Heathrow NCP Flightpath, London

Life Cycle Assessment (LCA) Report

For:
Iceni

Prepared by:
Sustainable Construction Services

SCS Reference:
31770

Revision Record

Description	Revision	Date	Prepared	Reviewed
LCA Report	Stage 2- Concept Design	15th June 2022	AF	SD

Disclaimer

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1 INTRODUCTION

This document reports the findings of the materials Life Cycle Assessment (LCA) undertaken on the proposed Iceni Heathrow NCP Flightpath, Bath Road, London. The building is a new construction single storey industrial warehouse.

Figure 1: Perspective view of proposed building (sketch courtesy of Chetwoods Architects)

The primary driver for undertaking this report is to contribute towards the BREEAM assessment for the building which is targeting BREEAM New Construction 2018. This level of BREEAM rating demonstrates a high performance in sustainability, and this study forms part of that performance.

This study has been undertaken at RIBA Stage 2 and within the Concept Design stage.

The calculations were performed with the One Click LCA calculation tool. The software has been verified to be IMPACT equivalent by BRE.

One Click LCA has also been third party verified by ITB for compliancy with the following LCA standards: EN 15978, ISO 21931–1 and ISO 21929, and data requirements of ISO 14040 and EN 15804. You can find the official letters of compliancy here: https://www.oneclicklca.com/wp-content/uploads/2016/11/360optimi-verification-ITB-Certificate-scanned-1.pdf.

ITB is a certification organization and a Notified Body (EC registration nr. 1488) to the European Commission designated for construction product certification. ITB activities are conducted in accordance to the requirements of the following assurance standards: ISO 9001, ISO/IEC 27001, ISO/IEC 17025, EN 45011, and ISO/IEC 17021

The primary environmental impact reported for a material selection is the carbon dioxide equivalent emissions (kgCO_2e), also referred throughout this report as Global Warming Potential (GWP). A range of impacts are reported by the tool including:

- Carbon dioxide equivalent emissions (kgCO_2), also referred throughout this report as Global Warming Potential (GWP)
- Acidification kg SO_2e
- Eutrophication kg PO_4e
- Ozone depletion potential kg CFC11e
- Formation of ozone of lower atmosphere kg Ethene
- Non-hazardous waste disposed kg

The benefits of measuring these impacts is for clients, developers, and the BRE to ultimately determine benchmarks of performance for the various measured impacts for future projects to be measured against.

2 METHODOLOGY

2.1 DATA GATHERING

In order for SCS to create an inventory of the currently proposed building materials information request lists were issued to the relevant design team members. In summary the following information was asked for:

- Current estimation or material quantities for the BREEAM MAT 01 LCA 'In scope' elements.
- A description of the type of materials or elements being proposed at the current stage of design.
- Potential alternative materials under consideration that SCS could include in the option appraisals required for the BREEAM credits.

The quantities of these materials were then either measured from drawings, documentation, extracted from the BIM model or received via emails from the team.

As SCS did not receive feedback on 'Superstructure' alternative material options, high level estimations were used for the quantities of some potential material comparisons. A separate embodied carbon tool (produced by Feilden Clegg Bradley Studios FCBS) was used for these estimated quantities. This tool enables high level material estimations for certain elements when basic building attributes are input e.g. building perimeter, height and number of storeys etc.

The specific options where this tool was used are highlighted throughout this document.

Following the above steps, the selection of material data input into the One Click LCA software was sourced from the current level of detail provided to SCS within specifications available at the time the study was completed.

In a number of cases, exact material selections were not determined so the closest equivalent available within the One Click data base was selected.

For a full break down of the details input into the LCA One Click software corresponding to the results presented in this report please refer to Appendix 1 of this document.

2.2 ONE CLICK LCA TOOL

The life cycle assessment was calculated using One Click LCA which is officially approved for the BREEAM UK Mat 01 credit by BRE. The results represent the total life cycle impact during 60-year service life according to BS EN 15978:2011 for the proposed design.

This study must be BREEAM compliant and therefore the following elements are modelled in line with the BREEAM New Construction 2018 Manual's 'In Scope Elements' as set out under the Mat 01 issue. As part of this scope the elements assessed are listed in Appendix 1.

The following life cycle stages are included in the assessment according to BS EN 15978:2011 were included:

- A1-A3 Construction Materials
- A4 Transport
- A5 Construction site impacts
- B4-B5 Replacement and refurbishment.
- C1-C4 End of life: Re-use, recycling, or disposal

The impact of building services (i.e., electricity and fuel usage) throughout the lifetime of the building is likely to be larger than the embodied impact of the building itself, and therefore to not mask the impacts of the building fabric, the services have been excluded in line with the BREEAM methodology.

2.3 BREEAM CREDITS

BREEAM credits potentially obtainable through this study are indicated in **BLUE.**

As this is an industrial building type – the BREEAM benchmarking exercise is applicable. However experience surrounding these benchmarking standards show that it is very difficult to meet the requirements. Therefore, it's likely that no additional benchmarking credits are achieved.

The structure of this LCA Study will be as follows:

- Overall materials LCA results for new materials associated with the construction project.
- Compare materials options as required by BREEAM for the Concept Design Stage:
    - 2 to 4 significantly different superstructure design options – assuming benchmarking credits not achieved - **2 credits**
    - At least 6 significantly different substructure or hard landscaping design options **1 credit**
    - At least 3 significantly different core building services design options **1 exemplary credit**
- Third Party Verification **1 exemplary credit** *(requires RIBA Stage 4 update to be completed).*
- Update at technical design stage to carry out a building LCA options appraisal of 2 to 3 significantly different superstructure design options **2 credits** (requires RIBA Stage 4 update to be completed).

2.4 THIRD PARTY VERIFICATION

Requirements

a) BREEAM NC 2018 MAT01 criteria 16, 17, 18 require a suitably qualified third party either carries out the building LCA work or verifies the building LCA work (if by others), and produces a report describing how they have checked the building LCA work accurately represent the designs under consideration during Concept Design and Technical Design.

b) For each LCA option, itemise in the report the checks made by the suitably qualified third party including, as a minimum, the BREEAM quality requirements.

c) The suitably qualified third party's relevant skills and experience and a declaration of their third-party independence from the project client and design team.

Responses

a) The report was verified by Steve Down of Sustainable Construction Services who is a suitably qualified third party and has checked that the scope of the study, and the study methodology to ensure that the work accurately represents the designs under consideration during the concept design stage and will continue to do so during the technical design stage.

b) For each LCA option the verifier has made the following checks to ensure the study meets the BREEAM quality requirements:

   a. Accurate building elements dimensions have been taken from the architect's drawings towards ensuring quantities are within 10% of those shown in the design documents.

   b. Where an exact match cannot be found, the closest plausible material match has been selected as appropriate to optimise accuracy.

   c. Ensured that minor elements like adhesives and fixings are excluded from the study in line with the BREEAM quality standards.

   d. Used the 60 year study period as defined in the BREEAM quality standards.

   e. Reported the findings of the study via the BREEAM Mat01/Mat02 tool in line with BS EN 15978:2011 according to building lifecycle stage.

   f. Ensured the scope of the study includes all applicable materials as defined in tables 9.1, 9.2, 9.3 of the BREEAM 2018 NC MAT01 credit guidance.

   g. This work has been internally audited by another member of the SCS team to ensure accuracy and that the BREEAM quality standards have been met.

b) Steve Down has been undertaking building material lifecycle IMPACT assessments for over two years on a range of sectors including industrial, multi residential, and offices. Steve Down is experienced and skilled at undertaking LCA studies and helped a number of projects to see a benefit from the LCA study process, as well as BREEAM compliance. He has undertaken more than three different LCAs for paying customers in the last two years.

   Steve Down has received training from One Click LCA.

   Steve Down is a third party, independent from the project design team. He does not provide any design advice to the team. Steve is not associated with any products, manufacturers or materials that may be referenced in this study. Therefore, he is in a suitable position to be undertaking LCA studies to independently identify the impacts of particular design options without outside influence from the client or design team.

2.5 DESIGN OPTIONS CONSIDERED

2.5.1 Concept Design Stage

Following correspondence with the design team members some material design options were identified for further optioneering within the LCA study.

The following list outlines the separate options considered within each option study – the specific element or material changed in each option is highlighted in **Blue.**

A) Superstructure

1. **Structural Frame:** Steel **| External Wall:** Kingspan Quadcore panel **| Window Frame:** Aluminium.
2. **Structural Frame:** Reinforced Concrete * **| External Wall:** Facing brick only **| Window Frame:** Hybrid (Aluminium+ Timber).
3. **Structural Frame:** Timber * **| External Wall:** Timber cladding **| Window Frame:** Hybrid (Aluminium+ Timber).
4. **Structural Frame:** Steel **| External Wall:** Kingspan Quadcore panel **| Window Frame:** Hybrid (Aluminium+ Timber).

B) Substructure

1. **Foundations:** 20% GGBS.
2. **Foundations:** 40% GGBS.
3. **Foundations:** 70% GGBS.

C) Hard landscaping

1. **Pedestrian Footpath:** Tarmac with gravel margin
2. **Pedestrian Footpath:** Concrete paving
3. **Pedestrian Footpath:** Concrete base

D) Building Services

1. **Heat Source**: ASHP **| Heating Emitter:** UFH.
2. **Heat Source:** VRF **| Heating Emitter:** Ceiling cassettes.
3. **Heat Source:** ASHP **| Heating Emitter:** Radiant panels.

Abbreviations

- **ASHP –** Air Source Heat Pump
- **RC –** Reinforced Concrete
- **GGBS –** Ground Granulated Blast-furnace Slag
- **VRF-** Variable Refrigerant Flow
- **UFH-** Underfloor Heating

* Both the reinforced concrete and timber frame alternative options are based on high level estimations from the FCBS Carbon Tool. Were these alternative materials to be considered, we would recommend that a structural engineer carries out their own estimations based on their knowledge of the project prior to any definitive conclusions being made in respect to the embodied carbon impact of these alternatives.

3 RESULTS

3.1 LCA RESULT SUMMARY

The total embodied carbon, or the global warming potential (GWP), associated with the new materials as part of the proposed building design (see Appendix 1) are summarised in the following table and graphs.

The results represent the total life cycle impact during 60 year service life according to BS EN 15978:2011 for the proposed design.

Life Cycle Stages		Global Warming Potential $kgCO_2e$
A1-A3	Construction Materials	3,297,843
A4	Transportation to site	70,902
A5	Construction process	279,099
B4-B5	Use stage: Replace and refurbish	498,560
C1-C4	End of life: Re-use, recycling or disposal	28,792
	Total (kg CO_2e)	4,175,196

Table 1: The global warming potential associated with the refurbishment works at each life cycle stage over a 60-year period

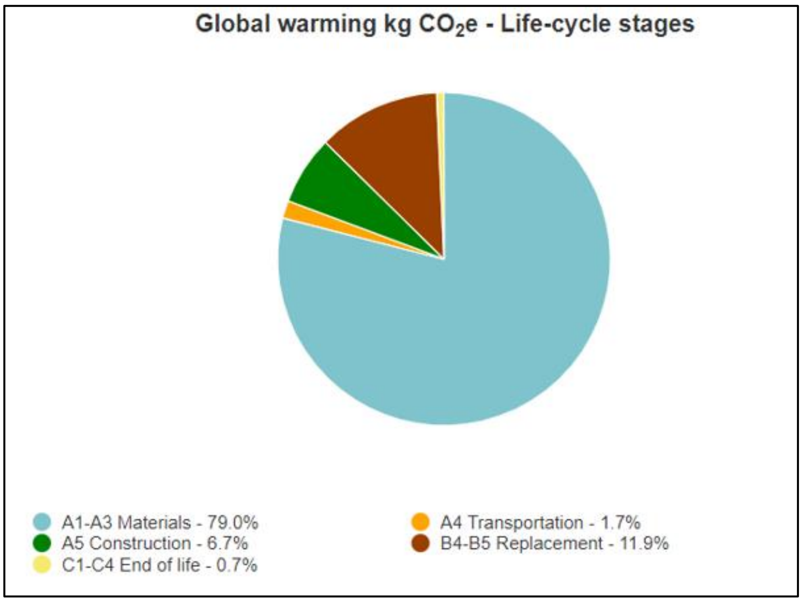

Figure 2: Pie chart of the global warming potential associated with the building at each life cycle stage over a 60 year period

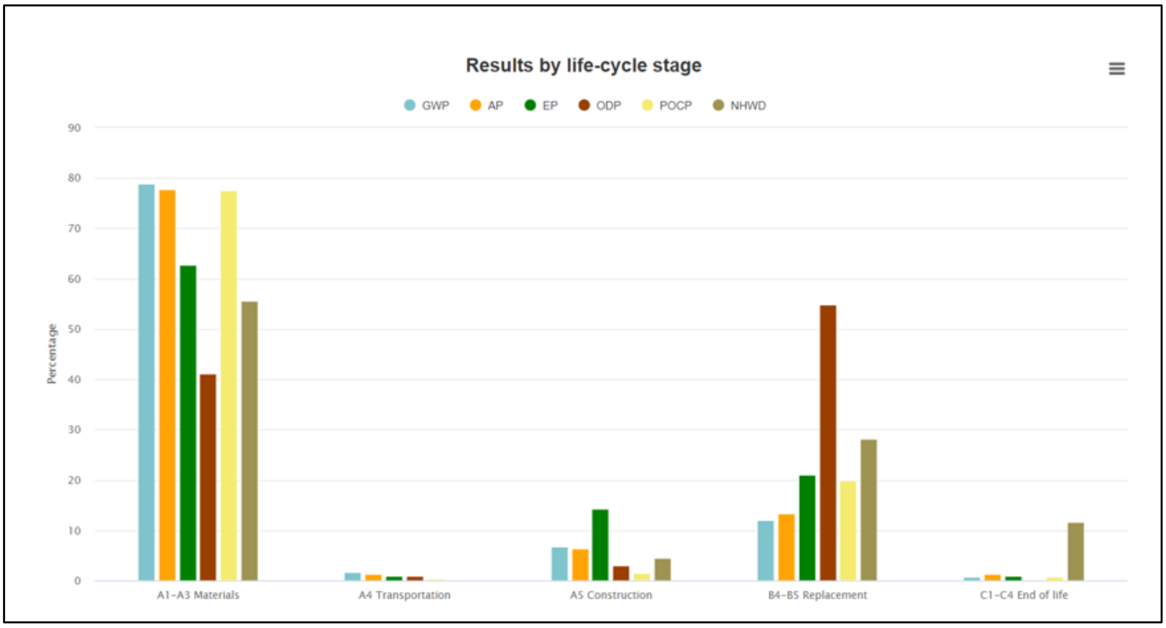

Figure 3: Results distribution by life-cycle stage

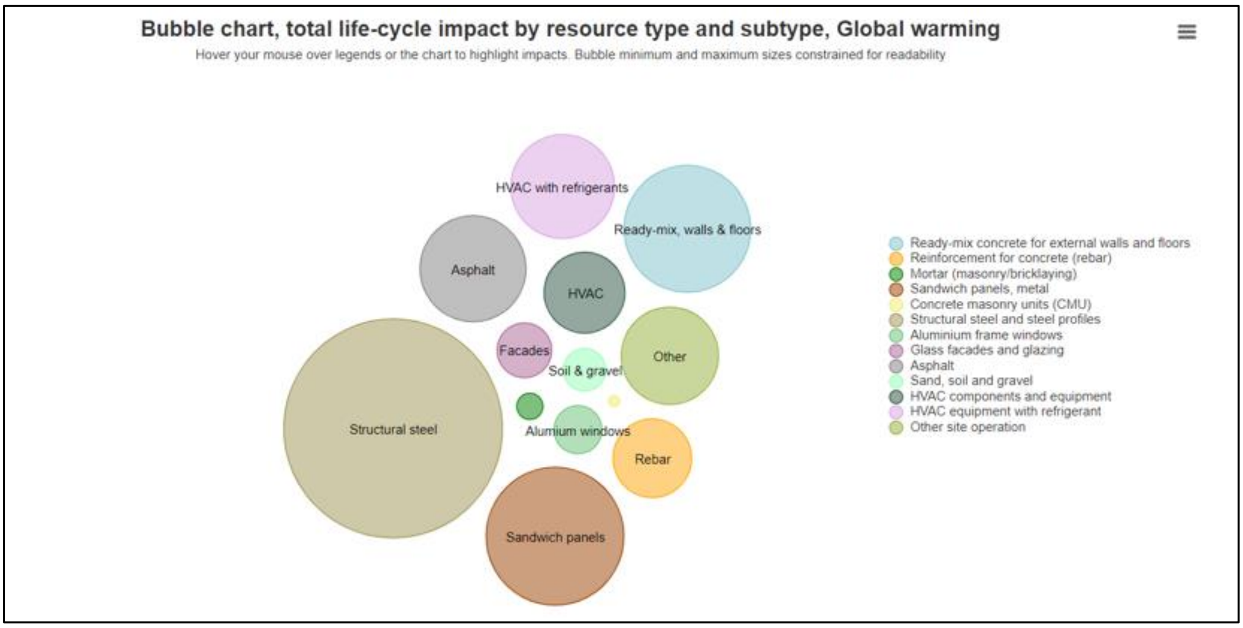

Figure 4: Total life cycle impact by resource type and subtype (Global Warming Potential GWP)

Having identified the environmental impacts of the base building above, the key findings include:

- The lifecycle stage with highest CO_2 impact is A1-A3 materials, followed by B4-B5 material replacement. There also appears to be a high value at the end-of-life stage associated with Ozone Depletion Potential. Note that operational energy is not included in line with the BREEAM quality standards, but it is likely to have a high impact.

- The bubble chart reveals that the galvanised steel associated with foundations and other steel frame components are the highest resource types in terms of their contribution to the building's total 60-year GWP potential.

The following sections provide the results for each material option study undertaken. In each case, rather than reporting the 60-year embodied or life cycle carbon figure for only those elements in question, the total building figure is provided. The results are structured in this way for two reasons:

1. The impact on embodied carbon demonstrated by each option can be viewed in the context of the entire development.

2. In some circumstances changes in one element category can have implications to the quantities of materials in other categories. E.g., a change in the structural frame and upper floor materials (i.e., superstructure) can have impacts upon the foundations (i.e., substructure).

It is important to note that, although the results provided for each option represent the combined impact of all relevant 'BREEAM In Scope' elements, as the only material being altered in each result is the material or element that's indicated, it still allows the reader to understand how each material choice performs relative to one another.

3.2 CONCEPT DESIGN STAGE OPTION APPRAISAL RESULTS

3.2.1 Option Study for Superstructure Materials

Following correspondence with the architect on the project four alternative superstructure materials options have been compared in the OneClick LCA software to assist with optioneering as follows:

1. **Structural Frame:** Steel **|** **External Wall:** Kingspan Quadcore panel **|** **Window Frame:** Aluminium.
2. **Structural Frame:** Reinforced Concrete * | **External Wall:** Facing brick only | **Window Frame:** Hybrid (Aluminium+ Timber).
3. **Structural Frame:** Timber * **|** **External Wall:** Timber cladding **|** **Window Frame:** Hybrid (Aluminium+ Timber).
4. **Structural Frame:** Steel **|** **External Wall:** Kingspan Quadcore panel **|** **Window Frame:** Hybrid (Aluminium+ Timber).

Life Cycle Stages		Global Warming Potential kgCO_2e			
		1	2	3	4
A1-A3	Construction Materials	3,297,843	2,156,351	1,711,096	3,255,434
A4	Transportation to site	70,902	79,979	67,070	70,900
A5	Construction process	279,099	279,099	279,099	279,099
B4-B5	Use stage: Replace and refurbish	498,560	508,526	531,691	515,002
C1-C4	End of life	28,792	35,116	93,562	29,482
	Total (kg CO_2)	**4,175,196**	**3,059,070**	**2,682,518**	**4,149,918**

*Table 2: Summary 60-year lifecycle kgCO_2e comparison between superstructure types for. The **RED** figures indicate the highest kgCO_2e figure across all options, whereas **GREEN** represents the lowest kgCO_2e figure.*

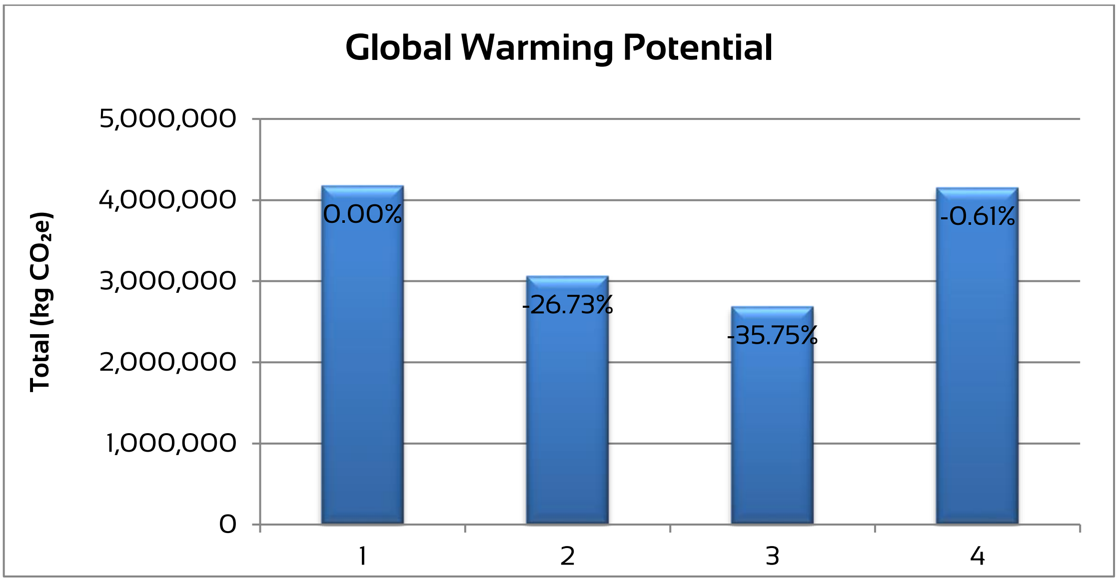

Figure 5: Comparison of lifecycle CO_2 between superstructure options

3.2.2 Option Study for Substructure Materials

Three alternative substructure materials options have been compared in the OneClick LCA software to assist with optioneering as follows:

1. **Foundations:** 20% GGBS.
2. **Foundations:** 40% GGBS.
3. **Foundations:** 70% GGBS.

Life Cycle Stages		Global Warming Potential kgCO₂e		
		1	2	3
A1-A3	Construction Materials	3,297,843	3,275,257	3,246,514
A4	Transportation to site	70,902	70,902	70,902
A5	Construction process	279,099	279,099	279,099
B4-B5	Use stage: Replace and refurbish	498,560	498,560	498,560
C1-C4	End of life	28,792	28,792	28,792
Total (kg CO_2e)		**4,175,196**	**4,152,610**	**4,123,867**

*Table 3: Summary lifecycle CO_2 comparison between substructure types. The **RED** figures indicate the highest CO_2 figure across all options, whereas **GREEN** represents the lowest CO_2 figure.*

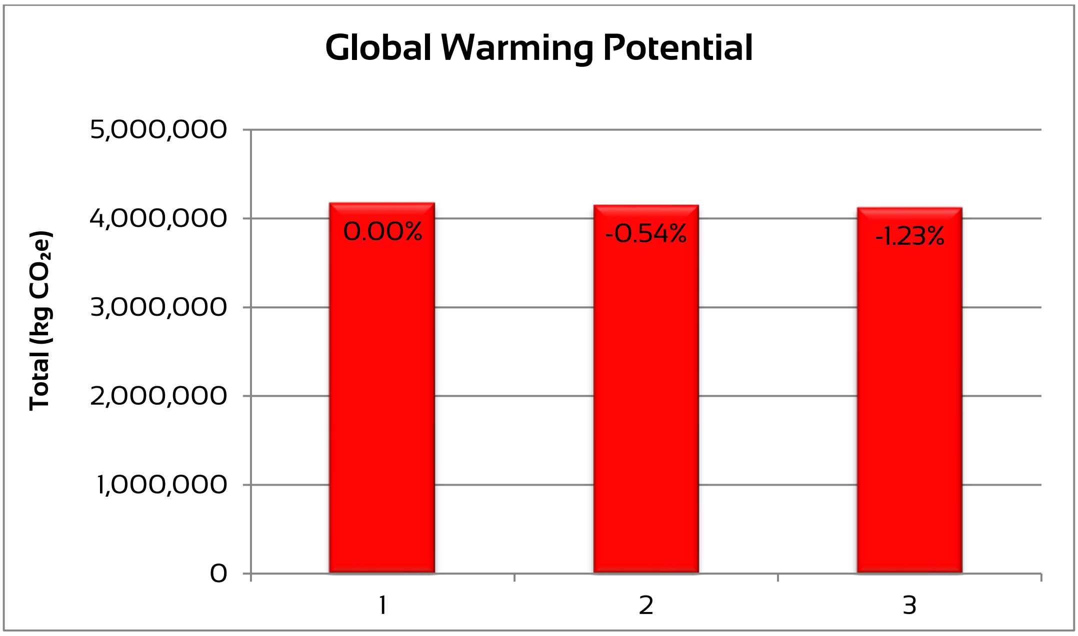

Figure 6: Comparison of lifecycle CO_2 between substructure options

1.2.3 Option Study for Hard Landscaping

Three alternative hard landscaping material options have been compared in the OneClick LCA software to assist with optioneering as follows:

1. **Pedestrian Footpath:** Tarmac with gravel margin
2. **Pedestrian Footpath:** Concrete paving
3. **Pedestrian Footpath:** Concrete base

Life Cycle Stages		Global Warming Potential $kgCO_2e$		
		1	2	3
A1-A3	Construction Materials	3,297,843	3,251,853	3,321,783
A4	Transportation to site	70,902	70,786	69,748
A5	Construction process	279,099	279,099	279,099
B4-B5	Use stage: Replace and refurbish	498,560	406,261	492,024
C1-C4	End of life	28,792	28,748	28,807
	Total (kg CO_2e)	**4,175,196**	**4,036,747**	**4,191,460**

*Table 4: Summary lifecycle CO_2 comparison between hard landscaping types. The **RED** figures indicate the highest CO_2 figure across all options, whereas **GREEN** represents the lowest CO_2 figure.*

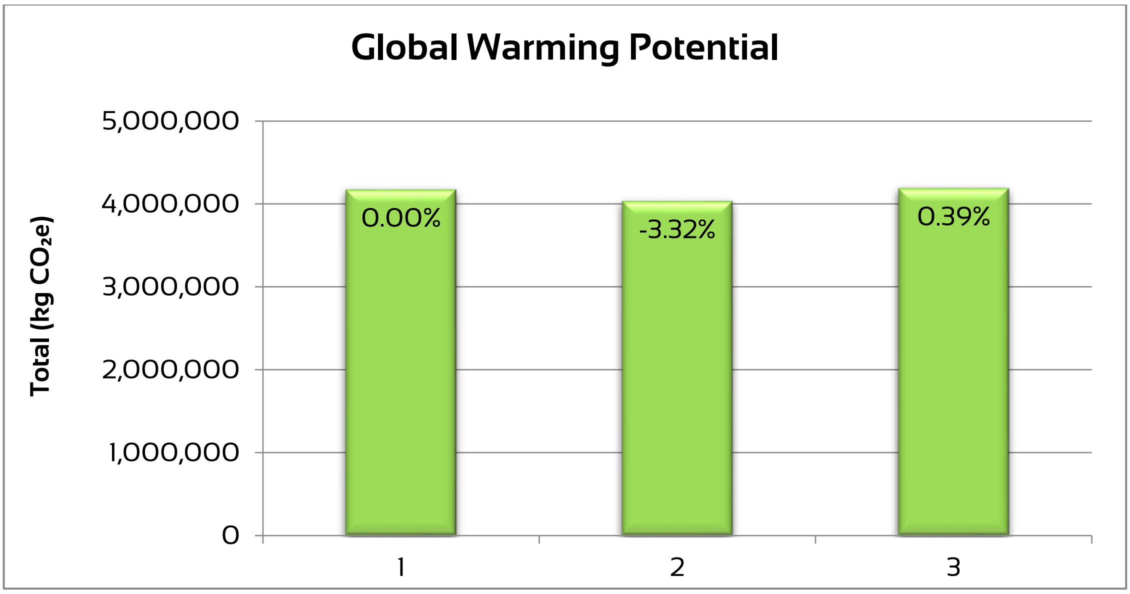

Figure 7: Comparison of lifecycle CO_2 between hard landscaping options

3.2.4 Option Study for Building Services

Three alternative building servicing strategies (in terms of materials use) have been compared in the OneClick LCA software to assist with optioneering as follows:

1. **Heat Source**: ASHP **| Heating Emitter:** UFH.
2. **Heat Source:** VRF **| Heating Emitter:** Ceiling cassettes.
3. **Heat Source:** ASHP **| Heating Emitter:** Radiant panels.

Life Cycle Stages		Global Warming Potential kgCO_2e		
		1	2	3
A1-A3	Construction Materials	3,297,843	3,251,853	3,269,433
A4	Transportation to site	70,902	70,786	70,830
A5	Construction process	279,099	279,099	279,099
B4-B5	Use stage: Replace and refurbish	498,560	406,261	441,516
C1-C4	End of life	28,792	28,748	28,752
	Total (kg CO_2)	**4,175,196**	**4,036,747**	**4,089,629**

*Table 5: Summary lifecycle CO_2 comparison between service types. The **RED** figures indicate the highest CO_2 figure across all options, whereas **GREEN** represents the lowest CO_2 figure.*

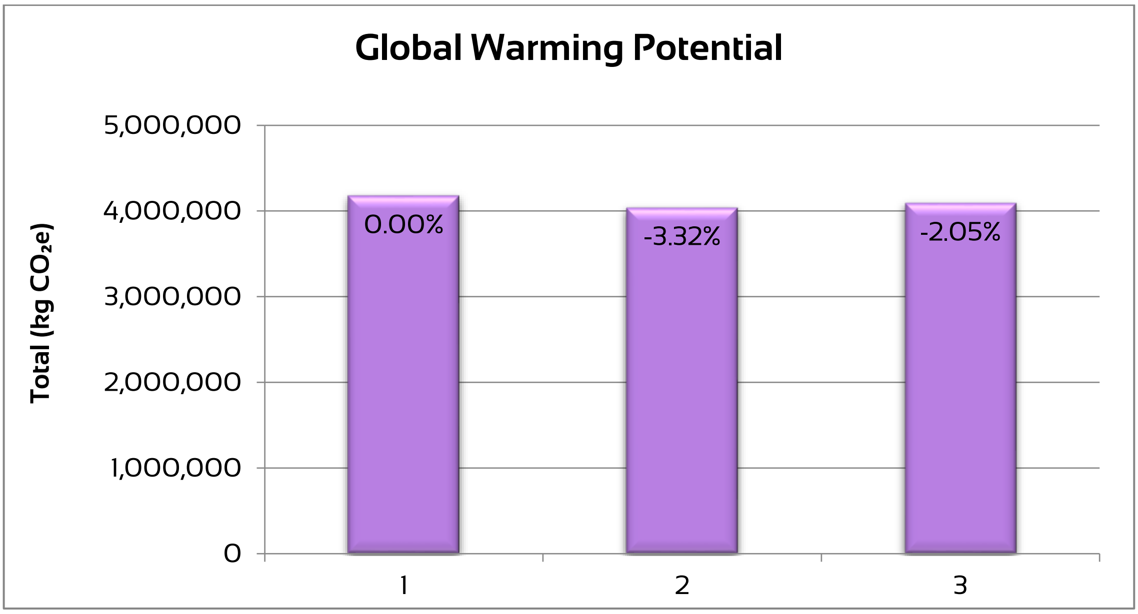

Figure 8: Comparison of lifecycle CO_2 between services options

4 CONCLUSIONS

For this project, the overall life cycle assessment for the proposed design associated with the new materials are reported. This is in relation to the overall carbon emissions or global warming potential (GWP). The total carbon dioxide equivalent emissions associated with the works, according to the scope of this study are as follows:

CO_2 **4 175 Tons CO_2e**

Furthermore, to assist in the decision-making processes for material selections, four options studies were conducted for materials within the following elements:

- Superstructure
- Substructure
- Hard landscaping
- Services

The findings of each are summarised below: The findings of each are summarised below:

A) Superstructure

1. **Structural Frame:** Steel **|** **External Wall:** Kingspan Quadcore panel **|** **Window Frame:** Aluminium.
2. **Structural Frame:** Reinforced Concrete * | **External Wall:** Facing brick only | **Window Frame:** Hybrid (Aluminium+ Timber).
3. **Structural Frame:** Timber * **|** **External Wall:** Timber cladding **|** **Window Frame:** Hybrid (Aluminium+ Timber).
4. **Structural Frame:** Steel **|** **External Wall:** Kingspan Quadcore panel **|** **Window Frame:** Hybrid (Aluminium+ Timber).

The results suggest that the timber frame option results in a notable reduction in embodied carbon compared to a steel frame structure. The Reinforced concrete (RC) frame scenario falls in the middle of these two options.

However, there are some important aspects to consider when interpreting these results as follows:

- As already outlined in previous sections, the structural material quantity estimates are high level estimations, particularly for the alternative concrete and timber scenarios which were not sourced from the structural engineer, but a rule of thumb third party embodied carbon tool.

  In other words, the actual material quantities required could vary than the estimations used at this stage in the design.

- Biogenic sequestration has not been accounted for in terms of a reduction to total embodied carbon.

The final option (Option 4 above) compared the current complete aluminium window frames to a hybrid timber/aluminium frame example. The latter results in a slight reduction in embodied carbon.

B) Substructure

1. **Foundations:** 20% GGBS.
2. **Foundations:** 40% GGBS.
3. **Foundations:** 70% GGBS**.**

In this study, a foundation type was tested by varying a specific material quantity. The results show the 70% GGBS (option 3) has a relatively lower embodied carbon content compared to the baseline option.

C) Hard landscaping

1. **Pedestrian Footpath:** Tarmac with gravel margin
2. **Pedestrian Footpath:** Concrete paving
3. **Pedestrian Footpath:** Concrete base

For the hard landscaping options, option 3 (concrete base) has a relatively higher embodied carbon content compared to the baseline option. This correlates with the Global Warming Potential (GWP) of each option, with option 2 (concrete paving) having the least GWP.

D) Building Services

1. **Heat Source**: ASHP **| Heating Emitter:** UFH.
2. **Heat Source:** VRF **| Heating Emitter:** Ceiling cassettes.
3. **Heat Source:** ASHP **| Heating Emitter:** Radiant panels.

Here, the baseline option (ASHP + UFH) results in the highest GWP while option 2 (VRF + Ceiling cassettes) has the least GWP.

When considering the choice of building services, it is likely that aspects relating to occupancy comfort, energy and carbon emissions associated with the operation of these services, will most likely take president in deciding the optimal servicing strategy to incorporate into the design.

It's important to note that the results from the above are not considering operational energy implications, only embodied carbon impacts linked to materials.

Final Conclusion

It is important to understand the limitations of this study to best understand how to use the findings of this report.

It is important to remember that despite the advantages of some materials over others in terms of environmental impacts there are several practical factors not considered in this study. Aspects such as structural considerations linked to the weight of materials, the aesthetic impacts of material choices when considering the appearance of nearby buildings and construction complexity are just some examples.

The materials datasets, on which this report is based, have been assembled by One Click LCA Ltd and approved for use by the BRE for the purposes of BREEAM. It is important to note that as with any other simulation it can never completely reflect reality. With the environmental impact of materials, there are variables which are project specific such as material transportation to site.

How far do the materials need to travel to site? What mode of transport will be used? These are things which cannot be known until building materials are being procured, and therefore cannot be accurately reflected in the analysis.

Although the LCA dataset is very detailed, different manufacture processes by individual manufacturers cannot be reflected in this study. For example, some manufacturers may operate thorough environmental management systems to lower their impacts, and some do not.

Generic materials data must be used, and at best this could give 'ballpark' results i.e., sufficient to compare options but not necessarily accurate to quantify exact figures. Therefore, this report should be used as an approximate guide and cannot guarantee the accuracy of the results if measured in the future.

In conclusion, this LCA study has been undertaken in compliance with the BREEAM 2018 Mat 01 credit and can be used by the project team during the materials selection process to benefit sustainable design.

5 APPENDICES

APPENDIX 1: MODELLING INPUTS & LCA DATA

The BLUE and ORANGE texts indicate the material quantities and/or material types used in the alternative options under each category as outlined in section 2.5.

Model Option	Building Element	Sub Element	Area m²	Thick / Length m	Volume m³	No. of	kW	Weight kg	Service life	One Click LCA Material Selected
SUPERSTRUCTURE										
Frame										
A1,A4	Steel Frame	Columns, beams, etc.						631000	As building	Structural steel profiles, generic, 20% recycled content, I, H, U, L, and T sections, S235, S275 and S355
A2	Reinforced Concrete column	Concrete			355.00				As building	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% fly ash content (300 kg/m3; 20 lbs/ft3 total cement)
		Rebar						106500	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
A2	Reinforced Concrete beams	Concrete			209.40				As building	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% fly ash content (250 kg/m3; 20 lbs/ft3 total cement)
		Rebar						52350	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
A3	Timber Frame	Timber frame walls and isolated supports Glulam			726.50				As building	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)
Upper Floor Construction										
A1, A4	Ribdeck and concrete floors	Concrete C30	1614.00	0.15	242.1				As building	Ready-mix concrete, normal strength, generic, C30/37 (4400/5400 PSI) with CEM III/A, 50% GGBS content (100 kg/m3; 18.72 lbs/ft3 total cement)
		Steel reinforcement to metal deck floor slabs						24210	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
A2	Precast Concrete planks	Concrete	1614.00	0.15	242.1				As building	Ready-mix concrete, normal-strength, generic, C40/50 (5800/7300 PSI), 20% recycled binders in cement (400 kg/m3 / 24.97 lbs/ft3)
		Steel Reinforcement						24210	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
A3	Timber Upper Floors Structure	Timber floor build-up including floor covering	1614.00	0.2	322.8				As building	Solid Timber Panels (Cross-Laminated Timber, CLT) (Stora Enso)
Roof										

Model Option	Building Element	Sub Element	Area m²	Thick / Length m	Volume m³	No. of	kW	Weight kg	Service life	One Click LCA Material Selected
All	Roof	Kingspan Quadcore sandwich panel	7827.00	0.1	782.7				As building	Sandwich panel with insulation foam core and double steel siding, U = 0.18 W/m2K, Core thickness = 100 mm, 11.788 kg/m2, 117.88 kg/m3, KS 1000 Trapezoidal Quadcore RW Panel (Kingspan (2020))
Stairs and Ramps										
All	Stairs	Concrete stairs	20.00						As building	Concrete assembly for stairs per one metre height
External Walls										
A1, A4	External Walls -Kingspan QuadCore composite panels (Steel frame)	Kingspan Quadcore sandwich panel	5256						As building	Sandwich panel with glasswool insulation and double steel siding, U = 0.21 W/(m2K), 201.1 mm (Total), 0.7 mm (Outer sheet), 0.4 mm (Liner sheet), 180 mm (Insulation), 15.51 kg/m2, Twin-Therm wall, FireWall (Tata Steel Europe & CA Building Products)
A2	External Walls - Facing brick only (RC frame)	102.5mm Brickwork	5256	0.103	457.93				As building	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))
		Mortar	5256	0.103	80.81					HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)
		150mm mineral wool insulation	5256	0.150	788.40				As building	Rock wool/mineral wool insulation, L = 0.035-0.037 W/mK, 33-45 kg/m3, Fire resistance class = A1 (Knauf Insulation (2019))
		Steel framing	5256					43624.80	As building	Galvanised steel profiles (studs) for internal wall framing, 0.7 mm, 0.9 kg/m, 37 mmx73.5 mm
		2 x 12.5mm fire resistant plasterboard	5256	0.025	131.40				As building	Gypsum plasterboard, 12.5 mm, 8.985 kg/m2 (average product weight) (Etex Building Performance)
A3	External Walls - timber cladding panels (Timber frame)	timber cladding panels	5256	0.002	10.51				As building	Laminated zinc cladding pannels, 0.7 mm, Façade joint debout en zinc laminé texturé matifié Azengar (VM BUILDING SOLUTIONS)
		18mm WBP OSB	5256	0.018	94.61				As building	Oriented strand board (OSB), generic, 9.5-28.5 mm (0.37-1.12 in), 610 kg/m3 (38.1 lbs/ft3), min. G4-2
		150mm mineral wool insulation	5256	0.150	788.40				As building	Rock wool/mineral wool insulation, L = 0.035-0.037 W/mK, 33-45 kg/m3, Fire resistance class = A1 (Knauf Insulation (2019))
		Vapour control layer	5256	0.000	1.05				As building	Plastic vapour control layer, 0.2 mm (Tommen Gram)
		Timber framing	5256					53874.00	As building	Planed timber, conifer (Treindustrien)
		2 x 12.5mm fire resistant plasterboard	5256	0.025	131.40				As building	Gypsum plasterboard, 12.5 mm, 8.985 kg/m2 (average product weight) (Etex Building Performance)
All	Block lining wall to offices	blockwork	726	0.100	61.71				As building	Precast concrete block, 700-2100 kg/m3 (BPCF)
		Mortar	726	0.100	10.89				As building	HS2 baseline - Cement grout, Cementitious modified mineral mortar (-)
Windows and Doors										

Sustainable Construction Services

Model Option	Building Element	Sub Element	Area m²	Thick / Length m	Volume m³	No. of	kW	Weight kg	Service life	One Click LCA Material Selected
A2,A3,A4	Windows - Hybrid system by Kawneer/Technal Double glazed sectioned with Aluminium Anodized external finish and internal timber sections.		183.00						As Building	Mixed tempered wood/aluminium frame windows and patio doors, double glazed, biogenic CO2 not subtracted (for CML), 30.23 kg/m2 (CODIFAB)
A1	Windows - RAL tbc. by Kawneer/Technal Double glazed sections with PPC Aluminium external and internal finish.		183.00						As Building	Aluminium frame window, double glazed, 32.259 kg/m2, 1.23 x 1.48 m, Masterline 8 Standard (Reynaers Aluminium)
All	EO Curtain wall		200.00						As Building	Glass façade, with aluminum composite profile framing, double glazed, 33200 mm x 3973 mm, 50.9 kg/m2, FWS 50 (Schüco)
All	GRP (factory assembled) Roof lights	Glazing unit	783.00						As Building	FRP composite sandwich panelized rooflight, cell dimensions 61.0 cm x 30.0 cm, thickness 70 mm, 9.77 kg/m2, TRANSLUCENT SKYROOFS (Kalwall)
SUB-STRUCTURE										
Foundations										
B1	RC Pad Foundation (Steel frame)	Concrete C32			491.00				As building	Ready-mix concrete, normal strength, generic, C25/30 (3600/4400 PSI) with CEM II/B-V, 20% fly ash content (280 kg/m3; 17.5 lbs/ft3 total cement)
		Steel reinforcement for foundations						49100.00	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
B2	Pad foundations 40% GGBS	Concrete C32/40 40% GGBS			491.00				As building	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM III/A, 40% GGBS content (320 kg/m3; 20 lbs/ft3 total cement)
		Steel reinforcement for foundations						49100.00	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
B3	Pad foundations 70% GGBS	Concrete C32/40 70% GGBS			491.00				As building	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM III/A, 70% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA 2022)
		Steel reinforcement for foundations						49100.00	As building	Carbon steel reinforcing bar (secondary production route – scrap), 97.07% recycled steel, 7850 kg/m3 (UK Cares)
Lowest Floor Construction										
ALL	Ground floor (Steel frame)	Concrete C30	7370.00	0.18	1289.75				As building	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)
		Steel reinforcement						128975.00	As building	Reinforcement steel (rebar), generic, 97% recycled content (typical)
EXTERNAL WORKS										

Model Option	Building Element	Sub Element	Area m²	Thick / Length m	Volume m³	No. of	kW	Weight kg	Service life	One Click LCA Material Selected
Roads, Paths & Paving										
C1	Vehicle Tarmac	Vehicle Tarmacadam	5670.32	0.150	850.55				30	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3
		300mm Sub-base	5670.32	0.300	1701.10				As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
	Pedestrian walkway (tarmac with gravel margin)	Tarmacadam	765.57	0.150	114.84				As Building	Precast concrete paving products, 2350 kg/m3 (BPCF)
		300mm Sub-base	765.57	0.300	229.67				As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
	Gravel margin	Rough cut Gravel	191.39						As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
C2	Vehicle Tarmac	Vehicle Tarmacadam	5670.32	0.150	850.55				30	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3
		300mm Sub-base	5670.32	0.300	1701.10				As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
	Marshalls saxon textured concrete paving	60mm concrete paving	956.96	0.060	57.42				As Building	Precast concrete paving products, 2350 kg/m3 (BPCF)
		Asphalt and Laying course	956.96	0.08	76.56				30	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3
		300mm Sub-base	956.96	0.300	287.09				As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
C3	Vehicle Tarmac	Vehicle Tarmacadam	5670.32	0.150	850.55				30	Asphalt, generic, compacted, 5/95% bitumen-aggregate ratio, 2350 kg/m3
		300mm Sub-base	5670.32	0.300	1701.10				As Building	Crushed rock / gravel mix (50-50 %), wet bulk density, 2000 kg/m3
	Concrete Base	Poured concrete mix	956.96	0.150	143.54				As Building	Ready-mix concrete, normal strength, generic, C32/40 (4600/5800 PSI) with CEM II/B-V, 20% fly ash content (320 kg/m3; 20 lbs/ft3 total cement)
BUILDING SERVICES										
Heating and Cooling System										
D1,D3	Heat Source	ASHP-External Units				8.03	643		22.00	Reversible air/water heat pump for collective housing, 1500.6 kg/unit, P=80-200 kW, DONNEE PAR DEFAUT (DED)
D1	Heat Source	UFH	8033.00							Underfloor heating system PEX, installation pipe spacing: 200mm, 30 mm insulation panel
D2	Heat Source	VRF - External Units				25.60	643		22.00	Air-to-air heat pump, external unit, heating (26.9 kW) and cooling (25.1 kW), DAIKIN : RXYQ8T - MITSUBISHI ELECTRIC :

Model Option	Building Element	Sub Element	Area m²	Thick / Length m	Volume m³	No. of	kW	Weight kg	Service life	One Click LCA Material Selected
										PUHYP250YKB - YACK & MITSUBISHI HEAVY INDUSTRIES : FDC224KXE6 (Uniclima)
D2	Heating and cooling	VRF- Internal Units (Ceiling mounted cassette units)				148.76	643		25.00	Air-to-air heat pump, internal unit, heating (4.66 kW) and cooling (4.32 kW), DAIKIN : FXSQ32A - MITSUBISHI ELECTRIC : PEFY-P40VMA-E - YACK & MITSUBISHI HEAVY INDUSTRIES : FDUM45KXE6F (Uniclima)
D3	Heat Source	Radiant Panels	8033.00			643.00	643		25.00	Radiant heating panel, 5.42 kg/unit, Rayonnant RSCD 2 - 444415 (Groupe Atlantic)
Ventilation System										
All	Mechanical Ventilation (offices)	plate heat exchanger with heat recovery units	876.00						25	Ventilation system for educational and commercial buildings
All	Ventilation ductwork	Ductwork					750m		25	Ventilation system for educational and commercial buildings