Whole Life Carbon Assessment

WB Shiels Ltd.

Kneller Hall
Twickenham
TW2 7DU

SRE

Version	Revision	Date	Author	Reviewer	Project Manager
1	A	06.09.2022	Callum Nelmes	Elsa Withnell	Bo Yang
1	B	15.09.2022	Callum Nelmes	Elsa Withnell	Bo Yang

The figures within this report may be based on indicative modelling and an assumed specification outlined within the relevant sections. Therefore, this modelling may not represent the as built emission or energy use of the Proposed Development and further modelling may need to be undertaken at detailed design stage to confirm precise performance figures. Please contact SRE should you have any questions, or should you wish further modelling to be undertaken post planning.

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Executive Summary

This Whole Life Carbon Assessment (WLCA) has been written to demonstrate the embodied and operational carbon emissions for the Proposed Development located at Kneller Hall, Twickenham.

The Kneller Hall project represents a multifaceted development of 6 no. buildings consisting of the demolition of various existing structures, construction of 3 new buildings as well as areas of refurbishment and renovation of three further buildings which are Grade II listed and curtilage listed.

The aim of this assessment is to model the whole life carbon impact of the 3 no. new buildings and 2 no. extensions to the School Hall in accordance with RICS Guidance[1], and the GLA's Whole Life Cycle Carbon Assessment Guidance 2022[2].

Using IES VE 2022 and OneClick LCA software, the assessment has been undertaken in line with the RICS Whole Life Carbon Assessment for the Built Environment, which forms the basis for this initial assessment to RIBA Stage 2.

The assessment has considered embodied and regulated operational energy of the Proposed Development, commencing from a "cleared flat site" in accordance with RICS guidelines.

Figure 1 below illustrates the overall 'Cradle to Grave' emissions of each building studied within this report.

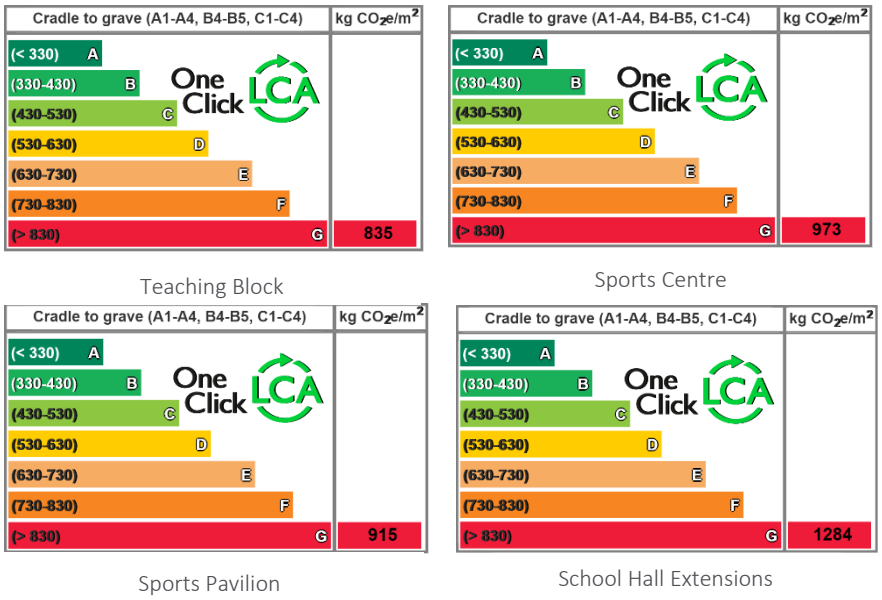

Figure 1: Embodied Carbon by square meter – OneClick LCA

[1] RICS professional standards and guidance, UK Whole life carbon assessment for the built environment 1st edition, November 2017

[2] London Plan Guidance, Whole Life-Cycle Carbon Assessments, March 2022.

1.0 Introduction

This Whole Life Carbon Assessment has been written by SRE on behalf of WB Sheils Ltd. For Dukes Education (The Client) to represent the embodied and operational carbon emissions of the new construction at Kneller Hall, Twickenham (the Proposed Development).

The Whole Life Carbon Assessment (WLCA) is being undertaken in accordance with the London Plan Whole Life-Cycle Carbon Assessments Guidance (March 2022) which outlines how to calculate the Whole Life-Cycle Carbon (WLC) emissions in line with Policy SI 2 F of the London Plan 2021. The WLC assessment has followed the 'RICS Whole Life Carbon Assessment for the Built Environment' (First Edition, November 2017), where applicable, which provides technical detail and calculation requirements on the practical implementation of the European standard EN 15978: 2011 'Sustainability of Construction Works' principles.

The assessment utilises recognised industry software and inputs from IES VE 2022 dynamic energy modelling to evaluate the lifecycle carbon content of materials and M&E fittings of the site, over a 60-year lifespan. The evaluation of the materials' carbon emissions also includes the replacement of certain items in line with industry standards. The resulting figure represents a 'Cradle to Grave' approach, encapsulating all embodied carbon as well as emissions across the entire lifespan of the building.

2.0 The Site and Proposed Development

The Kneller Hall project comprises of development of 6 no. buildings consisting of the demolition of various existing buildings, construction of 3 no. new buildings and 2 extensions (8,812.85m² total) and refurbishment and renovation of three further buildings which are Grade II listed and curtilage listed. The Proposed Development is situated in Twickenham, Richmond Upon Thames and marks the closure of the previous Kneller Hall Royal Military School nearly 170 years after its opening in 1857. The site will be converted and developed into a new educational facility through the development of new modern structures and the incorporation of the Grade II listed house and two ancillary curtilage listed buildings.

Figure 2 below illustrates the layout of the Proposed Development and marks the buildings which are to be included and excluded from this assessment.

Figure 2 – Site Plan of the Proposed Development - Green buildings represent those included in the study scope whereas red defines those not included in this assessment.

The included structures highlighted above are as follows.

1. Teaching Block
2. Sports Centre
3. Sports Hall – Extensions Only
4. Sports Pavilion

Buildings demarcated in red will not be represented within the following report.

Kneller hall is found within the locality of Whitton in close proximity to Twickenham Stadium. Outside the site boundary, houses are predominantly semidetached or terraced from the inter-war period. The area is further characterised by large front gardens, now converted to off-street parking, tree lined streets and generous rear gardens.

3.0 Methodology and Standards

There are multiple definitions of Zero Carbon Development which can impact the method of reporting. For the purpose of this assessment, the following definition from the UK Green Building Council has been implemented[3]:

Net Zero Carbon – Whole Life: *"When the amount of carbon emissions associated with the building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative"*

The aim of this assessment is to model the whole life carbon impact of the proposed design in accordance with RICS guidance and GLA Whole Life-Cycle Carbon Guidance. The assessment has been carried out to meet the carbon emission reduction in line with the targets set out in the Richmond Climate Emergency Strategy 2020-2024 (2022 Action Plan)[4] and Policy SI 2 F of the London Plan 2021.

The minimum requirements for a WLCA to enable a thorough and detailed carbon analysis are represented in Table 1 below. To achieve this baseline within this study, data from the following sources have been inputted into the One Click WLCA Tool.

- OneClick LCA material & component database.
- Drawings, plans, sections, elevations from AKS Ward & ADP (Architects).
- Initial materials assumptions based on information provided by AKS Ward & ADP (Architects).
- Operational energy calculations from 3D modelling, SBEM modelling results, and M&E Input .

Minimum requirements for whole life carbon assessment	
Building Parts to be included	Substructure Superstructure
Life stages to be included	Product Stage (A1-A3) Construction Process Stage (A4-A5) Replacement Stage (B4) Operational Energy Use (B6)
Assessment Timing	At planning application submission stage – prior to technical design

Table 1: Minimum requirements for whole life carbon assessment

[3] Outlined in SRE's 'Zero/Net Carbon Approach and Definition' document.

[4] Richmond Climate Emergency Strategy 2020-2024 – 2022 Action Plan, https://www.richmond.gov.uk/media/24162/climate_change_emergency_strategy_report_2022.pdf

The RICS Document[5] states the following in relation to the baseline to which the WLC should take place. This is described as follows:

"New build projects assessed are considered to commence their development on a cleared, flat site for consistency purposes. Demolition works are often decoupled from new construction, hence the responsibility for any emissions arising from demolition is not necessarily solely attributable to the new build project. Therefore, all carbon emissions associated with works as listed under 'Demolition'……should be reported separately and not aggregated with the rest of the project emissions. However, due to potential opportunities for recovery, reuse, and recycling, and for improving the deconstruction and demolition process, pre-demolition assessments should be carried out where possible."

The scope and approach of this assessment is outlined below:

- Under the scope of this assessment, there will not be any associated demolition waste with demolition – Demolition works of other structures across the site have been carried out under a separate scheme and therefore have not been taken into account in the WLCA modelling.
- Construction Stages (both new and existing) – included.
- Offset Measures – to be calculated and including/informing any on-site generation and potential GHG Offset.

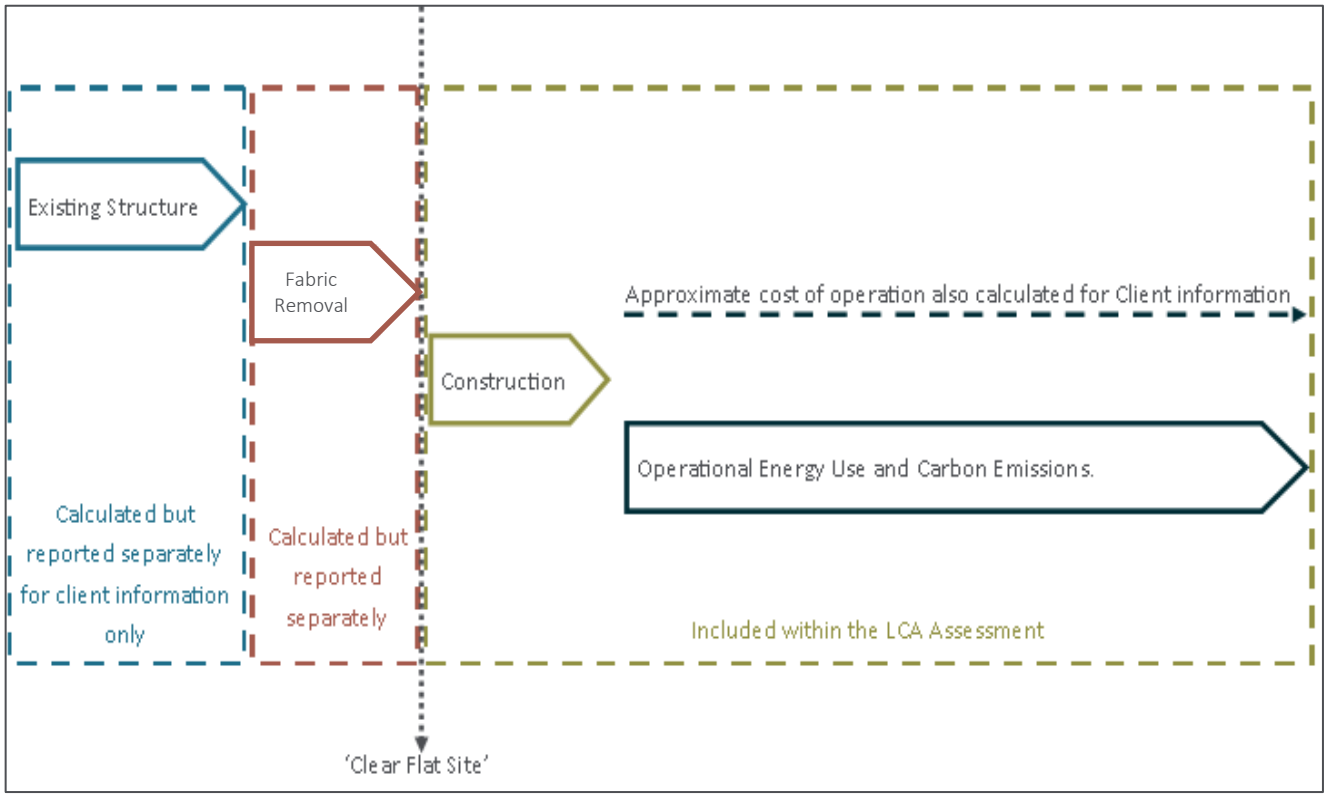

Figure 3: Process of Assessment Diagram

[5] RICS, Whole life carbon assessment for the built environment. First Edition, November 2017 (Page 9, Section 3.2.2)

3.1.1 Lifecycle Stages

The embodied carbon of a site included within this assessment, are separated into the following sections:

Stage	Stage Identifier	Stage Name and Scope	Description
Product Stage	A1 – A3	Product Stage	Raw material to Product Completion
Construction Process Stage	A4 – A5	Construction Process Stage: Transport to site and construction installation process.	Transportation of goods to site and installation on-site
Use Stage	B1	In Use Emissions	Emissions arising during the life of the building from its components – such as the emissions from GHG and HFC blown insulation, which leeches over time.
	B2	Maintenance, cleaning, and associated works	Emissions associated with energy and products for maintenance
	B3	Repair Emissions	Reasonable allowance for repairing unpredictable damage over and above the standard maintenance regime.
	B4	Replacement Emissions	Emissions associated with the replacement of items within the building, in accordance with the standard expected lifespan.
	B6	Operational Energy Use	Emissions associated with the operation of the building through the operation of its technical systems over the life of the building.
	B7	Operational Water Use	Emissions associated with the water use during the operation of a building during its operational life.
End of Life Stage	C1	Deconstruction and Demolition Emissions	Emissions covered by all site activity required to dismantle, deconstruct and/or demolish the built asset
	C2	Transport Emissions	Transport emissions associated with the discarded items from site
	C3	Waste Processing for reuse, recovery, or recycling emissions	Processing emissions for waste arising from the demolition of the site when processing for recycling, reuse, or recovery
	C4	Disposal Emissions	Emissions associated with the disposal of materials which are not being recycled and are to be disposed of.

Table 2: Outline of all assessment elements covered by the WLCA

With regards to the above stages, the following approach has been taken:

Construction Stage

Construction activities on site have been informed by the 'scope of work' with calculations based on the building dimensions and the geographical location of the site. This, in turn, will inform the total energy use and associated carbon emissions of the proposed works. This is calculated within the OneClick LCA software.

Use Stage

Operational energy demands for the site have been based on the SBEM modelling using carbon factors that align with those used in the energy strategy. The 'regulated' (heating, cooling, lighting, ventilation) emissions are taken into account to accurately represent the scheme's energy consumption and associated carbon emissions; with these values being partially offset by the planned installation of PV panels across the Teaching Block, Sports Hall, and School Hall Extensions. The emissions associated with 'un-regulated' (appliances and process loads based on intended usage) have also been reported from the BRUKL.

3.1.2 Limitations

The Assessment has been conducted as accurately as possible, with the utmost care taken to ensure that modelling and materials reflect the proposed building and any retained and new hard landscaping onsite, as well as the systems and material installations proposed within the building specification of works. However, as with all early-stage assessments, the products used within this assessment may not exactly reflect those being installed on site at a later date. Moreover, limited possible material inputs within the One Click WLCA tool may not enable an exact replica of the construction products used. In these cases, the most alike materials will be selected. In addition to this, the changing of products after the completion of the Proposed Development will ultimately alter the embodied carbon information used within the WLCA model, in addition to the mileage associated with transport of these materials to the site.

Mileage and the effect of travel has been assessed within the OneClick software, albeit at a default setting. The setting gives values for the transportation of goods as outlined below within Table 3. These assumptions will be reviewed post completion in line with GLA guidance.

Transport Scenario	km by road*	km by sea**
Locally manufacturer e.g., Concrete, aggregate, earth	50	-
Nationally manufactured e.g., plasterboard, blockwork, insultation	300	-
European manufacturers e.g. CLT, façade modules, carpet	1,500	-
Globally manufactured e.g., specialist stone cladding	200	10,000

* Means of transport assumed as average rigid HGV with average laden – average laden as per BEIS carbon conversion factors.

** Means of transport assumed as average containership

Table 3: Default Transport scenarios for UK projects

The replacement of building elements is also considered within the WLCA based on information within the RICS documentation. The lifespan of a product is generic and is also based upon the element type. This will therefore not represent actual building use, or the precise product selected. By way of an example, a product with a 10-year lifespan prediction, will need to be replaced 5 times through the 60-year lifespan – in addition to the first installation.

The lifespan of the products is based on the information contained within Table 4.

Building Part	Building Elements/Components	Expected Lifespan
Roof	Roof Coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall Finishes: render/paint	30/10 years respectively
	Floor finishes: Raised Access Floor (RAF)/Finish Layers	30/10 years respectively
	Ceiling finishes: substrate/paint	20/10 years respectively
Furniture, fixings, and Equipment (FF&E)	Loose furniture and fittings	10 years
Services/MEP	Heat source, e.g. boiler, calorifiers	20 years
	Space heating and air treatment	20 years
	Ductwork	20 years
	Electrical installations	30 years
	Lighting fittings	15 years
	Communications installations and controls	15 years
	Water and disposal installations	25 years
	Sanitaryware	20 years
	Lift and conveyor installations	20 years
Façade	Opaque modular cladding e.g., rain screens, ey panels	30 years
	Glazed cladding/curtain walling	35 years
	Windows and external doors	30 years

Table 4: Assumed lifespan of materials

All specific assumptions made by SRE are included in Appendix C. These relate to specifications, inputs into OneClick and modelling software.

4.0 Results

4.1 Outcomes and Units

The units required to be used within the outputs for the WLCA are clearly defined by the RICS documentation. This is to ensure that the results can be compared to peer projects meaningfully and fairly. Therefore, the following normalisation units are utilised for the proposed building use at the site:

- Buildings; planning use classes D1-D2: *$kgCO_2e/m^2$ of Net Internal Area*

4.2 Outcomes per lifecycle stage

The embodied WLC for the Proposed scheme has been based on the full OneClick material component database and supporting information provided as listed in Section 3.0, and results summarised within Table 5 below:

	Building				
Module	School Hall Extensions	Sports Hall	Sports Pavilion	Teaching Block	Sitewide
A1-A5 Construction Process stage ($kgCO_2e$)	136,407	1,930,232	210,259	3,076,980	5,353,878
B1-B5 Use Stage (Excluding B6-B7) ($kgCO_2e$)	74,314	762,464	94,094	1,600,075	2,530,947
C1-C4 End of Life stage ($kgCO_2e$)	5,432	156,760	12,819	107,213	282,224
Biogenic Carbon ($kgCO_2e$)	-2,889	-104,611	-5,508	-21,935	-134,943
Total GWP ($kgCO_2e$)	213,264	2,744,845	311,664	4,762,333	8,032,106
Total GWP ($kgCO_2e/m^2$)	1,376	1,024	1,020	963	

Table 5: WLCA Emission Results per Lifecycle Stage (sitewide and per building)

It should be noted that the figures presented in Table 5 are the result of a point-in-time assessment, based on the information available at the time of the assessment. As more quantities and details of the components become available, the WLCA model may need to be updated to capture the embodied carbon emissions for the development more accurately.

Figure 4 below shows that life cycle stage A1-A3, Materials & Product stage accounts for the greatest quantities of carbon emissions within all buildings studied within the scope. This is followed by the life cycle stage B4 Replacement with specifically the MEP replacement products accounting for the largest proportion of the B4 emissions.

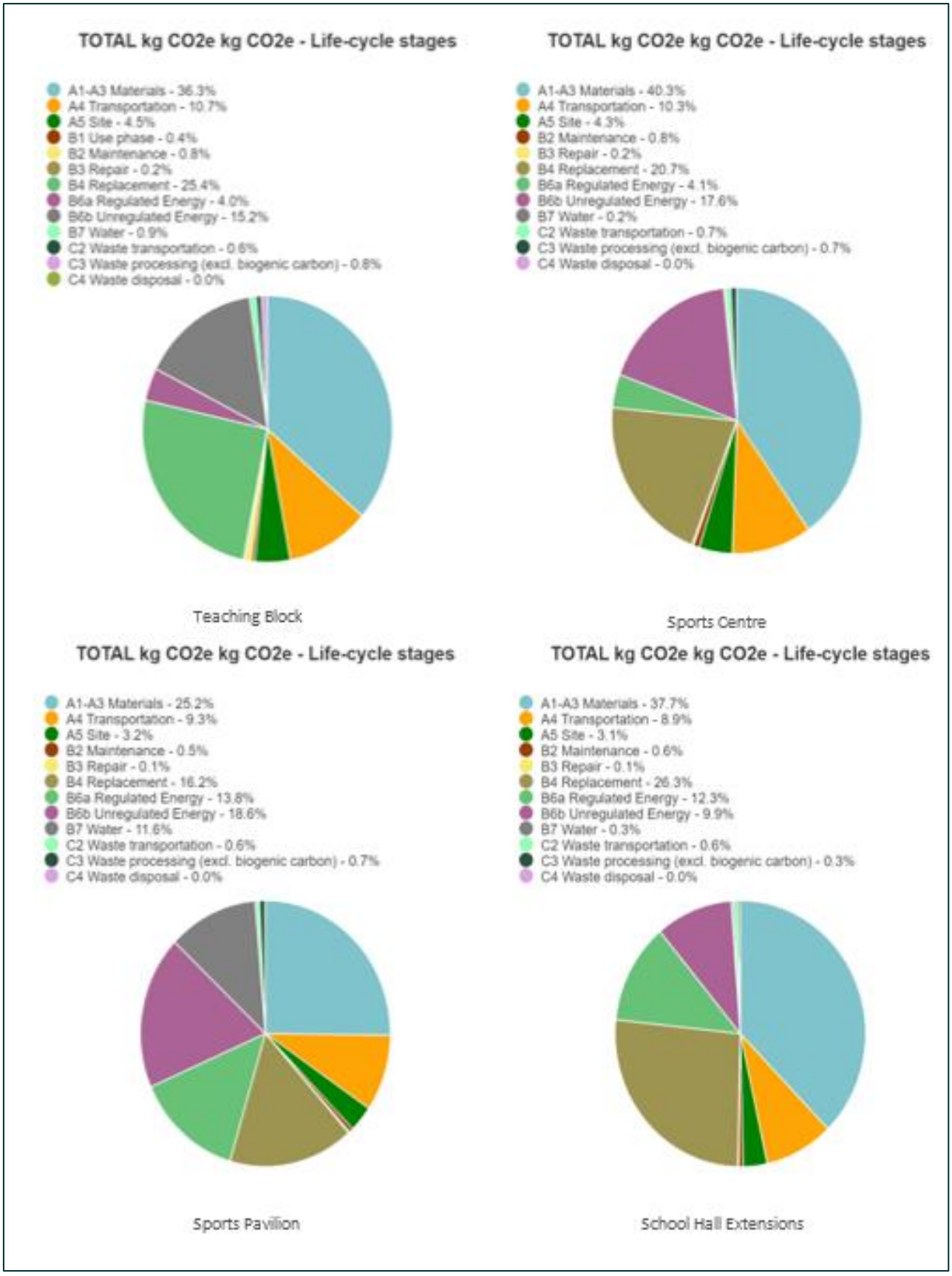

Figure 4: Breakdown of Carbon Emissions by Lifecycle Stage per Building

4.3 Most Contributing Building Elements & Materials

In order to capture a more detailed picture of carbon emissions related to A1-A3 lifecycle stages, Figure 6 give a breakdown of the different resource type contributions to overall carbon emissions whereas figure 7 represent the most contributing building elements.

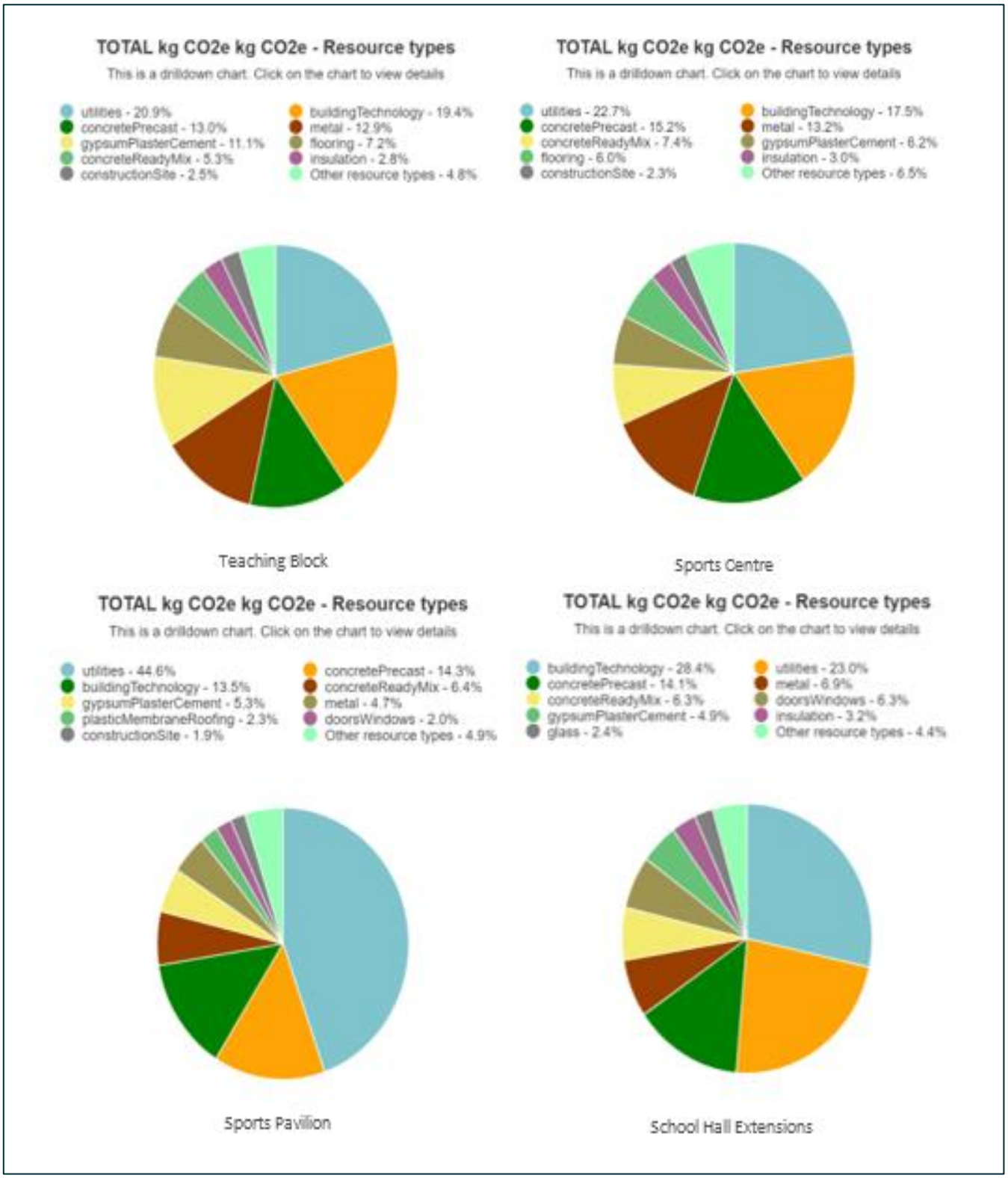

Figure 5 – Kneller Hall Carbon Emissions Split by Contributing Materials per Building

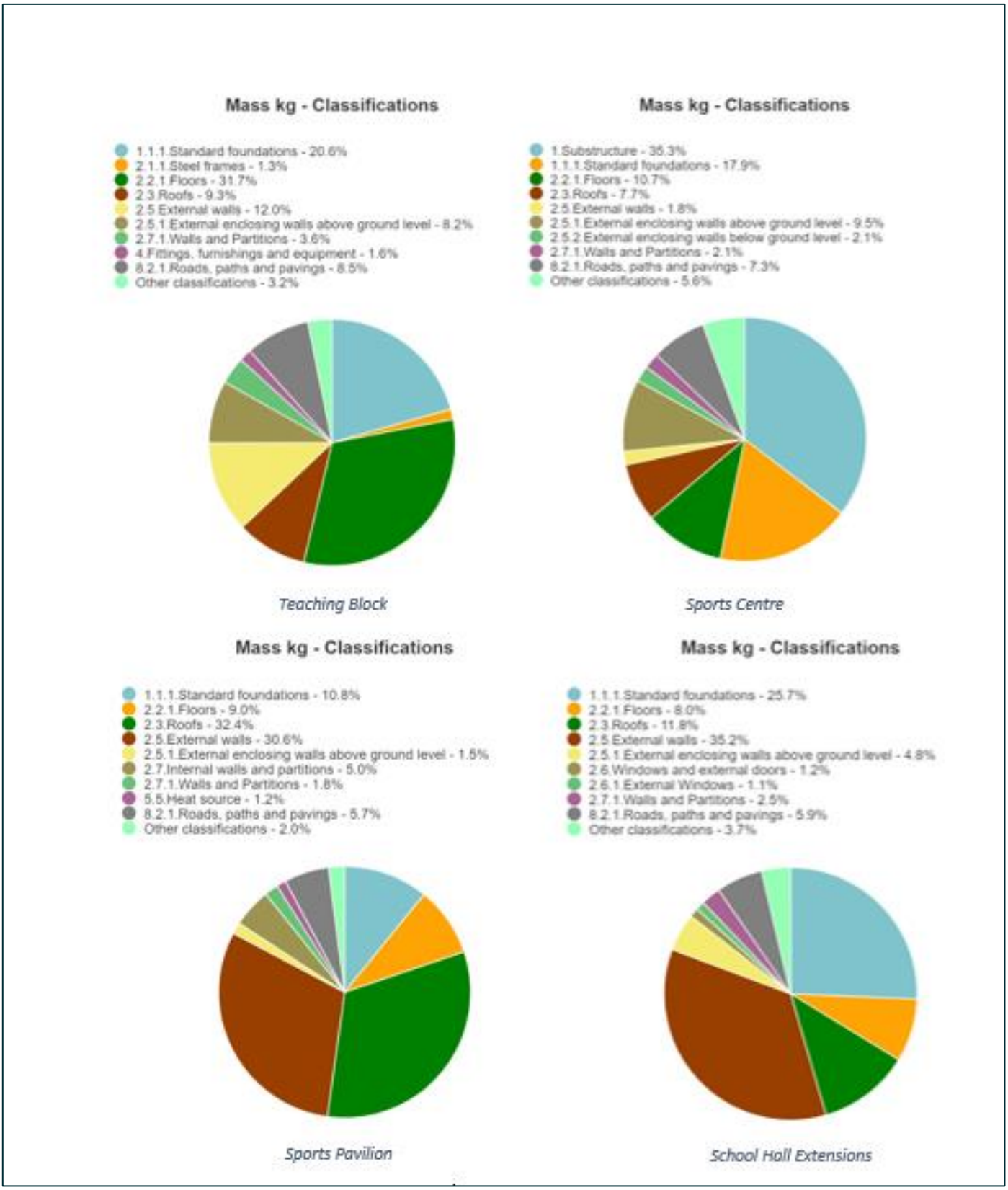

Figure 6 – Kneller Hall Carbon Emissions Split by Contributing Element per Building

4.4 Discussion of Results

By completing the WLCA model and reviewing the design information available to date, the following observations have been made.

4.4.1 Operational Energy Use

As can be seen in Section 4.2, carbon emissions within the lifecycle stage B6, Operational Energy Use, has a substantial contribution to the WLC performance of the scheme.

Results from the Dynamic Energy SBEM model of the Proposed Development provided have been used as input to the WLCA model to represent the regulated energy use of the scheme. This includes energy use related to building services (heating, cooling, hot water, ventilation) and lighting as well as the unregulated energy load (appliances and process loads based on intended usage). Figure 7 below shows the operational energy consumption of the teaching Block as an example.

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	7.89	9.79
Cooling	0.23	0.14
Auxiliary	5.82	2.51
Lighting	3.31	6.13
Hot water	3.1	5.09
Equipment*	22.51	22.51
TOTAL**	**20.34**	**23.66**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	23.46	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*23.46*	*0*

Figure 7 – Regulated and Unregulated Energy consumption and PV offsetting (Teaching Block BRUKL report)

In most of the buildings, space heating makes up the greatest contribution to the overall regulated energy use of the scheme. However, the results shown represents the actual heating demand from the heat pumps and not the consumption of electricity from the grid. As both the heating and hot water are provided by ASHPs, the consumption of grid electricity is taken as one third of the heating and water heating demand from the communal heat pump (assuming heat pump efficiency of 300%). However, in the case of the Sports Centre, due to the addition of the large swimming pool, water heating contributes the largest proportion of energy consumption which will have to be confirmed at post-construction stage by a recognised specialist.

4.4.2 Materials Assumptions and Potential Improvements

As can be seen from Section 4.2, carbon emissions within the lifecycle stage A1-A3, Materials and Product, has the most significant impact on the WLC performance of the scheme. The following discusses some of the assumptions used in the WLCA modelling and the recommendations that can be explored to minimize the embodied carbon associated within stages A1-A3 of the WLCA.

Timber

Timber studwork in the Proposed Development has been taken as softwood, and timber formwork taken as plywood in accordance to RICS guidance. Glulam beams have also been proposed for the Sports Centre and Pavilion. Alongside serving aesthetic preference, these materials assist in the reduction of life cycle emissions through the increase in biogenic storage and the less carbon intensive manufacturing methods.

Insulation

Where unspecified, the insulation used in floors, roof and external walls have been taken as mineral wool, otherwise where specified, the insulation type has been included according to information provided.

Precast / Concrete

Concrete's environmental impact can be reduced by replacing a proportion of the ordinary Portland Cement and sand content with recycled alternatives such as fly ash or ground granulated blast furnace slag (GGBS). The default RICS guidance is an allowance of 20% cement replacement.

Hard Landscaping

Tarmac hard landscaping has been proposed to be used for pedestrian/vehicular surfaces and car parking spaces on Site. As the design progresses, the team will explore alternative materials to reduce the total embodied carbon impact of the Proposed Development. Permeable paving and soft landscaping are also proposed on part of the site to maintain suitable drainage.

Glazing frames

Standard aluminium framed windows have been assumed for the Proposed Development. In order to reduce the embodied carbon result, the development team will explore alternative measures including Timber window frames.

Photovoltaics (PV)

A total annual PV generation of approximately 184,834kWh has been taken into account for to offset part of the operational carbon emissions impact (Stage B6) over the life of the Proposed Development.

Transportation

At this stage, the RICS recommended transport distances (see Table 3) have been adopted. It has been recommended that locally sourced materials with an EPD should be used where possible.

Waste Removal

Removal of waste has been taken into account as part of Stage D of the WLCA – This will offset the amount of embodied carbon in the scheme.

Refrigerants

Refrigerant masses have been calculated from VRV capacities and given models provided by the Project Team. Leakages have been taken from assumptions available within Appendices 4 and 5 in the Integral Group Practice Guide (https://www.integralgroup.com/news/refrigerants-environmental-impacts/).

4.4.3 Embodied Carbon

Results of the proposed scheme are shown in Table 7 and can be compared against the WLC benchmarks for apartments specified in the GLA guidance (Appendix E).

The WLC benchmarks specified are used as a guide where projects with higher WLC emissions than the benchmarks are urged to examine how they can reduce WLC emissions. A further set of aspirational WLC benchmarks have been developed which are based on a 40% reduction in WLC emissions on the first set of WLC benchmarks. This is based on the World Green Building Council's target to achieve a 40% reduction in WLC emissions by 2030. As of now, modules B6, B7 and D have not been included in the benchmarks due to their variability in predicted and actual readings upon construction and use of the Proposed Development.

The results show that the carbon emissions associated with the Kneller Hall development do not fall within the boundaries established within the GLA guidelines. Material carbon emissions can be seen to remain below the GLA benchmark partially due to the implementation of glulam and other biogenic materials around the site.

On the other hand, through the addition of intensive MEP strategies with the example of pool heating in the Sports Centre, 'use-phase' emissions can be seen to exceed the WLC benchmark by approximately 91.99 kgCO2e/m2 . Despite this, the Project Team have targeted the implementation of air source and ground source heat pumps across the new constructions which can be credited as renewable technologies compared to alternatives such as gas boilers for example.

Life Cycle Stages	Site Emissions	GLA Baseline WLC Benchmark	GLA Aspirational WLC Benchmark
A1-A5 (excluding sequestration)	664.19	<750 kgCO2e/m^2	<500 kgCO2e/m^2
B-C (excluding B6 and B7)	341.99	<250 kgCO2e/m^2	<175 kgCO2e/m^2
A-C (excluding B6 & B7, including sequestration)	1,006.40	<1000 kgCO2e/m^2	<675 kgCO2e/m^2

Table 7 – Embodied carbon emissions over life cycle of the proposed scheme

5.0 Conclusion

Through a considered cradle to grave approach to carbon life cycle costs, the Proposed Development at Kneller Hall, Twickenham can be seen to incorporate modern and renewable materials and mechanisms in attempts to reduce its overall impact on both the local and global environment.

The selection of highly sustainable materials within some of the new constructions, where suitable, the scheme aims to facilitate best practice construction techniques and implementation. Despite not meeting the GLA guidelines regarding carbon emission per square meter, the ability to facilitate carbon reductions in other areas including the implementation of PV panels across the two largest roof areas prove testament to the Project Team's attempts to encourage a more sustainable and environmentally conscious site.

Appendices

Appendix A Carbon Reporting for the Teaching Block: Whole life carbon assessment, Greater London Authority (based on RICS guidance)

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B6 Operational Energy use - Unregulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																		
0.2 Demolition																		
0.3 Supports																		
0.4 Groundworks																		
0.5 Diversion																		
1 Substructure	0	272 696	52 002	15 289			0							9 543	808	18	350 355	−43 786
2.1 Frame	0	266 351	3 393	9 043			0							4 067	231		283 085	−193 488
2.2 Upper Floors	0	337 827	288 434	30 325			0	521 864	0					5 580	27 895	34	1 211 959	−278 595
2.3 Roof	−271	201 672	98 646	7 628			0	28 059	0					2 703	17 932	80	354 447	−55 716
2.4 Stairs & Ramps	0	16 994	6 560	38			0							125	14		23 732	−2 548
2.5 Ext. Walls	−72	303 352	132 706	23 244			0	73 063	0					6 716	700	45	539 755	−46 317
2.6 Windows & Ext. Doors	0	286 397	2 024	19 288			0	38 187	0					2 085	74	0	348 056	−234 691
2.7. Int. Walls & Partitions	−744	71 654	4 805	8 381			0	47 888	0					2 770	840	64	135 657	−17 302
2.8 Int. Doors	−7 426	4 251	647	0			0	4 958	0					16	7 467	2	9 915	0
3 Finishes																		
4 Fittings, furnishings & equipments	−13 423	46 649	1 838	1 952			0	243 985	0					81	13 640	11	294 734	0
5 Services (MEP)	0	263 959	3 028	1 190	25 550	49 438	12 600	554 483	0	238 822	906 087	52 148		1 361	121	23	2 110 809	−156 124
6 Prefabricated																		
7 Existing bldg																		
8 Ext. works	0	94 346	47 766	4 591			0							1 959	210		148 871	−2 668
Unclassified / Other				150 012													150 012	
TOTAL kg CO2e kg CO2e	−21 935	2 166 147	639 850	270 983	25 550	49 438	12 600	1 512 487	0	238 822	906 087	52 148		37 004	69 932	277	5 961 390	−1 031 235

Appendix B Carbon Reporting for the Sports Centre: Whole life carbon assessment, Greater London Authority (based on RICS guidance)

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B6 Operational Energy use - Unregulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																		
0.2 Demolition																		
0.3 Supports																		
0.4 Groundworks																		
0.5 Diversion																		
1 Substructure	0	502 813	179 886	18 233			0							13 782	1 225	20	715 959	-84 750
2.1 Frame	-18 435	136 535	3 426	6 242			0							1 962	18 691		148 441	-111 634
2.2 Upper Floors	-41	78 698	23 343	8 065			0	205 795	0					1 325	13 955	8	331 148	-118 977
2.3 Roof	-82 087	217 420	63 267	13 457			0	16 580	0					2 159	91 919	37	322 752	-120 502
2.4 Stairs & Ramps	0	4 865	1 907	9			0							36	4		6 821	-703
2.5 Ext. Walls	-104	175 682	58 465	16 983			0	47 608	0					2 605	938	46	302 223	-53 183
2.6 Windows & Ext. Doors	-3 537	31 289	763	778			0	25 314	0					553	3 562	1	58 722	-4 123
2.7. Int. Walls & Partitions	-346	26 174	1 996	3 246			0	20 791	0					1 207	387		53 455	-5 690
2.8 Int. Doors																		
3 Finishes																		
4 Fittings, furnishings & equipments	-61	4 575	88	188			0	23 478	0					8	83	1	28 362	0
5 Services (MEP)	0	186 918	3 115	965	0	26 800	6 803	389 295	0	143 676	620 411	7 387		952	85	13	1 386 419	-113 751
6 Prefabricated																		
7 Existing bldg																		
8 Ext. works	0	51 141	25 892	2 489			0							1 062	114		80 697	-1 446
Unclassified / Other				81 320													81 320	
TOTAL kg CO2e kg CO2e	-104 611	1 416 110	362 148	151 974	0	26 800	6 803	726 861	0	143 676	620 411	7 387		25 671	130 964	125	3 516 319	-614 759

Appendix C Carbon Reporting for the Sports Pavilion: Whole life carbon assessment, Greater London Authority (based on RICS guidance)

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B6 Operational Energy use - Unregulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																		
0.2 Demolition																		
0.3 Supports																		
0.4 Groundworks																		
0.5 Diversion																		
1 Substructure	0	34 360	8 820	1 255			0							1 001	67	3	45 507	−3 934
2.1 Frame	−1 574	157	128	50			0							3	1 585		348	−1 371
2.2 Upper Floors	−341	3 432	5 160	1 138			0	8 509	0					95	355		18 347	−1 463
2.3 Roof	0	29 937	27 224	1 369			0	5 643	0					798	3 731	40	68 742	−11 650
2.4 Stairs & Ramps																		
2.5 Ext. Walls	−3 350	24 295	6 475	1 542			0	1 761	0					731	3 529	3	34 987	−9 245
2.6 Windows & Ext. Doors	0	9 305	139	104			0	8 558	0					92	2	0	18 201	−2 498
2.7. Int. Walls & Partitions	0	14 739	345	1 229			0	10 271	0					217	14		26 815	−859
2.8 Int. Doors	−243	139	21	0			0	162	0					1	244	0	325	0
3 Finishes																		
4 Fittings, furnishings & equipments	0	5 335	124	219			0	27 353	0					3	8	0	33 043	0
5 Services (MEP)	0	13 121	315	75	0	3 054	756	28 027	0	77 140	103 883	64 800		148	13	2	291 334	−22 579
6 Prefabricated																		
7 Existing bldg																		
8 Ext. works	0	5 814	2 943	283			0							121	13		9 174	−164
Unclassified / Other				10 665													10 665	
TOTAL kg CO2e kg CO2e	−5 508	140 635	51 695	17 929	0	3 054	756	90 284	0	77 140	103 883	64 800		3 209	9 561	49	557 487	−53 763

Appendix D Carbon Reporting for the School Hall Extensions: Whole life carbon assessment, Greater London Authority (based on RICS guidance)

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B6 Operational Energy use - Unregulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																		
0.2 Demolition																		
0.3 Supports																		
0.4 Groundworks																		
0.5 Diversion																		
1 Substructure	0	25 641	12 969	612			0							689	53	1	39 966	−4 301
2.1 Frame	−2 864	7 010	392	558			0	927	0					83	2 893		8 999	−6 803
2.2 Upper Floors	0	1 462	2 284	493			0	3 793	0					42	5		8 079	−478
2.3 Roof	0	10 607	104	254			0	1 278	0					131	650		13 024	−4 170
2.4 Stairs & Ramps																		
2.5 Ext. Walls	−3	16 905	6 445	1 083			0	705	0					421	51	3	25 610	−3 147
2.6 Windows & Ext. Doors	0	12 030	398	113			0	11 523	0					159	1	1	24 226	−626
2.7. Int. Walls & Partitions	−23	2 456	75	270			0	1 401	0					85	26	3	4 292	−504
2.8 Int. Doors																		
3 Finishes																		
4 Fittings, furnishings & equipments	0	772	71	34			0	4 247	0					2	5	0	5 131	0
5 Services (MEP)	0	23 705	124	209	0	1 550	359	48 532	0	33 669	27 181	729		52	5	1	136 116	−8 022
6 Prefabricated																		
7 Existing bldg																		
8 Ext. works	0	2 976	1 507	145			0							62	7		4 696	−84
Unclassified / Other				4 703													4 703	
TOTAL kg CO2e kg CO2e	−2 889	103 566	24 368	8 473	0	1 550	359	72 405	0	33 669	27 181	729		1 727	3 695	10	274 842	−26 136

Appendix E London Plan Guidance WLC Benchmarks

Whole Life-Cycle Carbon Assessments – London Plan Guidance

Schools, universities etc.			
Modules	**WLC benchmark ($kgCO_2e/m^2$ GIA)**	**Aspirational WLC benchmark ($kgCO_2e/m^2$ GIA)**	**Breakdown of a typical development**
A1-A5 (excluding sequestration)	<750	<500	Substructure: 33 per cent Superstructure: 30 per cent Façade: 13 per cent
B-C (excluding B6 & B7)	<250	<175	Substructure: 2 per cent Superstructure: 4 per cent Façade: 37 per cent Internal finishes: 14 per cent Services/MEP: 29 per cent External works: 14 per cent
A-C (excluding B6 & B7, including sequestration)	<1000	<675	Substructure: 25 per cent Superstructure: 24 per cent Façade: 19 per cent Internal finishes: 9 per cent Services/MEP: 15 per cent External works: 8 per cent

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Appendix F WLCA OneClick Inputs – Teaching Block

RICS Category		Element Description	Material Used	Total Qty	Unit
1. Foundations and substructure	Foundations	Pile Cap	Pile cap, reinforced concrete, 1.6x1.6x0.5 m (5.25x5.25x1.64 ft)	60	Unit
		Concrete Piles	Deep foundation concrete piles, Joint piles 235x235 mm (9x9 in), 4 reinforcing bars Ø16 mm (0.6 in)	1420	m
		Ground Insulation	Phenolic insulation with double aluminium foil facing as vapor barrier, L = 0.022 W/mK, R = 3 m2K/W, 66 mm, 3.96 kg/m2, 60 kg/m3, KoolDuct Insulation (Kingspan Insulation)	112.69	m^3
		Ground Beam	Precast concrete ground beam, 2400 kg/m3 (British Precast)	0.36	m^3
		Ground Floor Slab Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	454.67	m^3
		Ground Floor Slab Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	14.09	m^3
2. Vertical structures and façade	External Wall	External Blockwork	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB).	209.05	m^3
		Blockwork Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	14.12	m^3
		Façade Columns Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	4.74	m^3
		Façade Floor Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	0.70	m^3
		Wall Pillars Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	1.72	m^3
		Parapet Blockwork	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB).	66.43	m^3
		Parapet Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	4.77	m^3
		External Insulation	Glass wool insulation panels, unfaced, generic, L = 0.032 W/mK, R = 3.13 m2K/W (18 ft2°Fh/BTU), 50 kg/m3 (3.12 lbs/ft3), (applicable for densities: 25-50 kg/m3 (1.56-3.12 lbs/ft3)), Lambda=0.032 W/(m.K)	140.04	m^3

		External Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	14.00	m^3
		Plaster Finish	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	5.60	m^3
		Red Brick Cladding	Red brick, average production, UK, 215 mm x 102.5 mm x 65 mm, 2.13 kg/unit, 1485 kg/m3 (Brick Development Association (BDA) Ltd (2019))	94.27	m^3
		Brick Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	20.00	m^3
		Copper Façade	Metal facade cladding from copper (Nordic Green, Blue and Brown), 0.6 mm, 6.7 kg/m2, Design profile Venice, Design profile Tokyo, Design profile Rome (Ruukki Construction Oy)	193.76	m^2
		Copper Cladded Blockwork	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB)	36.16	m^3
		Copper Cladded Blockwork Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	2.60	m^3
		Copper Cladded External Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	2.42	m^3
		Copper Cladded Plaster Finish	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	0.97	m^3
		Copper Cladded Insulation	Glass wool insulation panels, unfaced, generic, L = 0.032 W/mK, R = 3.13 m2K/W (18 ft2°Fh/BTU), 50 kg/m3 (3.12 lbs/ft3), (applicable for densities: 25-50 kg/m3 (1.56-3.12 lbs/ft3)), Lambda=0.032 W/(m.K)	24.22	m^3
		Perforated Dense Brick	Perforated dense facing bricks, light coloured, 215 x 100 x 65 mm, 2.375 kg/unit, 0.012 m3/unit, 1950 kg/m3, 22.5 N/mm2 (Marshalls Bricks and Masonry)	9284.28	Unit
		External Spandrel Panels	Sandwich panel with insulation foam core and double steel/membrane siding, U=0.14 W/m2K, 120 mm, 12.5 kg/m2, 104.2 kg/m3, KS1000 Quadcore Topdek Insulated Panel (Kingspan)	94.39	m^2
		Wall Pillars Concrete	Precast concrete wall elements (solid, uninsulated), generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3), incl. reinforcement	55.65	m^3
		Façade Floor Concrete	Precast concrete wall elements (solid, uninsulated), generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3), incl. reinforcement	22.76	m^3

		Façade Columns Concrete	Precast concrete wall elements (solid, uninsulated), generic, C30/37 (4400/5400 PSI), 20% recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3), incl. reinforcement	153.19	m^3
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
2. Vertical structures and façade	Columns and Load-Bearing Vertical Structural	Steel Columns	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	29088.36	kg
	Internal Walls and Non-Bearing Structures	IP Studs	Galvanised steel profiles (studs) for internal wall framing, 0.7 mm, 0.9 kg/m, 37 mmx73.5 mm	1805.81	kg
		IP Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	17.01	m^3
		IP Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	1.71	m^3
		IP Acoustic Insulation	Acoustic partition roll insulation, unfaced, L = 0.043 W/mK, R = 1.70 m2K/W, 75 mm, 0.9 kg/m2, 12 kg/m3, (APR 1200) 75mm (Saint-Gobain ISOVER UK)	23.92	m^3
		IP Studs	Galvanised steel profiles (studs) for internal wall framing, 0.7 mm, 0.9 kg/m, 37 mmx73.5 mm	5173.20	kg
		IP Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	148.92	m^3
		IP Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	14.89	m^3
		IP Acoustic Insulation	Acoustic partition roll insulation, unfaced, L = 0.043 W/mK, R = 1.70 m2K/W, 75 mm, 0.9 kg/m2, 12 kg/m3, (APR 1200) 75mm (Saint-Gobain ISOVER UK)	223.38	m^3
		IP Block	Autoclaved aerated concrete blocks, 460-760 kg/m3, Aircrete (BPCF)	15.54	m^3
		IP Block Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	0.10	m^3
		IP Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	2.97	m^3
		IP Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	0.59	m^3
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
	Roofs Floors	1^{st} and 2^{nd} Floor Slabs	Hollow-core slab floor assembly, incl. mineral wool acoustic slabs, 340 mm, with Okobau.dat data	3236.34	m^2

3. Horizontal structures: beams, floors and roofs	Balconies	Roof Slab	Hollow-core slab roof assembly, HDF270	1693.34	m^2
		Flooring	Foam backed vinyl (PVC) flooring, heterogeneous, 3.1 mm, 2.67 kg/m2, Tapiflex Essential 50, TX Modulaire (Tarkett)	4943.81	m^2
		Finishes	Calcium sulphate screed, 1500 kg/m3	346.07	m^3
		Underside	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	61.62	m^3
		Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	24.65	m^3
		Beams	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	77112	kg
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
4. Other structures and materials	Windows and Doors Finishes and coverings Fittings	Teacher Desks	Wooden desk with screen, 64.48 kg/unit (47.97 kg/m2 of workspace), 0.96 m2 workspace unit (0.744 workspace units/m2), Ratio Desk with Screen (Herman Miller (UK plant))	12.54	m^2
		Teacher Chairs	Office chair, 8.22 kg/unit, Caper Chair (Herman Miller (UK plant))	41	Unit
		Student Desks	Wooden desk with screen, 64.48 kg/unit (47.97 kg/m2 of workspace), 0.96 m2 workspace unit (0.744 workspace units/m2), Ratio Desk with Screen (Herman Miller (UK plant))	185.24	m^2
		Student Chairs	Wooden chair, 4 kg/unit, Postura (KI)	571	Unit
		Staff Room Sofa	3-seater sofa, 40.0 kg/unit, Nexus (VAD)	6	Unit
		Student Tables	Adjustable table, 24 x 48 inch, 57 kg/unit, Toggle (KI)	76	Unit
		Round Café Tables	Round table, white, Dia. 700 mm, 22.79 kg/unit (23.72 kg with packaging), Optima conference table Ø700 HPL white (JSC Svenheim)	19	Unit
		Café Table Chairs	Canteen chair, 5.2 kg/unit, RBM Noor 6050/55 (Flokk AS)	76	Unit
		Canteen Dining Tables	Dining table, wooden, 26.75 kg/unit, Pan (Helland Møbler)	55	Unit
		Canteen Chairs	Canteen chair, 5.2 kg/unit, RBM Noor 6050/55 (Flokk AS)	330	Unit
		Upstairs Round Tables	Round table, white, Dia. 700 mm, 22.79 kg/unit (23.72 kg with packaging), Optima conference table Ø700 HPL white (JSC Svenheim)	8	Unit
		Upstairs Round Tables Seating	Canteen chair, 5.2 kg/unit, RBM Noor 6050/55 (Flokk AS)	52	Unit
		Precast Staircase	Precast concrete staircase, width 140mm (MDEGD)	24.07	m
		Stair Handrail	Stainless steel handrail, diam. 45mm, Donnee par default (MDEGD)	125.51	m

		Rainwater Pipe	Rainwater drainage pipe, PVC, diamètre 100 mm, DONNEE PAR DEFAUT (DED)	272.40	m
		Sinks	Porcelain sink, 29.6 kg/unit, 50 x 70 cm (SFISB)	23	Unit
		Double Glazing 20mm	Double glazing - no frame, 1 mm, ex cavity and ex frame	478.86	m^2
		Aluminium Window Frames	Extruded aluminium profiles for window and door frames, generic, 40% recycled content, average world technology (One Click LCA 2022)	141.03	m^2
		Mullions	Aluminium sheet, generic, 20% recycled content, average European technology (One Click LCA 2022)	10.01	m^3
		Louvers	Painted aluminum louvers, 19.14 kg/m2 (Industrial Louvers, Inc. (ILI))	94.21	m^2
		Double Glazing 20mm	Double glazing - no frame, 1 mm, ex cavity and ex frame	85.25	m^2
		Mullions	Aluminium sheet, generic, 20% recycled content, average European technology (One Click LCA 2022)	1	m^3
		Doors	Doors with wooden frame, interior, DONNEE PAR DEFAUT (DED)	311.56	m^2
		Toilets	Porcelain WC kit (toilet and tank), 37.4 kg/unit, DURAVIT : Duraplus (023009+087920) KOHLER : Odeon Up (4956CK+E4708 ; 4956CK+E4740 ; 18557K+E4708 ; 18557K+E4740). Brive (E4380+E4452 ; E4380+E4453 ; E4381+E4452 ; E4381+E4453 ; E1730+E4452). Eolia (E4380+E4269). Patio (UJD101+ETB111 ; UJB101+ETB111 ; UJV101+ETB111 ; UJW101+ETB111 ; UJV101+ETB211). Struktura (UJX101+ETE111 ; UJH101+ETE111) // ROCA : VICTORIA (A349392000 ; A349393000 ; A34P395000). DEBBA (A34D999000 ; A34D99L000) (Association Française des Industries de la Salle de Bains)	44	Unit
		Rooflight	Aluminium framed rooflight, U = 1.1 W/m2K, 51.67 kg/m2, Mardome Glass Trade (Brett Martin Daylight Systems)	5	m^2
		Round Windows	Aluminium frame window, 24.27 kg/m2, 2.3 m2/unit (Organisation professionnelle représentative des concepteurs, fabricants et installateurs de menuiseries extérieures en profilés aluminium)	16.52	m^2
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
5. External areas and site elements	Materials and constructions	Permeable Paving	Ceramic paving stones, 2300 kg/m3 (Hispalyt)	89.75	m^3
		Tarmac	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3	91.81	m^3

	for external areas	Resin Bound Aggregate	Resin bound aggregate decorative paving system, 3-10 mm grain size, 100 - 150 mm, 1060 kg/m3, Addaset, Addabound, Terrabound and Terrabase (Addagrip Terraco)	233.16	m^3
6. Building technology	Building systems and installations	PV Panels	Solar panel photovoltaic system, EU average	672.30	m^2
		GSHP	Ground source heat pump (excluding ground tubes), per 1kW max output power -beta	329	kW
		Water	Electric water heater (water cylinder), 200 liter capacity, Aquanext Plus, Nuos Plus 200, Aquanext Plus 250, Nuos Plus 250, Aquanext Opti 110, Nuos Evo 110 (Chaffoteaux)	3	Unit
		Kitchen Water	Electric water heater (water cylinder), 200 liter capacity, Aquanext Plus, Nuos Plus 200, Aquanext Plus 250, Nuos Plus 250, Aquanext Opti 110, Nuos Evo 110 (Chaffoteaux)	8	Unit
		Dining Hall AHU	Air handling unit, with heat recovery through indirect liquid circulation heat recovery, 10 000 m3/h (5885.8 ft3/min) 510 kg/unit (1124 lbs/unit)	12	Unit
		Kitchen Extract	Ventilation unit, air extraction, 78.1 kg/unit, 250-4000 m3/h, DONNEE PAR DEFAUT (DED)	3	Unit
		Kitchen Supply	Ventilation unit, air extraction, 78.1 kg/unit, 250-4000 m3/h, DONNEE PAR DEFAUT (DED)	3	Unit
		Lighting	LED office lighting, 5.95 kg/unit	508	Unit
		Local MVHR	Single-flow controlled mechanical ventilation unit (CMV), per unit, 4.61 kg/unit, 59 m3/h, HYGROCOSY BC-FLEX ref. 412279 (Groupe Atlantic)	1250	Unit
		Main Roof MVHR Units	Single-flow controlled mechanical ventilation unit (CMV), per unit, 4.61 kg/unit, 59 m3/h, HYGROCOSY BC-FLEX ref. 412279 (Groupe Atlantic)	117	Unit
		ICT FCU	Fan coil unit, 50 kg/unit, P=1 kW (One Click LCA)	32	Unit
		Space Heating	Electric radiator, per 1kW / unit	130	kW

Appendix G WLCA OneClick Inputs – Sports Hall

RICS Category		Element Description	Material Used	Total Qty	Unit
1. Foundations and substructure	Foundations	Floor Slab Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	563.61	m^3
		Floor Slab Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	17.43	m^3
		Pool Slab Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	101.31	m^3
		Pool Slab Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	3.13	m^3
		Floor Insulation	Phenolic insulation with double aluminium foil facing as vapor barrier, L = 0.022 W/mK, R = 3 m2K/W, 66 mm, 3.96 kg/m2, 60 kg/m3, KoolDuct Insulation (Kingspan Insulation)	1936.80	m^2
		Ground Beam	Precast concrete ground beam, 2400 kg/m3 (British Precast)	6.37	m^3
		Pile Caps	Pile cap, reinforced concrete, 1.6x1.6x0.5 m (5.25x5.25x1.64 ft)	36	Unit
		Concrete Piles	Concrete piles, rectangular, 235x235 mm, C50/60, XC2, XF1, reinforcement 4 st. Ø16 (Skanska)	2376	m
2. Vertical structures and façade	External Wall	External Blockwork	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB).	353.03	m^3
		Blockwork Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	25.35	m^3
		Red Brick Cladding	Red brick, average production, UK, 215 mm x 102.5 mm x 65 mm, 2.13 kg/unit, 1485 kg/m3 (Brick Development Association (BDA) Ltd (2019))	25.10	m^3
		Brick Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	0.91	m^3
		Pool Wall	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	39.42	m^3

		Pool Wall	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	1.22	m³
		External Insulation	Glass wool insulation panels, unfaced, generic, L = 0.032 W/mK, R = 3.13 m2K/W (18 ft2°Fh/BTU), 50 kg/m3 (3.12 lbs/ft3), (applicable for densities: 25-50 kg/m3 (1.56-3.12 lbs/ft3)), Lambda=0.032 W/(m.K)	236.49	m³
		External Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	23.65	m³
		Plaster Finish	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	9.46	m³
		Pool Wall Insulation	Insulation, EPS hard foam (grey) with thermal radiation absorber, L = 0.033 W/mK, 16.6 kg/m3 (IVH)	17.46	m³
		Mullions	Aluminium sheet, generic, 20% recycled content, average European technology (One Click LCA 2022)	1.77	m³
		Louvers	Painted aluminum louvers, 19.14 kg/m2 (Industrial Louvers, Inc. (ILI))	75.25	m²
		Court Louvers	Painted aluminum louvers, 19.14 kg/m2 (Industrial Louvers, Inc. (ILI))	641.98	m²
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
2. Vertical structures and façade	Columns and Load-Bearing Vertical Structural	Steel Columns	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	14324.88	kg
	Internal Walls and Non-Bearing Structures	IP Studs	Galvanised steel profiles (studs) for internal wall framing, 0.7 mm, 0.9 kg/m, 37 mmx73.5 mm	2296.97	kg
		IP Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	78.70	m³
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
3. Horizontal structures: beams, floors and roofs	Roofs Floors Balconies	Central Roof	Hollow-core slab roof assembly, HDF270	874.17	m²
		Pool and Tennis Roof	Timber (LVL) roof panel assembly	1162.96	m²
		Tennis Court Floor	Heterogeneous sports flooring, 4.44 kg/m2, Omnisports Reference,Omnisports Training, Omnisports Reference Multi-Use, Omnisports Active (Tarkett)	699.48	m²
		Roofloght Casing	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in	24.98	m³

			cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)		
		Rooflight Casing	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	0.77	m^3
		Pool Beams	Glued laminated timber (Glulam) beams (Kjeldstad)	26.64	m^3
		Underside Finishes	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	743.17	m^2
		Ground Floor Finish	Foam backed vinyl (PVC) flooring, heterogeneous, 2.6 mm, 1.8 kg/m2, TX Classic (Tarkett)	743.17	m^2
		Floor Finish	Foam backed vinyl (PVC) flooring, heterogeneous, 2.6 mm, 1.8 kg/m2, TX Classic (Tarkett)	1237.31	m^2
		Screed	Calcium sulphate screed, 1500 kg/m3	52.02	m^3
		Structure	Hollow-core slab floor assembly, incl. mineral wool acoustic slabs, 340 mm	743.17	m^2
		Beams	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	36301.80	kg
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
4. Other structures and materials	Windows and Doors Finishes and coverings Fittings	Precast Staircase	Precast concrete staircase, width 140mm (MDEGD)	7	m
		Bathroom Sinks	Glazed steel sink, Long. 860 mm Larg. 500 mm Haut. 140 mm, DONNEE PAR DEFAUT (DED)	18	Unit
		Toilets	Ceramic toilet, 19.6 kg/unit, - DURAVIT : Starck 3 (420009; 452709; 220209). ME by Starck (452909; 453009). DuraStyle (455209; 457109). // - KOHLER : Struktura (EDE101-00 ; EDF101-00). Patio (EDV101-00 ; E1534-00). Brive (E4345-00) // - ROCA : DEBBA (A346998000 ; A34699L000). VICTORIA (A34630300S). (Association Française des Industries de la Salle de Bains)	47	Unit
		Toilet Units	Bathroom vanity unit, biogenic CO2 not subtracted (for CML), 17.55 kg/unit, DONNEE PAR DEFAUT (DED)	2	Unit
		Stair Handrails	Stainless steel handrail, diam. 45mm, Donnee par default (MDEGD)	30.08	m
		Specified Cabinet	Cabinet, 100.303 kg/unit	1	Unit
		266 Lockers	3-Door particleboard locker, 1180 x 300 x 500 mm, 0.162 m3 storage/unit, 24.1 kg/unit, 3-DOOR LOCKER (Bisley)	86	Unit
		External Windows	Double glazing - no frame, 1 mm, ex cavity and ex frame	360.85	m^2

		Window Frames	Extruded aluminium profiles for window and door frames, generic, 40% recycled content, average world technology (One Click LCA 2022)	90.22	m²
		Rooflights	Aluminium framed rooflight, U = 1.1 W/m2K, 51.67 kg/m2, Mardome Glass Trade (Brett Martin Daylight Systems)	87.16	m²
		All Doors	Doors with wooden frame, interior, DONNEE PAR DEFAUT (DED)	148.41	m²
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
5. External areas and site elements	Materials and constructions for external areas	Permeable Paving	Ceramic paving stones, 2300 kg/m3 (Hispalyt)	48.65	m³
		Tarmac	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3	49.77	m³
		Resin Bound Aggregate	Resin bound aggregate decorative paving system, 3-10 mm grain size, 100 - 150 mm, 1060 kg/m3, Addaset, Addabound, Terrabound and Terrabase (Addagrip Terraco)	126.38	m³
6. Building technology	Building systems and installations	DHW Whole Building	Hot water heater (water cylinder), air/air heatpump powered, KALIKO SPLIT TWH WH-E, KALIKO SPLIT WH 200 E - 7632382 KALIKO SPLIT WH 150 E - 7632383 (De Dietrich)	7	Unit
		Pool Area AHU Coils	Heating coil, 4.9 kg/unit, 500-3100 W, DONNEE PAR DEFAUT (DED)	36	Unit
		Pool AHU	Air handling unit, with heat recovery through indirect liquid circulation heat recovery, 1000 m3/h (588.6 ft3/min), 92 kg/unit (203 lbs/unit)	21	Unit
		Pool Water Heating	Electric heat pump (air-water), 14 kW	29	Unit
		DHW	Electric heat pump (air-water), 14 kW	18	Unit
		Corridors, Lobby AHU	Air handling unit, with heat recovery through indirect liquid circulation heat recovery, 1000 m3/h (588.6 ft3/min), 92 kg/unit (203 lbs/unit)	12	Unit
		Sports Hall Heating Coil	Heating coil, 4.9 kg/unit, 500-3100 W, DONNEE PAR DEFAUT (DED)	5	Unit
		Assumed Cooling Coil Sports Hall	Heating coil, 4.9 kg/unit, 500-3100 W, DONNEE PAR DEFAUT (DED)	5	Unit
		Other Rooms	Air handling unit, with heat recovery through indirect liquid circulation heat recovery, 1000 m3/h (588.6 ft3/min), 92 kg/unit (203 lbs/unit)	9	Unit
		ASHP – Changing Area	Air heat pump, 2,2 kW, R410A	9	Unit
		Underfloor Heating	Underfloor heating system PEX, installation pipe spacing: 200mm, 30 mm insulation panel	209.11	m²

		LED Lighting	LED office lighting, 5.95 kg/unit	207	Unit
		PV Panels	Solar panel photovoltaic system, EU average	421.10	m²
		Changing Areas AHU Coils	Heating coil, 4.9 kg/unit, 500-3100 W, DONNEE PAR DEFAUT (DED)	8	Unit

Appendix H - WLCA OneClick Inputs – Sports Pavilion

RICS Category		Element Description	Material Used	Total Qty	Unit
1. Foundations and substructure	Foundations	Piles	Concrete piles, rectangular, 350x350 mm, C50/60, XC2, XF1, reinforcement 4 st. Ø20 (Skanska)	160	m
		Pile Caps	Pile cap, reinforced concrete, 1.6x1.6x0.5 m (5.25x5.25x1.64 ft)	8	Unit
		Ground Slab Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	81.48	m³
		Ground Slab Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	2.52	m³
		Floor Insulation	Phenolic insulation with double aluminium foil facing as vapor barrier, L = 0.022 W/mK, R = 3 m2K/W, 66 mm, 3.96 kg/m2, 60 kg/m3, KoolDuct Insulation (Kingspan Insulation)	305.44	m²
		Ground Beam	Precast concrete ground beam, 2400 kg/m3 (British Precast)	1.92	m³
2. Vertical structures and façade	External Wall	Aluminium Cladding	Aluminium facade cladding for ventilated curtain walls (VCW), 1 mm, 5.05 kg/m2, wellTEC, planTEC and colTEC (MN Metall)	4.62	m²
		Façade Insulation System	Façade insulation panel system, 100 mm (Isoklinker)	7.49	m²
		Timber Frame External Wall Assembly	Timber frame external wall assembly, incl. mineral wool insulation, U-value 0.18 W/m2K, 320 mm	192.09	m²
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
2. Vertical structures and façade	Columns and Load-Bearing Vertical Structural	Timber Columns	Timber column - for timber frame buildings, 190 mm x 360 mm	23.12	m

	Internal Walls and Non-Bearing Structures	IP	Autoclaved aerated concrete blocks, 460-760 kg/m3, Aircrete (BPCF)	2.45	kg
		IP	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	0.18	m^3
		IP	Fibre cement boards, 1300 kg/m3 (81.16 lbs/ft3)	3.60	m^3
		Ip	Autoclaved aerated concrete blocks, 460-760 kg/m3, Aircrete (BPCF)	11.18	m^3
		IP	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	0.80	m^3
		IP	Fibre cement boards, 1300 kg/m3 (81.16 lbs/ft3)	1.54	m^3
		IP	Gypsum plasterboard, 12.5 mm, 8.985 kg/m2 (average product weight) (Etex Building Performance)	4.45	m^3
		IP	Autoclaved aerated concrete blocks, 460-760 kg/m3, Aircrete (BPCF)	15.50	m^3
		IP	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	1.11	m^3
		IP	Gypsum plasterboard, 12.5 mm, 8.985 kg/m2 (average product weight) (Etex Building Performance)	4.32	m^3
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
3. Horizontal structures: beams, floors and roofs	Roofs Floors Balconies	Green Roof	Green roof assembly, with hollow-core concrete deck	351.95	m^2
		Screed	Calcium sulphate screed, 1500 kg/m3	21.38	m^3
		Roof Liner Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	18.78	m^3
		Roof Liner Steel Reinforcement	HS2 baseline - Steel reinforcement Bars & cages, EAF 97% Recycled Content (-)	0.58	m^3
		Glulam Beams	Glue laminated timber (Glulam) beams, 485.7 kg/m3, biogenic CO2 not subtracted (for CML), Poutre en Douglas lamellé-collé hors aubier des adhérents de France Douglas (France Douglas)	0.47	m^3
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
4. Other structures and materials	Windows and Doors Finishes and coverings	Toilets	Porcelain WC kit (toilet and tank), 37.4 kg/unit, DURAVIT : Duraplus (023009+087920) KOHLER : Odeon Up (4956CK+E4708 ; 4956CK+E4740 ; 18557K+E4708 ; 18557K+E4740). Brive (E4380+E4452 ; E4380+E4453 ;	5	Unit

	Fittings		E4381+E4452 ; E4381+E4453 ; E1730+E4452). Eolia (E4380+E4269). Patio (UJD101+ETB111 ; UJB101+ETB111 ; UJV101+ETB111 ; UJW101+ETB111 ; UJV101+ETB211). Struktura (UJX101+ETE111 ; UJH101+ETE111) // ROCA : VICTORIA (A349392000 ; A349393000 ; A34P395000). DEBBA (A34D999000 ; A34D99L000) (Association Française des Industries de la Salle de Bains)		
		Sinks	Porcelain sink, 29.6 kg/unit, 50 x 70 cm (SFISB)	5	Unit
		Soap Disepnsers	Electronic soap dispenser, 6.09 kg/piece, RS10F/B – stainless steel (VOLA)	5	Unit
		Mirror	Mirror, 6 mm, 15 kg/m2, 2500 kg/m3, Mirox MNGE Mirox MNGE SAFE + Mirox 4Green Mirox 4Green SAFE+ (AGC France SAS)	3.6	m^2
		Round Tables	Round table with one column foot, 16,3 kg (17,1 kg with packaging), Sector (Svenheim Møbelindustri)	6	Unit
		Round Table Chairs	Canteen chair, 5.2 kg/unit, RBM Noor 6050/55 (Flokk AS)	24	Unit
		Viewing Benches	Four seat bench, 68.2 kg/unit, Transit 24 (Fora Form AS)	8	Unit
		Windows	Double glazing - no frame, 1 mm, ex cavity and ex frame	48.41	m^2
		Window Frames	Extruded aluminium profiles for window and door frames, generic, 40% recycled content, average world technology (One Click LCA 2022)	12.10	m^2
		Doors	Doors with wooden frame, interior, DONNEE PAR DEFAUT (DED)	10.20	m^2
		Aluminium Doors	Aluminium door for exterior use, per m2, 70mm, 30.6kg/m2, ALU60 / ALU80 (CETIH)	16.02	m^2
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
5. External areas and site elements	Materials and constructions for external areas	Permeable Paving	Ceramic paving stones, 2300 kg/m3 (Hispalyt)	5.53	m^3
		Tarmac	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3	5.66	m^3
		Resin Bound Aggregate	Resin bound aggregate decorative paving system, 3-10 mm grain size, 100 - 150 mm, 1060 kg/m3, Addaset, Addabound, Terrabound and Terrabase (Addagrip Terraco)	14.37	m^3
6. Building technology	Building systems and installations	MVHR	Single-flow controlled mechanical ventilation unit (CMV), per unit, 4.61 kg/unit, 59 m3/h, HYGROCOSY BC-FLEX ref. 412279 (Groupe Atlantic)	59	Unit
		GSHP	Ground source heat pump (excluding ground tubes), per 1kW max output power -beta	106	kW

		DHW	Electric water heater (water cylinder), 200 liter capacity, Aquanext Plus, Nuos Plus 200, Aquanext Plus 250, Nuos Plus 250, Aquanext Opti 110, Nuos Evo 110 (Chaffoteaux)	5	Unit
		Lighting	LED office lighting, 5.95 kg/unit	23	Unit

Appendix I - WLCA OneClick Inputs – School Hall Extensions

RICS Category		Element Description	Material Used	Total Qty	Unit
1. Foundations and substructure	Foundations	Pile Cap	Pile cap, reinforced concrete, 1.6x1.6x0.5 m (5.25x5.25x1.64 ft)	13	Unit
		Concrete Piles	Deep foundation concrete piles, Joint piles 235x235 mm (9x9 in), 4 reinforcing bars Ø16 mm (0.6 in)	260	m
		Ground Insulation	Phenolic insulation with double aluminium foil facing as vapor barrier, L = 0.022 W/mK, R = 3 m2K/W, 66 mm, 3.96 kg/m2, 60 kg/m3, KoolDuct Insulation (Kingspan Insulation)	131.60	m^3
		Ground Beam	Precast concrete ground beam, 2400 kg/m3 (British Precast)	35.10	m^3
		Ground Floor Slab Concrete	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)	1.09	m^3
2. Vertical structures and façade	External Wall	External Blockwork	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB).	17.34	m^3
		Blockwork Mortar	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)	0.61	m^3
		Insulation	Glass wool insulation panels, unfaced, generic, L = 0.031 W/mK, R = 3.23 m2K/W (18 ft2°Fh/BTU), 25 kg/m3 (1.56 lbs/ft3), (applicable for densities: 0-25 kg/m3 (0-1.56 lbs/ft3)), Lambda=0.031 W/(m.K)	5.75	m^3
		Insulated Cladding	Insulated wall/roofing cladding panel, 100 mm, 14.4 kg/m2, U 0.18 W/m2K, BENCHMARK Quadcore Karrier (Kingspan)	46	m^2
		Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	0.575	m^3
		Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	0.23	m^3

		Steel Mesh Wall	Steel fencing welded wire mesh with columns per meter, h. 1,2m, DONNEE PAR DEFAUT (DED)	15.67	m
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
2. Vertical structures and façade	Columns and Load-Bearing Vertical Structural	Steel Columns	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355	1916.07	kg
	Internal Walls and Non-Bearing Structures	IP Studs	Galvanised steel profiles (studs) for internal wall framing, 0.7 mm, 0.9 kg/m, 37 mmx73.5 mm	205.67	kg
		IP Plasterboard	Gypsum plasterboard, L= 0.19 W/mK, R = 0.065 m2K/W, 12.5 mm, 8.1 kg/m2, 648 kg/m3, Wallboard (Knauf UK GmbH)	10.37	m^3
		IP Render	Gypsum finish plaster, damage resistant, 1250 kg/m3, Thistle DuraFinish (British Gypsum Saint Gobain (2021))	5.19	m^3
		IP Acoustic Insulation	Rock wool insulation panels, L=0.035 W/mK, R=4.29 m2k/W, 150 mm, 9 kg/m2, 60 kg/m3, Lambda=0.035 W/(m.K), Rainscreen Duo Slab 150mm (ROCKWOOL, UK plant)	10.37	m^3
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
3. Horizontal structures: beams, floors and roofs	Roofs Floors Balconies	Glulam Beams	Glue laminated timber (Glulam) beams, 485.7 kg/m3, biogenic CO2 not subtracted (for CML), Poutre en Douglas lamellé-collé avec aubier, traitée, des adhérents de France Douglas (France Douglas)	3.95	m^3
		Roof Assembly	Hollow-core slab roof assembly, HDF270	119	m^2
		Plant Room Steel Mesh Roof	Steel mesh ceiling tile system with acoustic inserts, 30mm, from 1200 x 300mm to 3000 x 600mm, 7.496kg/m2, 249.9kg/m2, SAS 320 (SAS International)	36	m^2
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
4. Other structures and materials	Windows and Doors Finishes and coverings Fittings	Double Glazed Windows	Double glazing - no frame, 1 mm, ex cavity and ex frame	52.56	m^2
		Window Frames	Extruded aluminium profiles for window and door frames, generic, 40% recycled content, average world technology (One Click LCA 2022)	13.14	m^2
		Doors	Aluminium door system, 1100 x 2200 mm, 96.48 kg, 39.87 kg/m2, ADS 75.SI (Schüco)	52.05	m^2
		Ceramic Toilet	Ceramic toilet, 19.6 kg/unit, - DURAVIT : Starck 3 (420009; 452709; 220209). ME by Starck (452909; 453009). DuraStyle (455209; 457109). // - KOHLER : Struktura (EDE101-00 ; EDF101-00). Patio (EDV101-00 ; E1534-00). Brive (E4345-00)	4	Unit

			// - ROCA : DEBBA (A346998000 ; A34699L000). VICTORIA (A34630300S). (Association Française des Industries de la Salle de Bains)		
		Porcelain Sink	Porcelain sink, 29.6 kg/unit, 50 x 70 cm (SFISB)	4	Unit
		Round Table	Round table, 53,0 kg (53,5 with packaging), 26 x D1200 mm, Optima (Svenheim Møbelindustri)	6	Unit
		Canteen Chairs	Canteen chair, 5.2 kg/unit, RBM Noor 6050/55 (Flokk AS)	24	Unit
RICS Category		**Element Description**	**Material Used**	**Total Qty**	**Unit**
5. External areas and site elements	Materials and constructions for external areas	Permeable Paving	Ceramic paving stones, 2300 kg/m3 (Hispalyt)	2.83	m^3
		Tarmac	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3	2.90	m^3
		Resin Bound Aggregate	Resin bound aggregate decorative paving system, 3-10 mm grain size, 100 - 150 mm, 1060 kg/m3, Addaset, Addabound, Terrabound and Terrabase (Addagrip Terraco)	7.36	m^3
6. Building technology	Building systems and installations	Toilet Extract Fan	Rooftop exhaust fan, max flowrate: 300 m3/h (176.6 ft3/min) - beta	1	Unit
		DHW	Electric water heater (water cylinder), 200 liter capacity, Aquanext Plus, Nuos Plus 200, Aquanext Plus 250, Nuos Plus 250, Aquanext Opti 110, Nuos Evo 110 (Chaffoteaux)	2	Unit
		ASHP – Main Extension	Air heat pump, 2,2 kW, R410A	8	Unit
		Lighting	LED office lighting, 5.95 kg/unit	22	Unit
		Radiators	Water circulation radiator, per 1kW / unit	16	kW

Appendix J – SRE Assumptions

Assumptions (All Buildings)
Final measurements/values are taken from the provided REVIT models.
12.5mm plasterboard, 48 S 50mm 'C' Gypframe at 600mm centres, 12.5mm plasterboard, assume steel studs are 0.4% of the volume, density of steel is 7850kg/m3.
All concrete has a recycled value of at least 20%.

Reinforced concrete contains 3% (97% recycled content) steel of volume.
Water consumption taken from '*Good Practice*' of Water Benchmarking Guide - https://waterwise.org.uk/wp-content/uploads/2019/10/Copy-of-TWWM-ech2os-water-awareness-workshops-report-final-Aug-09.pdf
Render on all plasterboard surfaces 5mm thickness.
Mortar constitutes 6.7% of total blockwork volume.
Mortar constitutes 17.5% of all brickwork volume.
66mm Phenolic insulation with double aluminium vapour membrane on substructures.
Hard Landscaping materials have been divided proportionally amongst the buildings within the scope, dependent on GIA – Teaching Block 61.15%, Sports Hall 33.15%, Sports Pavilion 3.77%, School Hall Extensions 1.93%.
Tarmac assumed 25mm thickness.
Resin bound aggregate assumed 100mm thickness.
Permeable Paving assumed 30mm thickness.
Columns and Beams 356x171x51.
Steel columns and beams 51kg/m.
All windows assumed as double glazing – 15mm thickness.
Window build ups assumed at 80% double glazing, 20% aluminium frame (40% recycled content – no 35% available).
B2 maintenance assumption of 10kgCO2e/m2 gross internal area (GIA) following GLA guidance.
B3 repair assumption of 25% of module B2 emissions following GLA guidance.

Assumptions (School Hall Extensions)
13 Columns (305x305x118) assumed at 2.89m height.
13 Pile Caps – 26 Piles at 10m below ground level.
Assumed 300 lux for main extension for lighting level.
Gulam beams to main extension spanning existing wall and new steel posts.
Existing building Main auditorium ventilated via air handling unit at 5.0m3/s. Air handling unit with heating (45kW) and cooling (115kW) coils. Entire Building including existing and new extension connected to air source heat pump.
Natural ventilation to lobby area. 1 no. extract fan for WCs 100l/s.
Domestic hot water – 1 hot water cylinder 300l capacity with 40kW heat capacity.
Total space heating load for extension 16kW. Assumed 8 no. radiators at 2kW each.
No cooling assumed – all natural ventilation.
Assumptions (Sports Hall)
Swimming Pool room columns assumed 6.7m height (305305x18).
Glulam beams over pool area (8 beams) assumed 88cm width, 17.2cm depth *(https://civilsir.com/glulam-span-rule-of-thumb/).*
108 piles assumed at 22m below ground level (36 pile caps).
Assumed 400 lux for the Sports Hall for lighting level.
Assumed 266 lockers.
Entire building connected to air source heat pump for heating , cooling, and domestic hot water.

Pool plant assumed at 50kW/hour.
Pool area 1 no. air handling unit with heating only 5.7m3/2 and 111kW heating coil.
Pool area 1 no. 1890l domestic hot water cylinder. 240kW heat capacity.
Sports hall 1 no. air handling unit for heating and cooling 3.3m3/s. Heating coil 14kW, cooling coil 15kW.
Sports hall space heating and cooling via air handling unit.
Ventilation for all building area broken out into 3 no. separate air handling units, each serving a designated area of the building.
All space heating via air handling units or LTHW underfloor heating connected to air source heat pump.
Changing area ventilation own dedicated air handling unit 4.8m3/s with heating only 23kW coil.
Changing area LTHW underfloor heating 20kW.
Assumptions (Teaching Block)
108 piles 22m below ground level (235x235).
Ground Source Heat Pump for Cooling, Heating and Domestic Hot Water – 130kW space heating, 103kW domestic hot water and 96kW cooling.
1x 500L domestic hot water cylinder, 1x 1500L domestic host water cylinder.
3 no. MVHR units – 1x 80l/s, 1x 340l/s, 1x 770l/s.
1x Centralised air handling unit with heat recovery for ventilation, space heating and cooling for the Dining Hall and Kitchen ~3300l/s.
1 no. kitchen extract fan at 3400l/s, and 1 no. supply fan at 3100l/s.

8 no. fan cooling units with 4kW sensible cooling per unit.
WC extract fans – 2 no. 80l/s and 340 l/s MVHR units serving the Teaching Block WC areas.
Assumed 10kg R32 refrigerant. 6% (high) annual leakage rate with 95% EoL recovery rate following BREEAM 2018 guidance. (https://www.integralgroup.com/news/refrigerants-environmental-impacts/)
Assumptions (Sports Pavilion)
5 no. MVHR units. 4 no. serving the changing rooms at 140l/s supply and extract. 1 no. MVHR unit serving the club room at 400l/s supply and extract.
No cooling confirmed.
Building linked to ground source heat pump. Space heating peak load 106kW.
Domestic heat water demand to be fed from ground source heat pump system. 1 no. Cylinder required 960l capacity, 60kW heat capacity.
Assumed 32 piles 10m depth.
Glulam Beams assumed 90mm thickness 50mm depth

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