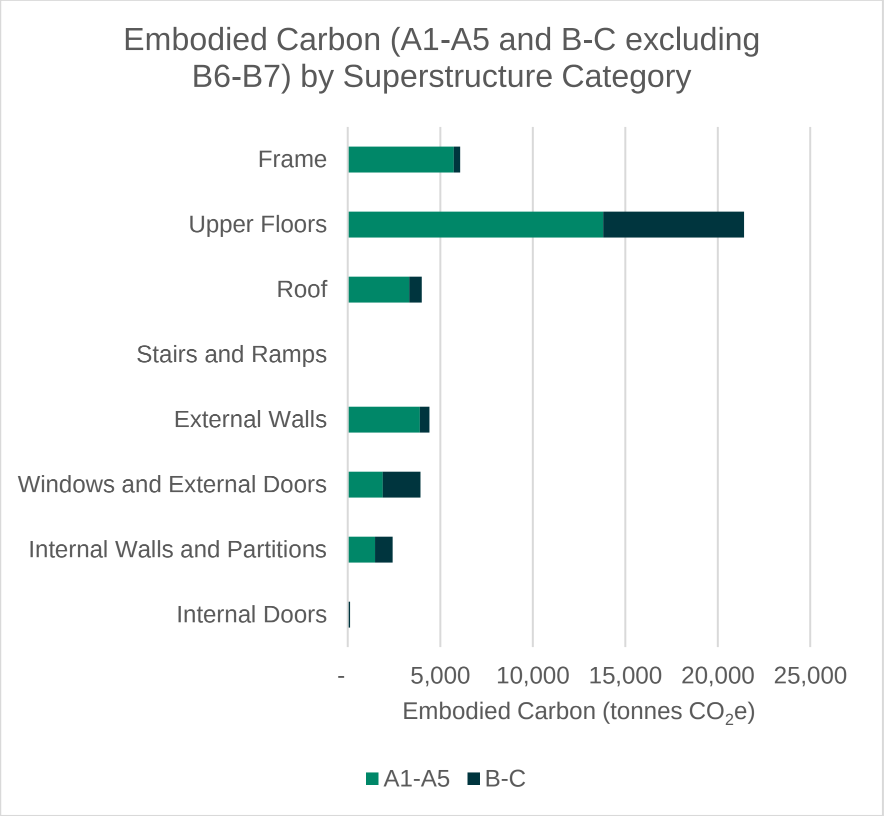

Figure 8. Breakdown of embodied carbon of Hospital Redevelopment superstructure

Figure 8 provides a further breakdown of the overall embodied carbon by superstructure category. The study demonstrates that the largest share (50%) of the embodied carbon of the superstructure of Hospital Redevelopment is attributed to the Upper Floors. The structural frame contributes to 14% of the embodied carbon of the superstructure and windows and external doors contribute to 9% of the embodied carbon of the superstructure. Therefore, large proportions of embodied carbon are attributed to concrete, steel reinforcement and glazing. The remaining superstructure categories are responsible for 27% of the superstructure's embodied carbon.

2.3 Masterplan Development

Based on the information provided the overall whole life-cycle carbon of Masterplan Development is 72,028,859 kgCO_2eq or 1,780 kgCO_2eq/m2 GIA, as indicated in Table 13. The total GIA has been taken as 40,463.627 m².

Table 13. Whole Life-Cycle Carbon of Masterplan Development

	GIA (m^2)	Overall Carbon (tonnes CO_2eq)	Carbon per m^2 GIA (kgCO_2eq/m^2)
WLC (A-C)	40,463.627	72,029	1,780
Embodied Carbon A1-A5		25,627	633
Embodied Carbon B-C (excluding B6-B7)		11,265	278

Table 14 shows the breakdown of the overall WLC of Masterplan Development by the main life-cycle stages, over the assumed 60-year lifecycle of the Proposed Development. The total impact does not include Module D. This follows the GLA benchmarks which exclude Module D.

Table 14. Breakdown of embodied carbon of Masterplan Development by life-cycle stages

Life-cycle Stage		Embodied carbon (tonnes CO_2eq)	Embodied carbon per GIA (kgCO_2eq / m^2)
Biogenic Carbon	-	-1,788	-44
Products	A1-A3	18,689	462
Transport	A4	2,940	73
Construction	A5	3,999	99
Recurring	B1-B5	8,530	211
Energy	B6- B7	36,925	913
End of Life	C1-C4	2,734	68
Product Reuse	D	-14,209	-351
Total (excluding Module D and biogenic carbon)	A-C	73,817	1,824

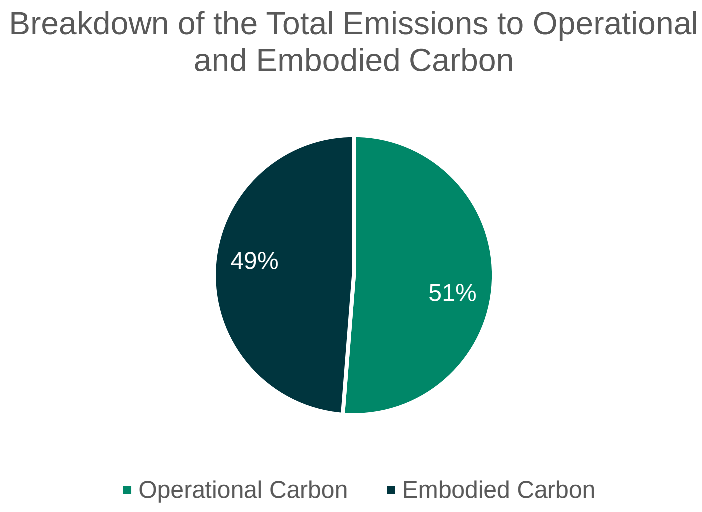

Figure 9. Breakdown of the Whole Life-Cycle Carbon of Masterplan Development by operational and embodied carbon

As indicated in Figure 9, the operational carbon is responsible for 51% of the WLC carbon of Masterplan Development over a 60-year study period and 49% is attributed to the embodied carbon of the building materials, facilitating works and external works.

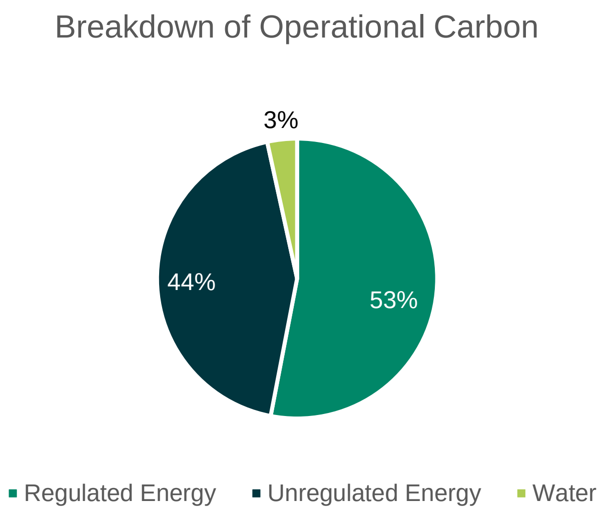

Figure 10. Breakdown of operational carbon of Masterplan Development

As indicated in Figure 10, regulated energy is responsible for 53% of operational carbon and unregulated energy is responsible for 44%. Operational water accounts for the final 3% of operational energy.

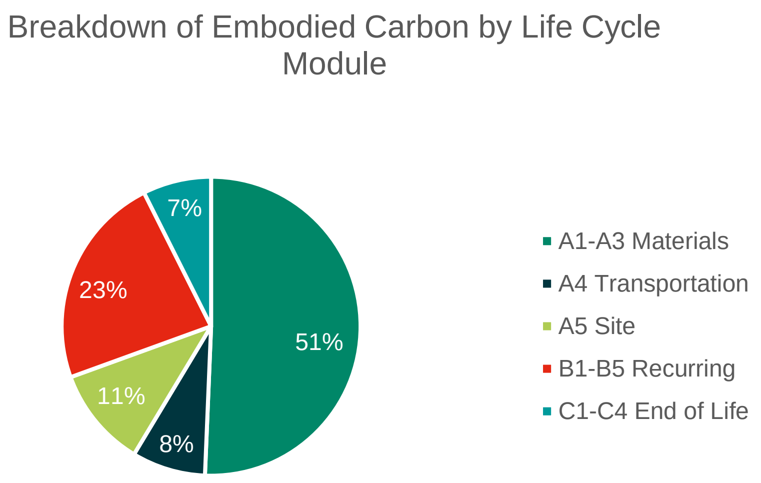

Figure 11. Breakdown of embodied carbon of Masterplan Development by life-cycle module

Figure 11 shows the percentages of contribution of the different life-cycle stages to the total embodied carbon (A-C excluding B6-B7). The product stage (A1 – A3) of the building life cycle, otherwise known as the 'cradle to gate' stages (consisting of raw material extraction, transport and processing within the manufacturing of the product), is responsible for approximately 51% of the total embodied carbon of Masterplan Development. Transport and construction stages (A4 – A5) contribute around 19% of total embodied carbon. Therefore, life-cycle stages A1-A5 indicate that the embodied impact at completion of construction works accounts for 70% of the total embodied impact over the 60-year life cycle.

The embodied carbon from recurring building elements (B1-B5) contributes approximately 23% of the total embodied carbon. This is due to elements that need repairing and replacing over the 60-year life cycle of the buildings. The contribution from end of life and disposal (C1-C4) accounts for about 7% of the total embodied carbon.

The Hillingdon Hospital Redevelopment

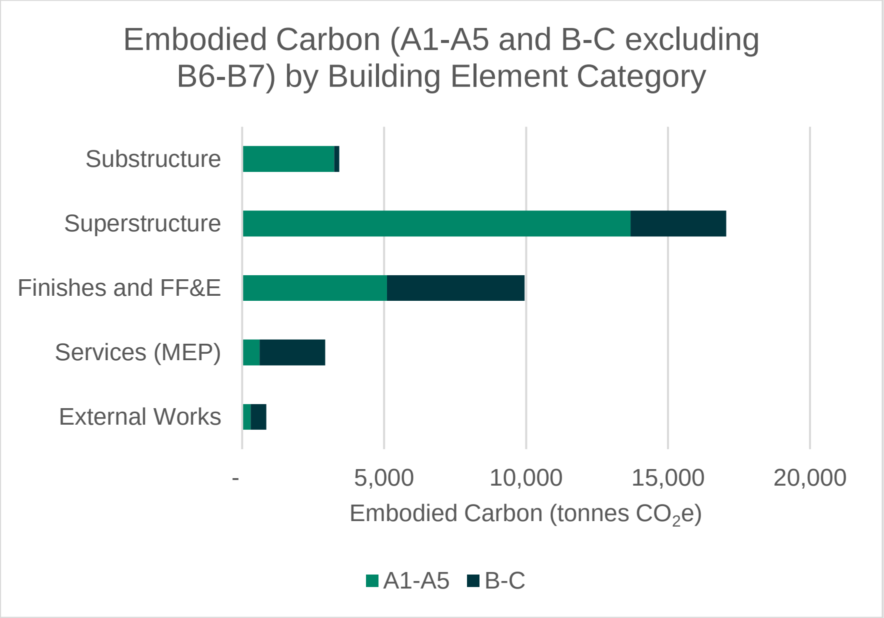

Figure 12. Breakdown of the total embodied carbon of Masterplan Development by Building Element Categories

Based on Figure 12, 50% of the total embodied carbon of Masterplan Development is attributed to Superstructure and 29% to Finishes and FF&E. The rest of the building categories are responsible for 21% of the total embodied carbon. For the substructure and superstructure the highest amount of embodied carbon is attributed to Module A. Modules B-C (excluding B6-B7) contribute to a high proportion of the embodied carbon of the services, finishes and FF&E, and external works as a result of repair and replacement rates.

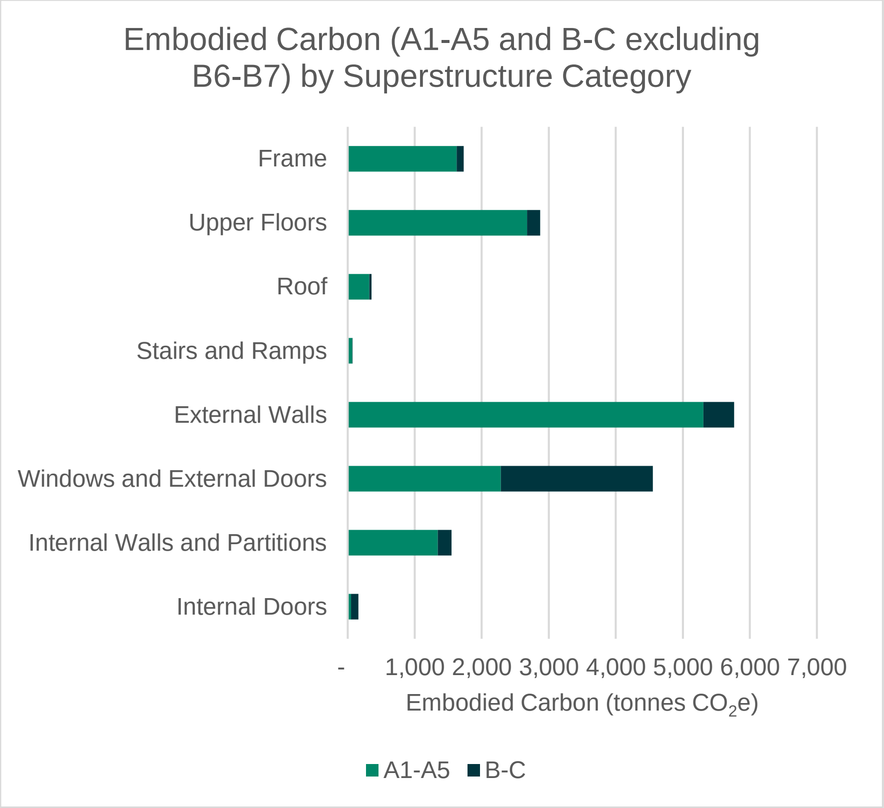

Figure 13. Breakdown of embodied carbon of Masterplan Development superstructure

Figure 13 provides a further breakdown of the overall embodied carbon of Masterplan Development by superstructure category. The study demonstrates that the largest share (34%) of the embodied carbon of the superstructure of Masterplan Development is attributed to the external walls. The windows and external doors contribute to 27% of the embodied carbon of the superstructure and the upper floors contribute to 17%. Therefore, large proportions of embodied carbon are attributed to the brick masonry, concrete and steel reinforcement. The remaining superstructure categories are responsible for 22% of the superstructure's embodied carbon.

3. Comparison of the Results with Benchmarks

According to the GLA's Whole Life-Cycle Carbon Assessment Guidance[4] published in March 2022, it is required that the results of the WLC are compared with the benchmarks provided in the same document. The embodied carbon results of the Hospital Redevelopment have been compared with the WLC benchmarks for Schools, Universities etc., and the results of the Masterplan Development have been compared with the WLC Residential benchmarks.

Table 15 provides an overview of the comparison of the results of the WLC of the Proposed Development with the relevant GLA WLC benchmarks. The GLA requires that the modelled embodied carbon of the buildings for the Modules A1-A5 and B-C are compared to the respective benchmarks separately. The operational carbon (B6-B7) is not included in the benchmarks for the Modules B-C.

The proposed design for Hospital Redevelopment achieves GLA WLC Benchmarks for Schools, Universities etc. for Modules A1-A5 and B-C. This is due to careful selection of materials, type of substructure and superstructure and the use of 30% GGBS cement replacement for all structural elements. The proposed design is close to achieve GLA WLC Aspirational benchmarks for Schools, Universities etc for Modules A1-A5 however, is not close to achieve GLA WLC Aspirational benchmarks for Modules B-C. This is due to the services, equipment, fittings and finishes that need replacement during the lifecycle of the building. GLA WLC benchmarks for Schools, Universities etc. do not reflect hospitals design and were used due to lack of relevant benchmarks. Sitting close to GLA WLC Aspirational benchmarks for Schools, Universities etc depicts an exceptional design for such a development.

The proposed design for Masterplan Development achieves GLA Residential benchmarks for Modules A1-A5. This is due to careful selection of materials, no basement, type of substructure and superstructure selection, and the use of 30% GGBS cement replacement for all superstructure elements. The proposed design does not achieve the aspirational benchmarks for Modules A1-A5. This is due to the ground conditions being unknown at this stage and these might prevent the use of cement replacements. Thus, a more conservative approach (i.e. 0% GGBS for substructure elements) was followed. The proposed design achieves both (current and aspirational) GLA Residential benchmarks for Modules B-C (excl. B6 & B7). This is due to careful selection of services, fittings and finishes that need replacement during the lifecycle of the building.

Table 15. Comparison of WLC results of all buildings of the Proposed Development with the GLA WLC Benchmarks

	Modules A1-A5 Embodied carbon per GIA ($kgCO_2eq/m^2$)	Modules B – C (excluding B6 & B7) Embodied carbon per GIA ($kgCO_2eq/ m^2$)
GLA Schools, Universities etc. WLC benchmark (Hospital Redevelopment)	<750	<250
GLA Schools, Universities etc. Aspirational WLC benchmark (Hospital Redevelopment)	<500	<175
Hospital Redevelopment	514.8	249.2
GLA Residential WLC benchmark (Masterplan Development)	<850	<350
GLA Residential Aspirational WLC benchmark (Masterplan Development)	<500	<300
Masterplan Development	633.3	278.4

[4] https://www.london.gov.uk/sites/default/files/lpg_-_wlca_guidance.pdf

4. Embodied Carbon Reduction Measures and Further Recommendations

4.1 Hospital Redevelopment

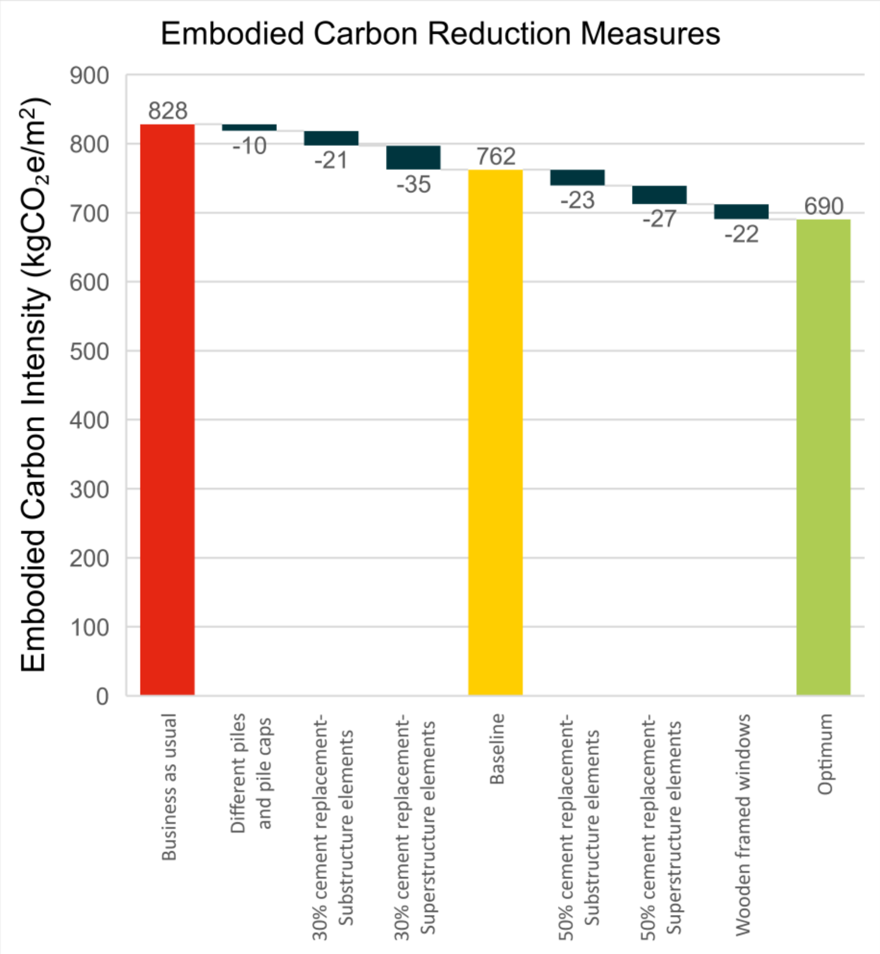

Figure 14. Embodied carbon reduction measures taken for the Hospital Redevelopment and those suggested to further reduce the embodied carbon

4.1.1 Foundations

The study demonstrates that a large proportion (16%) of the embodied carbon comes from the substructure. A change in the number and the diameter of piles and in the amount of concrete for the piles caps reduces the emissions by 10 kg CO_2eq/m^2 of GIA.

4.1.2 Cement Replacements in Concrete

The study demonstrates that a large proportion of the embodied carbon is attributed to the substructure, upper floors, and frame. The main material used for the above-mentioned elements is reinforced concrete.

While the proposed substructure and superstructure for the Hospital Redevelopment is composed of reinforced concrete with 30% cement replacement and reduces the amount of emissions by 56 kg CO_2eq/m^2 of GIA, the concrete elements should be optimised by using 50% GGBS cement replacement (where possible) to all structural and other concrete elements. The specification of 50% GGBS in all concrete elements results in a whole life carbon reduction of 50 $kgCO_2e/m^2$ GIA, as demonstrated in Figure 14.

4.1.3 Timber framed windows

The proposed window frame material for Hospital Redevelopment is aluminium. Opting for alternative window frames such as timber can reduce the whole life carbon of the Proposed Development by 22 $kgCO_2e/m^2$ GIA, as demonstrated in Figure **14**.

4.2 Masterplan Development

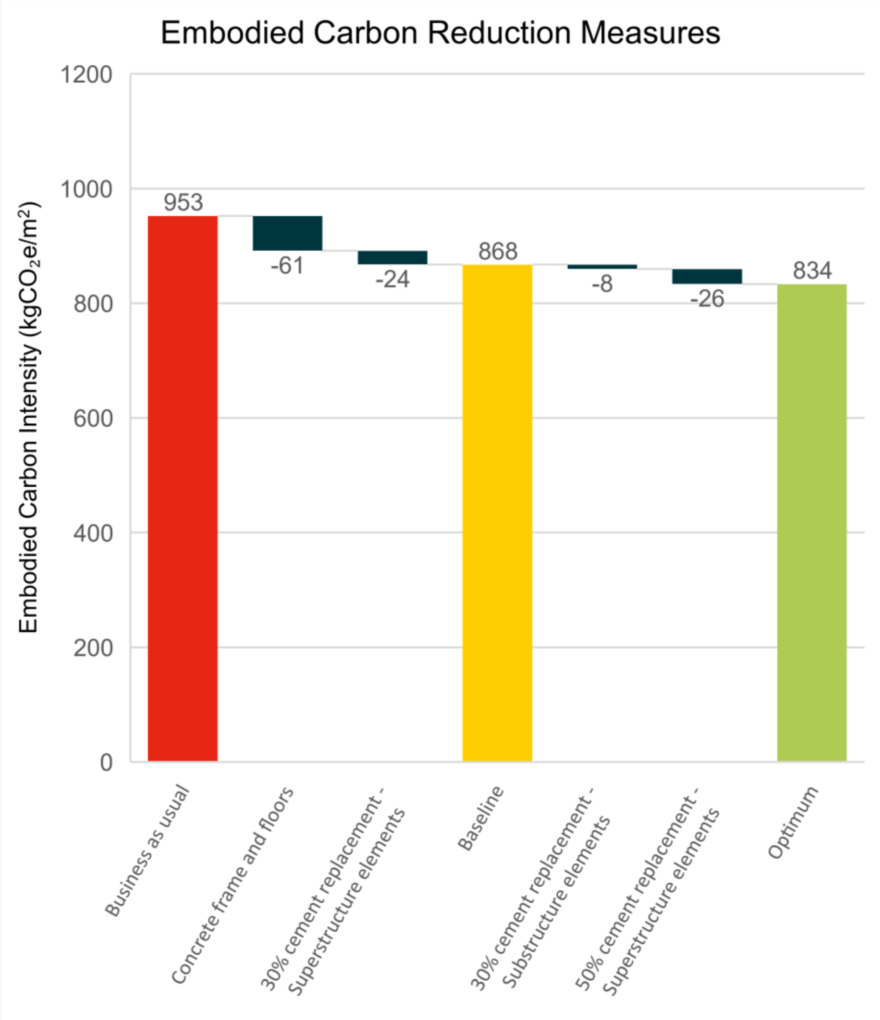

Figure 15: Embodied carbon reduction measures taken for the Masterplan Development and those suggested to further reduce the embodied carbon

4.2.1 Concrete frame

The study demonstrates that a large proportion of the embodied carbon is attributed to the substructure, upper floors and frame. The use of concrete structural frame and floors instead of steel frame and comflor reduces the emissions by 61 $kgCO_2eq/m^2$ GIA.

4.2.2 Cement Replacements in Concrete

The proposed substructure for the Masterplan Development is composed of reinforced concrete with 0% Ground Granulated Blast - furnace Slag (GGBS) cement replacement. The use of 30% GGBS cement replacement reduces the emissions by 24 $kgCO_2eq/m^2$ GIA.

It is proposed that all concrete elements should be optimised by using 30% GGBS cement replacement to the Substructure elements, and 50% GGBS cement replacement (where possible) to the Superstructure elements. These improvements would lead to a whole life carbon reduction of 34 $kgCO_2eq/m^2$ GIA, as demonstrated in Table 15.

4.3 Further Recommendations

The embodied carbon impact from the structural concrete is also attributed to the large quantities of reinforcing steel required within the structure. The current WLC has used an average carbon factor for reinforcing steel in the structural concrete elements. It is however possible to source lower carbon reinforcing steel within the UK. The UK CARES programme provides EPD (environmental product declaration) carbon data for low carbon reinforcing steel products that are produced via an electric arc furnace. This process uses electricity (some of which can be sourced from renewables) and a high recycled content of steel, compared with the more typical blast oxygen furnace process which requires the use of coal and virgin iron ore.

With the move towards decarbonisation of the electricity grid, heat pumps are becoming more commonly specified for new developments. One of the key aspects when specifying heat pumps and considering the embodied carbon impact, is the choice of refrigerant.

There is a wide range of refrigerants, many of which have a global warming potential (GWP, $kgCO_2e/kg$) that is many times greater than CO_2. The carbon impact of such refrigerants released into the atmosphere, which can occur from leakages, can be significant. Therefore, refrigerants with lower GWP should be preferred if feasible, but this should be considered against the energy efficiency of the heat pump system to ensure the greatest reduction in WLC in the system.

Table 16: Global Warming Potential of different refrigerants

Refrigerant name	Trade or common name	High-GWP?	Global Warming Potential (kgCO2e/kg)
R-744	CO_2	No	1
R-290	Propane	No	4
R-170	Ethane	No	6
R-152a	HFC-152a	No	124
R-32	HFC-32	Yes	675
R-134a	HFC-134a	Yes	1430
R-407C	HFC-407C	Yes	1774
R-22	HCFC-22, Freon	Yes	1810
R-410A	Puron, AZ-20	Yes	2088
R-125	HFC-125	Yes	3500
R-404A	HP-62	Yes	3900
R-502	-	Yes	4656.72
R-12	CFC-12	Yes	10900

The Hillingdon Hospital Redevelopment

5. Conclusion and Next Steps

This document accompanies the Greater London Authority (GLA) WLC Templates, which have been developed to meet the relevant planning Policy SI 2 F of the Publication London Plan December 2020. The report outlines the Scope of the WLC, presents and analyses the results of the WLC of the Proposed Development and compares them with the corresponding Benchmarks that are provided in the GLA's Whole Life-Cycle Carbon Assessment Guidance published in March 2022.

Based on the current assumptions, the development meets the GLA embodied carbon benchmarks for modules A1-A5 and B-C.

The overall whole life-cycle carbon of the Proposed Development over its 60-year life cycle is 309,263 tonnes CO_2eq for the Hospital Redevelopment which corresponds to 3,013 kg CO_2eq/m² GIA, and 72,029 tonnes CO_2eq for the Masterplan Development which corresponds to 1,780 kg CO_2eq/m² GIA.

For the Hospital Redevelopment, the operational carbon is responsible for 75% of the WLC, while 25% is attributed to the embodied carbon of the building materials, facilitating works and external works. The largest share of embodied carbon (i.e. excluding operational carbon B6-B7) emissions, approximately 45% of the whole, is attributed to the product stage (life cycle stages A1-A3). Transport and construction stages (A4 – A5) contribute around 22% of total embodied carbon. The embodied carbon from recurring building elements (B1-B5) contributes approximately 30% of the total embodied carbon. The superstructure is responsible for approximately 59% of the embodied carbon, while the Services (MEP) have the second highest impact accounting for 19% of the overall embodied carbon emissions.

For the Masterplan Development, the operational carbon is responsible for 51% of the WLC, while 49% is attributed to the embodied carbon of the building materials, facilitating works and external works. The largest share of embodied carbon (i.e. excluding operational carbon B6-B7) emissions, approximately 51% of the whole, is attributed to the product stage (life cycle stages A1-A3). Transport and construction stages (A4 – A5) contribute around 19% of total embodied carbon. The embodied carbon from recurring building elements (B1-B5) contributes approximately 23% of the total embodied carbon. The superstructure is responsible for approximately 50% of the embodied carbon, while the Finishes and FF&E have the second highest impact accounting for 29%.

It has been demonstrated that a large amount the embodied carbon from the Proposed Development can be attributed to the large quantities of reinforced concrete. Since no or low percentage (maximum 30%) of GGBS cement replacement is proposed for all the buildings of the Proposed Development, it is recommended that GGBS cement replacement use is optimized.

Furthermore, it has been demonstrated that a large proportion of the embodied carbon can be attributed to windows and external doors. Opting for timber framed windows instead of aluminium would reduce the whole life carbon of the Proposed Development.

The possibility for sourcing lower carbon reinforcing steel within the UK should also be investigated. The UK CARES programme provides EPD (environmental product declaration) carbon data for low carbon reinforcing steel products that are produced via an electric arc furnace.

Careful consideration of the type of refrigerant required in building services is necessary to ensure embodied carbon impacts are not adversely affected.

It is suggested that the internal finishes and fittings are sourced with environmental product declarations and compared to ensure the lowest impact possible is attributed to these elements. The use of timber in all building elements is recommended where feasible.

A further WLC should also be completed at the post-construction stage, as per the GLA's Whole Life-Cycle Carbon Assessment Guidance published in March 2022. The post-construction WLC will require an update of the information provided at this planning submission stage (RIBA Stage 2/3) and for the actual WLC carbon emission figures to be reported. The WLC calculation results should be updated for all modules, based on the actual materials, products and systems used for the construction of the Proposed Development. For example, for modules A1-A5 the actual transportation emissions from the delivery of materials, removal of waste and site work emissions.

The evidence listed below should be provided as a minimum to support the updated results:

- Site energy (including fuel) use record;
- Contractor confirmation of as-built material quantities and specifications;

- Record of material delivery including distance travelled and transportation mode (including materials for temporary works);
- Waste transportation record including waste quantity, distance travelled and transportation mode (including materials for temporary works) broken down into material categories used in the assessment; and
- A list of product-specific EPDs for the products that have been installed. The data collected at this stage will provide an evidence base that could help inform future industry-wide benchmarks or performance ratings for building typologies.

The post-construction results will need to be compared with the WLC emissions baseline reported at planning submission stage and with the WLC benchmarks. This will need to be accompanied by an explanation for the difference, including any design changes that may have impacted on the results.

A summary of the lessons learnt that will inform future projects, will also be provided. This should include what went well and what could be improved next time to achieve WLC reductions.

Appendix A Bill of Materials

A.1 Hospital Redevelopment

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
	Note/example	Breakdown of material type in each category [Insert more lines if needed] e.g. Concrete	65000 kg	For all primary building systems (structure, substructure, envelope, MEP services, internal finishes) including assumed material/product lifespans and annual maintenance/repair %	Declare 'end of life' scenario as per project's Circular Economy Statement, and used in the WLC assessment to produce Module C results	0 kg	25 kg
		e.g. Reinforcement	5000 kg			2 kg	8 kg
		e.g. Formwork	250 kg			0 kg	0 kg
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment		0 kg			0 kg	0 kg
0.2	Major Demolition Works		0 kg			0 kg	0 kg
0.3	Temporary Support to Adjacent Structures		0 kg			0 kg	0 kg
0.4	Specialist Ground Works		0 kg			0 kg	0 kg
1	Substructure	Redevelopment - Concrete C30/37 (30% recycled binders	62,990,952 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	62,990,952 kg
		Redevelopment - Reinforcement steel	3,700,558 kg	Lifespan as building	Steel recycling	0 kg	3,700,558 kg
		Redevelopment - Aggregate (crushed gravel)	1,292,475 kg	Lifespan as building	Reuse as material	1,292,475 kg	0 kg
		Redevelopment - Excavation works (removed mass)	51,355,040 kg	Lifespan as building	Reuse as material	51,355,040 kg	0 kg
2.1	Superstructure: Frame	Redevelopment - Concrete C40 (30% GGBS)	21,396,000 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	21,396,000 kg
		Redevelopment - Concrete C50/60 (30% GGBS)	8,006,400 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	8,006,400 kg
		Redevelopment - Reinforcement steel	2,328,250 kg	Lifespan as building	Steel recycling	0 kg	2,328,250 kg
2.2	Superstructure: Upper Floors	Redevelopment - Concrete C30/37 (30% recycled binders	56,670,072 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	56,670,072 kg
		Redevelopment - Concrete C50/60 (30% GGBS)	8,640,000 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	8,640,000 kg
		Redevelopment - Reinforcement steel	5,826,568 kg	Lifespan as building	Steel recycling	0 kg	5,826,568 kg
		Redevelopment - Polyurethane self-leveling flooring	107,108 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Paint coating primer	8,273 kg	Lifespan 10 years	Landfilling (for inert materials)	0 kg	0 kg
		Redevelopment - Leveling screed	8,805,303 kg	Lifespan 30 years	Cement/mortar use in a backfill	8,805,303 kg	0 kg
		Redevelopment - Vinyl (PVC) floor covering	258,980 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
2.3	Superstructure: Roof	Redevelopment - Sand	2,410 kg	Lifespan as building	Reuse as material	2,410 kg	0 kg
		Redevelopment - Rubber floor covering	1,151 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Wood slats	7,189 kg	Lifespan as building	Wood incineration	0 kg	0 kg

		Redevelopment - Resin bound	61,565 kg	Lifespan as building	Asphalt reuse via reprocessing	61,565 kg	0 kg
		Redevelopment - Polyurethane self-leveling flooring	9,864 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Precast concrete paving tiles/slabs	251,466 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	5,029 kg	246,436 kg
		Redevelopment - Soil	701,280 kg	Lifespan as building	Reuse as material	701,280 kg	0 kg
		Redevelopment - Geotextile	1,594 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Drainage mat	382 kg	Lifespan 30 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Bitumen-polymer waterproofing membra	190,482 kg	Lifespan 30 years	Landfilling	0 kg	0 kg
		Redevelopment - Cellular glass insulation	366,823 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Redevelopment - Bitumen primer	5,313 kg	Lifespan 30 years	Bitumen membrane recycling	0 kg	5,313 kg
		Redevelopment - Aggregate (crushed gravel)	763,072 kg	Lifespan as building	Reuse as material	763,072 kg	0 kg
		Redevelopment - Concrete C30/37 (30% recycled binders	9,539,400 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	9,539,400 kg
		Redevelopment - Reinforcement steel	993,688 kg	Lifespan as building	Steel recycling	0 kg	993,688 kg
2.4	Superstructure: Stairs and Ramps	Redevelopment - Precast concrete part, staircase	133,620 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	2,672 kg	130,948 kg
2.5	Superstructure: External Walls	Redevelopment - Aluminium profiled sheets	4,449 kg	Lifespan as building	Aluminium recycling	0 kg	4,449 kg
		Redevelopment - Aluminium composite panels	455,682 kg	Lifespan as building	Aluminium recycling	0 kg	455,682 kg
		Redevelopment - Red brick	527,324 kg	Lifespan as building	Brick/stone crushed to aggregate	0 kg	527,324 kg
		Redevelopment - Rock wool insulation	302,268 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Redevelopment - Float glass	1,806 kg	Lifespan 35 years	Glass recycling	0 kg	1,806 kg
		Redevelopment - Terracotta	43,509 kg	Lifespan as building	Brick/stone crushed to aggregate	0 kg	43,509 kg
		Redevelopment - Precast concrete cladding	271,890 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	5,438 kg	266,452 kg
		Redevelopment - Concrete facade elements (glassfibre re	339,607 kg	Lifespan 30 years	Concrete crushed to aggregate	0 kg	339,607 kg
		Redevelopment - Precast concrete block	209,712 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	209,712 kg
		Redevelopment - Precast concrete external wall	2,359,153 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	47,183 kg	2,311,970 kg
		Redevelopment - Brick-faced concrete cladding	975,802 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	19,516 kg	956,286 kg
		Redevelopment - Steel stud	31,910 kg	Lifespan as building	Steel recycling	0 kg	31,910 kg
		Redevelopment - Gypsum plasterboard	394,643 kg	Lifespan 30 years	Gypsum recycling	0 kg	394,643 kg
2.6	Superstructure: Windows and External Doors	Redevelopment - Curtan wall (triple glazing)	86,308 kg	Lifespan 35 years	Glass recycling	0 kg	86,308 kg

		Redevelopment - Float glass	16,402 kg	Lifespan 35 years	Glass recycling	0 kg	16,402 kg
		Redevelopment - Rock wool insulation	9,431 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Redevelopment - Aluminium profile sheet	2,378 kg	Lifespan as building	Aluminium recycling	0 kg	2,378 kg
		Redevelopment - Decorative laminate	14,437 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Aluminium framed door	4,752 kg	Lifespan 30 years	Glass-containing product recycling (80 % glass)	0 kg	3,802 kg
		Redevelopment - Triple glazed windows (aluminium frame)	172,876 kg	Lifespan 30 years	Glass-containing product recycling (80 % glass)	0 kg	138,301 kg
2.7	Superstructure: Internal Walls and Partitions	Redevelopment - Gypsum plasterboard	4,911,977 kg	Lifespan 30 years	Gypsum recycling	0 kg	4,911,977 kg
		Redevelopment - Steel stud	165,487 kg	Lifespan as building	Steel recycling	0 kg	165,487 kg
2.8	Superstructure: Internal Doors	Redevelopment - Wooden door	31,535 kg	Lifespan 30 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
3	Finishes	Redevelopment - Emulsion paint	34,610 kg	Lifespan 10 years	Landfilling (for inert materials)	0 kg	0 kg
		Redevelopment - Steel stud	115,784 kg	Lifespan as building	Steel recycling	0 kg	115,784 kg
		Redevelopment - Gypsum plasterboard	715,979 kg	Lifespan 30 years	Gypsum recycling	0 kg	715,979 kg
4	Fittings, furnishings & equipment (FFE)	Redevelopment - Cabinet	122,344 kg	Lifespan 10 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
		Redevelopment - Wooden shelf	44,806 kg	Lifespan 10 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
		Redevelopment - Alarm unit	20 kg	Lifespan 30 years	Metal-containing product recycling (90 % metal)	0 kg	18 kg
		Redevelopment - Bell	3 kg	Lifespan 30 years	Metal-containing product recycling (90 % metal)	0 kg	3 kg
		Redevelopment - Seat (stadium type)	3,576 kg	Lifespan 10 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
		Redevelopment - Workbench	49,843 kg	Lifespan 10 years	Wood-containing product incineration (80% wood)	0 kg	0 kg
		Redevelopment - Mirror (glass)	11,863 kg	Lifespan 35 years	Glass recycling	0 kg	11,863 kg
5	Services (MEP)	Redevelopment - Sewage water drainage piping network	16,422 kg	Lifespan 25 years	Plastic-based material incineration	0 kg	0 kg
		Redevelopment - Drinking water supply piping network	7,852 kg	Lifespan 25 years	Metal-containing product recycling (90 % metal)	0 kg	7,067 kg
		Redevelopment - Heat distribution piping network	14,750 kg	Lifespan 25 years	Metal-containing product recycling (90 % metal)	0 kg	13,275 kg
		Redevelopment - Geothermal heat pump	33,132 kg	Lifespan 20 years	Metal-containing product recycling (90 % metal)	0 kg	29,819 kg
		Redevelopment - Water heat pump	50,997 kg	Lifespan 20 years	Metal-containing product recycling (90 % metal)	0 kg	45,897 kg
		Redevelopment - Air/air heat pump	82,232 kg	Lifespan 20 years	Metal-containing product recycling (90 % metal)	0 kg	74,009 kg
		Redevelopment - Electricity cabling	231,961 kg	Lifespan 25 years	Metal-containing product recycling (90 % metal)	0 kg	208,765 kg
		Redevelopment - Photovoltaic panels	9,095 kg	Lifespan 25 years	Metal-containing product recycling (90 % metal)	0 kg	8,185 kg

		Redevelopment - Acrylic bathtub	10,400 kg	Lifespan 20 years	Landfilling		0 kg	0 kg
		Redevelopment - Porcelain sink	56,355 kg	Lifespan 20 years	Landfilling		0 kg	0 kg
		Redevelopment - Ceramic toilet	32,104 kg	Lifespan 20 years	Landfilling		0 kg	0 kg
		Redevelopment - Ceramic cistern	9,002 kg	Lifespan 20 years	Landfilling		0 kg	0 kg
		Redevelopment - Thermostat	14 kg	Lifespan 20 years	Metal-containing product recycling (90 % metal)		0 kg	13 kg
		Redevelopment - Brass tap	670 kg	Lifespan 25 years	Metal-containing product recycling (90 % metal)		0 kg	603 kg
		Redevelopment - Reinforced marker sign	73 kg	Lifespan 15 years	Landfilling		0 kg	0 kg
		Redevelopment - Luminescent ceiling light	5,554 kg	Lifespan 15 years	Landfilling		0 kg	0 kg
		Redevelopment - Emergency boxes	21 kg	Lifespan 15 years	Metal-containing product recycling (90 % metal)		0 kg	19 kg
		Redevelopment - Dishwasher	4,438 kg	Lifespan 20 years	Metal-containing product recycling (90 % metal)		0 kg	3,994 kg
		Redevelopment - Push button	68 kg	Lifespan 30 years	Metal-containing product recycling (90 % metal)		0 kg	62 kg
		Redevelopment - Electrical switches	699 kg	Lifespan 30 years	Metal-containing product recycling (90 % metal)		0 kg	629 kg
		Redevelopment - Electric socket	3,667 kg	Lifespan 30 years	Metal-containing product recycling (90 % metal)		0 kg	3,300 kg
6	Prefabricated Buildings and Building Units		0 kg				0 kg	0 kg
7	Work to Existing Building		0 kg				0 kg	0 kg
8	External works	Redevelopment - Aggregate (crushed gravel)	9,237,782 kg	Lifespan as building	Reuse as material		9,237,782 kg	0 kg
		Redevelopment - Asphalt supporting layer	3,633,124 kg	Lifespan as building	Asphalt reuse via reprocessing		0 kg	3,633,124 kg
		Redevelopment - Asphalt surface layer	797,052 kg	Lifespan as building	Asphalt reuse via reprocessing		0 kg	797,052 kg
		Redevelopment - Sand	237,262 kg	Lifespan as building	Reuse as material		237,262 kg	0 kg
		Redevelopment - Wood slats	7,530 kg	Lifespan as building	Wood incineration		0 kg	0 kg
		Precast concrete blocks	645,760 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate		12,915 kg	632,845 kg
Refrigerants		**Refrigerant name**	**Initial Charge(kg)**	**Annual leakage rate %**	**Refrigerant GWP ($kgCO_2e/kg$)**	**End of Life recovery rate %**		
a	Refrigerants Type 1 (if applicable) - please see CIBSE TM65 for methodology	Redevelopment - R513A	5,352 kg	2	656.45	99		
b	Refrigerants Type 2 (if applicable) - please see CIBSE TM65 for methodology	Redevelopment - R1234ze	2,400 kg	2	31.01	99		
c	Refrigerants Type 3 (if applicable) - please see CIBSE TM65 for methodology		0 kg					
		TOTAL	271,983,207 kg				72,548,944 kg	197,644,891 kg
		Material intensity (kg/m2 GIA)	2,650 kg/m2 GIA				707 kg/m2 GIA	1,926 kg/m2 GIA

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A.2 Masterplan Development

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
Note/example		Breakdown of material type in each category [Insert more lines if needed] e.g. Concrete	65000 kg	For all primary building systems (structure, substructure, envelope, MEP services, internal finishes) including assumed material/product lifespans and annual maintenance/repair %	Declare 'end of life' scenario as per project's Circular Economy Statement, and used in the WLC assessment to produce Module C results	0 kg	25 kg
		e.g. Reinforcement	5000 kg			2 kg	8 kg
		e.g. Formwork	250 kg			0 kg	0 kg
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment		0 kg			0 kg	0 kg
0.2	Major Demolition Works		0 kg			0 kg	0 kg
0.3	Temporary Support to Adjacent Structures		0 kg			0 kg	0 kg
0.4	Specialist Ground Works		0 kg			0 kg	0 kg
1	Substructure	Masterplan - Hard foam insulation	7,725 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Masterplan - Concrete C32/40 (0% GGBS)	18,111,120 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	18,111,120 kg
		Masterplan - Red brick	58,830 kg	Lifespan as building	Brick/stone crushed to aggregate	0 kg	58,830 kg
		Masterplan - Reinforcement steel	773,762 kg	Lifespan as building	Steel recycling	0 kg	773,762 kg
		Masterplan - Sewage water drainage piping	770 kg	Lifespan as building	Metal-containing product recycling (90% metal)	0 kg	693 kg
		Masterplan - Synthetic membrane for waterproofing	8,184 kg	Lifespan as building	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Excavation works (removed masses)	7,887,387 kg	Lifespan as building	Reuse as material	7,887,387 kg	0 kg
2.1	Superstructure: Frame	Masterplan - Concrete C30/37 (30% recycled binder	10,344,624 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	10,344,624 kg
		Masterplan - Reinforcement steel	868,752 kg	Lifespan as building	Steel recycling	0 kg	868,752 kg
2.2	Superstructure: Upper Floors	Masterplan - Aluminium sheet	3,774 kg	Lifespan as building	Aluminium recycling	0 kg	3,774 kg
		Masterplan - Precast concrete	1,257,438 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	25,149 kg	1,232,290 kg
		Masterplan - Concrete C30/37 (30% recycled binder	19,843,080 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	19,843,080 kg
		Masterplan - Reinforcement steel	604,718 kg	Lifespan as building	Steel recycling	0 kg	604,718 kg
		Masterplan - Stainless steel	1,995 kg	Lifespan as building	Stainless steel recycling	0 kg	1,995 kg
		Masterplan - Aluminium ceiling system	1,965 kg	Lifespan 30 years	Aluminium recycling	0 kg	1,965 kg

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2.3	Superstructure: Roof	Masterplan - Waterproofing system	22,715 kg	Lifespan 30 years	Landfilling	0 kg	0 kg
		Masterplan - Mineral wool insulation	121,092 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Masterplan - Precast concrete paving	16,939 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate	339 kg	16,600 kg
		Masterplan - Concrete C30/37 (30% recycled binder	899,136 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	899,136 kg
		Masterplan - Reinforcement steel	18,732 kg	Lifespan as building	Steel recycling	0 kg	18,732 kg
		Masterplan - Stainless steel handrail	881kg	Lifespan as building	Stainless steel recycling	0 kg	881kg
2.4	Superstructure: Stairs and Ramps	Masterplan - Concrete C30/37 (30% recycled binder	426,816 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	426,816 kg
		Masterplan - Reinforcement steel	17,784 kg	Lifespan as building	Steel recycling	0 kg	17,784 kg
		Masterplan - Stainless steel handrail	1,336 kg	Lifespan as building	Stainless steel recycling	0 kg	1,336 kg
2.5	Superstructure: External Walls	Masterplan - Aluminium composite panels	9,540 kg	Lifespan as building	Aluminium recycling	0 kg	9,540 kg
		Masterplan - Gypsum plasterboard	296,988 kg	Lifespan 30 years	Gypsum recycling	0 kg	296,988 kg
		Masterplan - Gypframe	512,334 kg	Lifespan as building	Steel recycling	0 kg	512,334 kg
		Masterplan - Particleboard	135,757 kg	Lifespan 30 years	Wood incineration	0 kg	0 kg
		Masterplan - Concrete C30/37 (30% recycled binder	520,128 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	520,128 kg
		Masterplan - Red brick	2,515,601kg	Lifespan as building	Brick/stone crushed to aggregate	0 kg	2,515,601kg
		Masterplan - Reinforcement steel	32,505 kg	Lifespan as building	Steel recycling	0 kg	32,505 kg
		Masterplan - Rock wool insulation	591,020 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Masterplan - Stainless steel sheet	123,931kg	Lifespan as building	Stainless steel recycling	0 kg	123,931kg
		Masterplan - Steel cladding	1,002 kg	Lifespan as building	Steel recycling	0 kg	1,002 kg
		Masterplan - Steel formwork	570,166 kg	Lifespan as building	Steel recycling	0 kg	570,166 kg
2.6	Superstructure: Windows and External Doors	Masterplan - Aluminium frame window	2,072 kg	Lifespan 30 years	Glass-containing product recycling (80% glass)	0 kg	1,657 kg
		Masterplan - Aluminium frame window, double glaze	187,403 kg	Lifespan 30 years	Glass-containing product recycling (80% glass)	0 kg	149,922 kg
		Masterplan - Fire resistant door	94,138 kg	Lifespan 30 years	Glass-containing product recycling (80% glass)	0 kg	75,310 kg
		Masterplan - Wooden door leaf	24,494 kg	Lifespan 30 years	Wood-containing product incineration	0 kg	0 kg
		Masterplan - Wooden door	3,445 kg	Lifespan 30 years	Wood-containing product incineration	0 kg	0 kg
2.7	Superstructure: Internal Walls and Partitions	Masterplan - Concrete block wall	492,019 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	492,019 kg
		Masterplan - Concrete block wall	5,667,676 kg	Lifespan as building	Concrete crushed to aggregate	0 kg	5,667,676 kg

		Masterplan - Glass wool insulation panels	81,058 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Masterplan - Gypsum plasterboard	103,955 kg	Lifespan 30 years	Gypsum recycling	0 kg	103,955 kg
		Masterplan - Plasterboard	648,461 kg	Lifespan 30 years	Gypsum recycling	0 kg	648,461 kg
		Masterplan - Rock wool insulation	7,467 kg	Lifespan as building	Landfilling	0 kg	0 kg
2.8	Superstructure: Internal Doors	Masterplan - Interior wooden door	37,082 kg	Lifespan 30 years	Wood-containing product incineration	0 kg	0 kg
		Masterplan - Steel door	56 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)	0 kg	50 kg
3	Finishes	Masterplan - Aluminium sheet	339 kg	Lifespan as building	Aluminium recycling	0 kg	339 kg
		Masterplan - Carpet tiles	8,075 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Cellular glass insulation panels	537,206 kg	Lifespan as building	Landfilling	0 kg	0 kg
		Masterplan - Ceramic tiles	27,964 kg	Lifespan 10 years	Brick/stone crushed to aggregate	0 kg	27,964 kg
		Masterplan - Laminate flooring	205,526 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Emulsion matt paint	9,467 kg	Lifespan 10 years	Landfilling	0 kg	0 kg
		Masterplan - Epoxy flooring system	586 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Expanded vinyl	6,714 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Screed	7,604 kg	Lifespan 30 years	Cement/mortar use in a backfill	0 kg	7,604 kg
		Masterplan - Foam backed vinyl	244 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Gypsum plasterboard for ceiling	231,979 kg	Lifespan 30 years	Gypsum recycling	0 kg	231,979 kg
		Masterplan - Gypsum plasterboard	213,670 kg	Lifespan 30 years	Gypsum recycling	0 kg	213,670 kg
		Masterplan - MDF plinth	12,892 kg	Lifespan 30 years	Wood incineration	0 kg	0 kg
		Masterplan - MDF	3,057 kg	Lifespan 30 years	Wood incineration	0 kg	0 kg
		Masterplan - Carpet underlay	24,805 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
		Masterplan - Acrylic eggshell paint	9,672 kg	Lifespan 10 years	Landfilling	0 kg	0 kg
		Masterplan - Plywood	84,194 kg	Lifespan 30 years	Wood incineration	0 kg	0 kg
		Masterplan - Solid wood flooring	602,050 kg	Lifespan as building	Wood incineration	0 kg	0 kg
		Masterplan - Vinyl floor covering	24 kg	Lifespan 10 years	Plastic-based material incineration	0 kg	0 kg
4	Fittings, furnishings & equipment (FFE)	Masterplan - Bathtub	9,069 kg	Lifespan 20 years	Landfilling	0 kg	0 kg
		Masterplan - Ceramic sink	13,395 kg	Lifespan 20 years	Landfilling	0 kg	0 kg

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		Masterplan - Ceramic toilet	13,936 kg	Lifespan 20 years	Landfilling		0 kg	0 kg
5	Services (MEP)	Masterplan - Electricity cabling	83,018 kg	Lifespan 30 years	Metal-containing product recycling (90% metal)		0 kg	74,717 kg
		Masterplan - Elevator basic component	2,331 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)		0 kg	2,098 kg
		Masterplan - Air source heat pump	4,866 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)		0 kg	4,380 kg
		Masterplan - Piping system	4,775 kg	Lifespan 25 years	Landfilling		0 kg	0 kg
		Masterplan - Sprinkler system	46,285 kg	Lifespan 25 years	Landfilling		0 kg	0 kg
		Masterplan - Ventilation system	23,142 kg	Lifespan 20 years	Metal-containing product recycling (90% metal)		0 kg	20,828 kg
6	Prefabricated Buildings and Building Units		0 kg				0 kg	0 kg
7	Work to Existing Building		0 kg				0 kg	0 kg
8	External works	Masterplan - Clay bricks	217,744 kg	Lifespan as building	Brick/stone crushed to aggregate		0 kg	217,744 kg
		Masterplan - Resin	53,677 kg	Lifespan 10 years	Landfilling		0 kg	0 kg
		Masterplan - Gravel	227,937 kg	Lifespan as building	Reuse as material		227,937 kg	0 kg
		Masterplan - Precast concrete paving	108,100 kg	Lifespan as building	Rebar separated (2%), concrete to aggregate		2,162 kg	105,938 kg
		Masterplan - Concrete C32/40 (0% GGBS)	344,861kg	Lifespan as building	Concrete crushed to aggregate		0 kg	344,861kg
		Masterplan - Sand	139,791kg	Lifespan as building	Reuse as material		139,791kg	0 kg
Refrigerants		**Refrigerant name**	**Initial quantity/charge (kg)**	**Assumed annual leakage rate %**	**Refrigerant GWP ($kgCO_2e/kg$)**	**End of Life recovery rate %**		
a	Refrigerants Type 1 (if applicable) - please see CIBSE TM65 for methodology	Masterplan - R-410A	480 kg	2	2087.5	99		
b	Refrigerants Type 2 (if applicable) - please see CIBSE TM65 for methodology		0 kg					
c	Refrigerants Type 3 (if applicable) - please see CIBSE TM65 for methodology		0 kg					
		TOTAL	77,237,327 kg				8,282,765 kg	66,200,254 kg
		Material intensity (kg/m2 GIA)	1,909 kg/m2 GIA				205 kg/m2 GIA	1,636 kg/m2 GIA

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Appendix B Assessment Results – GLA WLC Spreadsheet

B.1 Hospital Redevelopment

GWP POTENTIAL FOR ALL LIFE-CYCLE MODULES ($kgCO_2e$) (See Note 1 below if you entered a reference study period in cell C12)		Sequestered (or biogenic) carbon (negative value) ($kgCO_2e$)	Product stage ($kgCO_2e$)	Construction process stage ($kgCO_2e$)		Use stage ($kgCO_2e$)								End of Life (EoL) stage ($kgCO_2e$)				TOTAL Modules A-C $kgCO_2e$	Benefits and loads beyond the system boundary ($kgCO_2e$)
			Module A			Module B								Module C					Module D
Building element category			[A1] to [A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[B6]		[B7]	[C1]	[C2]	[C3]	[C4]		
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment													[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
0.2	Major Demolition Works													[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
0.3	Temporary Support to Adjacent Structures	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
0.4	Specialist Ground Works	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
0.5	Temporary Diversion Works	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
1	**Substructure**	0 kg CO2e	8,055,650 kg CO2e	2,511,524 kg CO2e	440,288 kg CO2e	0 kg CO2e	245,528 kg CO2e	61,382 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	353,666 kg CO2e	33,106 kg CO2e	0 kg CO2e	11,701,145 kg CO2e	-10,273,546 kg CO2e
2.1	Superstructure: Frame	0 kg CO2e	4,429,835 kg CO2e	1,055,771 kg CO2e	243,581 kg CO2e	0 kg CO2e	127,793 kg CO2e	31,948 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	175,191 kg CO2e	15,235 kg CO2e	0 kg CO2e	6,079,354 kg CO2e	-6,382,201 kg CO2e
2.2	Superstructure: Upper Floors	0 kg CO2e	10,248,988 kg CO2e	2,767,274 kg CO2e	802,708 kg CO2e	0 kg CO2e	308,240 kg CO2e	77,060 kg CO2e	5,984,501 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	441,415 kg CO2e	794,417 kg CO2e	22 kg CO2e	21,424,625 kg CO2e	-22,245,414 kg CO2e
2.3	Superstructure: Roof	-10,701 kg CO2e	2,628,644 kg CO2e	543,228 kg CO2e	157,484 kg CO2e	0 kg CO2e	74,263 kg CO2e	18,566 kg CO2e	444,942 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	68,589 kg CO2e	66,141 kg CO2e	1,449 kg CO2e	3,992,605 kg CO2e	-2,766,800 kg CO2e
2.4	Superstructure: Stairs and Ramps	0 kg CO2e	21,273 kg CO2e	8,528 kg CO2e	0 kg CO2e	0 kg CO2e	665 kg CO2e	166 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	391 kg CO2e	46 kg CO2e	0 kg CO2e	31,069 kg CO2e	-5,892 kg CO2e
2.5	Superstructure: External Walls	0 kg CO2e	3,166,103 kg CO2e	513,361 kg CO2e	213,861 kg CO2e	0 kg CO2e	86,843 kg CO2e	21,711 kg CO2e	369,493 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	42,749 kg CO2e	3,000 kg CO2e	786 kg CO2e	4,417,907 kg CO2e	-4,366,968 kg CO2e
2.6	Superstructure: Windows and External Doors	-19,282 kg CO2e	1,809,997 kg CO2e	69,981 kg CO2e	6,461 kg CO2e	0 kg CO2e	42,078 kg CO2e	10,520 kg CO2e	1,930,678 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	11,372 kg CO2e	49,171 kg CO2e	117 kg CO2e	3,911,092 kg CO2e	-122,740 kg CO2e
2.7	Superstructure: Internal Walls and Partitions	0 kg CO2e	955,946 kg CO2e	366,318 kg CO2e	159,033 kg CO2e	0 kg CO2e	33,041 kg CO2e	8,260 kg CO2e	787,228 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	114,137 kg CO2e	3,839 kg CO2e	0 kg CO2e	2,427,802 kg CO2e	-400,597 kg CO2e
2.8	Superstructure: Internal Doors	-51,455 kg CO2e	29,155 kg CO2e	10,064 kg CO2e	0 kg CO2e	0 kg CO2e	875 kg CO2e	219 kg CO2e	29,155 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	121 kg CO2e	51,779 kg CO2e	16 kg CO2e	69,929 kg CO2e	0 kg CO2e
3	**Finishes**	0 kg CO2e	262,859 kg CO2e	276,481 kg CO2e	54,332 kg CO2e	0 kg CO2e	13,242 kg CO2e	3,311 kg CO2e	265,083 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	20,248 kg CO2e	759 kg CO2e	90 kg CO2e	896,405 kg CO2e	-267,143 kg CO2e
4	**Fittings, furnishings & equipment**	-80,203 kg CO2e	328,580 kg CO2e	36,365 kg CO2e	14,470 kg CO2e	0 kg CO2e	8,463 kg CO2e	2,116 kg CO2e	1,611,119 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	1,300 kg CO2e	82,475 kg CO2e	115 kg CO2e	2,004,800 kg CO2e	-405 kg CO2e
5	**Services (MEP)**	0 kg CO2e	3,190,839 kg CO2e	92,236 kg CO2e	11,335 kg CO2e	4,341,167 kg CO2e	73,484 kg CO2e	18,371 kg CO2e	6,148,288 kg CO2e	0 kg CO2e	98,375,255 kg CO2e	131,229,507 kg CO2e	1,415,178 kg CO2e	[Where only a single C1-C4 is known, please include it here]	17,800 kg CO2e	1,568 kg CO2e	419 kg CO2e	244,915,448 kg CO2e	-2,254,877 kg CO2e
6	**Prefabricated Buildings and Building Units**	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
7	**Work to Existing Building**	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e
8	**External works**	-11,208 kg CO2e	339,396 kg CO2e	191,535 kg CO2e	799 kg CO2e	0 kg CO2e	11,861 kg CO2e	2,965 kg CO2e	0 kg CO2e	0 kg CO2e				[Where only a single C1-C4 is known, please include it here]	14,882 kg CO2e	12,853 kg CO2e	0 kg CO2e	563,083 kg CO2e	-58,898 kg CO2e
Other site construction impacts or overall construction stage [A5] carbon emissions not specific to an individual building element category					6,828,080 kg CO2e													6,828,080 kg CO2e	
TOTAL kg CO_2e		**-172,849 kg CO2e**	**35,467,265 kg CO2e**	**8,442,667 kg CO2e**	**8,932,433 kg CO2e**	**4,341,167 kg CO2e**	**1,026,376 kg CO2e**	**256,594 kg CO2e**	**17,570,488 kg CO2e**	**0 kg CO2e**	**229,604,763 kg CO2e**		**1,415,178 kg CO2e**	**0 kg CO2e**	**1,261,859 kg CO2e**	**1,114,389 kg CO2e**	**3,013 kg CO2e**	**309,263,343 kg CO2e**	**-49,145,480 kg CO2e**
TOTAL - kg CO_2e/m^2 GIA		**-2 kg CO2e/m2 GIA**	**346 kg CO2e/m2 GIA**	**82 kg CO2e/m2 GIA**	**87 kg CO2e/m2 GIA**	**42 kg CO2e/m2 GIA**	**10 kg CO2e/m2 GIA**	**3 kg CO2e/m2 GIA**	**171 kg CO2e/m2 GIA**	**0 kg CO2e/m2 GIA**	**2,237 kg CO2e/m2 GIA**		**14 kg CO2e/m2 GIA**	**0 kg CO2e/m2 GIA**	**12 kg CO2e/m2 GIA**	**11 kg CO2e/m2 GIA**	**0 kg CO2e/m2 GIA**	**3,013 kg CO2e/m2 GIA**	**-479 kg CO2e/m2 GIA**

B.2 Masterplan Development

GWP POTENTIAL FOR ALL LIFE-CYCLE MODULES ($kgCO_2e$) (See Note 1 below if you entered a reference study period in cell C12)		Sequestered (or biogenic) carbon (negative value) ($kgCO_2e$)	Product stage ($kgCO_2e$)	Construction process stage ($kgCO_2e$)		Use stage ($kgCO_2e$)							End of Life (EoL) stage ($kgCO_2e$)				TOTAL Modules A-C $kgCO_2e$	Benefits and loads beyond the system boundary ($kgCO_2e$)
			Module A			Module B							Module C					Module D
Building element category			[A1] to [A3]	[A4]	[A5]	[B1]	[B2]	[B3]	[B4]	[B5]	[B6]	[B7]	[C1]	[C2]	[C3]	[C4]		
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment												[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
0.2	Major Demolition Works												[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
0.3	Temporary Support to Adjacent Structures	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
0.4	Specialist Ground Works	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
0.5	Temporary Diversion Works	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
1	**Substructure**	0 kg CO2e	2,303,078 kg CO2e	825,358 kg CO2e	117,563 kg CO2e	0 kg CO2e	57,267 kg CO2e	14,317 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	82881.17	24874.08	20.29	3425357.121	-2,252,218 kg CO2e
2.1	Superstructure: Frame	0 kg CO2e	1,306,177 kg CO2e	248,824 kg CO2e	69,955 kg CO2e	0 kg CO2e	28,668 kg CO2e	7,167 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	63536.9	5468.13	0	1729796.341	-2,253,733 kg CO2e
2.2	Superstructure: Upper Floors	0 kg CO2e	2,183,600 kg CO2e	389,813 kg CO2e	104,641 kg CO2e	0 kg CO2e	47,247 kg CO2e	11,812 kg CO2e	39,332 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	85196.12	8630.36	0	2870271.69	-1,977,251 kg CO2e
2.3	Superstructure: Roof	0 kg CO2e	279,959 kg CO2e	28,897 kg CO2e	13,923 kg CO2e	0 kg CO2e	5,695 kg CO2e	1,424 kg CO2e	15,324 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	3885.01	3680.19	1898.83	354685.1768	-69,931 kg CO2e
2.4	Superstructure: Stairs and Ramps	0 kg CO2e	59,235 kg CO2e	7,808 kg CO2e	2,654 kg CO2e	0 kg CO2e	1,230 kg CO2e	307 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	1981.08	189.11	0	73404.06081	-58,127 kg CO2e
2.5	Superstructure: External Walls	-212,489 kg CO2e	4,422,702 kg CO2e	473,899 kg CO2e	409,452 kg CO2e	0 kg CO2e	93,611 kg CO2e	23,403 kg CO2e	57,189 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	65495.88	218201.43	1536.74	5553000.853	-3,880,259 kg CO2e
2.6	Superstructure: Windows and External Doors	-21,361 kg CO2e	2,185,684 kg CO2e	99,424 kg CO2e	0 kg CO2e	0 kg CO2e	40,315 kg CO2e	10,079 kg CO2e	2,185,684 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	10967.23	21707.39	162.02	4532661.654	-5,939 kg CO2e
2.7	Superstructure: Internal Walls and Partitions	0 kg CO2e	812,383 kg CO2e	446,816 kg CO2e	82,484 kg CO2e	0 kg CO2e	23,670 kg CO2e	5,918 kg CO2e	140,424 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	34796.12	2663.42	230.18	1549384.035	-105,117 kg CO2e
2.8	Superstructure: Internal Doors	-67,984 kg CO2e	38,075 kg CO2e	11,852 kg CO2e	0 kg CO2e	0 kg CO2e	881 kg CO2e	220 kg CO2e	38,075 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	144.12	68365.96	19.3	89648.70026	-220 kg CO2e
3	Finishes	-1,486,127 kg CO2e	4,118,230 kg CO2e	346,668 kg CO2e	482,881 kg CO2e	0 kg CO2e	87,290 kg CO2e	21,823 kg CO2e	2,404,621 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	15156.11	2003506.82	1446.58	7995495.711	-3,080,112 kg CO2e
4	Fittings, furnishings & equipment	0 kg CO2e	152,041 kg CO2e	5,876 kg CO2e	0 kg CO2e	0 kg CO2e	2,786 kg CO2e	697 kg CO2e	304,082 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	106.51	0	94.64	465682.0146	0 kg CO2e
5	Services (MEP)	0 kg CO2e	597,230 kg CO2e	8,799 kg CO2e	5,322 kg CO2e	1,212,218 kg CO2e	10,786 kg CO2e	2,696 kg CO2e	1,079,226 kg CO2e	0 kg CO2e	19,579,342 kg CO2e 16,079,940 kg CO2e	1,265,343 kg CO2e	[Where only a single C1-C4 is known, please include it here]	4490.19	389.86	162.24	39845944.17	-512,248 kg CO2e
6	Prefabricated Buildings and Building Units	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
7	Work to Existing Building	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	0	0	0	0	0 kg CO2e
8	External works	0 kg CO2e	230,182 kg CO2e	45,507 kg CO2e	18,512 kg CO2e	0 kg CO2e	5,190 kg CO2e	1,298 kg CO2e	548,428 kg CO2e	0 kg CO2e			[Where only a single C1-C4 is known, please include it here]	2119.67	231.99	139.57	851607.8535	-13,850 kg CO2e
Other site construction impacts or overall construction stage [A5] carbon emissions not specific to an individual building element category					2,691,920 kg CO2e												2691920	
TOTAL kg CO_2e		**-1,787,961 kg CO2e**	**18,688,576 kg CO2e**	**2,939,538 kg CO2e**	**3,999,306 kg CO2e**	**1,212,218 kg CO2e**	**404636.27**	**101159.0675**	**6,812,385 kg CO2e**	**0**	**35,659,283 kg CO2e**	**1265342.94**	**0**	**370756.11**	**2357908.74**	**5710.39**	**72028859.38**	**-14,209,005 kg CO2e**
TOTAL kg CO_2e/m^2 GIA		**-44 kg CO2e/m2 GIA**	**462 kg CO2e/m2 GIA**	**73 kg CO2e/m2 GIA**	**99 kg CO2e/m2 GIA**	**30 kg CO2e/m2 GIA**	**10**	**2.5**	**168 kg CO2e/m2 GIA**	**0**	**881 kg CO2e/m2 GIA**	**31.27112011**	**0**	**9.16270086**	**58.2723032**	**0.14112403**	**1780.089051**	**-351 kg CO2e/m2 GIA**

The Hillingdon Hospital Redevelopment

Appendix C GIA for Hospital Redevelopment and Masterplan Development

	Outline	
	GEA (m2)	GIA (m2)
PLOT P01		
Residential	14859.4	13819.242
Class E uses	450	418.5
Podium parking	3224.1	3224.1
PLOT P02		
Residential	8404.2	7815.906
Class E uses	150	139.5
Podium parking	2584.8	2584.8
PLOT P03		
Surface parking	-	-
PLOT P04		
Residential	10610.3	9867.579
Class E uses	200	186
Podium parking	2408	2408
Total for outline	**42890.8**	**40463.627**

	Detailed	
	GEA (m2)	GIA (m2)
Hospital	82938.3	79603.6
MSCP	23505	23034
Total for detailed	**106443.3**	**102637.6**

Total for outline + detailed	**149334.1**	**143101.227**

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