SYNTEGRA CONSULTING

Hillingdon Water Sports Facility and Activity Centre - Broadwater Lake

Whole Life-Cycle Carbon Assessment

November 2023

Ref: 22-10070

CONTENTS

Quality Standards Control

The signatories below verify that this document has been prepared in accordance with our quality control requirements. These procedures do not affect the content and views expressed by the originator.

Revision	*Initial*	*Rev A*	*Rev B*	*Rev C*
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1. Executive Summary

Syntegra Consulting Ltd has been commissioned by the London Borough of Hillingdon to undertake the Whole Life-cycle Assessment (WLC) for **Hillingdon Water Sports Facility and Activity Centre (HWSFAC), Broadwater Lake** Whole Life Cycle (WLC) assessment is a method to assess the environmental impacts associated with a building through the stages of its life cycle – from cradle to grave. This report details the results of a WLC assessment in accordance with the Council's planning requirements and as derived from local policy, the proposed developments will be expected to meet the criteria of the RICS methodology and in accordance with Whole Life-Cycle Carbon Assessments Guidance March 2022 developed by the Greater London Authority (GLA).

Consideration has primarily been given to the planning policy and other relevant standards and guidance prior to specifying the assessment object.

All stages of the project have then been considered, from raw material extraction, product manufacturing, transport, and installation on site through to the operation, maintenance, and eventual material disposal.

An early design stage WLC assessment at RIBA Stage 2 was carried out using the following information:

- Design information supplied by the design team.
- Default materials, as recommended by One Click LCA software library

The main objectives being:

- Assess the current carbon footprint position
- To integrate embodied carbon thinking into the project design and construction.
- To identify embodied carbon footprint reduction options of the project.

For this exercise, One Click LCA was used to calculate the Whole Life Carbon emissions results. The assessment tool is an approved tool within the GLA's Whole Life-Cycle Carbon Assessments Guidance.

Following the options appraisal and the implementation of the following options. The final design will incorporate the following low carbon options into the final design and construction of the building:

- Be Lean/Clean/Be Green measures
- >90% recycled content of structural steel
- Ready-mix concrete, 50% recycled binders in the cement
- Water based emulsion paint
- Medium density internal blockwork

The assessment has reviewed WLC over a 60-year period, in line with the recommended RICS approach. This identified total WLC emission of 6,968,444 kg CO2e.

Hillingdon Water Sports Facility and Activity Centre development's carbon emissions are shown to be lower than the Greater London Authority (GLA) benchmark emission rate for retail (most appropriate option) developments in the instances of both upfront and whole life-cycle embodied carbon (Figure 1). The benchmarks include all lifecycle modules excluding B6, B7 (operational energy and operational water) and module D.

Stages	WLC Benchmark [kg CO2eq/ m2]	Aspirational WLC Benchmark [kg CO2eq/ m2]	Proposed Development Carbon Emissions [kg CO2eq/ m2]
Embodied Carbon Modules A1-5	<850	<500	429
Embodied Carbon Modules B-C (excl B6 & B7)	<350	<300	267
Modules A-C (excl B6 & B7; including sequestered carbon)	<1200	<800	657

Figure 1.1 WLC Results

2. Introduction

This report has been prepared in support of a planning application submitted for the Hillingdon Water Sports Facility and Activity Centre (HWSFAC), Broadwater Lake, Moorhall Road, Harefield, UB9 6PE.

2.1 Proposed Development

Full planning permission is sought for the following development:

"Redevelopment of the site to create the Hillingdon Watersports Facility and Activity Centre including demolition of existing Broadwater Lake Sailing Club (BSC) clubhouse at the north of the lake and erection of a building to be occupied by HOAC and BSC including changing facilities, meeting rooms, storage, Workshop and seasonal worker accommodation (sui generis), activity shelters; installation of pontoons and concrete slipways; boat shed; equipment storage huts (north of lake and at entrance); boat parking and racking areas; camping area; outdoor activity areas; ecological enhancement throughout the site; new pedestrian routes through the peninsula; landscaping including new woodland, dense vegetation screens and boundary treatment; new access and access road; localised dredging and land reclamation; relocation of existing sailing area and creation of floating and fixed islands within the lake; coach drop off and turning area; vehicle parking; cycle parking; and associated works."

The Proposed Development comprises an outdoor activity centre which will provide a range of programs for sailing, rowing, woodland activities, camping and other water sports. The main components of the Proposed Development are as follows:

- Ecological mitigation and enhancement measures; ♣
- Demolition and relocation of the existing BSC clubhouse and associated car parking and boat parking from its existing location north of the existing lake; ♣ C
- Construction of a range of new fully accessible buildings including a two storey club house building (the 'Main Building') for use by HOAC and BSC (including changing facilities, meeting and training rooms, storage, Workshop and seasonal worker accommodation), seven activity shelters, a boat shed/ storage and Workshop/ sports stores;
- Three lake pontoons and two concrete slipways;
- Boat parking and racking areas;
- Localised dredging of the lake to create depths suitable for sailing and generate material to be re-used on-site, Partial land reclamation within the lake using dredged material to create a suitable platform for development on the peninsula;
- Removal of two islands and creation of new floating and fixed islands within the lake;
- Continued use of the lake for sailing and water based activities
- Facilities for outdoor activities including pedal karting, caving, archery, high level ropes, low level

ropes, zip lines, big swing, general activities area, pond dipping and camping

- Staff car parking, cycle parking, coach drop off and turning area;
- Improvements to the existing unnamed access road to Broadwater Lake from the south; and
- Landscaping including new woodland, dense vegetation screens and boundary treatment.

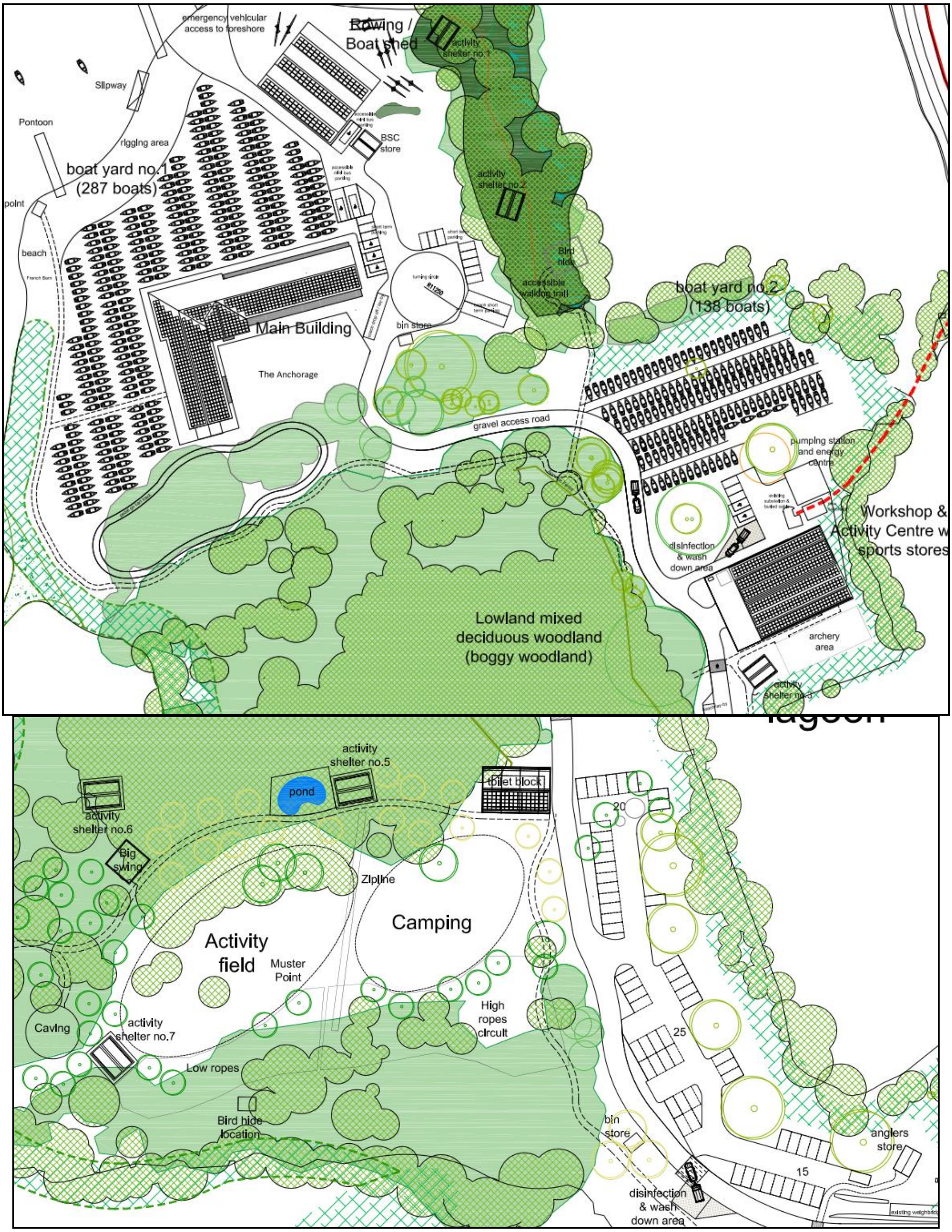

Figure 2.1: Site Masterplan Layouts

2.2 London Plan 2021

Policy SI2 Minimising greenhouse gas emissions

A) Major development should be net zero-carbon. This means reducing greenhouse emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

1. be lean: use less energy and manage demand during operation.
2. be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.
3. be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site.
4. be seen monitor, verify and report energy performance.

B) Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

C) A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:

1. through a cash in lieu contribution to the borough's carbon offset fund, or
2. off-site provided that an alternative proposal is identified, and delivery is certain.

D) Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually.

E) Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated 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.

RICS Whole life carbon assessment for the built environment 1st edition, November 2017

The RICS Whole Life Carbon professional statement is intended to standardise whole life carbon assessment and enhance consistency in outputs by providing specific practical guidance for the interpretation and implementation of the methodology in EN 15978 in carbon calculations, this is to achieve coherent and comparable results that can be used to benchmark the whole life carbon performance of built assets.

2.3 Whole Life-Cycle Carbon Assessments Guidance March 2022

This guidance explains how to prepare a Whole Life-Cycle Carbon (WLC) assessment in line with Policy SI 2 F of the London Plan 2021 using the WLC assessment template. Policy SI 2 F applies to planning applications which are referred to the Mayor.

- Designing a development that follows a WLC approach will:
- Ensure that a significant source of emissions from the built environment is accounted for, which is necessary in achieving a net zero-carbon city
- Achieve resource efficiency and cost savings, by encouraging refurbishment, and the retention and reuse of existing materials and structures, instead of new construction
- Identify the carbon savings from using recycled material and the benefits of designing for future reuse and recycling, to reduce waste and support the circular economy
- Encourage a ‘fabric first’ approach to building design, to minimise mechanical plant and services in favour of natural ventilation
- Ensure operational and embodied emissions are considered at the same time to find the best solutions for the development over its lifetime
- Identify the impact of maintenance, repair and replacement over a building’s life cycle which, by informing the building’s design and specification, improves lifetime resource efficiency and reduces lifecycle costs, contributing to the future proofing of asset value
- Encourage local sourcing of materials and short supply chains, with resulting carbon, social and economic benefits for the local economy • encourage durable construction and flexible design, both of which contribute to greater longevity and reduced obsolescence of buildings and avoid carbon emissions associated with demolition and new construction

2.4 Life Cycle Modules

The GLA's guidance references RICS and BS EN15978 which notes that the WLC assessment should be undertaken against the following four stages in the life of a typical building, described as life-cycle 'modules:

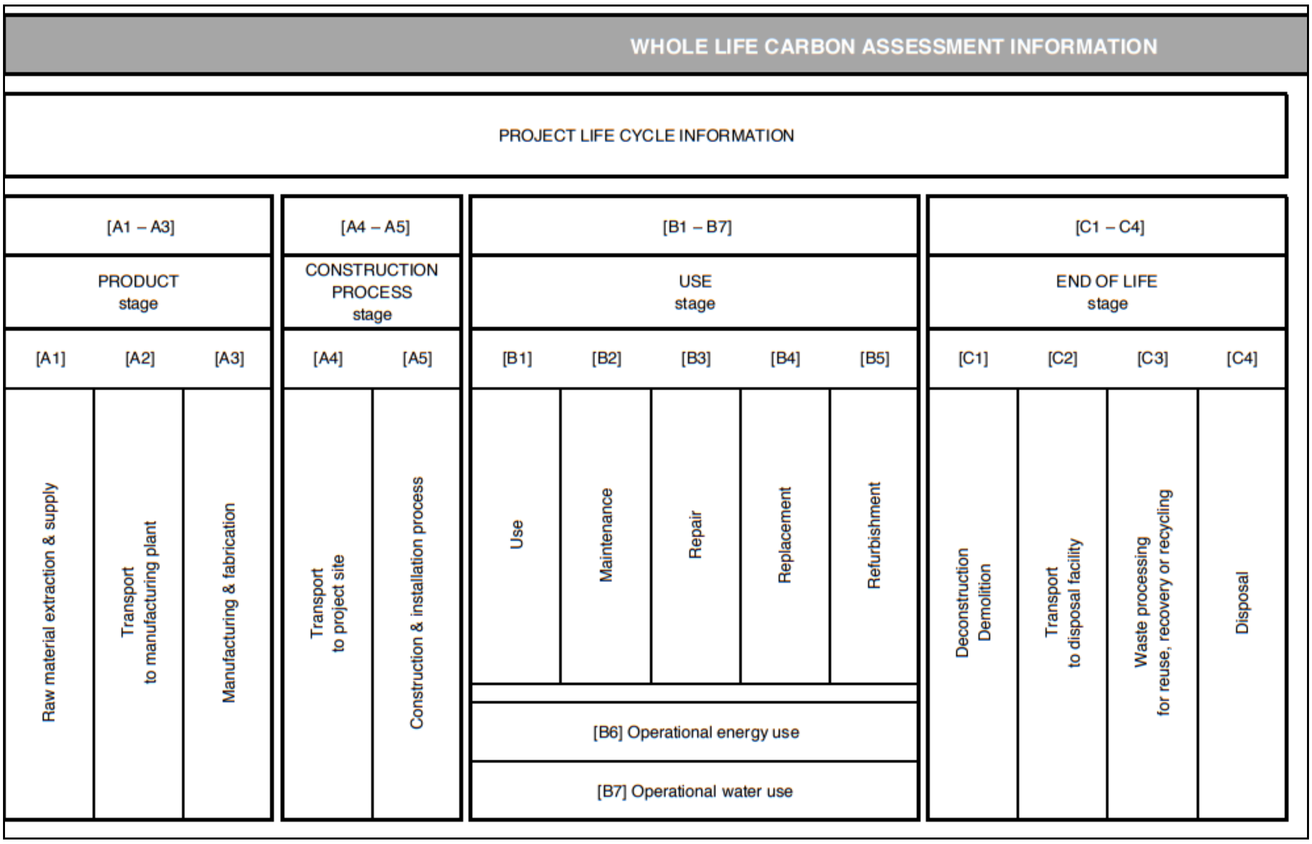

Figure 2.1. Life Cycle Modules Breakdown

The assessment covers the proposed development's carbon emissions over its lifetime, accounting for: its operational carbon emissions (both regulated and unregulated) and its embodied carbon emissions

Module A1-5 (Product sourcing and construction stage)

The product stage, detailed in Modules [A1] to [A3] deals with the carbon emissions involved in the cradle to gate processes, raw material supply, transport and manufacturing. A4-5: Modules [A4] and [A5] respectively identify the emissions correlating to the transportation of the materials and components from the factory gate to the project site, and also the assembly of the materials into a building.

Module B1-7 (Use stage)

Any emissions relating to operational energy are included here regulated and unregulated emissions, water use, and any embodied carbon impacts associated with maintenance, repair, replacement and refurbishment of building components are all included. Due to the limited information available on the materials/ manufacturers anticipated to be used at this stage, B2/B3 Maintenance/Repair are unable to be calculated, therefore any assumptions may negatively impact the results.

Module C1-4 (End of life stage)

Within this module, any emissions generated from decommissioning, stripping out, disassembly, deconstruction and demolition operations as well as from transport, processing and disposal of materials at the end of life of the project are accounted for.

Module D (Benefits and loads beyond the system boundary)

Within this module, any emissions generated from decommissioning, stripping out, disassembly, deconstruction and demolition operations as well as from transport, processing and disposal of materials at the end of life of the project are accounted for. This is not considered in a WLC assessment.

2.5 GLA Whole Life-Cycle Carbon Benchmarks

The Greater London Authority (GLA) has benchmarks for certain building types which do not include hotels. The benchmark emission rates for residential, published in March 2022, represent the closest use and most applicable benchmarks. It also provides the most challenging benchmark to meet. The WLC benchmarks include all life-cycle modules apart from B6, B7 (operational energy and operational water) and module D.

Comparison against benchmarks and other assessments provides an initial indication of the performance of the proposed project development against current industry average. The benchmark values, as taken from the GLA's Whole Life-Cycle Carbon Assessments London Plan guidance, are displayed in Table 2.2.

Stages	WLC Benchmark	Aspirational WLC Benchmark
	(kg CO2eq/ m2 GIA)	
Modules A1-5 (excluding sequestration)	<850	<500
Modules B – C (excluding B6 & B7)	<350	<300
Modules A1-5 (excluding sequestration) & Modules B – C (excluding B6 & B7)	<1200	<800

Figure 2.2 'Whole Life Cycle Carbon Assessments guidance' average benchmark targets comparison

3. Methodology

3.1 Data Source

The OneClick Tool was used to provide the Whole Life Cycle emissions factors and data sourced from various project documents to complete the inputs required to gain information on all the modules. The various sources include:

- Bill of Materials - Allowances have been made to determine uncertain quantities which is expected to reduce accuracy of the results. However, these quantities are generally overcompensated to ensure that a worst-case scenario of emissions is calculated. The assessment accounts for at least 95% of the capital cost allocated to each building element category
- Architect drawings and Design and Access Statement
- Layout drawing include Area Schedule
- Royal Institute of Chartered Surveyors (RICS), 2012 Methodology to calculate embodied carbon of materials;
- Energy and Sustainability Statement
- Demolition Audit
- MEP Design strategy
- Structural design
- The assessment was based on the current status of the electricity grid and, SAP 10 emission factors are used.
- The OneClick Tool provided a library of the EPD certificates,

The assessment was based on the current status of the electricity grid and, SAP 10 emission factors are in line with the GLA's Energy Assessment Guidance for operational energy calculations (B6). It is this first set of figures which will be compared to the WLC benchmarks.

3.2 Key Assumptions

The following table sets out the key assumptions used to assess the life cycle of the proposed building and each option.

Study Period
The assessment assumes a study period of 60 years. This represents the assumed building life expectancy as per the GLA's guidance. The existing building structure is not included in the building life calculation.
Functional Unit (FU)
To allow comparison with benchmark data, the Functional Unit (FU) for embodied carbon is shown in kgCO2eq per m2 of floor area (GIA). The overall GIA is extracted from the Area Schedule document 3859-ASP-XX-XX-SC-A-1100. With a proposed GIA of 4273.95m2
System Boundary
The assessment includes all embodied and operational impact from 'cradle' to 'grave', from production of raw materials (Stage A1) through to disposal (Stage C4). Where product stages are shown, these refer to the stages set out on BS 15978:2011.
Software Tools
OneClick LCA software and its accompanying database has been used to evaluate the buildings embodied carbon emissions. OneClick LCA is an approved software tool recognised by RICS.
Assessment Scope
The assessment covers the entire building and the hard landscaping up to the development's boundary. The elements included in the study are based on Table 6 from 'Whole life carbon assessment for the built environment' RICS (November 2017 edition) and in accordance with each elements scope of work.

Material Specification
Model inputs have been taken from the Bill of Materials provided by the Design Team. Where not clearly specified, the material type/specification was assumed to be generic (industry average) or, where not available, the closest best practice available product was assumed. Where information has otherwise not been provided or is unavailable, the assumptions taken from the OneClick LCA software which is sourced from the RICS professional statement guidance were adopted for material specifications, transport scenarios and expected lifespans.
Construction & Installation Process (A4-A5)
Transportation to site (A4) - calculated using RICS assumptions: 50 km (locally sourced materials like concrete -mix) 300 km (national sourced materials) 1500 km (internationally sourced within the EU) Site operations including construction waste (A5) - based on the project value per £1 million (as per the RICS guidance). For external windows 2.6 and internal doors 2.8, only prefabricated products have been chosen within the One Click Tool. This was based on input from the design team. The lack of A5 results for these products has been queried with One Click LCA and they gave the following response on prefabricated products *'These have no material waste which can be attributed to the construction site impacts. As you can see in the building materials query, the wastage percentage for prefab products is usually 0. Hence no A5 results for these categories.*
Substructure: Product and Construction Process Stage (A1-A5)
Calculated using EPDs which align with the most applicable similar product

Maintenance (B2) and Repair (B3)
As advised by the RICS guidance, reasonable maintenance scenarios should be developed based on facilities management information. Also that Emissions from maintenance, repair and replacement should be estimated using manufacturers' recommendations and Environment Product Declarations (EPDs) where possible (identifying the source EPD). The EPD do not provide B2 and B3 information, instead they provide B4/B5. Consumption of grid electricity, water, fuels, and replacements input is required for annual maintenance. Unfortunately, no accurate methodology to estimate B2 emissions exists as of today, however as per One Click guidance, for the design stage a total figure of 10 kgCO2e/m2 gross internal area (GIA) may be used to cover all building element categories, or 1 percent of modules A1-A5, whichever is greater. For the repair rate (B3) no accurate methodology exists to estimate this as of today, however, if filled in this percentage is often not more than 1 or 2 % (as this is the annual repair rate). Not all materials need to be repaired annually, and their rate depends on numerous factors like material quality, how it is installed, the expertise of craftsmen installing the materials, building type, building usage, building location, and the climate zone the building is in. As per One Click recommendations, these may be estimated as 25 percent of module B2, as per the RICS PS (item 3.5.3.3).

Replacement (B4) / Refurbishment (B5) & Expected Lifespan
In the absence of more specific data the lifespans against the materials (in years) for the assumed replacement cycles have been provided below based on RICS 'Whole life carbon assessment for the built environment' guidance. Some materials have been assigned 60 years to indicate they are expected to last the lifespan of the building as they are not covered in the RICS guidance as requiring replacement. These figures will be replaced with the actual life expectancies of the specific items at post-construction to be used in the project as information becomes available. Regarding B4, this refers to the replacements of parts as part of the maintenance (B2). So these impacts would be included in the default figure of 10kg CO2e/m2 GIA. For B5, the recommendation is that if there is an alteration or refurbishment (B5) planned from the outset of the project, then steps can be taken during the design stages to ensure that this will be facilitated with minimum or zero waste, or damage to existing fabric. Specific future alterations or improvements that are known and planned at the point of practical completion should be included."

End of life scenario (Module D)
The EoL of the building has been assumed based on OneClick typical default scenarios, which cater to a primarily recycled scenario. For the WLC calculation the estimate of recyclable materials has been estimated based on the RICS: Whole life carbon assessment for the built environment, section 3.5.4 EoL Stage. Therefore, the following recovery rates have been assumed for each material. Steel: 96%, Aluminium: 96%, Copper: 65%, Timber: 75% (energy recovery) and all other waste: 90%.

Refrigerant Leakage
The refrigerant quantity has been estimated, using the following assumptions: the ventilation is extract only for showers and toilet areas. There is one small MVHR unit that will serve a tearoom and first aid room in the Main Building. The refrigerant will come from a small condenser providing cooling to the server room via a split ac system. One small external unit, one small wall mounted unit internally.
Operational energy Consumption [Module B6]
The anticipated annual energy consumption during operation has been taken from the projects design stage energy modelling provided by Syntegra Group as part of the Energy Statement. This data is sourced from SAP 10 emission factors.
Water consumption [Module B7]
Multi-Purpose Space in Main Building - The anticipated water consumption has been made based on the values provided in Table 22 of the BSRIA Rules of thumb – Guidelines for the building services, 5th edition. This advises 20l/per person/per day in sports facilities Offices Spaces - The anticipated water consumption has been made based on the values provided in Table 22 of the BSRIA Rules of thumb – Guidelines for the building services, 5th edition. This advises 45l/per person/per day in offices Residential rooms in Main Building - The anticipated water consumption has been made based on the values provided in Building Standards Part G. This advises 125l/per person/per day in offices
Construction Site Scenarios
The software's average site impact template for temperature climate was used. The scenario considers electricity, fuel, waste and transportation impacts. The waste resulted from the demolition process has been included in accordance with Gross Internal Area. This scenario considers electricity and diesel usage in the deconstruction process.
CO2eq Emissions Factors
CO2eq emissions from consuming electricity were calculated by OneClick LCA. - 0.136 kg CO2e / kWh

Minor demolition and alteration works
The demolition works can be considered as Minor demolition and alteration works. Refer to Demolition Audit

Figure 3.1 Key Assumptions

3.3 Limitations

Whole Life Cycle Carbon Assessments can be difficult to apply with limited data at the pre-planning stage. Whilst this assessment has been undertaken in-line with current industry best practice standards (BS EN 15978) and compliant databases (using OneClick LCA software), the following limitations should be noted:

- This study has been based on the materials and areas specified by the outline bill of materials estimates and supporting information.
- Whole-life cycle assessment is imprecise method with a majority of estimated data at this stage.
- The OneClick LCA database has a limited number of entries, preventing the assessment of specific construction specification.
- Quantification of embodied carbon of building services is a relatively new area with LCAs and therefore available data is limited, and approximations have been made to best represent the proposed systems. For example, the OneClick LCA does not include and extensive building services resource.
- The OneClick database includes standard assumptions for the waste factor, life expectancy, recycled content and transport distance for each material type.

4. WLC Baseline Results

This establishes the proposed designs 'carbon baseline' allowing identification of areas with great carbon impacts. The main objectives being:

- To assess the current carbon footprint position.
- To integrate whole life-cycle carbon thinking into the project design and construction.
- To identify whole life-cycle carbon footprint reduction options for adoption within the project.

Options that the design could implement during RIBA stage 2 to reduce life-cycle carbon and identify what future reductions could be targeted during further design and construction stages were the focus. Workshops and discussions were held after issuance of the Stage 2 WLCA report, leading to informed modifications to the design which reduced the whole life embodied carbon impact.

The following table shows the breakdown of the emissions by the life cycle stage and structure. The GWP (Global Warming Potential) results are shown as follow:

Stages	Absolute GWP (kgCO2eq)	Unitary GWP [kg CO2eq/ m2]
Embodied Carbon Modules A1-5	1,834,731	429
Embodied Carbon Modules B1-5 & C1-4	1,142,713	267
Operational Carbon Modules B6-7	4,134,183	657

Figure 4.1 Final Design results

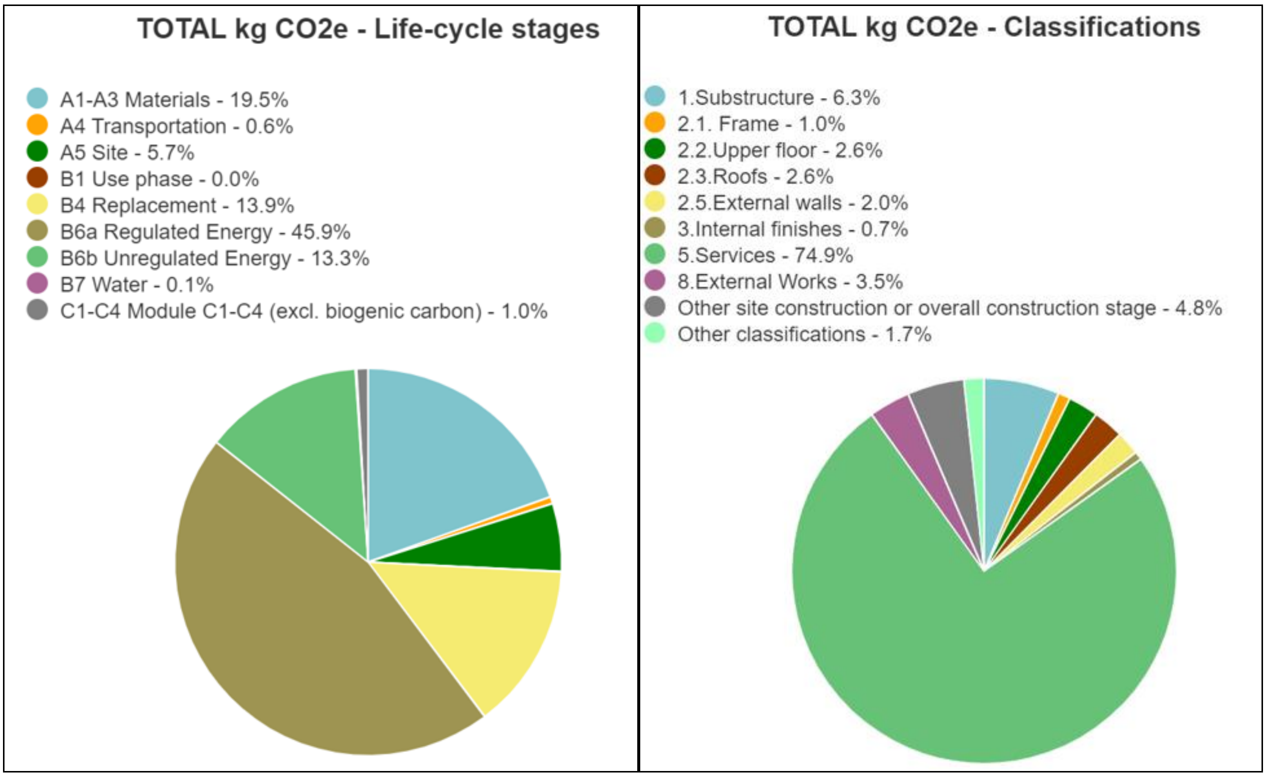

Figure 4.2 Baseline results

As can be observed by Figure 4.2, one of the largest contributor to the buildings lifecycle stage emissions are the A1-A3 materials, accounting for approximately 19.5%. The majority of A1-A3 emissions are associated with concrete and solar panels. Another large contributor to lifecycle stage emissions are B1-B5, accounting for approximately 13.9% of emissions. This is largely due to the regular maintenance, repair, and replacement of many materials and components over the buildings 60-year life, A4 and A5 accounts for 14% of emissions with many materials being sourced regionally (within 150km). C1-C4 account for few lifecycle stage emissions (4%) due to the Proposed Development using the default OneClick LCA EoL scenarios for recorded materials whilst construction and demolition-related items will follow the London Plan Policy Targets.

5. Embodied Carbon Optional Appraisal

5.1 Implemented Carbon Reduction Options

The following table describe the various low carbon design measure incorporated in the proposed design based on discussions from the circular economy/ whole life cycle assessment workshop and subsequent reviews conducted by the design team. These have been stipulated by building element.

Building Element	Low Carbon Measure Implemented	Carbon Emissions Reduction (kg CO2eq/ m2 GIA)
Superstructure	Increasing the recycled content of steel to 90% has a substantial impact upon the total embodied carbon.	-122 kg CO2eq/ m2
Various	Concrete to be 50% recycled binders.	-24 kg CO2eq/ m2
Internal Wall	A standard specification would include high density internal blockwork. To reduce the carbon emissions medium density internal blockwork.	-2 kg CO2eq/ m2
Operational Energy Use	Be Lean, Be Clean, Be Green Measures. See Energy Statement for further details	-523 kg CO2eq/ m2

Figure 5.1 Implemented Carbon Reduction Options

5.2 Potential Carbon Reduction Options

Further sustainable design measures were quantified during RIBA Stage 2 for continued consideration during the next stage of detailed design, to demonstrate the carbon potential of the scheme. These potential reduction options include

Building Element	Low Carbon Measure. Implemented	Carbon Emissions Reduction (kg CO2eq/ m2 GIA)
		Proposed Building Total Carbon Emissions – 476 kg CO2eq/ m2 GIA
Various	Source the materials locally within <75 miles. Specifically which default distances in the One Click tool are sourced furthest- metals, paints, floor finishes, timber, building services, furniture and fittings. This cannot be determined until a contractor is onboard and the procurement stage begins.	-1 kg CO2eq/ m2 Subject to material type and availability

Internal Walls	To reduce the carbon emissions high recycled content is an option with 60% recycled content in non-fire resistant plasterboard	-1 kg CO2eq/ m2

Figure 5.2 Implemented Carbon Reduction Options

6. WLC Assessment Results

Following the options appraisal and the implementation of the chosen design options. The table below shows the resultant breakdown of the emissions by the life cycle stage.

Stages	Absolute GWP (kgCO2eq)	Unitary GWP [kg CO2eq/ m2]
Embodied Carbon Modules A1-5	1,834,731	429
Embodied Carbon Modules B1-5 & C1-4	1,142,713	267
Operational Carbon Modules B6-7	4,134,183	657

Figure 4.1 Final Design results

6.1 Whole Life Cycle Carbon (WLC) Benchmarks

The project's carbon emissions are in line with the GLA Whole Life-Cycle Carbon Assessments Guidance March 2022 benchmark targets for the elected and most challenging, residential building type.

The WLC emissions are the carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. As seen below, the project is below the WLC benchmarks for both Module A1-5 and B – C (excluding B6 & B7).

Stages	WLC Benchmark	Aspirational WLC Benchmark	WLC of Project	Comments
	(kg CO2eq/ m2 GIA)			
Modules A1-5 (excluding sequestration)	<850	<500	429	It must be noted that volumes and weights of materials proposed for the various materials are only estimates and no defined figures have been set. Despite these limitations, it can still be understood that the development has been designed efficiently.
Modules B – C (excluding B6 & B7)	<350	<300	267	

Modules A1-5 (including sequestration) & Modules B – C (excluding B6 & B7)	<1200	<800	657	

Figure 6.2 'Whole Life Cycle Carbon Assessments guidance' average benchmark targets comparison

Figure 6.2 shows that the Proposed Development is estimated to produce 429 kg CO2e/m2 of upfront carbon (modules A1-A5 excluding sequestered carbon) which is lower than the WLC aspirational benchmark of <500. This is likely due to the specification of recycled and low carbon materials in some of the most contributing elements, the simple constructions, in addition to design optimisation carried out by the Design Team observed throughout this report. The specification of various measures in figure 5.1 has reduced the WLC of the development by an overall estimate of 152 kg CO2e/m2. The whole life carbon of the development (lifecycle stages A-C (excluding stages B6 & B7)) equates to 657 kg CO2e/m2 which is lower than the overall WLC aspirational benchmark of <800. The scheme has a 45% reduction below the WLC benchmark and 17% reduction below the aspirational WLC benchmark. The scheme has potential to meet the aspirational benchmark.

7. Whole Life Cycle Summary

The report summarises the outcome of a Whole Life-Cycle Carbon (WLC) assessment undertaken for Hillingdon Water Sports Facility and Activity Centre (HWSFAC), Broadwater Lake development.

A Whole Life Cycle (WLC) assessment is a method to assess the environmental impacts associated with a building through the stages of its life cycle – from cradle to grave. This report details the results of a WLC assessment undertaken based on the RICS methodology and in accordance with Whole Life-Cycle Carbon Assessments Guidance March 2022 developed by the Greater London Authority (GLA).

The assessment result demonstrates the emissions of the proposed development, compared with the benchmark at project completion stage would meet the GLA's target of 800 kgCO2e/m2

The results from the early design stage assessment in Section 5, Embodied Carbon Optional Appraisal identified locations of carbon 'hotspots' within the design. Additional lower embodied carbon design options will continue to be developed during the next design development stage to determine their feasibility.

Stages	WLC Benchmark [kg CO2eq/ m2]	Aspirational WLC Benchmark [kg CO2eq/ m2]	Proposed Development Carbon Emissions [kg CO2eq/ m2]
Embodied Carbon Modules A1-5	<850	<500	429
Embodied Carbon Modules B-C (excl B6 & B7)	<350	<300	267
Modules A-C (excl B6 & B7; including sequestered carbon)	<1200	<800	657

Figure 7.1 WLC Results

The Whole Life-Cycle Carbon emissions obtained in this report will also serve as the basis for future design decisions as well as informing on the choice of suppliers (such as favouring those with products covered with EPDs). Knowing that at this early stage, several assumptions had to be made, usually unfavourable to the amount of Embodied Carbon emissions to avoid under-reporting potential impacts, it is now important to improve the accuracy of this Embodied Carbon to give as representative a picture as possible of the Whole Life-Cycle Carbon impact of the Proposed Development.