

# Highgate School – Millinson Sports Centre

## Whole Life Carbon Assessment



March 2025

Document Control

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Executive Summary

This whole life carbon assessment has been carried out in accordance with the Greater London Authotiy (GLA) Whole Life-Cycle Carbon Assessment Guidance. The emobodied carbon calculations have been carried out using One Click LCA software. This assessment has been carried out based on a 60 year life cycle of the building. This document is submitted to support a complete planning application by Highgate School for the redevelopment of the Mallinson Sports Centre (MSC) Complex located on Bishopswood Road. The redevelopment is intended to be carried out in phases. It includes the extensive refurbishment of existing buildings and extensions to create new indoor spaces.

Type of Development

The proposed phased development builds upon the completed phase one Pool Hall refurbishment works. The proposed phases are:

Phase one works involve:

- Replacing the swimming pool roof
- New heating and ventilation plant and
- the reconfiguration of the sports hall changing rooms.

Phase two works involve:

- Demolition of the Squash Courts and Fives Courts
- Construction of new sports hall, classroom office and storage space
- Construction of the Fives Courts against sports hall (1)

Phase three works involve:

- The refurbishment of the sports hall (1) with a new roof and heating and ventilation plant

Phase four works involve:

- Fill the space between the sports hall (1) and pool hall with Squash courts.

The proposed works will modernise this important indoor sports facility with alterations and extensions and significantly extend the life of the retained elements of the existing building, additionally providing significant improvements for accessibility, energy efficiency and reduction of the carbon footprint of the whole development.

Retaining Existing Structures

The project is a phased redevelopment of the sports facilities, with approximately 30% of the original structure retained.

Existing Structure

- Pool Hall – Totally refurbished in 2020, including:  
New Roof,  
New ventilation plant and heating plant,  
Remodelled changing rooms.
- Dry sports hall (1) – retaining walls, and structural frame, replacing a roof.
- Remodelled circulation spaces

New Buildings

- Dry sports hall (2)
- Classrooms and offices
- Fives Courts
- Squash courts

Embodied Carbon Emissions Lost Through Demolition

KaNect has undertaken a pre-demolition audit, estimated demolition volumes, and recommended reusing the materials listed in section 5, Pre-demolition Audit.

The One Click LCA carbon life cycle model includes the material quantities.

Whole Life Cycle (WLC) Principles

The design team reviewed and contributed to Table 6 Explanation of Life Cycle Stages. During the design development, post-planning will consider how the building can be altered or dismantled for reuse at the end of life.

One Click LCA Software.

The assessment follows the RICS life cycle stages according to EN 15804:2012.

Results

Estimated total WLC emissions (kgCO<sub>2</sub>e and kgCO<sub>2</sub>e/ GIA) for each lifecycle module, which will form the development baseline and automatically populate based on the 'GWP of all lifecycle modules' table. The applicant will be required to report how the total WLC emissions compare against the WLC benchmarks. Life Cycle assessment is calculated using measured building data from the energy model, drawings, and generic construction materials. This model is refined throughout the project as additional information is generated. The additional measured data is unavailable as the project's costs are based on the square meter rate. Many construction materials are yet to be fully defined at the planning stage.

| Estimated WLC emissions (Assessment 1)<br>N.B. This forms the WLC baseline for development. The results from Assessment 1 below are automatically populated here. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                                |                              |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------|------------------------------|--------------------------------|
|                                                                                                                                                                   | Module A1-A5                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Module B1-B5                 | Module B6-B7                   | Module C1-C4                 | Module D                       |
| TOTAL kg CO <sub>2</sub> e                                                                                                                                        | 956,685 kg CO <sub>2</sub> e                                                                                                                                                                                                                                                                                                                                                                                                                                            | 617,422 kg CO <sub>2</sub> e | 3,685,967 kg CO <sub>2</sub> e | 397,590 kg CO <sub>2</sub> e | 6,769,014 kg CO <sub>2</sub> e |
| TOTAL kg CO <sub>2</sub> e/m <sup>2</sup> GIA                                                                                                                     | 202                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 130                          | 778                            | 84                           | 1430                           |
| Comparison with WLC benchmarks (see Appendix 2 of the guidance) if Assessment 1 was used to inform design decisions                                               | The development retains almost one-third of the original structure with new elements using long-lasting material. The design prioritises the use of timber structural elements over steel. The leisure building is not entirely comparable with the educational Benchmark as leisure buildings require large volume space, whereas educational buildings have more expansive internal spaces and use. The swimming pool increases the energy intensity of the building. |                              |                                |                              |                                |

Table 1 Estimated WLC emissions (Assessment 1)

| Estimated WLC emissions (Assessment 2)<br>N.B. The results from Assessment 2 below are automatically populated here. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                                |                              |                               |
|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------|------------------------------|-------------------------------|
|                                                                                                                      | Module A1-A5                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Module B1-B5                 | Module B6-B7                   | Module C1-C4                 | Module D                      |
| TOTAL kg CO <sub>2</sub> e                                                                                           | 816,685 kg CO <sub>2</sub> e                                                                                                                                                                                                                                                                                                                                                                                                                                            | 509,168 kg CO <sub>2</sub> e | 3,685,967 kg CO <sub>2</sub> e | 281,194 kg CO <sub>2</sub> e | -881,244 kg CO <sub>2</sub> e |
| TOTAL kg CO <sub>2</sub> e/m <sup>2</sup> GIA                                                                        | 172                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 107                          | 778                            | 59                           | -186                          |
| Comparison with WLC benchmarks (see Appendix 2 of the guidance) if Assessment 2 was used to inform design decisions  | The development retains almost one-third of the original structure with new elements using long-lasting material. The design prioritises the use of timber structural elements over steel. The leisure building is not entirely comparable with the educational Benchmark as leisure buildings require large volume space, whereas educational buildings have more expansive internal spaces and use. The swimming pool increases the energy intensity of the building. |                              |                                |                              |                               |

Table 2 Estimated WLC emissions (Assessment 2 FES 2021)

| A1-A5 (excluding sequestration)                  |     |                            |
|--------------------------------------------------|-----|----------------------------|
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <750                                             | 503 | <500                       |
| B-C (excluding B6 & B7)                          |     |                            |
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <250                                             | 130 | <175                       |
| A-C (excluding B6 & B7, including sequestration) |     |                            |
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <1000                                            | 693 | <675                       |

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2 Introduction

- 2.1 Highgate School has commissioned Peter Deer and Associates to carry out a Whole Life-Cycle Carbon Assessment for the proposed redevelopment of the Mallinson Sports Centre, Bishopswood Road, Highgate, London.
- 2.2 The purpose of this document is to calculate carbon emissions resulting from the proposed redevelopment of the Mallinson Sports Centre over a study period of 60 years. The WLC assessment is carried out to provide a true reflection of carbon impact on the environment and design measures considered to reduce the overall carbon impact.
- 2.3 This document should be read in conjunction with:
  - Design and Access Statement
  - Energy Statement
  - Sustainability Statement
  - Pre-Demolition and Pre-Redevelopment Audit Report.
  - Construction statement

Site

- 2.4 The Mallinson Sports Centre (MSC) is located on the bishop's wood Road campus of the school estate near other principal school buildings such as the Mills Centre, the Dining Hall, the Pre-preparatory School, and the Junior School.
- 2.5 Site address

Mallinson Sports Centre  
Bishopswood Road,  
London.  
N6 4PH
- 2.6 The main building comprises the Pool Hall and associated changing rooms, which was the first building on the site in 1969, followed by the main sports hall with associated ancillary accommodation, gym, entrance hall, central offices and other sports spaces completed in 1989.
- 2.7 The overriding aim of the design seeks to transform this building and create enhanced building aesthetics within the Conservation Area whilst providing all the sports and ancillary-related facilities that the school will need.
- 2.8 The intention is to retain the essential elements of the existing building that have significant long-term value and condition, providing spaces of the required technical standard, and integrating them with alterations and extensions into a unified whole, a single sports centre.
- 2.9 The new sports hall is the principal component of the proposed development of the school's indoor sports facilities. As part of the work, the school intends to demolish the existing Fives Court and Squash Courts building to open a large area within the site that can be more efficiently and architecturally developed. These works are also designed to incorporate a new sports centre building comprising an indoor sports hall, teaching classrooms and staff offices.
- 2.10 The hall's design is to accommodate a National Standard Netball Court within the hall, one that will allow Premier League games to be played. There is an aspiration nationally for netball courts of this standard, for a sport that is increasing in popularity. Many other sports courts will fit within this same interior footprint.

The Vision

- 2.11 The proposed development is auxiliary to several other applications in various parts of the school. The vision behind all the proposed developments at the school is set out in the planning statement accompanying the applications, an extract of which is reproduced as follows:

*"Being both a Charity and a School, sustaining and further improving what Highgate does for the benefit of its pupils and pupils of partner schools elsewhere within the borough is never finished business."*

*"The school has, over the last 15 years or so, been undertaking an extensive programme of modernising and renewing its extensive and mixed stock of buildings and facilities to meet the educational and other demands of a 21st Century establishment. Significant funds have been invested over that period, and the programme will continue over the next decade."*

*"This programme combines the continuing need to maintain, both in terms of safety and appearance, the buildings on several sites and in varying degrees of condition, with the need to provide essential, flexible, good quality and long-lasting educational facilities for its varied educational and charitable objectives, as well as catering for its diverse pupil-body, which meets the different educational and supporting requirements for each of the three Schools to satisfy Department of Education (DfE) and other statutory requirements."*

Existing Site

- 2.12 The MSC Site comprises the following buildings:
  - Main MSC building, including Pool Hall, and
  - Fives Courts and Squash Courts

Main MSC Building (including Pool Hall):

- 2.13 The main building comprises the Pool Hall and associated changing rooms, the first building on the site, and then the main sports hall with associated ancillary accommodation, gym, entrance hall, central offices and other sports spaces.
- 2.14 The MSC presents a low-formed building to Bishopswood Road, appearing single-storey in relation to the street level and stepping down between the two main parts. The structural frame is articulated, but otherwise, the building is plain, functional, introverted, and neutral to its site or neighbours.

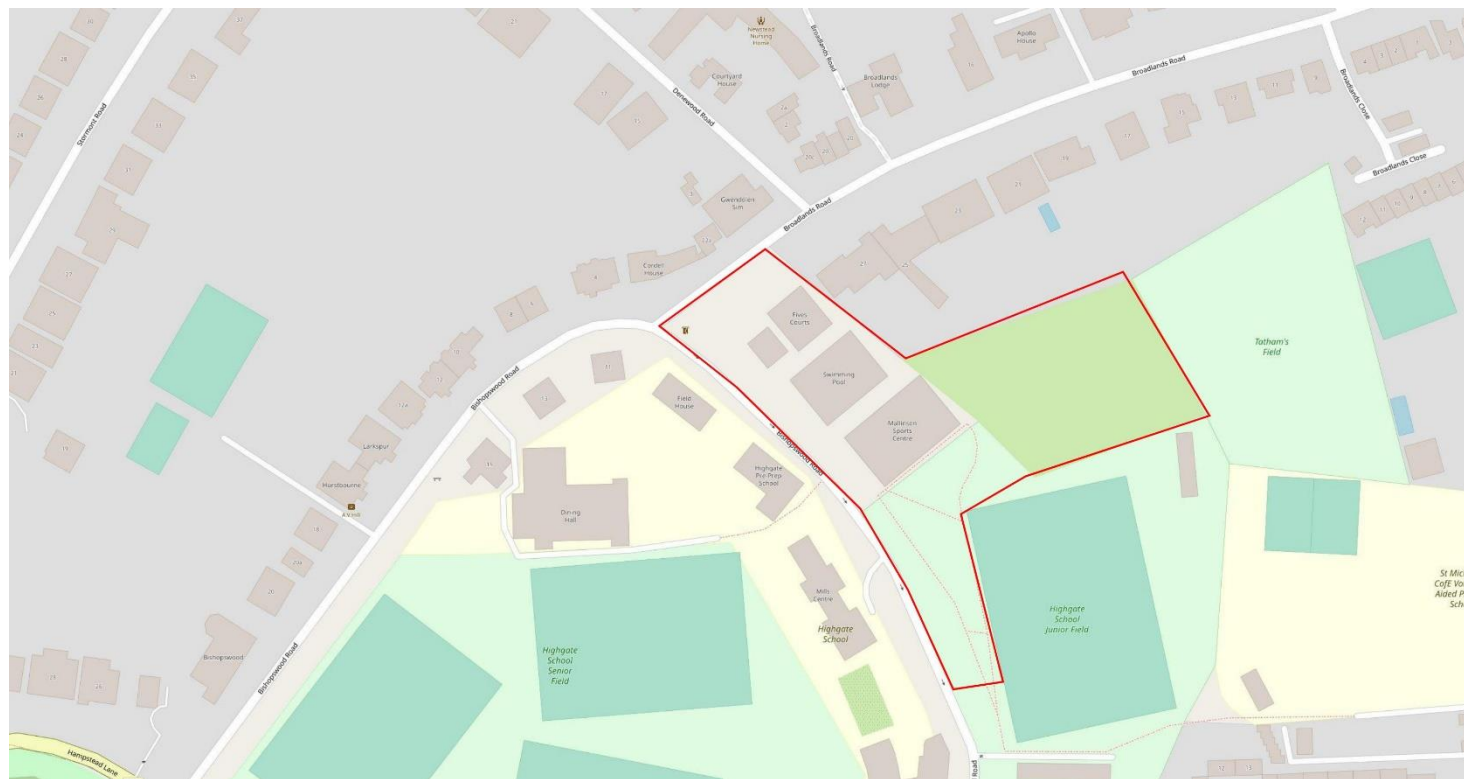
Fives Courts and Squash Courts

- 2.15 The Fives building is located in the northeast corner of the site. The courts, named after the game of "Eton Fives", a traditional doubles game of hand tennis played at Eton School, are comprised of red brick with rendered walls enclosing courts on three sides with projecting features and steps involved in gameplay. The eight courts, constructed as four back-to-back, were built in the early twentieth century. The fully glazed roof may have been added later rather than incorporated into the original design.
- 2.16 The indoor Squash Courts building on the northwest side of the site adjacent to Fives Courts is a system-built construction with exposed concrete panels. The building contains two squash courts. The building has uninsulated walls and roofs, causing severe maintenance issues, and the quality of its construction is at the end of its useful building life cycle.
- 2.17 The MSC sports centre is currently available to the community at certain times. The school is open to community uses for the outdoor pitches and the indoor sports centre, including other schools and sports clubs. In the holidays there are also holiday camps and other activities. The options for public use are noted as follows on the Camden Cindex website:

*Private school facilities are available to the public. Term-time sports activities for children aged 5-14. School holiday courses include multi-activity, football, cricket, tennis, and dance. Facilities for adults include squash, fitness suite and tennis (courts available), 25m x 12.5m swimming pool. Children's parties for 5-15-year-olds (maximum 25 children) are available at weekends, including a variety of sports options and games and swimming sessions. Bouncy castle party available for children aged 5-7 years. Swimming club.*



**Figure 1 Arial View of the site in Red**



### Figure 2 Site Location in Context (Open Street Map)

## The Proposed Works

- 2.18 The new extensions will create a larger building with various sports facilities, including a second sports hall, which will also be used for other school events, parent evenings, examinations, and assemblies.
- 2.19 The principle of a single secure point of access at the south end is to be maintained, with a larger and more open entrance and foyer fronting the all-weather pitches. Once inside the foyer via a draught lobby, the main Sports Centre reception desk immediately controls the area, which will always be staffed during regular operational hours. The desk will be open within the space to create a friendly and welcoming impression for pupils and visitors and improve visibility. It is anticipated that turnstiles will be used to control and monitor access to and within the building. The turnstiles are located at the west entrance next to the second hall. Turnstiles and entry doors would all be linked to the building fire alarm and detection system and default to open in the event of a fire for emergency egress.
- 2.20 As a result of the proposed extensions, new lifts will allow complete accessibility for disabled users to all areas of the building which is not currently wheelchair accessible.
- 2.21 Generally, during the school day, the main doors will be openable, the entry doors being on automatic electric opening systems for disabled and Part M access. After school hours, it is anticipated that the main doors at both entrances will have access security control, operated by coded entry devices with magnetic closing locks. An option being investigated is to have the entry systems used by pupil and staff cards, which will also serve several other functions in the school.
- 2.22 The proposed works in this submission include:
- The Fives Court and Squash Courts building is being demolition at the site's north end. The removal of the outer games court area and high chain-link fencing.
    - New northwest extension for a second indoor sports hall with associated:
      - new circulation corridor,
      - viewing gallery,
      - access stairs and lift,
      - ancillary spaces for storage and plant, and
      - A teaching block extension for 'Combined Cadet Force' and 'Outdoor Education' classrooms, offices, and associated storage.
  - A new south extension to the existing sports hall for eight (8) no. New external covered Fives Courts with run-off area.
  - New southwest extension and alterations to the existing building to create an enhanced entrance with a foyer, reception, and café. Including a bespoke staircase down to the current changing rooms.
  - New roof to sports hall 1 with new roof lights adding natural daylight to the and improved thermal comfort.
  - The courtyard between the pool hall and sports hall 1 will be covered to provide additional space. The space provides indoor squash courts forms connections back to the changing rooms, with ancillary external storage for sports.
  - The external surrounding is improved with new hard and soft landscaping around the site's perimeter, including removing three trees. The trees will be replaced with new semi-mature trees and form an entrance courtyard area at the new south main entrance.

Landscaping & External Works (including Orchard Site)

- 2.23The design strategy for the new sports centre is to:
- 2.24Create new landscape areas which maximise the amount of planting so that the new building becomes a recognisable and embedded part of the school's landscape and estate;
- The design strategy for the Orchard site is to:

Introduce new tree planting;

Provide low-level, safe, and efficient lighting for students and visitors;

Surface the paths with permeable paving as part of a sustainable drainage system;

Utilise a no-dig construction methodology to prevent damage to tree roots where necessary.

Create a new outdoor sports area with a unique and elegant oval-shaped amphitheatre that will not only provide seating around the pitch but also acts as a barrier and flood water storage device to prevent future flooding events;

Introduce new tree planting;

Provide accessible and safe access to the sports pitches for students and visitors, and connect with other areas of the school;

Utilise a no-dig construction methodology to prevent damage to tree roots where possible;

Minimise any impacts on the most valuable, existing trees around the site.

2.25There are mature trees around the site perimeter, between the MSC and the Orchard site, and to the east of the Orchard site, where there is a small natural wood.
- Mechanical Electrical and plumbing (MEP)
- Natural Ventilation
- Maintain natural air temperature and balanced humidity when the space is not in use.

Remove summer heat trapped in the sports hall

Provide natural night-time purge ventilation to cool the building structure
- Demand controlled mechanical ventilation system with heating and heat recovery is required to:
- Quickly heat the sports halls

Remove moisture and maintain space humidity when fully occupied or during high-activity sports.

Recover heat energy from the sports hall

Aid heat removal from the space in the summer months
- Strategy for mitigating overheating risk / TM59/TM52 overheating analysis
- The dynamic overheating analysis is not complete at this early planning design stage. A preliminary thermal model has been constructed and shows low risk for summer overheating. Further work is required to identify and size the natural ventilation openings and model air movement to develop the purge ventilation control strategy.
- Heating/cooling system description
- Fast-acting displacement air heating system for the sports halls. The sports hall should be kept at a lower air temperature when not in use.

Multi-split heating and cooling system for the fitness, dance studio, and cardio room.

Low temperatures heating radiator in the circulation areas and classroom.

Domestic hot water uses the swimming pool gas boiler and fast heat recovery energy-efficient plate heat exchanger hot water cylinders.
- Location of mechanical ventilation fans/heat recovery units/heat pumps.
- 2.26No plant is visible from Bishopswood and Broadlands Roads.

2.27The air handling plant for sports hall (2) on the corridor flat roof between the sports hall and swimming pool viewing gallery.

2.28The proposal is to relocate the air handling unit supplying the second swimming pool changing room.
- 2.29The plan is to replace sports hall (1) heating and ventilation equipment with a new energy-efficient unit with variable speed fans, heat recovery and ductwork.

2.30The designer will select the external heat pump condenser unit for low noise operation and, where required, fit the additional acoustic attenuation.
- Description of Building Services Systems
- Heating
- 2.31The improved building thermal element of the building fabric reduces the building's predicted heating energy by 18% from the Notional Building.
- Cooling
- 2.32Cooling and demand-controlled mechanical ventilation is required for gym and fitness studio where the occupants undertake active exercise, creating heat and humidity, which for health reasons, has to be actively controlled.
- Auxiliary Energy
- 2.33Auxiliary Energy is the energy used to distribute heating, cooling, and ventilation through the building.

2.34The pumps consume energy to move heat from the boiler to the radiators and air handling units.

2.35Auxiliary energy also includes the power to drive fans to move air.

2.36Refrigerant systems (heat pumps and multi-splits) do not require pumps to move heat, giving such systems an advantage over more traditional wet heating cooling systems.
- Lighting Energy
- 2.37The room activity database sets the illuminance levels and the scheduled lighting operation. The designers select the luminaires' type, efficiency, and operating control. In this case, high-efficiency LED lighting, infra-red sensor control in public areas, and manual switching for the pool and sports halls.
- | Room                           | Illuminance | Power  | Control                                               |
|--------------------------------|-------------|--------|-------------------------------------------------------|
| Public area                    | 200 lux     | 6 W/m² | Timed and daylight control                            |
| Corridors/ stair access routes | 100 lux     | 3 W/m² | Timed, reduced lighting between 23:00 and 06:00       |
| GYM and Sports hall            | 300 lux     | 6 W/m² | Manual on and off lights off when key card is removed |
| Office meeting rooms           | 300 lux     | 9 W/m² | Manual On, PIR off                                    |
| Store & plant rooms            | 100 lux     | 3 W/m² | Manual On, PIR off                                    |
| WC                             | 200 lux     | 6 W/m² | Manual On, PIR off                                    |
- Table 4 Typical Room illuminance and Power Ratios
- 2.38The lighting designers must provide illuminance calculations in inline Table 4 above.
- Highgate School – Millinson Sports Centre  
4309-250328ac – HGS MSC - GLA WLC Report

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Hot water

- 2.39The new SBEM has reclassified hot water demand and now considers the installation of a reduced Flowrate shower.
- 2.40The changing room is newly installed as part of the swimming pool refurbishment and uses low flow rate shower heads. Changing room hot water is generated in fast recover low volume high flowrate hot water cylinders using the same boiler as the swimming pool.
- 2.41The room activity database sets the water usage, which assumes a 100% room occupancy rate within each room using 130 litres of hot water per day (8l/m²/day), the BRE estimated water use. The water usage is the equivalent of two 15-minute showers in every room and is the equivalent of 100% capacity daily. The new water regulations limit the flow rates of shower heads to 8 litres/minute.
- 2.42The design inputs related to hot water are:

Efficiency and fuel choice of the hot water generation plant.

Storage heat losses

Circulation heat losses.
- 2.43The notional building and actual building model use the same gas-fired hot water generation plant with localised hot water storage on each floor. Therefore, the predicted energy use is similar.
- Demolition (Pre-Demolition and Pre-Redevelopment Audit report June 2022)
- Existing Site Analysis
- 2.44Several parameters were analysed to establish whether retrofitting would be a suitable option compared to demolishing the existing buildings (on-site). These parameters have been outlined in this section; however, for more details, please refer to the MSC Design and Access Statement prepared by Ed Toovey architects.
- Existing Fabric Condition
- 2.45The general structural and fabric condition is satisfactory for the main MSC building (excluding the Pool Hall, which was refurbished and completed in 2020). However, a structure of this age and type of construction attracts a higher degree of maintenance and running cost than modern construction.
- 2.46Very little thermal insulation is provided, resulting in greater heat loss through the building fabric than in modern construction. There is scope to improve the level of thermal insulation, for example, by installing secondary or double glazing and increasing the insulation to roofs. However, there is minimal scope to improve the heat loss through walls other than lining them internally, which would involve major disruption and cost. There are some required repairs externally, for example, renewal of the roof coverings, re-pointing of brickwork, and replacement of windows, which will require a significant cost outlay by the school.
- 2.47Roof covering and insulation will need to be addressed on a case-by-case basis. However, the proposed strategy of this application, to retain the sound elements of existing construction and to extend with new construction on the three principal sides, will allow existing external walls to become, in some cases, internal so that the new highly insulated modern construction of external walls will take on the task of energy and heat retention. Overall, this expansion strategy will also improve the overall performance of the building fabric.
- 2.48The Squash building is of poor construction by modern standards, with no insulating characteristics and heat loss issues that will increasingly require extensive maintenance, so it is at the end of its useful life functionally. Combining

its poor fabric state with its poor appearance and taking account of its location that effectively blocks sensible development in this area of the site, this building is therefore proposed for demolition.

- 2.49The Fives building will have higher maintenance and running costs than modern construction. Its retention would significantly compromise the rational and most efficient development of the site, so it is also proposed for demolition.
- 2.50Based on the above analysis, it was concluded that demolishing some existing buildings (Five Courts and the Squash building) would be a more suitable option.

Phased Construction

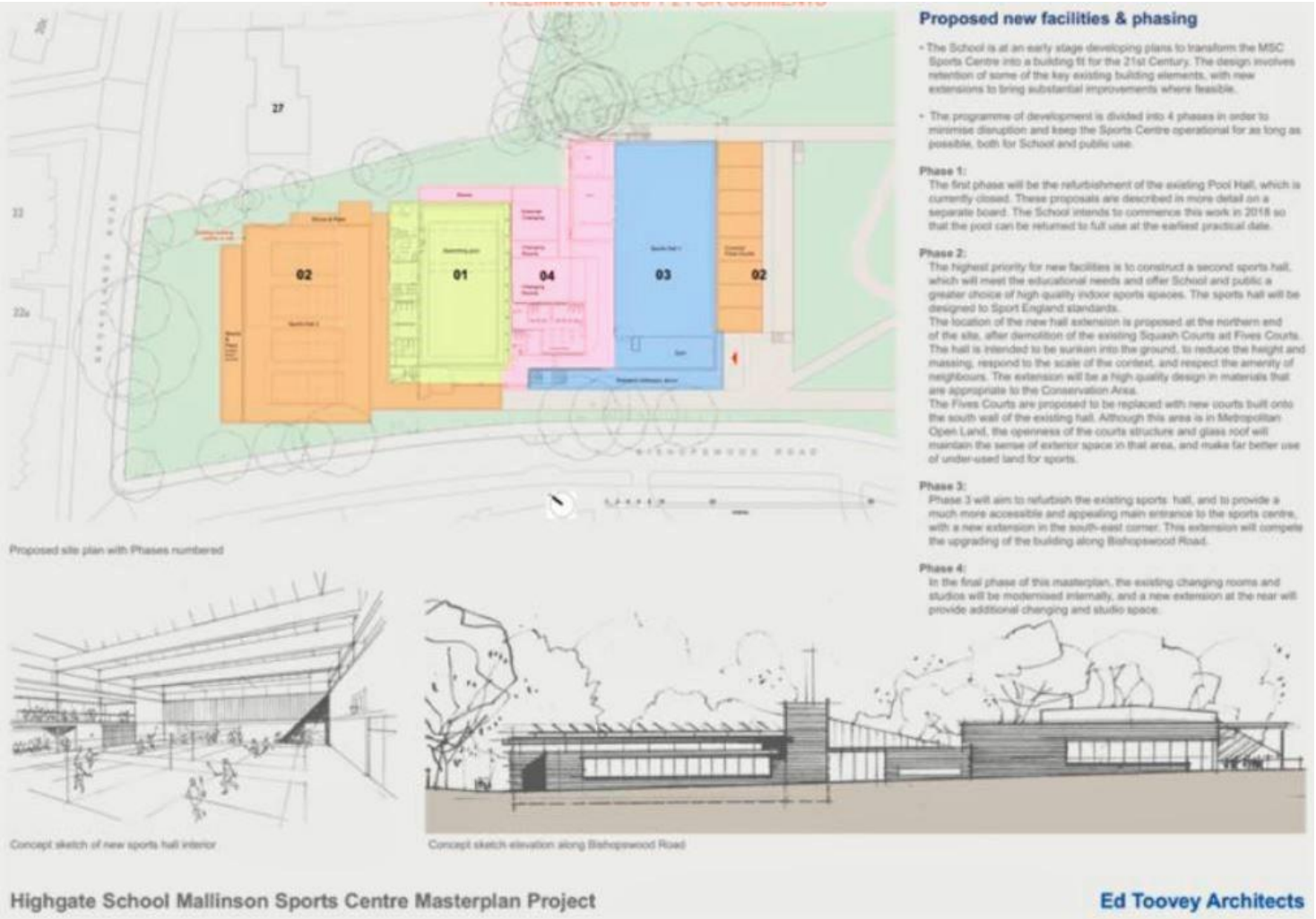


Figure 3 Phase Development Plan (D&A).

- Phase 1 Refurbishment of the swimming pool, including new roof, heating and ventilation plant and reconfigured changing rooms.
- Phase 2 Demolition of the Fives Courts and Squash Courts, construction of new dry sports hall (2), classroom, and offices.
- Phase 3 Refurbishment of the dry sports hall (1) including new roof and heating and ventilation plant
- Phase 4 New Infill squash courts between swimming pool and dry sports hall (1).

3 Planning Policies

- 3.1The National Planning Policy Framework ('NPPF') was published in 2021 and superseded the 2012, 2018 and 2019 versions. Paragraphs 2 and 12 within the Framework confirm that the NPPF must be considered a material planning consideration in planning decisions.
- 3.2To ensure that sustainable development is pursued positively, a presumption favouring sustainable development is at the heart of the NPPF. Sustainable development is explained in more detail in NPPF paragraph 11, which requires Local Planning Authorities to:
  - Approve development proposals that accord with an up-to-date development plan without delay; or
  - Where there are no relevant development plan policies or the policies which are most important for determining the application are out-of-date, granting permission unless the application of policies in the framework that protect areas or assets of particular importance provides an apparent reason for refusing the development proposed; or
  - any adverse impacts of doing so would significantly and demonstrably outweigh the benefits when assessed against the policies in this framework when taken as a whole.
- 3.3The NPPF includes a 'presumption in favour of sustainable development. It states that for plan-making, the presumption means that local authorities should positively seek opportunities to meet the development needs of their area and that plans should meet objectively assessed needs. Plans should also be based on the Local Plan.

London Plan

- 3.4The London Plan is the Mayor's planning strategy for Greater London. It sets borough-level housing targets and identifies locations for future growth of London-wide importance.
- 3.5The London Plan is the overall strategic plan for London, setting out an integrated economic, environmental, transport and social framework for the development of London over the next 20 to 25 years.
- 3.6The London Plan is part of the Development Plan. The policies have been drafted to allow London to implement this ambitious London Plan as soon as possible. There is no requirement for the policies to be repeated locally. However, some instances require a local approach within the overall policy context. The London Plan sets out where this is the case.
- 3.7The London Plan provides the strategic framework for making all these decisions. It guides boroughs' development Plans to ensure they work toward a shared vision for London. It establishes policies that allow everyone involved in new developments to know what is expected.

Policy SI 2 Minimising greenhouse gas emissions

- A) Major Development should be net zero-carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand under the following energy hierarchy:
  - 1) be lean: use less energy and manage demand during operation
  - 2) be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly
  - 3) be green: maximise opportunities for renewable energy by producing, storing, and using renewable energy on-site
  - 4) be seen: monitor, verify and report on energy performance.
- B) Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.
- C) A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the Borough, either:
  - 1) Through cash in lieu contribution to the Borough's carbon offset fund, or
  - 2) off-site provided that an alternative proposal is identified and delivery is certain.
- D) Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported annually
- E) Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e., unregulated emissions.
- F) Development proposals to the Mayor should calculate whole lifecycle carbon emissions through a nationally recognised Whole Lifecycle Carbon Assessment and demonstrate actions to reduce lifecycle carbon emissions.

Table 5 GLA Policy SI 2 Minimising greenhouse gas emissions

- 3.8The Mayor is committed to London becoming a zero-carbon city. Becoming zero-carbon will require reducing all greenhouse gases, of which carbon dioxide is the most prominent. London homes and workplaces are responsible for producing approximately 78 per cent of its greenhouse gas emissions. New development must meet the framework's requirements if London aims to become a zero-carbon city by 2050. Development involving major refurbishment should also aim to complete this framework.
- 3.9Electricity is essential for the functioning of any modern city. Demand is expected to rise in London in response to a long-term growing population and economy, the increased take-up of electric vehicles, and the switch to electric heating systems (such as through heat pumps). The electricity network and substations are at or near capacity in several areas, especially central London. The Mayor will work with the electricity and heat industry, boroughs, and developers to ensure that appropriate infrastructure is integrated within a broader innovative energy system designed to meet London's needs.
- 3.10Operational carbon emissions will make up a declining proportion of a development's whole lifecycle carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole lifecycle approach is needed to capture its unregulated emissions (i.e., those associated with cooking and small appliances), its embodied emissions (i.e., those related to raw material extraction, manufacture and transport of building materials and construction) and emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. Whole lifecycle carbon emission assessments are required for development proposals referred to the Mayor. Major non-referable development should calculate unregulated emissions and are encouraged to undertake whole lifecycle carbon assessments. The approach to whole lifecycle carbon emissions assessments, including when they should take place, what they should contain and how information should be reported, will be set out in guidance.

## Whole Life Cycle

### What is this guidance?

- 3.11
- This guide explains preparing a Whole Lifecycle Carbon (WLC) assessment in line with Policy SI 2DB of the Intend to Publish London Plan (London Plan). It is for anyone involved in, or with interest in, developing WLC assessments, including planning applicants, developers, designers, energy consultants and local government officials. Policy SI 2DB applies to planning applications which are referred to the Mayor. However, WLC assessments are also supported and encouraged on significant applications which are not referable to the Mayor. The WLC guide explains how to calculate WLC emissions and the information that needs to be submitted to comply with the policy. It also includes information on design principles and WLC benchmarks to aid planning applicants in designing buildings with low operational and embodied carbon.

### What are Whole Lifecycle Carbon Emissions?

- 3.12
- WLC emissions are those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions, i.e., those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. A WLC assessment also includes assessing the potential carbon emissions benefits from the reuse or recycling of components after the end of a building's useful life. It provides an accurate picture of a building's carbon impact on the environment. The World Green Building Council estimates that construction accounts for 11% of carbon emissions globally. Key players in the construction industry, from developers to engineers and architects, must respond to the climate emergency by designing and building according to WLC principles.

### The Mayor's Net Zero-Carbon Target

- 3.13
- National Building Regulations and the Mayor's net zero-carbon target for new developments account for a building's operational carbon emissions. As targets have become more stringent, methods and approaches for reducing operational emissions have become better understood, and these emissions are now beginning to make up a declining proportion of a development's carbon emissions. Attention now needs to turn to WLC to incorporate embodied carbon emissions.
- 3.14
- The Mayor's net zero-carbon target continues to apply to the operational emissions of a building. The WLC requirement is not subject to the Mayor's net zero-carbon target for new development, but, as set out in London Plan Policy SI 2, planning applicants are required to calculate these emissions and demonstrate how they can be reduced as part of the WLC assessment. Planning applicants should continue to follow the GLA's Energy Assessment Guidance to assess and mitigate operational emissions and insert the relevant information into the WLC assessment.
- 3.15
- A set of WLC benchmarks have been developed, which applicants are asked to compare against their results as part of their WLC assessment and which the GLA will refer to in its review of these assessments.

## Principal Benefits of a WLC assessment

- 3.16
- Calculating and reducing WLC emissions offers a wealth of benefits, including:

  - Ensuring that a significant source of emissions from the built environment is accounted for is necessary for achieving a net zero-carbon city.
  - Achieving resource efficiency and cost savings by encouraging the reuse of existing materials instead of new materials and the retrofit and retention of existing structures and fabric over new construction.
  - Identifying the carbon benefits of using recycled material and designing for future reuse and recycling to reduce waste and support the circular economy.
  - Encouraging a 'fabric first approach to building design minimises mechanical plant and services in favour of natural ventilation.
  - Considering operational and embodied emissions simultaneously to find the optimum solutions for the development over its lifetime.
  - Identifying the impact of maintenance, repair, and replacement over a building's lifecycle improves lifetime resource efficiency and reduces lifecycle costs, contributing to the future-proofing of asset value.
  - Encouragement by the GLA for local sourcing of materials and short supply chains, with resulting carbon, social and economic benefits for the local economy.
  - Encouraging durable construction and flexible design contribute to greater longevity, reduced obsolescence of buildings and avoiding carbon emissions associated with demolition and new construction.

## Life Cycle Stages

- 3.17
- A WLC assessment needs to cover the entirety of modules A, B, C and D to comply with Policy SI 2, rather than just the minimum requirements identified in the RICS Planning Stage.

  - Module A1 – A5 (Product sourcing and construction stage)
  - Module B1 – B7 (Use stage)
  - Module C1 – C4 (End of life stage)
  - Module D (Benefits and loads beyond the system boundary)
- 3.18
- Each module should be presented separately, as identified in the WLC assessment template. The assessment's reference study period (i.e., the assumed building life expectancy) is 60 years. Where the project's design life exceeds or is less than 60 years, the assessment should still be done for 60 years but with an accompanying explanation of the lifecycle and end-of-life scenarios for the actual design life.

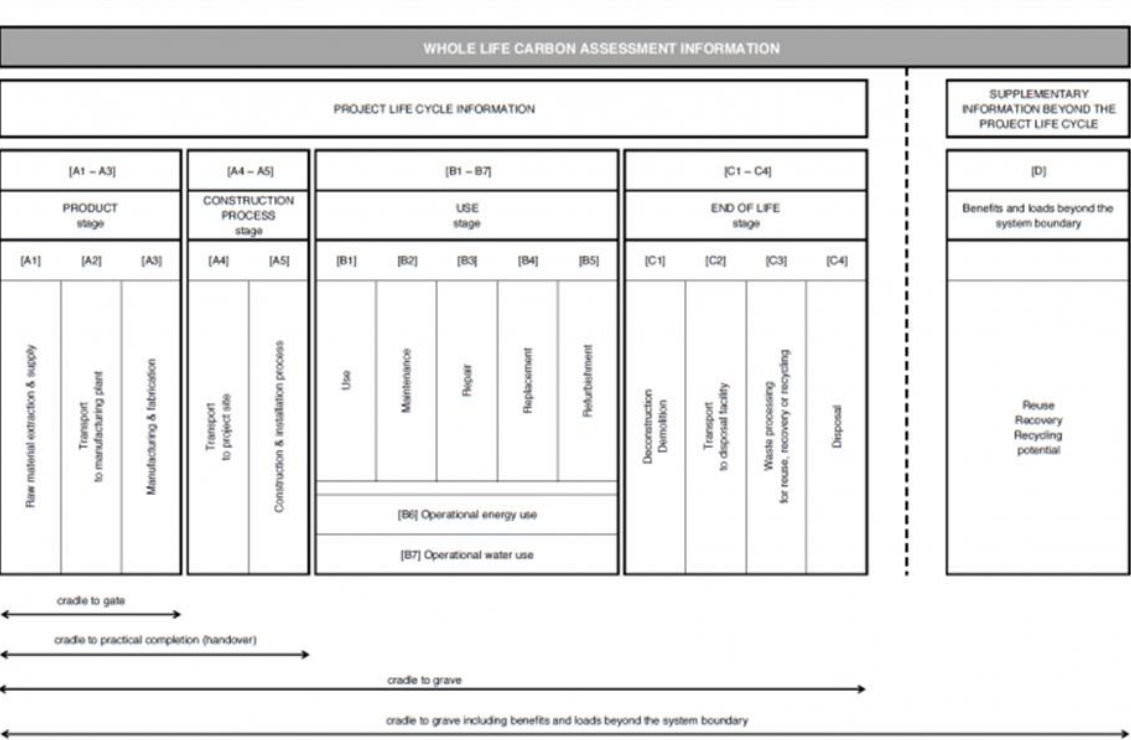


Figure 4 Life Cycle Modules (BS EN 15978)

Description of the life cycle stages and analysis scope are provided in the table below:

| Element                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1-A3 Construction Materials               | Raw material supply (A1) includes emissions generated when raw materials are taken from nature and transported to industrial units for processing. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from transporting all raw materials from suppliers to the manufacturer's production plant, as well as impacts on the production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as the handling of waste formed in the production processes at the manufacturer's production plants until the end-of-waste state. |
| A4 Transportation to Site                  | A4 includes exhaust emissions from the transport of building products from the manufacturer's production plant to the building site, as well as the environmental impacts of the production of the used fuel.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| A5 Construction/installation process       | A5 covers the exhaust emissions from using energy during site operations, the environmental impacts of production processes of fuel and energy and water production processes, as well as the handling of waste until the end of the state.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| B1-B5 Maintenance and material replacement | The environmental impacts of maintenance and material replacements (B1-B5) include environmental impacts from replacing building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation and production of replacing new material, as well as the effects from manufacturing the replacement material and handling waste until the end-of-waste state.                                                                                                                                                                                                                                           |
| B6 Energy use                              | The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also taken into account.                                                                                                                                                                                                                                                                                                                                                                              |
| B7 Water use                               | The considered use phase water consumption (B7) impacts include the environmental effects of the production processes of fresh water and the implications of wastewater treatment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| C1-C4 Deconstruction                       | The impacts of deconstruction include consequences for processing recyclable construction waste flows for recycling (C3) until the end-of-waste stage or the effects of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on the type of material. Additionally, deconstruction impacts include emissions caused by waste energy recovery.                                                                                                                                                                                                                                                                                           |
| D External impacts/end-of-life benefits    | The external benefits include emission benefits from recycling recyclable building waste. Benefits for reused or recycled material types include the positive impact of replacing virgin-based material with recycled material and benefits from materials that can be recovered for energy cover the positive effect of replacing other energy streams based on average implications of energy production.                                                                                                                                                                                                                                                            |

Table 6 Explanation of Life Cycle Stages.

Building elements

- 3.19

The WLC assessment should, in line with the RICS PS, cover all building elements listed in Table 1 that apply to the project and are to be included in the finished area of the completed project, including temporary works.
- 3.20

The building elements are broken down according to the RICS New Rules of Measurement (NRM) classification system level 2 sub-elements. The unit of area measurement to be used is Gross Internal Area (GIA). Floor areas should be measured following RICS Property Measurement standards.

Required Service Life.

3.21 This building generally undergoes major refurbishment, a 20 to the 30-year life cycle. The calculation is for a 60-year life cycle with one significant refurbishment period.

Life Cycle Impact Assessment Result Summary.

3.22 The life cycle assessment is calculated using One Click LCA. The results represent the total life cycle impact during 30-year / 60-year service life. The results are summarised in Table 8.

Environmental Data Sources

3.23 One Click LCA EN-15978 tool was used in the assessment. The tool supports CML (2002 - November 2012 or newer) methodology and all assessed impact categories. All of the datasets in the device follow EN 15804 standard. A complete list of data sources is presented in Attachment 1.

Project Data Sources and Assumptions

3.24 The proposed building was calculated in One Click LCA based on design data provided by the Architects and structural energy Revit BIM models

Benchmark

3.25 The GLA Schools and universities Benchmark is based on the small number of projects and educational buildings with various room types.

3.26 The MSC project is a university Benchmark building with large open spaces and high energy consumption relating to the swimming pool and changing rooms.

3.27 The building is still in the planning stage, the detailed design stage has not taken place, and some elements are still unknown. However, every effort has been made to make a measured assessment, as some elements are yet to be defined. Based on the initial assessment, it is likely that the WLC embodied emission will fall just below the GLA school benchmark and aspirational target.

| Modules                                          | WLC benchmark<br>(kgCO <sub>2</sub> e/ GIA) | Aspirational benchmark<br>(kgCO <sub>2</sub> e/ GIA) | WLC | Breakdown of a typical development                                                                                                |
|--------------------------------------------------|---------------------------------------------|------------------------------------------------------|-----|-----------------------------------------------------------------------------------------------------------------------------------|
| A1-A5 (excluding sequestration)                  | <750                                        | <500                                                 |     | Substructure: 33%<br>Superstructure: 30%<br>Façade: 13 %<br>Internal finishes: 6 %<br>Services/MEP: 11 %<br>External works: 7 %   |
| B-C (excluding B6 & B7)                          | <250                                        | <175                                                 |     | Substructure: 2 %<br>Superstructure: 4 %<br>Façade: 37 %<br>Internal finishes: 14 %<br>Services/MEP: 29 %<br>External works: 14 % |
| A-C (excluding B6 & B7, including sequestration) | <1000                                       | <675                                                 |     | Substructure: 25 %<br>Superstructure: 24 %<br>Façade: 19 %<br>Internal finishes: 9 %<br>Services/MEP: 15 %<br>External works: 8 % |

Table 7 School and University Benchmark (GLA Whole Life-Cycle Carbon Assessments - March 2022)

| A1-A5 (excluding sequestration)                  |     |                            |
|--------------------------------------------------|-----|----------------------------|
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <750                                             | 503 | <500                       |
| B-C (excluding B6 & B7)                          |     |                            |
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <250                                             | 130 | <175                       |
| A-C (excluding B6 & B7, including sequestration) |     |                            |
| WLC benchmark                                    | MSC | Aspirational WLC benchmark |
| <1000                                            | 693 | <675                       |

Table 8 Comparison with GLA School Building Benchmark.

## 4 Whole Life Cycle Reduction Principles.

|   | WLC Reduction Principle               | Key Benefits                                                                                                                                                                                                                         | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Reuse and retrofit existing buildings | Significant retention and reuse of structures are carbon-efficient and reduce construction costs.                                                                                                                                    | Reuse the existing sports hall (1) walls and roof supporting structure and replace the roof finish with a new, improved insulated system. The swimming pool and changing room were refurbished in 2020 as part of phase one works and are an integral part of the design to be retained. New squash courts are worked into and around the existing pool and sports hall (1). A new extension to the north creates a sports hall (2), classrooms, offices, and storerooms. On completion, approximately a third of the overall building development will have been retained structures. All are as outlined in the Design & Access Statement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 2 | Use recycled or repurposed material   | Reduces carbon emissions and waste.                                                                                                                                                                                                  | Identify potential material for reuse.<br>Identify material with suitability for recycling or the potential for energy recovery.<br>Pre-Demolition and Pre-development audit June 2022 submitted with the application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3 | Material selection                    | Appropriate material choices are crucial to carbon reduction. Ensuring synchronicity between selected materials and the planned life expectancy of the building reduces waste and the need for replacement, thus reducing use costs. | The architect has worked with the design team to select potential end-of-life recycling materials. The existing steel structural elements (sports hall 1) will be retained. The design team has evolved three structural options for different materials for the new sports hall structure. Bricks and concrete have the potential for reuse. Waste recycling and metal recovery are proposed for building service at the end. Natural refrigerants will be preferred over synthetic refrigerants. The proposal has highlighted the intention to use low carbon materials wherever possible, such as: <ul style="list-style-type: none"> <li>• Specifying low-carbon concrete within the structural frame.</li> <li>• Specifying cement replacement such as GGBS in the concrete foundations, slabs and retaining walls.</li> <li>• Aluminium-timber hybrid window frames.</li> <li>• Low carbon calcium sulphate screed.</li> <li>• Using timber lining for its acoustic and low embodied carbon properties</li> <li>• 100% recycled carpet tiles</li> <li>• Investigating the use of a timber frame structure</li> </ul> |
| 4 | Minimise operational energy use       | A 'fabric first approach should be prioritised to minimise energy demand and reduce carbon and in-use costs.                                                                                                                         | The proposal is for a very well-insulated structure with a very high standard of airtightness, reducing heating energy. Long life span LED lighting. Sophisticated building management system responding to temperature, humidity, and carbon dioxide. The use of presence detection controls. An energy assessment for the project is submitted with the planning application. <ul style="list-style-type: none"> <li>• Windows with high U-values – double glazing for windows and roof lights (or better)</li> <li>• Bris Soleil on the western side of the building provides solar shading.</li> <li>• The development will be 100% electrified.</li> <li>• It is highly insulated to minimise heat loss.</li> <li>• Mechanical ventilation with heat recovery (MVHR) throughout, as well as,</li> <li>• Natural ventilation from openable windows develops cross ventilation along the east and west facades.</li> </ul> Further opportunities to maximise energy efficiency will be explored at the next stage of design.                                                                                            |
| 5 | Minimise operational water use        | To avoid leakage and subsequent building damage, the choice of materials and durability of systems contribute to reducing the carbon cost of water use.                                                                              | The school has a recycling policy which monitors operational waste and looks at ways to reduce the waste. Leak detection is specified for water systems. Sports buildings tend to have low waste-generating building use.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 6 | Disassembly and reuse                 | Designing for future disassembly ensures that products do not become future waste and maintain their environmental and economic value.                                                                                               | The architect and structural engineer will work together to design an easily dismantled structure that allows the parts to be recovered for reuse. For example, avoid rigid insulation, which is not easily recyclable, and look at reusable structural elements. Notwithstanding this, the fabric and structure are designed for longevity, therefore, unlikely to be disassembled within the next 100 years.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 7 | Building shape and form               | Compact, efficient shapes help minimise operationally and embodied carbon emissions for a given floor area. This means a more efficient building overall resulting in lower construction and in-use costs.                           | Infilling spaces between buildings. The architect has optimised the building layout with the school for ease of access and movement around the building, using the natural fall of the land to add floor space without height and reduce excavation. The infilling has created a much more compact building shape with consequent external wall and roof efficiencies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|    | WLC Reduction Principle                                                  | Key Benefits                                                                                                                                                                                                                                                                                                      | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8  | Regenerative design                                                      | Removing CO <sub>2</sub> from the atmosphere through materials and systems capable of absorbing CO <sub>2</sub> makes optimistic contributes to reducing CO <sub>2</sub> emissions.                                                                                                                               | Sports facilities are large empty buildings with little opportunity for selecting natural materials over synthetic options; however, natural materials such as timber facings and finishes will be used where possible. The design includes a living green roof. Photovoltaic panels above the green roof will generate carbon-free electricity.                                                                                                                                                                                                                                                                                                          |
| 9  | Designing for durability and flexibility                                 | Durability means reduced repair and replacement, which helps minimise lifetime building costs. A building designed for flexibility can respond with minimum environmental impact to future changing requirements and a changing climate, thus avoiding obsolescence which also underwrites future building value. | <p>The design team will consider design flexibility as the BREEAM assessment process requirement.</p> <ul style="list-style-type: none"> <li>For example, adding a mezzanine floor to the sports halls could create additional classroom space. The sports hall is already designed as a multifunction space.</li> <li>For example, a sporting arena to have alternative uses for performance and theatre arts, school gatherings and assemblies and an examination room.</li> <li>The north block floorspace is essentially an open plan structure and can be subdivided to suit alternative uses. Gyms and studios can be easily repurposed.</li> </ul> |
| 10 | Optimisation of the relationship between operational and embodied carbon | Optimising the operational/embodied carbon relationship contributes to resource efficiency and cost reduction.                                                                                                                                                                                                    | The size and shape of the building design are driven by the final use of the building as a sports hall and art performance and training space. Roof lights will help to reduce artificial lighting energy. Solar shading glass and external shading lessen the requirement for cooling.                                                                                                                                                                                                                                                                                                                                                                   |
| 11 | Building life expectancy                                                 | Defining life expectancy guides project teams on the most efficient choices for materials and products. This aids overall resource efficiency, including cost efficiency, and helps future-proof asset value.                                                                                                     | The MSC sports facility was constructed over 40 years ago. The school has been operating for almost 500 years, and there is an expectation that these buildings will be in use for another 40-plus years as a minimum. The building designs are developed with the expectation for these buildings to be in continuous service for 50-plus years. New building services and control are generally replaced on 15-year cycles as new, more efficient technologies replace existing ones.                                                                                                                                                                   |
| 12 | Local sourcing                                                           | Sourcing local materials reduces transport distances and supply chain lengths and has associated local social and economic benefits.                                                                                                                                                                              | As far as possible, the contractor must use local supplies as part of the contract. The architect and designers will avoid specifying materials that are manufactured abroad. The contractor will be required to employ local labour to avoid transport emissions as part of the Contract Preliminaries.                                                                                                                                                                                                                                                                                                                                                  |
| 13 | Minimising waste                                                         | Waste represents an unnecessary and avoidable carbon cost. Buildings should be designed to minimise fabrication and construction waste and to ease repair and replacement with minimum waste, which helps reduce initial and in-use costs.                                                                        | <p>Review the various waste streams using the waste hierarchy to develop policies and staff training to reduce construction waste before the waste reaches the site. Primary waste sources are:</p> <ul style="list-style-type: none"> <li>Brick &amp; Block Plasterboard and timber sheeting</li> <li>Packaging pallets</li> <li>Timber is measured and cut to reduce waste.</li> <li>Plastic waste (including insulation waste). specific returnable / reusable packaging. Return unused items to wholesalers.</li> <li>Delivery of sanitary fitting or bathroom (off-site modular construction)</li> </ul>                                             |
| 14 | Efficient fabrication                                                    | Efficient construction methods (e.g., modular systems, precision manufacturing and modern construction methods) improve build quality, reduce construction phase waste, and reduce the need for repairs during post-completion and the defects period (snagging).                                                 | <ul style="list-style-type: none"> <li>The architect will review the design to identify components suitable for off-site manufacture where the process is to reduce transport and construction waste.</li> <li>The contractor will operate and promote waste management policies, which will be required in the Contract Preliminaries.</li> <li>The contractor will operate a quality control scheme for the overall construction quality assurance.</li> <li>The designer will attend regular site meetings, review the construction process, and work with the contractor on scheduled delivery.</li> </ul>                                            |
| 15 | Lightweight construction                                                 | Lightweight construction uses less material which reduces the carbon footprint of the building as there is less material to source, fabricate and deliver to the site.                                                                                                                                            | The site is in a building conservation area, and the planners have requested the use of brick to integrate positively with the local context. Brick is also a natural material with a long lifespan and is fundamentally reusable.                                                                                                                                                                                                                                                                                                                                                                                                                        |

|    | WLC Reduction Principle | Key Benefits                                                                                                             | Examples                                                                                                                                                                                                                                                |
|----|-------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16 | Circular Economy        | The circular economy principle focuses on more efficient use of materials, leading to carbon and financial efficiencies. | The designer will review the construction to design a building that can be dismantled for reuse. Sports hall building frame and subcomponents have potential value for reuse. Brickwork can be reused, especially if combined with natural lime mortar. |

5 Pre-demolition Audit

- 5.1
- Estimated quantities of the materials anticipated to be generated during the demolition process are provided in Table 9. The estimated volumes are based on the Site visit by KaNect. The pie charts in Figure 5 and Figure 6 show the percentage breakdown of waste identified during the Site visit.
- 5.2
- It should be noted that the recovery potential provided within Table 9 is based on the best practices as suggested by the Waste and Resource Action Program (WRAP).
- 5.3
- Reusing material on-site or on a nearby, similar project is the ideal option from an environmental and economic perspective. The Client and Architect are best positioned to consider these options and enable these initiatives. Doing so also often results in reduced transportation, reducing embodied CO<sub>2</sub> emissions and costs associated with material management on the project. To take advantage of this opportunity, it is advised that the following are considered:

- Opportunities for reuse on-Site,
- Safe storage of these items on-Site, in a separate storage area, if feasible,
- Opportunities for reuse by the Client on other projects,
- Opportunities for reuse on local/similar projects,
- Advertisement of specific items on websites (e.g., [www.salvo.co.uk](http://www.salvo.co.uk)),
- Contacting local architectural salvage merchants about objects, and
- Selling or gifting items locally.

- 5.4
- Waste arising during demolition should be continually monitored to provide a thorough understanding of the types and amounts of waste coming from the site. This data collection will help with the continual improvement of material and waste management on-site. Data collection can also help set more demanding waste segregation targets for future demolition and refurbishment projects.

| Material                                         | European Waste Catalogue Code (EWC) | Volume (m³) | % Of Total Volume (m³) | Tones (t) | % Of Total Tonnage (t) | Recovery Potential (%) (Best Practice)<br>i.e., % diverted from landfill | Recovery Potential (i.e., m³ diverted from landfill) | Disposal to Landfill/ Energy from Waste (m³) | Recovery Potential (i.e., tones diverted from landfill) | Disposal to Landfill/ Energy from Waste (Tonnes) |
|--------------------------------------------------|-------------------------------------|-------------|------------------------|-----------|------------------------|--------------------------------------------------------------------------|------------------------------------------------------|----------------------------------------------|---------------------------------------------------------|--------------------------------------------------|
| Concrete                                         | 17-01-01                            | 532.95      | 83%                    | 1,492.26  | 85%                    | 100%                                                                     | 532.95                                               | -                                            | 1,492.26                                                | -                                                |
| Bricks                                           | 17-01-02                            | 43.40       | 7%                     | 114.58    | 7%                     | 100%                                                                     | 43.40                                                | -                                            | 114.58                                                  | -                                                |
| Suspended Grid Mineral Ceiling Tile              | 17-09-04                            | 1.73        | 0.3%                   | 5.19      | 0.3%                   | 75%                                                                      | 1.30                                                 | 0.43                                         | 3.89                                                    | 1.30                                             |
| Metals                                           | 17-04-05                            | 55.91       | 9%                     | 141.70    | 8%                     | 100%                                                                     | 55.91                                                | -                                            | 141.70                                                  | -                                                |
| Timber and Timber Products                       | 17-02-01                            | 3.44        | 1%                     | 2.41      | 0.1%                   | 95%                                                                      | 3.27                                                 | 0.17                                         | 2.29                                                    | 0.12                                             |
| Plasterboard (other gypsum-containing materials) | 17-08-02                            | 5.63        | 1%                     | 3.38      | 0.2%                   | 95%                                                                      | 5.34                                                 | 0.28                                         | 3.21                                                    | 0.17                                             |
| Glass                                            | 17-02-02                            | 0.02        | 0.003%                 | 0.05      | 0.003%                 | 100%                                                                     | 0.02                                                 | -                                            | 0.05                                                    | -                                                |
| Asphalt containing (bituminous material)         | 17-03-03                            | 1.32        | 0.2%                   | 1.41      | 0.1%                   | 0%                                                                       | -                                                    | 1.32                                         | -                                                       | 1.41                                             |
| Total                                            |                                     | 644.39      | 100%                   | 1,760.96  | 100%                   |                                                                          | 642.19                                               | 2.21                                         | 1,757.96                                                | 3                                                |

Table 9 Estimated Demolition Quantities of Materials.

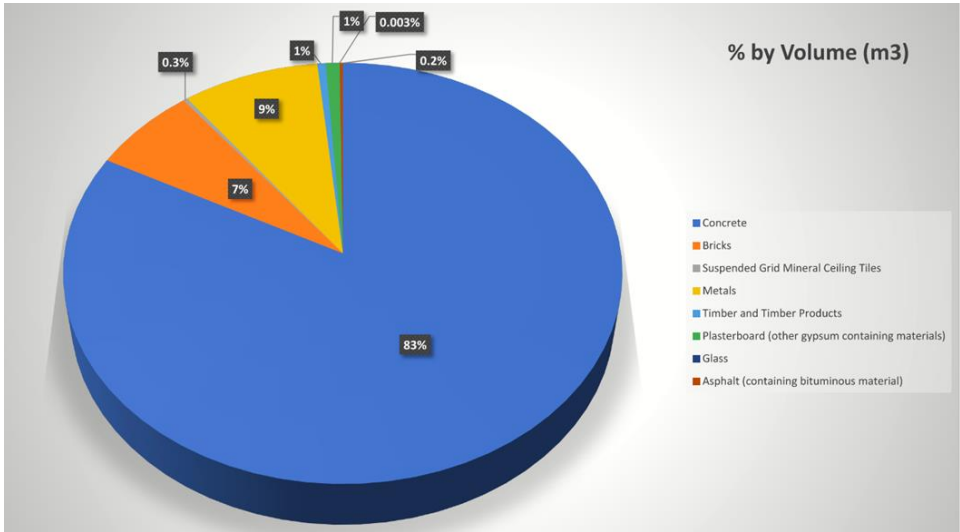


Figure 5 Estimated Volume

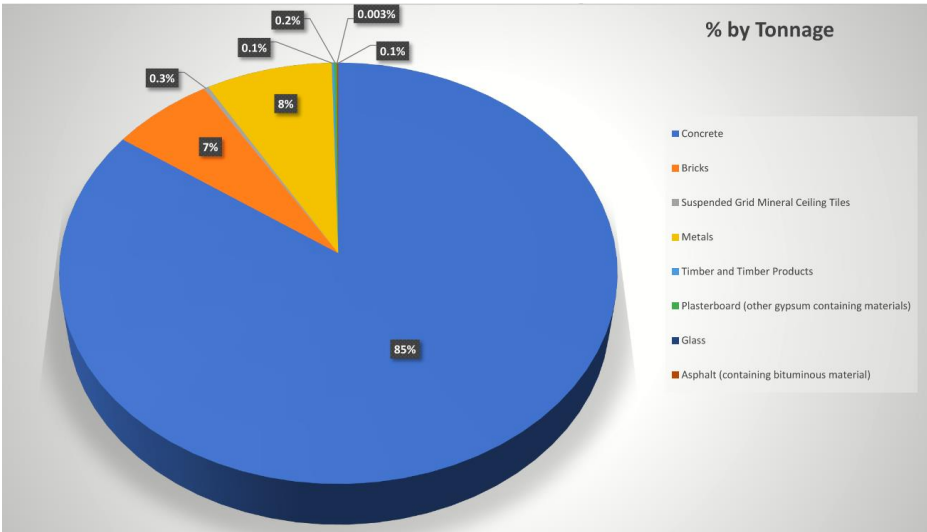


Figure 6 Estimated Tonnage.

6 Appendices

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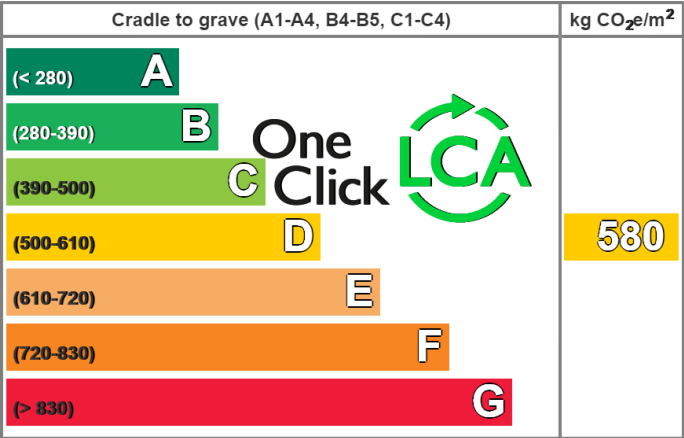
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Appendix E

Appendix A

One Click LCA Results

Performance metric Carbon Heroes Benchmark (A1-A4, B4-B5, C1-C4) CH Q3 2021 United Kingdom  
About benchmark



Future Energy Scenarios (FES) represent various credible ways to decarbonise our energy system as we strive toward the 2050 target. We are less than 30 years from the Net Zero deadline, which is not long when you consider investment cycles for gas networks, electricity transmission lines and domestic heating systems. FES is critical in stimulating debate and helping shape the future's energy system.

The base year without discount.

Decarbonisation scenario for materials manufacturing. The scenario assumes that 20% of material impacts in B2-5 and stages derive from electricity consumption. Electricity impact changes are calculated based on FES Reports (Steady Progression scenario) and RICS equation. The base year for this calculation is set to be 2022. The scenario will adjust impacts for relevant stages as per GLA requirements.

| Result category              | Biogenic carbon (kg CO <sub>2</sub> e) | A1-A3 Product Stage (kg CO <sub>2</sub> e) | A4 Transportati on to the site (kg CO <sub>2</sub> e) | A5 Site operations (kg CO <sub>2</sub> e) | B1 Use Phase (kg CO <sub>2</sub> e) | B2 Maintenanc e (kg CO <sub>2</sub> e) | B4 Material replacement – materials (kg CO <sub>2</sub> e) | B5 Material refurbishme nt (kg CO <sub>2</sub> e) | B6 Operational Energy use – Regulated (kg CO <sub>2</sub> e) | B6 Operational Energy use – Unregulated (kg CO <sub>2</sub> e) | B7 Operational Water use (kg CO <sub>2</sub> e) | C1 Deconstruct ion / demolition (kg CO <sub>2</sub> e) | C2 Waste transportati on (kg CO <sub>2</sub> e) | C3 Waste processing (kg CO <sub>2</sub> e) | C4 Waste disposal (kg CO <sub>2</sub> e) l | TOTAL kg CO <sub>2</sub> e | D External impacts (not included in totals) |
|------------------------------|----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------------------------------------------|-------------------------------------|----------------------------------------|------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------|-------------------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------|---------------------------------------------|
| 0.1 Toxic Mat.               |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 0.2 Demolition               | -16                                    | 1,136,210                                  | 10,619                                                | 80,108                                    |                                     |                                        | 0                                                          | 823                                               | 0                                                            |                                                                |                                                 |                                                        | 5,880                                           | 9,468                                      | 769                                        | 0                          | 1,243,862                                   |
| 0.3 Supports                 |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 0.4 Groundworks              |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 0.5 Diversion                |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 1 Substructure               | 0                                      | 66,359                                     | 7,312                                                 | 3,703                                     |                                     |                                        | 0                                                          | 95,422                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 4,003                                      | 470                                        | 26                         | 177,296                                     |
| 2.1 Frame                    | -211                                   | 57,362                                     | 3,130                                                 | 2,464                                     |                                     |                                        | 0                                                          |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 | 1,365                                      | 362                                        |                            | 64,473                                      |
| 2.2 Upper Floors             | 0                                      | 185,615                                    | 1,912                                                 | 8,988                                     |                                     |                                        | 0                                                          | 92,377                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 5,668                                      | 432                                        | 22                         | 295,015                                     |
| 2.3 Roof                     | -208,638                               | 235,712                                    | 4,258                                                 | 33,384                                    |                                     |                                        | 0                                                          | 53,833                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 6,731                                      | 234,981                                    | 511                        | 360,772                                     |
| 2.4 Stairs & Ramps           | 0                                      | 2,816                                      | 41                                                    | 0                                         |                                     |                                        | 0                                                          |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 | 52                                         | 6                                          |                            | 2,914                                       |
| 2.5 Ext. Walls               | 0                                      | 222,399                                    | 16,769                                                | 9,762                                     |                                     |                                        | 0                                                          | 103,461                                           | 0                                                            |                                                                |                                                 |                                                        |                                                 | 7,657                                      | 901                                        | 29                         | 360,977                                     |
| 2.6 Windows & Ext. Doors     | 0                                      | 50,683                                     | 82                                                    | 0                                         |                                     |                                        | 0                                                          | 61,090                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 757                                        | 10                                         | 6                          | 112,629                                     |
| 2.7. Int. Walls & Partitions | 0                                      | 0                                          | 188                                                   | 0                                         |                                     |                                        | 0                                                          | 22,572                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 551                                        | 34                                         | 1                          | 23,345                                      |
| 2.8 Int. Doors               | 0                                      | 0                                          | 13                                                    | 0                                         |                                     |                                        | 0                                                          | 2,780                                             | 0                                                            |                                                                |                                                 |                                                        |                                                 | 10                                         | 27                                         | 1                          | 2,831                                       |

| Result category                                 | Biogenic carbon (kg CO <sub>2</sub> e) | A1-A3 Product Stage (kg CO <sub>2</sub> e) | A4 Transportati on to the site (kg CO <sub>2</sub> e) | A5 Site operations (kg CO <sub>2</sub> e) | B1 Use Phase (kg CO <sub>2</sub> e) | B2 Maintenanc e (kg CO <sub>2</sub> e) | B4 Material replacement – materials (kg CO <sub>2</sub> e) | B5 Material refurbishme nt (kg CO <sub>2</sub> e) | B6 Operational Energy use – Regulated (kg CO <sub>2</sub> e) | B6 Operational Energy use – Unregulated (kg CO <sub>2</sub> e) | B7 Operational Water use (kg CO <sub>2</sub> e) | C1 Deconstruct ion / demolition (kg CO <sub>2</sub> e) | C2 Waste transportati on (kg CO <sub>2</sub> e) | C3 Waste processing (kg CO <sub>2</sub> e) | C4 Waste disposal (kg CO <sub>2</sub> e) l | TOTAL kg CO <sub>2</sub> e | D External impacts (not included in totals) |
|-------------------------------------------------|----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------------------------------------------|-------------------------------------|----------------------------------------|------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------|-------------------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------|---------------------------------------------|
| 3 Finishes                                      |                                        |                                            |                                                       |                                           |                                     |                                        | 0                                                          |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            | 0                                           |
| 4 Fittings, furnishings & equipment's           |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 5 Services (MEP)                                | 0                                      | 81,644                                     | 116                                                   | 615                                       |                                     |                                        | 0                                                          | 185,125                                           | 0                                                            | 3,568,967                                                      |                                                 | 117,000                                                |                                                 | 419                                        | 37                                         | 7                          | 3,953,931                                   |
| 6 Prefabricated                                 |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| 7 Existing bldg.                                |                                        |                                            |                                                       |                                           |                                     | 762                                    |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            | 762                                         |
| 8 Ext. works                                    |                                        |                                            |                                                       | 170,207                                   |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            | 170,207                                     |
| Unclassified / Other                            |                                        |                                            |                                                       |                                           |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                            |                                            |                            |                                             |
| TOTAL kg CO <sub>2</sub> e kg CO <sub>2</sub> e | -208,865                               | 2,038,800                                  | 44,440                                                | 309,231                                   |                                     | 762                                    | 0                                                          | 617,484                                           | 0                                                            | 3,568,967                                                      |                                                 | 117,000                                                | 5,880                                           | 36,681                                     | 238,029                                    | 603                        | 6,769,013                                   |

Electricity grid decarbonisation scenario FES2021.

Decarbonisation scenario for materials manufacturing. The scenario assumes that 20% of material impacts in B2-5 and stages derive from electricity consumption. Electricity impact changes are calculated based on FES Reports (Steady Progression scenario) and RICS equation. The base year for this calculation is set to be 2022. The scenario will adjust impacts for relevant stages as per GLA requirements.

| Result category  | Biogenic carbon (kg CO <sub>2</sub> e) | A1-A3 Product Stage (kg CO <sub>2</sub> e) | A4 Transportatio n to the site (kg CO <sub>2</sub> e) | A5 Site operation s (kg CO <sub>2</sub> e) | B1 Use Phase (kg CO <sub>2</sub> e) | B2 Maintena nce (kg CO <sub>2</sub> e) | B4 Material replacement – materials (kg CO <sub>2</sub> e) | B5 Material refurbishme nt (kg CO <sub>2</sub> e) | B6 Operational Energy use – Regulated (kg CO <sub>2</sub> e) | B6 Operational Energy use – Unregulated (kg CO <sub>2</sub> e) | B7 Operational Water use (kg CO <sub>2</sub> e) | C1 Deconstructio n / demolition (kg CO <sub>2</sub> e) | C2 Waste transportati on (kg CO <sub>2</sub> e) | C3 Waste processin g (kg CO <sub>2</sub> e) | C4 Waste disposal (kg CO <sub>2</sub> e) l | TOTA L kg CO <sub>2</sub> e | D External impacts (not included in totals) | Resu lt cate gory |
|------------------|----------------------------------------|--------------------------------------------|-------------------------------------------------------|--------------------------------------------|-------------------------------------|----------------------------------------|------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------|-------------------------------------------------|---------------------------------------------|--------------------------------------------|-----------------------------|---------------------------------------------|-------------------|
| 0.1 Toxic Mat.   |                                        |                                            |                                                       |                                            |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                             |                                            |                             |                                             |                   |
| 0.2 Demolition   | -16                                    | 1,136,210                                  | 10,619                                                | 80,108                                     |                                     |                                        | 0                                                          | 676                                               | 0                                                            |                                                                |                                                 |                                                        | 5,880                                           | 9,468                                       | 769                                        | 0                           | 1,243,714                                   | - 790,712         |
| 0.3 Supports     |                                        |                                            |                                                       |                                            |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                             |                                            |                             |                                             |                   |
| 0.4 Groundwor ks |                                        |                                            |                                                       |                                            |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                             |                                            |                             |                                             |                   |
| 0.5 Diversion    |                                        |                                            |                                                       |                                            |                                     |                                        |                                                            |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 |                                             |                                            |                             |                                             |                   |
| 1 Substructur e  | 0                                      | 66,359                                     | 7,312                                                 | 3,703                                      |                                     |                                        | 0                                                          | 78,360                                            | 0                                                            |                                                                |                                                 |                                                        |                                                 | 4,003                                       | 470                                        | 26                          | 160,234                                     | - 22,206          |
| 2.1 Frame        | -211                                   | 57,362                                     | 3,130                                                 | 2,464                                      |                                     |                                        | 0                                                          |                                                   |                                                              |                                                                |                                                 |                                                        |                                                 | 1,365                                       | 362                                        |                             | 64,473                                      | - 11,709          |

| Result category                                 | Biogenic carbon (kg CO <sub>2</sub> e) | A1-A3 Product Stage (kg CO <sub>2</sub> e) | A4 Transportation to the site (kg CO <sub>2</sub> e) | A5 Site operations (kg CO <sub>2</sub> e) | B1 Use Phase (kg CO <sub>2</sub> e) | B2 Maintenance (kg CO <sub>2</sub> e) | B4 Material replacement – materials (kg CO <sub>2</sub> e) | B5 Material refurbishment (kg CO <sub>2</sub> e) | B6 Operational Energy use – Regulated (kg CO <sub>2</sub> e) | B6 Operational Energy use – Unregulated (kg CO <sub>2</sub> e) | B7 Operational Water use (kg CO <sub>2</sub> e) | C1 Deconstruction / demolition (kg CO <sub>2</sub> e) | C2 Waste transportation (kg CO <sub>2</sub> e) | C3 Waste processing (kg CO <sub>2</sub> e) | C4 Waste disposal (kg CO <sub>2</sub> e) | TOTAL kg CO <sub>2</sub> e | D External impacts (not included totals) | Result category |
|-------------------------------------------------|----------------------------------------|--------------------------------------------|------------------------------------------------------|-------------------------------------------|-------------------------------------|---------------------------------------|------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------|------------------------------------------------|--------------------------------------------|------------------------------------------|----------------------------|------------------------------------------|-----------------|
| 2.2 Upper Floors                                | 0                                      | 185,615                                    | 1,912                                                | 8,988                                     |                                     |                                       | 0                                                          | 76,278                                           | 0                                                            |                                                                |                                                 |                                                       |                                                | 5,668                                      | 432                                      | 22                         | 278,915                                  | -40,226         |
| 2.3 Roof                                        | -208,638                               | 235,712                                    | 4,258                                                | 33,384                                    |                                     |                                       | 0                                                          | 44,222                                           | 0                                                            |                                                                |                                                 |                                                       |                                                | 6,731                                      | 234,981                                  | 511                        | 351,161                                  | -267,193        |
| 2.4 Stairs & Ramps                              | 0                                      | 2,816                                      | 41                                                   | 0                                         |                                     |                                       | 0                                                          |                                                  |                                                              |                                                                |                                                 |                                                       |                                                | 52                                         | 6                                        |                            | 2,914                                    | -640            |
| 2.5 Ext. Walls                                  | 0                                      | 222,399                                    | 16,769                                               | 9,762                                     |                                     |                                       | 0                                                          | 84,962                                           | 0                                                            |                                                                |                                                 |                                                       |                                                | 7,657                                      | 901                                      | 29                         | 342,478                                  | -44,004         |
| 2.6 Windows & Ext. Doors                        | 0                                      | 50,683                                     | 82                                                   | 0                                         |                                     |                                       | 0                                                          | 50,154                                           | 0                                                            |                                                                |                                                 |                                                       |                                                | 757                                        | 10                                       | 6                          | 101,693                                  | -9,598          |
| 2.7. Int. Walls & Partitions                    | 0                                      | 0                                          | 188                                                  | 0                                         |                                     |                                       | 0                                                          | 18,566                                           | 0                                                            |                                                                |                                                 |                                                       |                                                | 551                                        | 34                                       | 1                          | 19,339                                   | -1,712          |
| 2.8 Int. Doors                                  | 0                                      | 0                                          | 13                                                   | 0                                         |                                     |                                       | 0                                                          | 2,282                                            | 0                                                            |                                                                |                                                 |                                                       |                                                | 10                                         | 27                                       | 1                          | 2,333                                    | 0               |
| 3 Finishes                                      |                                        |                                            |                                                      |                                           |                                     |                                       | 0                                                          |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            | 0                                        |                 |
| 4 Fittings, furnishings & equipment             |                                        |                                            |                                                      |                                           |                                     |                                       |                                                            |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            |                                          |                 |
| 5 Services (MEP)                                | 0                                      | 81,644                                     | 116                                                  | 615                                       |                                     |                                       | 0                                                          | 153,582                                          | 0                                                            | 3,568,967                                                      |                                                 | 117,000                                               |                                                | 419                                        | 37                                       | 7                          | 3,922,388                                | 78,237          |
| 6 Prefabricated                                 |                                        |                                            |                                                      |                                           |                                     |                                       |                                                            |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            |                                          |                 |
| 7 Existing bldg.                                |                                        |                                            |                                                      |                                           |                                     | 762                                   |                                                            |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            | 762                                      |                 |
| 8 Ext. works                                    |                                        |                                            |                                                      | 170,207                                   |                                     |                                       |                                                            |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            | 170,207                                  |                 |
| Unclassified / Other                            |                                        |                                            |                                                      |                                           |                                     |                                       |                                                            |                                                  |                                                              |                                                                |                                                 |                                                       |                                                |                                            |                                          |                            |                                          |                 |
| TOTAL kg CO <sub>2</sub> e kg CO <sub>2</sub> e | -208,865                               | 2,038,800                                  | 44,440                                               | 309,231                                   |                                     | 762                                   | 0                                                          | 509,083                                          | 0                                                            | 3,568,967                                                      |                                                 | 117,000                                               | 5,880                                          | 36,681                                     | 238,029                                  | 603                        | 6,660,612                                | -1,109,762      |

| Most contributing materials (TOTAL kg CO2e) |                                                                       |                                |                           |                               |
|---------------------------------------------|-----------------------------------------------------------------------|--------------------------------|---------------------------|-------------------------------|
| No.                                         | Resource                                                              | Cradle to gate impacts (A1-A3) | Of cradle to gate (A1-A3) | Sustainable alternatives      |
| 1.                                          | Aluminium General, Worldwide ?                                        | 950 tons CO <sub>2</sub> e     | 46.6 %                    | Show sustainable alternatives |
| 2.                                          | Ready-mix concrete, normal-strength, generic ?                        | 222 tons CO <sub>2</sub> e     | 10.9 %                    | Show sustainable alternatives |
| 3.                                          | Ready-mix concrete ?                                                  | 177 tons CO <sub>2</sub> e     | 8.7 %                     | Show sustainable alternatives |
| 4.                                          | Sandwich panel with PUR/PIR core and double steel siding, for roofs ? | 84 tons CO <sub>2</sub> e      | 4.1 %                     | Show sustainable alternatives |
| 5.                                          | Glued laminated timber (Glulam) beams ?                               | 79 tons CO <sub>2</sub> e      | 3.9 %                     | Show sustainable alternatives |
| 6.                                          | Ready-mix concrete ?                                                  | 66 tons CO <sub>2</sub> e      | 3.3 %                     | Show sustainable alternatives |
| 7.                                          | Reinforcement steel (rebar), generic ?                                | 66 tons CO <sub>2</sub> e      | 3.2 %                     | Show sustainable alternatives |
| 8.                                          | Ready-mix concrete ?                                                  | 57 tons CO <sub>2</sub> e      | 2.8 %                     | Show sustainable alternatives |
| 9.                                          | Aluminium frame window ?                                              | 51 tons CO <sub>2</sub> e      | 2.5 %                     | Show sustainable alternatives |
| 10.                                         | Self levelling mortar, for floors, walls and overhead appl. ?         | 43 tons CO <sub>2</sub> e      | 2.1 %                     | Show sustainable alternatives |
| 11.                                         | Precast concrete floor slab ?                                         | 42 tons CO <sub>2</sub> e      | 2.0 %                     | Show sustainable alternatives |
| 12.                                         | Air handling unit, with heat recovery through plate heat exchanger ?  | 41 tons CO <sub>2</sub> e      | 2.0 %                     | Show sustainable alternatives |
| 13.                                         | Hollow core concrete slabs, generic ?                                 | 27 tons CO <sub>2</sub> e      | 1.3 %                     | Show sustainable alternatives |
| 14.                                         | LED lighting ?                                                        | 21 tons CO <sub>2</sub> e      | 1.0 %                     | Show sustainable alternatives |
| 15.                                         | Air conditioning system, per 1 kW ?                                   | 18 tons CO <sub>2</sub> e      | 0.9 %                     | Show sustainable alternatives |
| 16.                                         | Glass wool insulation ?                                               | 17 tons CO <sub>2</sub> e      | 0.8 %                     | Show sustainable alternatives |
| 17.                                         | Hollow core concrete slabs ?                                          | 14 tons CO <sub>2</sub> e      | 0.7 %                     | Show sustainable alternatives |
| 18.                                         | FRP composite sandwich panelized rooftop ?                            | 9,2 tons CO <sub>2</sub> e     | 0.5 %                     | Show sustainable alternatives |
| 19.                                         | Laminated veneer lumber (LVL) ?                                       | 8,9 tons CO <sub>2</sub> e     | 0.4 %                     | Show sustainable alternatives |
| 20.                                         | Aluminium ceiling systems ?                                           | 8,7 tons CO <sub>2</sub> e     | 0.4 %                     | Show sustainable alternatives |
| 21.                                         | Extensive green roof system ?                                         | 5,3 tons CO <sub>2</sub> e     | 0.3 %                     | Show sustainable alternatives |
| 22.                                         | Gypsum plasterboard, fire resistant ?                                 | 6,3 tons CO <sub>2</sub> e     | 0.3 %                     | Show sustainable alternatives |
| 23.                                         | Lightweight concrete block, with expanded clay aggregate, generic ?   | 3,9 tons CO <sub>2</sub> e     | 0.2 %                     | Show sustainable alternatives |
| 24.                                         | Bitumen-polymer membrane roofing, 2 layer, mechanically fastened ?    | 4,9 tons CO <sub>2</sub> e     | 0.2 %                     | Show sustainable alternatives |
| 25.                                         | Planned timber, conifer ?                                             | 4,9 tons CO <sub>2</sub> e     | 0.2 %                     | Show sustainable alternatives |

▼ Completeness (100%) and plausibility checker (grade: A)

! RICS Guidance requires the following. Document them if present.  
Recommended elements present: [3/8]. Missing elements:  
[1.1.5.Basement retaining walls, 2.1.1.Steel frames, 2.1.2.Space decks, 2.1.3.Concrete casings to steel frames, 2.1.6.Other frame systems]

👍 All required and recommended elements are present in the design for scope: RICS: Whole life carbon assessment

👍 LCA Checker overall grade: A. Grade is based on data you have provided.

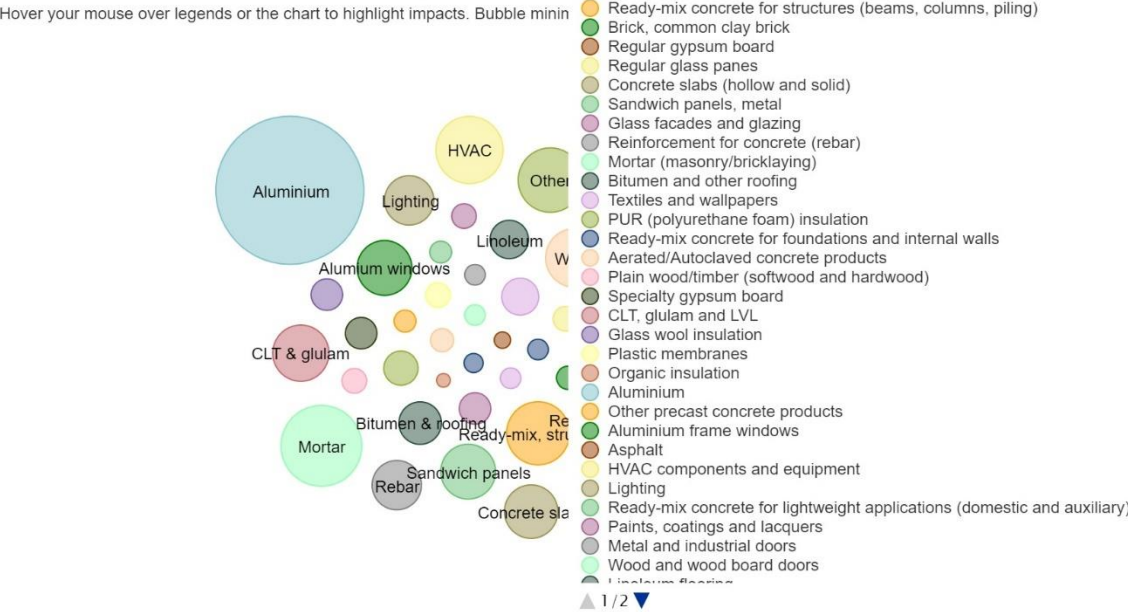
LCA Checker overall grade: A

LCA Checker checks the embodied impacts plausibility. These results reflect plausibility for 4753.0 m<sup>2</sup> project of type expansion of an existing building with frame type timber frame with scope consisting of foundations and substructure, structure and enclosure, finishings and other materials, external areas, services. To edit these parameters open LCA Parameters query. The result is intended as indicative of the plausibility; and exceptions may occur.

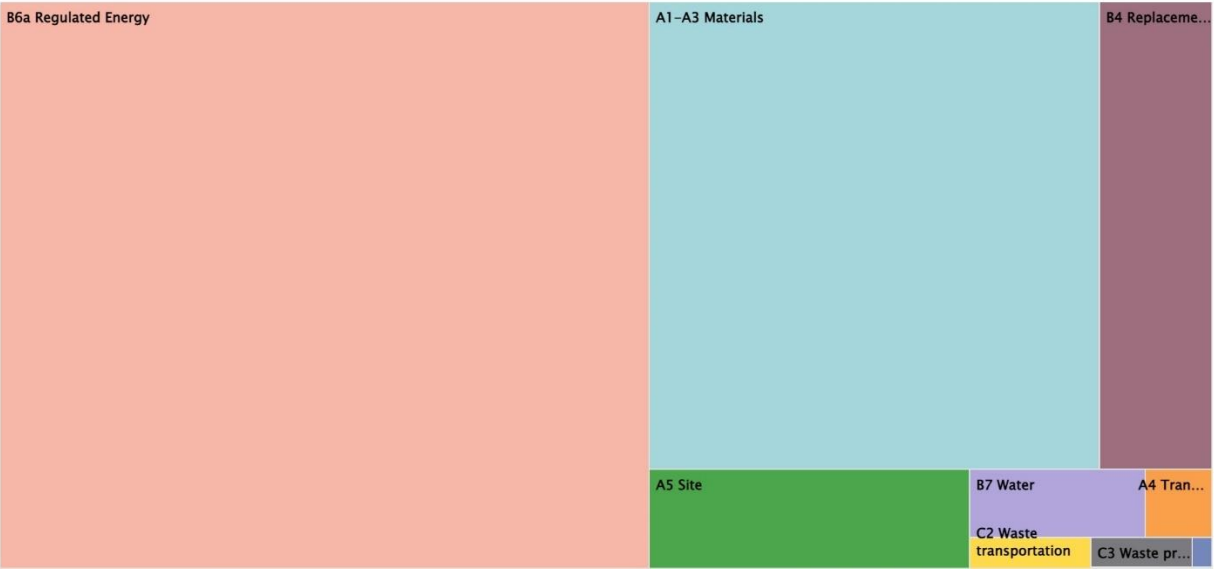
Using the free version of LCA Checker, query about the Business version for more comprehensive results.

| No.              | Check description                 | Project value | Threshold value | Typical value | Unit | Type | Validated ? |
|------------------|-----------------------------------|---------------|-----------------|---------------|------|------|-------------|
| Validated checks |                                   |               |                 |               |      |      |             |
| 1                | Ready mix and reinforcement ratio | 2.305         | 1 - 7           |               | %    | ✓    | 🔘           |
| 2                | Too dominant single material      | 46.581        | less than 50    |               | %    | ✓    | 🔘           |

Bubble chart, total life-cycle impact by resource 1



TOTAL kg CO2e kg CO2e - Life-cycle stages



Appendix B Resource Data

| Resource name                                                        | Technical specification                                    | Product                     | Manufacturer                                                                                                                              | EPD program              | EPD number                      | Environment Data Source                                                                                 | Standard   | Verification                            | Year | Country                                                                | Upstream database | Density | Product Category Rules (PCR)                                                       | Notes about PCR    |
|----------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------|------------|-----------------------------------------|------|------------------------------------------------------------------------|-------------------|---------|------------------------------------------------------------------------------------|--------------------|
| Air conditioning system, per 1 kW                                    |                                                            |                             |                                                                                                                                           | OKOBAUDAT                | -                               | Oekobau.dat 2020-II                                                                                     | EN15804+A1 | Third-party verified (as per ISO 14025) | 2020 | Germany                                                                | GaBi              |         | EN15804+A1                                                                         | -                  |
| Air handling unit, with heat recovery through a plate heat exchanger | 10 000 m3/h (5885.8 ft3/min), 1256 kg/unit (2769 lbs/unit) |                             |                                                                                                                                           | One Click LCA            | -                               | One Click LCA                                                                                           | EN15804+A1 | Internally verified                     | 2019 | LOCAL                                                                  | ecoinvent         |         | EN15804+A1                                                                         | -                  |
| Aluminium General, worldwide                                         | Worldwide production                                       |                             |                                                                                                                                           | ICE                      | -                               | ICE database August 2019, V3.0                                                                          | EN15804+A1 | Self-declared                           | 2019 | world                                                                  | -                 |         | EN15804+A1                                                                         | -                  |
| Aluminium ceiling systems                                            | 5.15 kg/                                                   |                             | TAIM                                                                                                                                      | EPD Denmark              | MD-19005-EN                     | EPD Metal ceiling systems made of steelTAIM e.V.                                                        | EN15804+A1 | Third-party verified (as per ISO 14025) | 2019 | Europe                                                                 | GaBi              |         | PCR Metal ceilings, 07.2014                                                        | Only with EN15804  |
| Aluminium frame window                                               | 26.33 kg/, 2.3 /unit                                       |                             | Organisation professionnelle représentative des concepteurs, fabricants et installateurs de menuiseries extérieures en profilés aluminium | INIES                    | INIES_CFEN20181017_145618, 8714 | FDES                                                                                                    | EN15804+A1 | Third-party verified (as per ISO 14025) | 2018 | France                                                                 | ecoinvent         |         | EN15804+A1                                                                         | EN15804+A1         |
| Aluminium profile for windows and doors                              | 2600 kg/m3                                                 | Al Profile                  | Saray                                                                                                                                     | International EPD System | S-P-00833                       | EPD for Aluminium Profiles                                                                              | EN15804+A1 | Third-party verified (as per ISO 14025) | 2016 | turkey                                                                 | ecoinvent         |         | PCR 2012:01 Construction products and Construction services, ver. 2.01, 09/03/2016 | Only with EN151404 |
| Asphalt, generic, compacted                                          | 5/95% bitumen-aggregate ratio, 2350 kg/m3                  |                             |                                                                                                                                           | One Click LCA            | -                               | One Click LCA                                                                                           | EN15804+A1 | Internally verified                     | 2018 | LOCAL                                                                  | ecoinvent         | 2350    | EN15804+A1                                                                         | -                  |
| Bitumen-polymer membrane roofing, 2 layers, fully torched            |                                                            |                             | EWA                                                                                                                                       | EPD Norge                | NEPD00269E                      | Multi-layer fully torched modified bitumen roof waterproofing system, Bitumen Waterproofing Association | EN15804+A1 | Third-party verified (as per ISO 14025) | 2014 | Europe, Belgium, Denmark, Finland, Germany, Italy, Netherlands, Sweden | -                 | 1232    | NPCR 022 Roof Waterproofing, rev1                                                  | Only with EN15804  |
| Brick sandwich wall assembly, incl. mineral wool insulation          |                                                            |                             |                                                                                                                                           | One Click LCA            |                                 | One Click LCA generic construction definitions                                                          |            |                                         |      | Europe                                                                 | Other             |         |                                                                                    |                    |
| Bricks                                                               | 226x104x60, 226x85x60 mm                                   | N.F. with holes & solid, RF | Wiener Berger                                                                                                                             | IBU                      | EPDWIE20130206-IAB1EN           | Bricks Wiener Berger AS                                                                                 | EN15804+A1 | Third-party verified (as per ISO 14025) | 2014 | Germany                                                                | GaBi              | 1700    | PCR Bricks, 07/2013                                                                | Only with EN15804  |

| Resource name                                       | Technical specification                                                                    | Product              | Manufacturer       | EPD program    | EPD number                       | Environment Data Source                                                                        | Standard                | Verification                            | Year | Country       | Upstream database | Density | Product Category Rules (PCR)                                                                                                                                          | Notes about PCR   |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------|--------------------|----------------|----------------------------------|------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------|------|---------------|-------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Ceiling tiles                                       | biogenic CO <sub>2</sub> not subtracted, 15, 25, 35 mm, 647.5 kg/m3                        | Heradesign           | Knauf              | IBU            | EPD-KNA-20140051-IBC1-DE         | Oekobau.dat 2017-I, EPD Heradesign Akustikplatten Knauf AMF Deckensysteme Ges.m.b.H            | EN15804+A1              | Third-party verified (as per ISO 14025) | 2014 | Austria       | GaBi              | 647.5   | PCR Holzwerkstoffe, 07/2012                                                                                                                                           | Only with EN15804 |
| Clay brick                                          |                                                                                            |                      | One Click LCA      | One Click LCA  | -                                | One Click LCA                                                                                  | EN15804+A1 , EN15804+A2 | Internally verified                     | 2022 | LOCAL         | ecoinvent         |         | EN15804+A1                                                                                                                                                            | -                 |
| Concrete block internal wall assembly, incl. render |                                                                                            |                      |                    | -              |                                  | One Click LCA generic construction definitions                                                 |                         |                                         |      | France        | -                 |         |                                                                                                                                                                       |                   |
| Concrete cleanliness per GFA                        | C12/C15                                                                                    |                      |                    | One Click LCA  |                                  | One Click LCA generic construction definitions                                                 |                         |                                         |      | LOCAL         | Ecoinvent         |         |                                                                                                                                                                       |                   |
| Concrete masonry units                              | 200 mm                                                                                     | DONNEE PAR DEFAULT   | DED                | INIES          | INIES_DPET20201130_220801, 28710 | MDEGD_FDES                                                                                     | EN15804+A1              | Third-party verified (as per ISO 14025) | 2022 | France        | ecoinvent         |         | EN15804+A1                                                                                                                                                            | EN15804+A1        |
| Doors with wooden frames, interior                  |                                                                                            | DONNEE PAR DEFAULT   | DED                | INIES          | INIES_DPOR20180830_104138, 8591  | MDEGD_FDES                                                                                     | EN15804+A1              | Third-party verified (as per ISO 14025) | 2018 | France        | ecoinvent, ELCD   |         | EN15804+A1                                                                                                                                                            | EN15804+A1        |
| Extensive green roof system                         | 40mm, 23.34 kg/                                                                            | Urbanspace           | Knauf              | IBU            | EPD-KNI-20160071-CBA1-EN         | EPD URBANSCAPE Extensive Green Roof System                                                     | EN15804+A1              | Third-party verified (as per ISO 14025) | 2016 | Germany       | GaBi              | 583.5   | PCR Part B Prevegetated green roof system for extensive use, 03/2016                                                                                                  | Only with EN15804 |
| External door                                       |                                                                                            |                      |                    | One Click LCA  |                                  | One Click LCA generic construction definitions                                                 |                         |                                         |      | Europe        | Other             |         |                                                                                                                                                                       |                   |
| FRP composite sandwich panelised rooflight          | cell dimensions 61.0 cm x 30.0 cm, thickness 70 mm, 9.77 kg/                               | TRANSLUCENT SKYROOFS | Kalwall            | UL Environment | 4790187800.104.1                 | EPD TRANSLUCENT SKYROOFS FRP COMPOSITE SANDWICH PANELISED ROOFLIGHT                            | EN15804+A1              | Third-party verified (as per ISO 14025) | 2022 | North America | GaBi              |         | PCR ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services. | Only with EN15804 |
| Filter fabric N2                                    |                                                                                            |                      |                    | One Click LCA  | -                                | Polypropylene (P.P.), Environmental Product Declarations of the European Plastic Manufacturers | ISO14040                | Internally verified                     | 2008 | LOCAL         | ecoinvent         | 330     | PCR for uncompounded polymer resins and reactive polymer precursors                                                                                                   | Only with EN15804 |
| Finishing wall mortars, French average              | 3 mm, 4.2 kg/                                                                              | DONNEE PAR DEFAULT   | DED                | INIES          | INIES_DMOR20170317_174244, 6396  | MDEGD_FDES                                                                                     | EN15804+A1              | Third-party verified (as per ISO 14025) | 2017 | France        | ecoinvent         | 1400    | EN15804+A1                                                                                                                                                            | EN15804+A1        |
| Float glass, single pane, generic                   | 3-12 mm (0.12-0.47 in), 10 kg/ (2.05 lbs/ft2) (for 4 mm/0.16 in), 2500 kg/m3 (156 lbs/ft3) |                      |                    | One Click LCA  | -                                | One Click LCA                                                                                  | EN15804+A1              | Internally verified                     | 2018 | LOCAL         | ecoinvent         | 2500    | EN15804+A1                                                                                                                                                            | -                 |
| Gas boiler                                          | 104 kg/unit, 100 kW                                                                        |                      | One Click LCA 2022 | One Click LCA  | -                                | One Click LCA                                                                                  | EN15804+A1 , EN15804+A2 | Internally verified                     | 2022 | LOCAL         | ecoinvent         |         | EN15804+A1                                                                                                                                                            | -                 |

| Resource name                                                     | Technical specification                                                                                                                              | Product            | Manufacturer              | EPD program   | EPD number                       | Environment Data Source                                                                   | Standard   | Verification                            | Year | Country        | Upstream database | Density | Product Category Rules (PCR)                               | Notes about PCR   |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------------|---------------|----------------------------------|-------------------------------------------------------------------------------------------|------------|-----------------------------------------|------|----------------|-------------------|---------|------------------------------------------------------------|-------------------|
| Glass wool insulation panels, unfaced, generic                    | L = 0.031 W/mK, R = 3.23 K/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) |                    |                           | One Click LCA | -                                | One Click LCA                                                                             | EN15804+A1 | Internally verified                     | 2018 | LOCAL          | ecoinvent         | 25      | EN15804+A1                                                 | -                 |
| Glass, General, per kg                                            |                                                                                                                                                      |                    |                           | ICE           | -                                | ICE database August 2019, V3.0                                                            | EN15804+A1 | Self-declared                           | 2019 | United Kingdom | -                 |         | EN15804+A1                                                 | -                 |
| Green roof assembly, with hollow-core concrete deck               |                                                                                                                                                      |                    |                           | -             |                                  | One Click LCA generic construction definitions                                            |            |                                         |      | Europe         | Other             |         |                                                            |                   |
| Gypsum board                                                      | 12.5 mm, 9.3 kg/, 744 kg/m³                                                                                                                          | Placoplatre® BA 13 | PLACOPLATRE               | INIES         | INIES_IPLA20121002_132553, 22894 | FDES                                                                                      | EN15804+A1 | Third-party verified (as per ISO 14025) | 2020 | France         | ecoinvent         | 744     | EN15804+A1                                                 | EN15804+A1        |
| Gypsum plasterboard                                               | 12.5 mm, 8.985 kg/ (average product weight)                                                                                                          |                    | Etex Building Performance | BRE           | BREG EN EPD 000204               | EPD GTEC Plasterboard                                                                     | EN15804+A1 | Third-party verified (as per ISO 14025) | 2018 | United Kingdom | ecoinvent         | 718.8   | EN15804+A1                                                 | -                 |
| Hollow core concrete slabs                                        | B45 M45, 320x1200 mm, 8 rebars/, 392 kg/                                                                                                             | HD 320             | Spenncon                  | EPD Norge     | NEPD-14-317-NO                   | Cover Elements perforated, type HD 265 B45 M45, NEPD-14-223-NO, Spenncon, Consolis        | EN15804+A1 | Internally verified                     | 2016 | Norway         | ecoinvent         |         | NPCR 020 Precast Concrete Products, 2011                   | Only with EN15804 |
| In-situ concrete column, 400 x 400 mm                             | C32/40, with One Click LCA data                                                                                                                      |                    |                           | One Click LCA |                                  | One Click LCA generic construction definitions                                            |            |                                         |      | LOCAL          | Ecoinvent         |         |                                                            |                   |
| Interior Door                                                     |                                                                                                                                                      |                    |                           | -             |                                  | One Click LCA generic construction definitions                                            |            |                                         |      | France         | -                 |         |                                                            |                   |
| LED lighting                                                      | 82W                                                                                                                                                  | DONNEE PAR DEFAULT | DED                       | INIES         | INIES_DRÉG20190918_145258, 13827 | MDEGD_FDES                                                                                | EN15804+A1 | Third-party verified (as per ISO 14025) | 2019 | France         | ecoinvent         |         | EN15804+A1                                                 | EN15804+A1        |
| Lightweight concrete block, with expanded clay aggregate, generic | 650 kg/m³ (40.6 lbs/ft³), 18 kg/block (39.7 lbs/block), 0.5x0.3x0.185 mm (0.019x0.012x0.007 in)                                                      |                    |                           | One Click LCA | -                                | One Click LCA                                                                             | EN15804+A1 | Internally verified                     | 2018 | LOCAL          | ecoinvent         | 650     | EN15804+A1                                                 | -                 |
| Linoleum floor covering                                           |                                                                                                                                                      |                    |                           | One Click LCA |                                  | One Click LCA generic construction definitions                                            |            |                                         |      | Europe         | Other             |         |                                                            |                   |
| Linoleum flooring                                                 | 2.25 mm, 2.9 kg/                                                                                                                                     |                    | ERFMI                     | IBU           | EPD-ERF-2013811-E                | EPD ERFMI - European Resilient Flooring Manufacturers' Institute – Linoleum               | EN15804+A1 | Third-party verified (as per ISO 14025) | 2013 | Europe         | GaBi              | 1288.89 | PCR for Floor coverings, 09/07/2012Version 1/1: 29/10/2012 | Only with EN15804 |
| Masonry mortar, light                                             | 1000 kg/m³                                                                                                                                           |                    | quick-mix                 | IBU           | EPD-QMX-20150010-IBC1-DE         | EPD Mineralische Werkmörtel: Mauermörtel Leichtmauermörtel quick mix Gruppe GmbH & Co. KG | EN15804+A1 | Third-party verified (as per ISO 14025) | 2015 | Germany        | GaBi              | 1000    | PCR Mineralische Werkmörtel                                | Only with EN15804 |

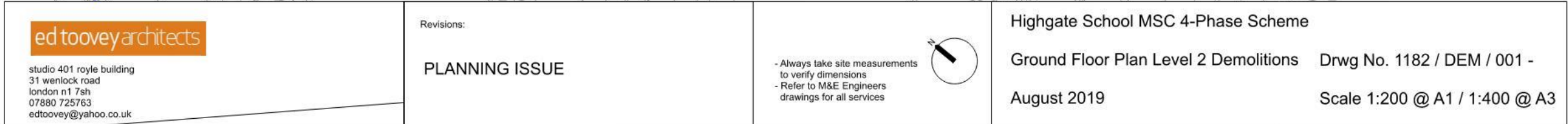
| Resource name                                                    | Technical specification                                                                                      | Product                                             | Manufacturer                                             | EPD program   | EPD number                           | Environment Data Source                              | Standard               | Verification                            | Year | Country        | Upstream database | Density | Product Category Rules (PCR)                   | Notes about PCR   |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------------|---------------|--------------------------------------|------------------------------------------------------|------------------------|-----------------------------------------|------|----------------|-------------------|---------|------------------------------------------------|-------------------|
| Mineral mortar                                                   |                                                                                                              |                                                     | SNMI                                                     | INIES         | INIES_CMOR20120508_190302_2012, 4249 | FDES                                                 | EN15804+A1             | Third-party verified (as per ISO 14025) | 2015 | France         | ecoinvent         | 1500    | EN15804+A1                                     | EN15804+A1        |
| Mortar for masonry use                                           | 1500 kg/m³                                                                                                   |                                                     | SNMI                                                     | INIES         | INIES_CMOR20110829_083510, 6064      | FDES                                                 | EN15804+A1             | Third-party verified (as per ISO 14025) | 2016 | France         | ecoinvent         | 1500    | EN15804+A1                                     | EN15804+A1        |
| Multifunctional steel door, product group 1                      | 1000mm x 2125 mm                                                                                             | H 3 D, H 3 OD, H 3 VM, H 3 KT, RS 55, D 65 OD, D 65 | Hörmann                                                  | ift Rosenheim | EPD-MT-0.1.1                         | EPD Multifunktionstüren aus Stahl Hörmann KG Freisen | EN15804+A1             | Third-party verified (as per ISO 14025) | 2015 | Germany        | GaBi              |         | PCR Dokument Türen und Tore - PCR-TT-1.1: 2013 | Only with EN15804 |
| P.U. thermal insulation boards with multi-layer aluminium facing | L = 0.023 W/mK, 31 kg/m³                                                                                     |                                                     |                                                          | OKOBAUDAT     | -                                    | Oekobau.dat 2020-II                                  | EN15804+A1             | Third-party verified (as per ISO 14025) | 2020 | Germany        | GaBi              | 31      | EN15804+A1                                     | -                 |
| Precast concrete floor slab                                      | 117.63 kg/                                                                                                   |                                                     | CENTRE D'ETUDES ET DE RECHERCHES DE L'INDUSTRIE DU BÉTON | INIES         | INIES_CZVO20220228_111824, 29322     | FDES                                                 | EN15804+A1             | Third-party verified (as per ISO 14025) | 2022 | France         | ecoinvent         |         | EN15804+A1                                     | EN15804+A1        |
| Precast concrete part, staircase                                 | 1,1 m wide, 9 steps each 16 cm, 1965 kg/unit                                                                 |                                                     |                                                          | OKOBAUDAT     | -                                    | Oekobau.dat 2020-II                                  | EN15804+A1             | Third-party verified (as per ISO 14025) | 2020 | Germany        | GaBi              |         | EN15804+A1                                     | -                 |
| Ready-mix concrete                                               | 32/40 MPa                                                                                                    |                                                     |                                                          | ICE           | -                                    | ICE database August 2019, V3.0                       | EN15804+A1             | Self-declared                           | 2019 | United Kingdom | -                 | 2400    | EN15804+A1                                     | -                 |
| Ready-mix concrete                                               | 40/50 Mpa                                                                                                    |                                                     |                                                          | ICE           | -                                    | ICE database August 2019, V3.0                       | EN15804+A1             | Self-declared                           | 2019 | United Kingdom | -                 | 2400    | EN15804+A1                                     | -                 |
| Ready-mix concrete                                               | PAV2                                                                                                         |                                                     |                                                          | ICE           | -                                    | ICE database August 2019, V3.0                       | EN15804+A1             | Self-declared                           | 2019 | United Kingdom | -                 | 2400    | EN15804+A1                                     | -                 |
| Ready-mix concrete, low-strength, generic                        | C12/15 (1700/2200 PSI), 0% recycled binders in cement (220 kg/m³ / 13.73 lbs/ft3)                            |                                                     |                                                          | One Click LCA | -                                    | One Click LCA                                        | EN15804+A1             | Internally verified                     | 2018 | LOCAL          | ecoinvent         | 2200    | EN15804+A1                                     | -                 |
| Ready-mix concrete, normal strength, generic                     | C32/40 (4600/5800 PSI) with CEM II/A-V, 10% fly ash content in cement (300 kg/m³; 18.7 lbs/ft3 total cement) |                                                     | One Click LCA 2022                                       | One Click LCA | -                                    | One Click LCA                                        | EN15804+A1, EN15804+A2 | Internally verified                     | 2022 | LOCAL          | ecoinvent         | 2400    | EN15804+A1, EN15804+A2                         | -                 |
| Ready-mix concrete, normal-strength, generic                     | C20/25 (2900/3600 PSI), 0% recycled binders in cement (240 kg/m³ / 14.98 lbs/ft3)                            |                                                     |                                                          | One Click LCA | -                                    | One Click LCA                                        | EN15804+A1             | Internally verified                     | 2018 | LOCAL          | ecoinvent         | 2200    | EN15804+A1                                     | -                 |
| Reinforcement steel (rebar), generic                             | 90% recycled content, A615                                                                                   |                                                     |                                                          | One Click LCA | -                                    | One Click LCA                                        | EN15804+A1             | Internally verified                     | 2018 | LOCAL          | ecoinvent         | 7850    | EN15804+A1                                     | -                 |

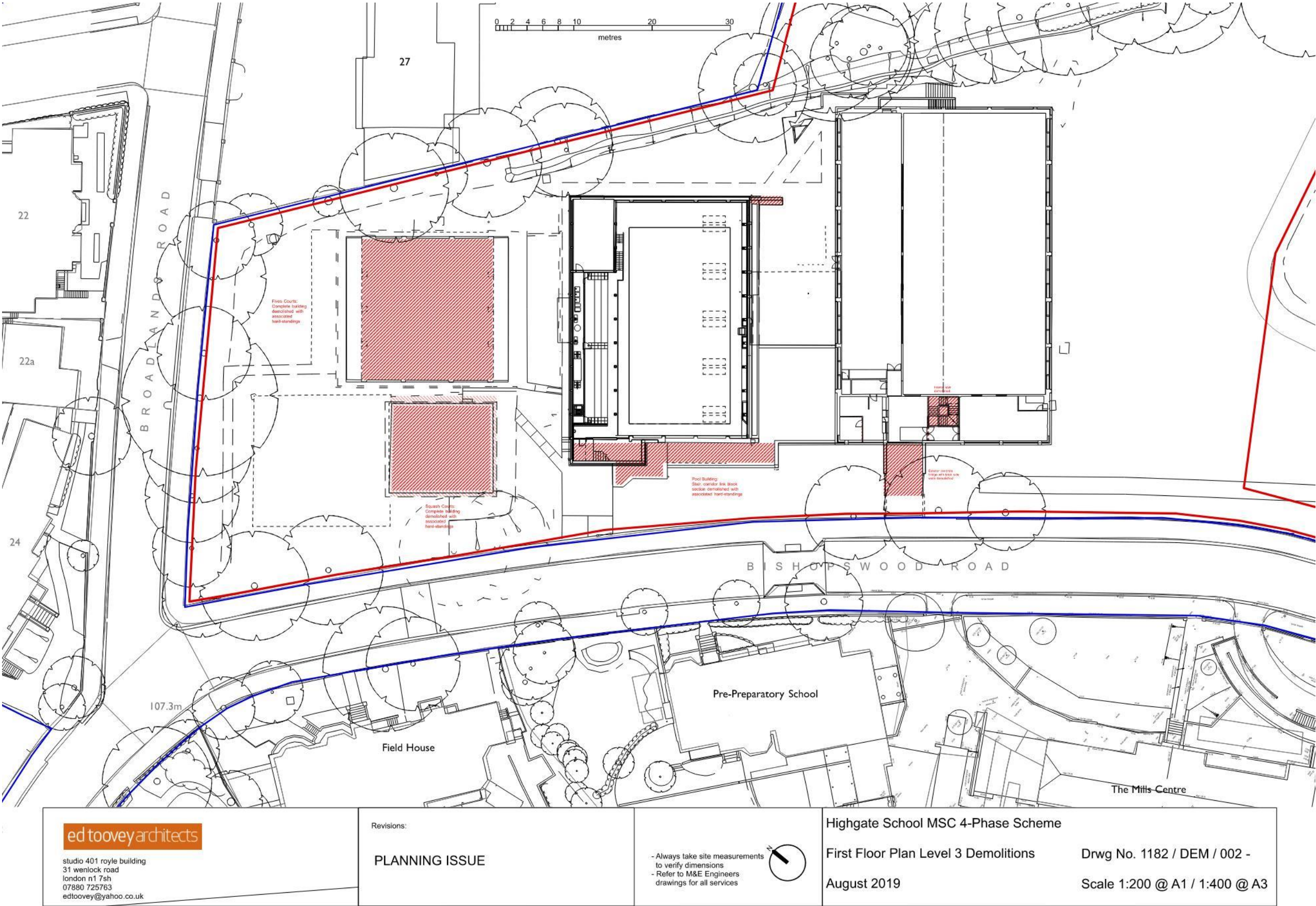
| Resource name                                                      | Technical specification                                      | Product                                                                                                                 | Manufacturer                                       | EPD program   | EPD number                       | Environment Data Source                        | Standard   | Verification                            | Year | Country         | Upstream database | Density | Product Category Rules (PCR)                                                          | Notes about PCR   |
|--------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------|----------------------------------|------------------------------------------------|------------|-----------------------------------------|------|-----------------|-------------------|---------|---------------------------------------------------------------------------------------|-------------------|
| Sandwich panel with PUR/PIR core and double steel siding for roofs | U=0.50/0.20 W/K, ép. 100/240mm PUR/PIR, 29.73 kg/, 100 kg/m3 |                                                                                                                         | L'É <sup>TM</sup> ENVELOPPE METALLIQUE DU BATIMENT | INIES         | INIES_CPAN20170724_174558, 16374 | FDES                                           | EN15804+A1 | Third-party verified (as per ISO 14025) | 2017 | France          | ecoinvent         |         | EN15804+A1                                                                            | EN15804+A1        |
| Timber - Average of all data                                       |                                                              |                                                                                                                         |                                                    | ICE           | -                                | ICE database August 2019, V3.0                 | EN15804+A1 | Self-declared                           | 2019 | United Kingdom  | -                 |         | EN15804+A1                                                                            | -                 |
| Timber, Glulam                                                     |                                                              |                                                                                                                         |                                                    | ICE           | -                                | ICE database August 2019, V3.0                 | EN15804+A1 | Self-declared                           | 2019 | United Kingdom  | -                 |         | EN15804+A1                                                                            | -                 |
| Triple glazed window, incl. aluminium frame                        |                                                              |                                                                                                                         |                                                    | One Click LCA |                                  | One Click LCA generic construction definitions |            |                                         |      | Europe          | Other             |         |                                                                                       |                   |
| Waterborne interior paints                                         | 1.36 kg/L, average coverage 8-10 /L                          | Biora, Ekora, Kolibri Sand, Paneelikattomaali, Ranch, Superlateksi, Tapettipohjamaali, Teknospro, Tela, Timantti, Trend | Teknos                                             | RTS           | RTS_14_18                        | EPD RTS EPD, Waterborne interior paints        | EN15804+A1 | Third-party verified (as per ISO 14025) | 2018 | Finland, OCLEPD | ecoinvent         | 1360    | RTS PCR protocol: EPDs published by the Building Information Foundation RTS sr (2016) | Only with EN15804 |
| Waterborne matte paints                                            |                                                              |                                                                                                                         | SIPEV                                              | INIES         | INIES_CPEI20141211_190531, 4875  | FDES                                           | EN15804+A1 | Third-party verified (as per ISO 14025) | 2014 | France          | ecoinvent         |         | EN15804+A1                                                                            | EN15804+A1        |

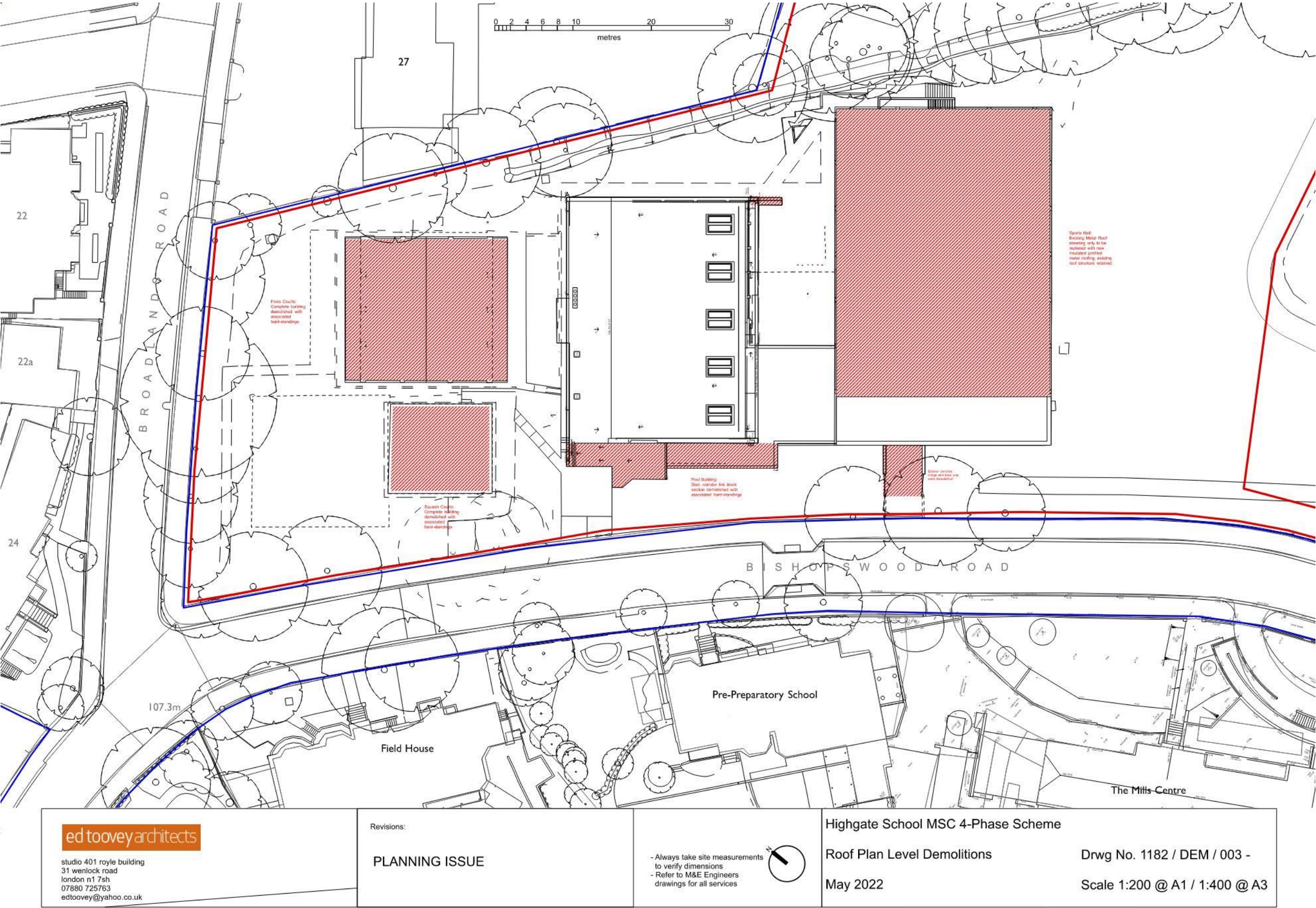
Appendix C Site Drawings.

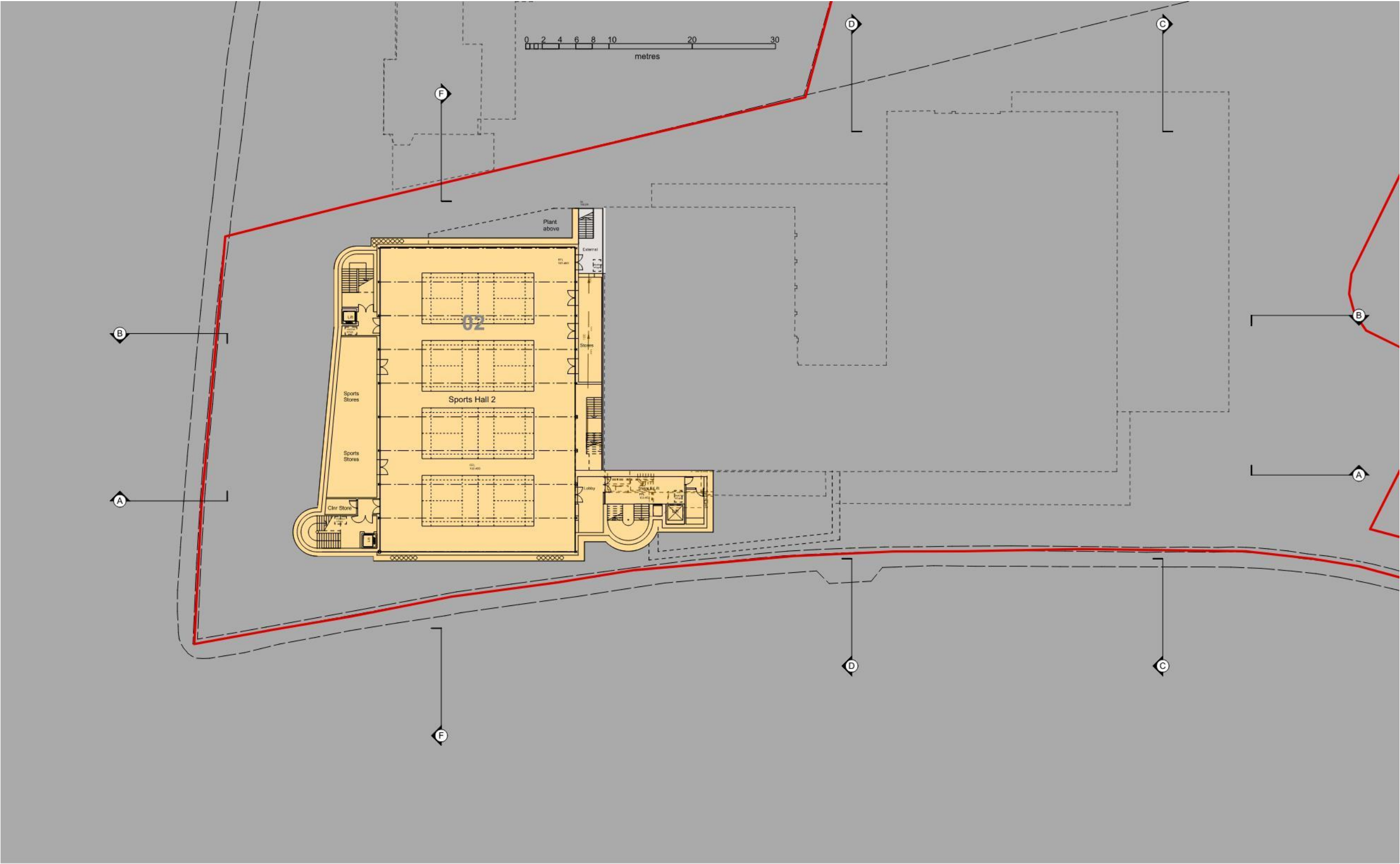


|                                                                                                                                                     |                                                |                                                                                                                                |                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ed toovey architects</b></p> <p>studio 401 royle building<br/>31 wenlock road<br/>london n1 7sh<br/>07880 725763<br/>edtoovey@yahoo.co.uk</p> | <p>Revisions:</p> <p><b>PLANNING ISSUE</b></p> | <p>- Always take site measurements to verify dimensions<br/>- Refer to M&amp;E Engineers drawings for all services</p> <p></p> | <p><b>Highgate School MSC 4-Phase Scheme</b></p> <p>Site plan existing      Drwg No. 1182 / GL / 002 -</p> <p>August 2018      Scale 1:500 @ A1 / 1:1000 @ A3</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|

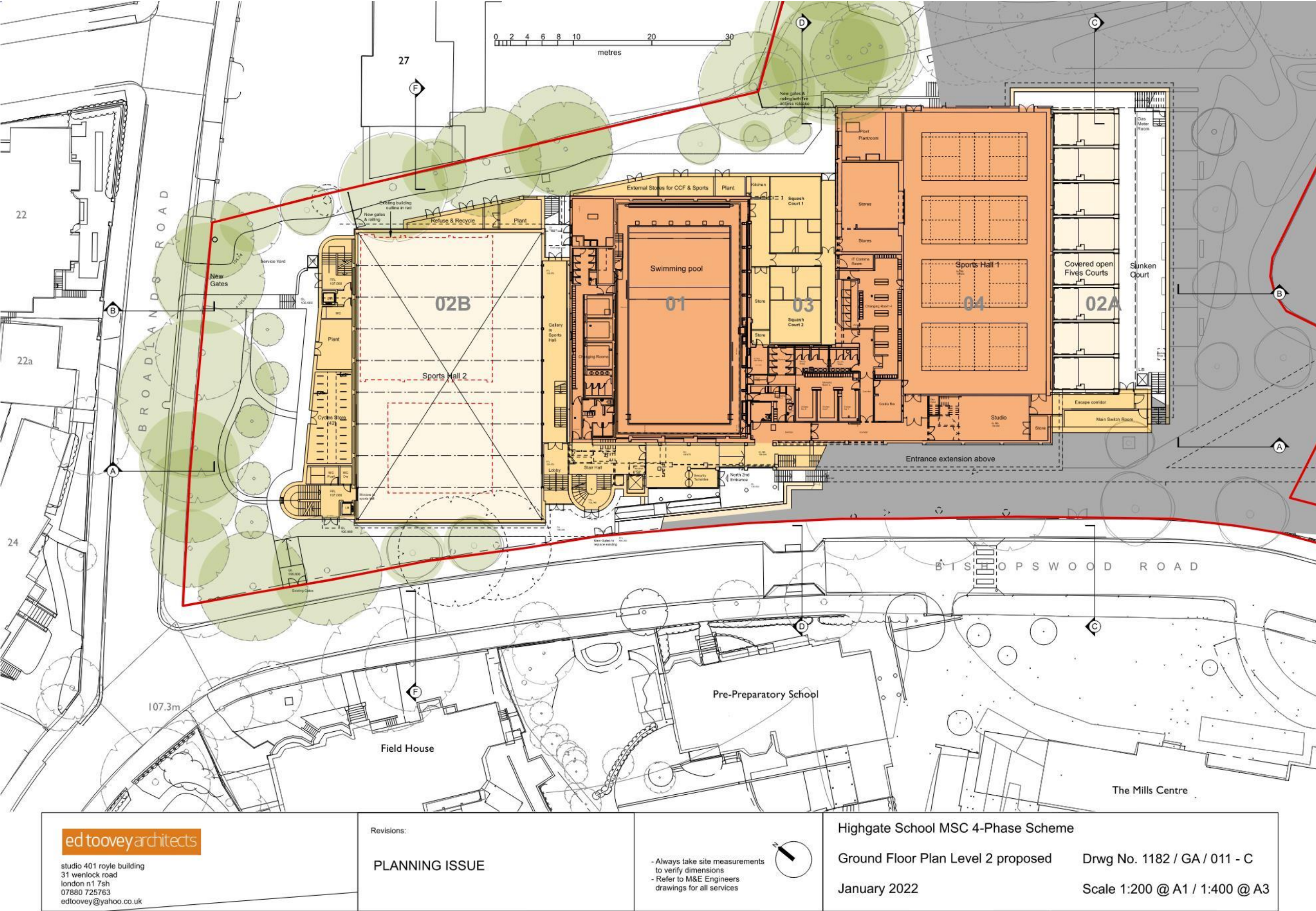


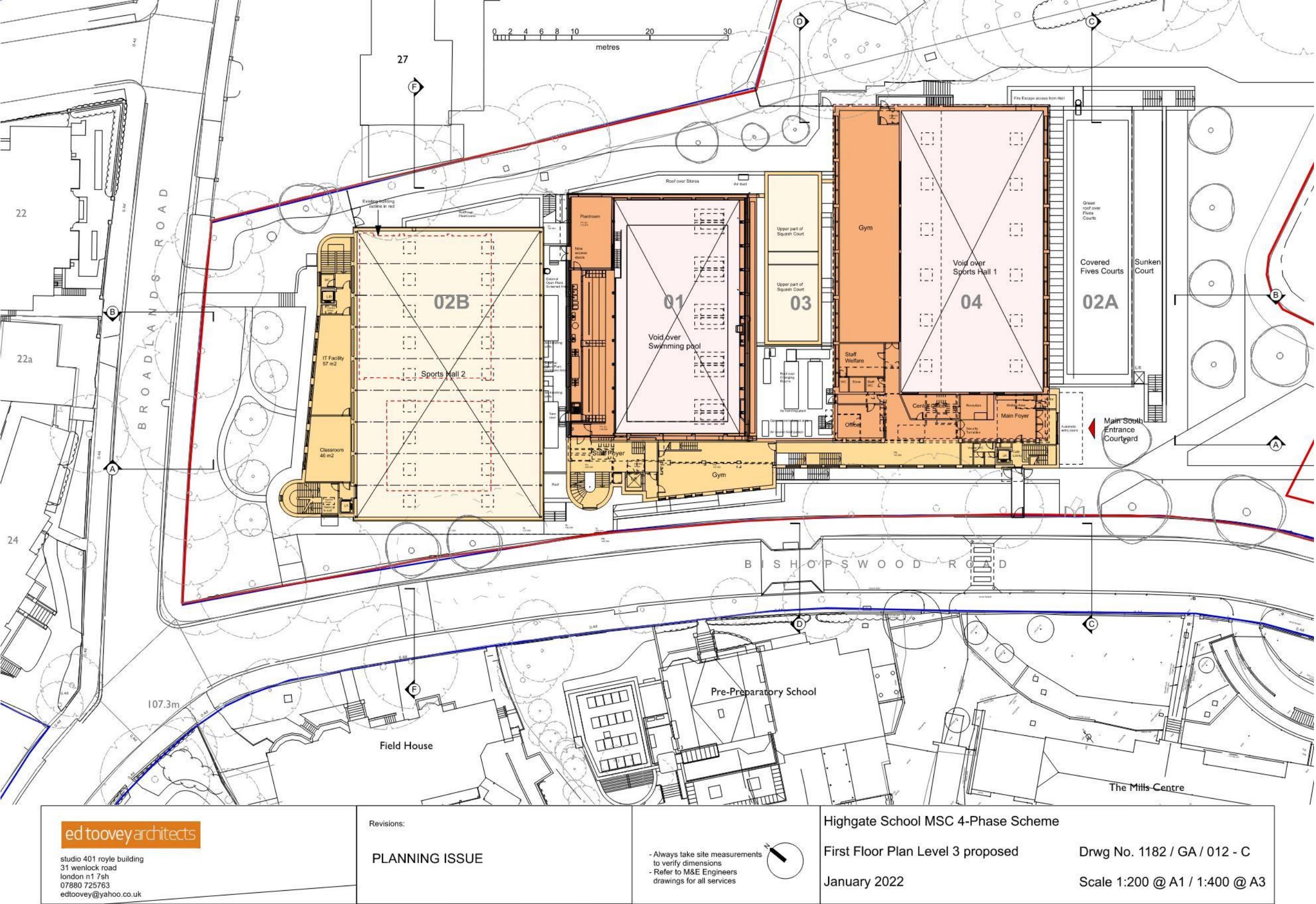


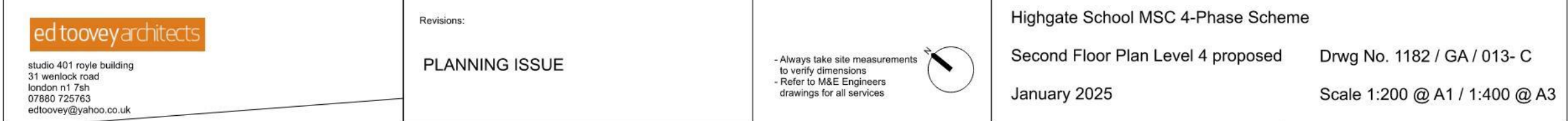




|                                                                                                                                                    |                                                |                                                                                                                                                                                                              |                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ed tooveyarchitects</b></p> <p>studio 401 royle building<br/>31 wenlock road<br/>london n1 7sh<br/>07880 725763<br/>edtoovey@yahoo.co.uk</p> | <p>Revisions:</p> <p><b>PLANNING ISSUE</b></p> | <p>- Always take site measurements to verify dimensions<br/>- Refer to M&amp;E Engineers drawings for all services</p>  | <p>Highgate School MSC 4-Phase Scheme</p> <p>Basement Plan Level 1 proposed      Drwg No. 1182 / GA / 010 - C</p> <p>January 2022      Scale 1:200 @ A1 / 1:400 @ A3</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|









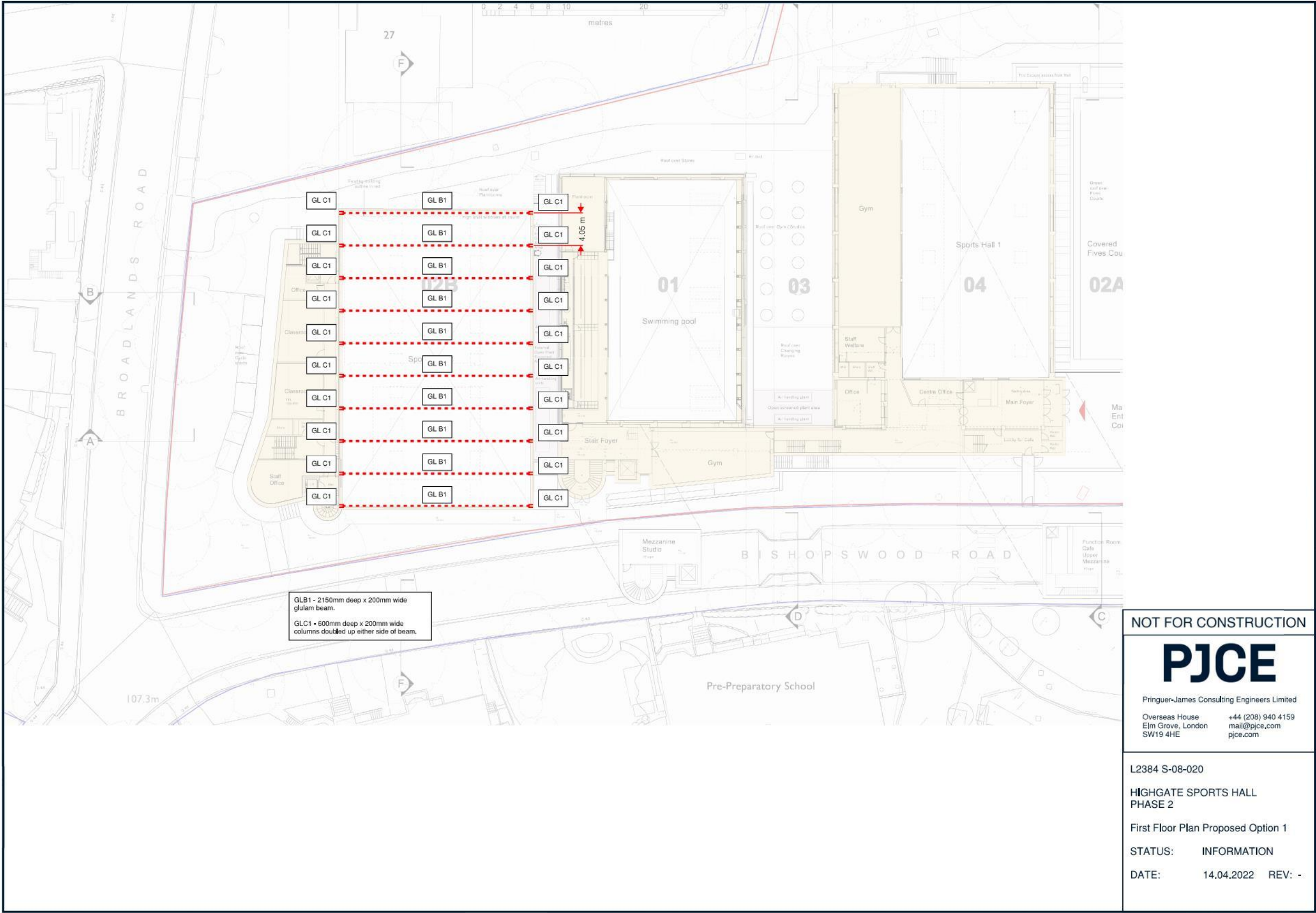
# Highgate Sports Hall

Embodied Carbon Study

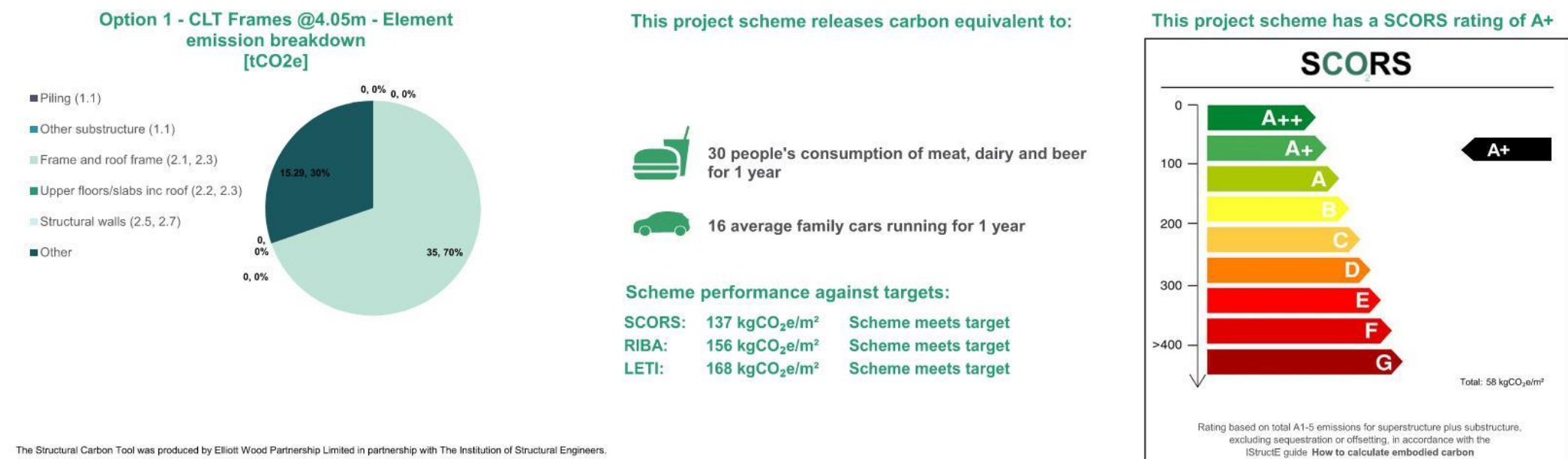
**PJCE**

# Option 1

Glulam Frames @4.05m

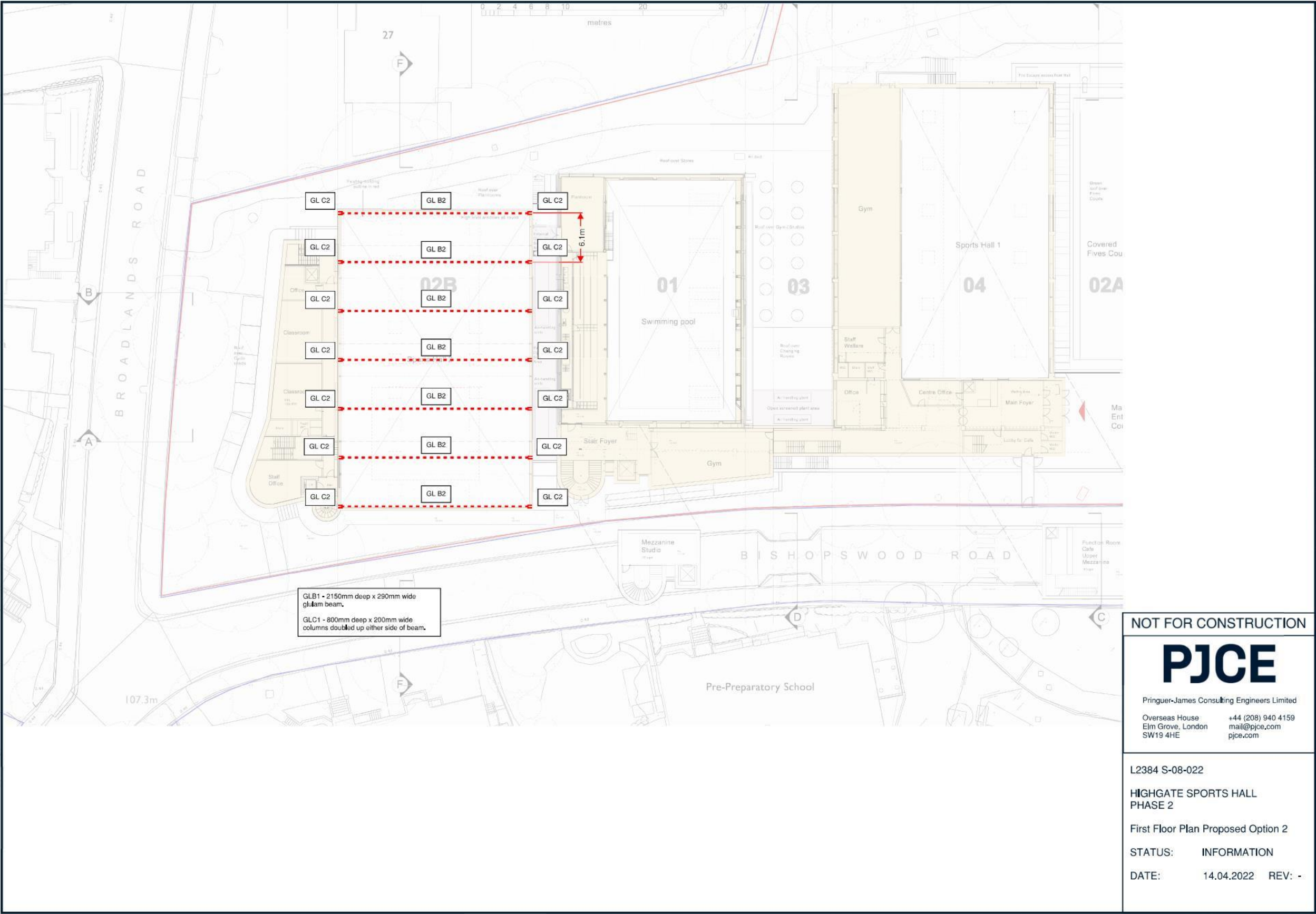




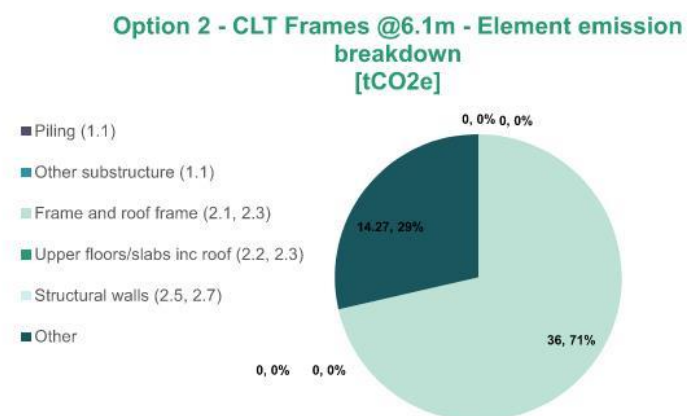
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# Option 2

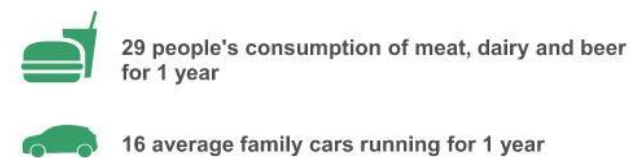
## Glulam Frames @6.10m



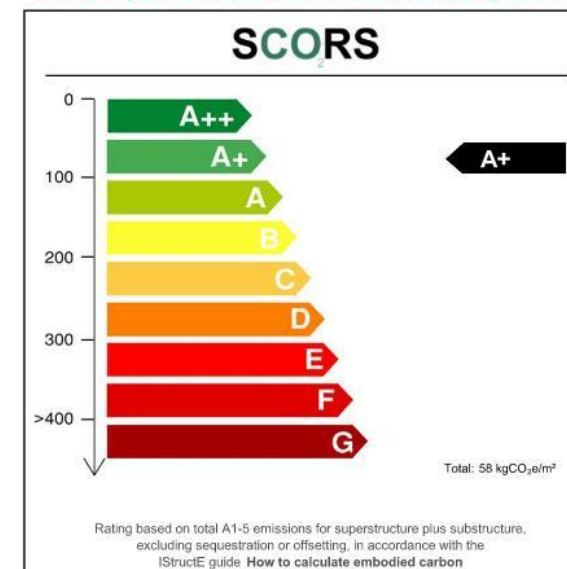


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**This project scheme releases carbon equivalent to:**



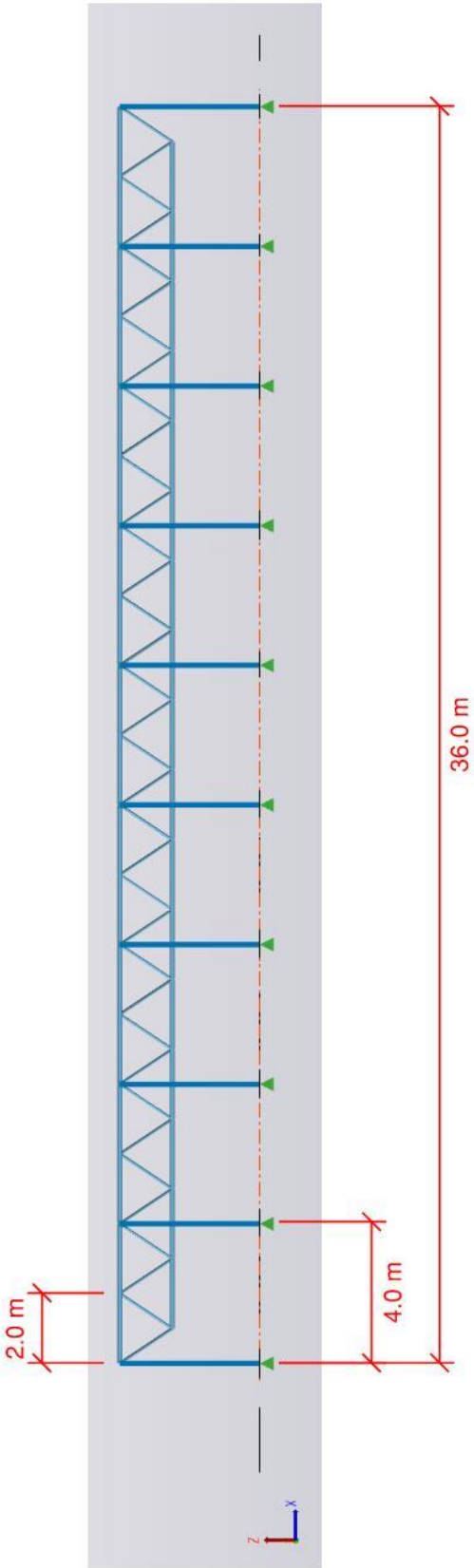
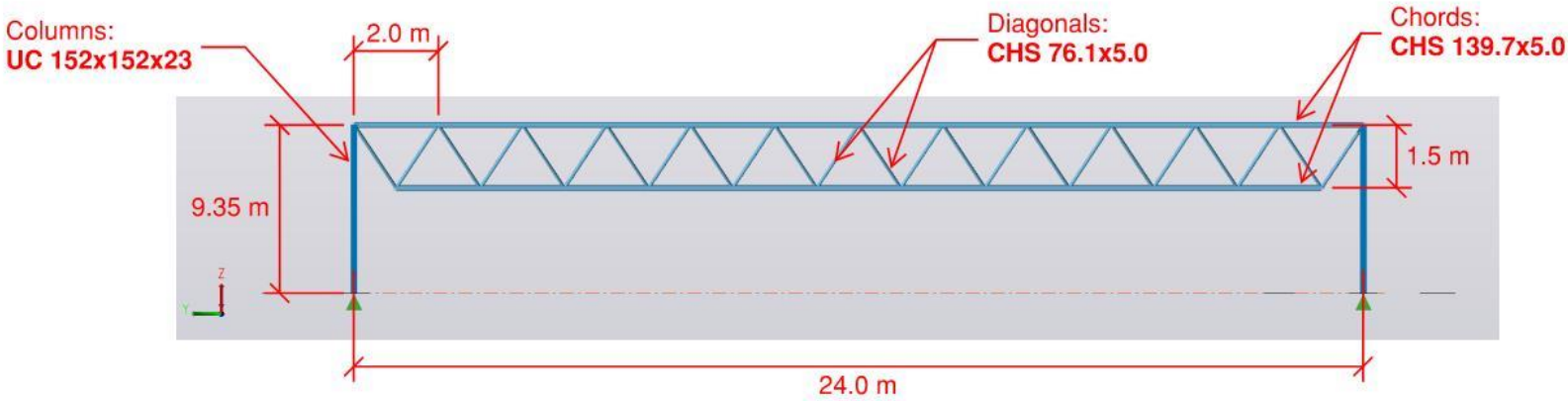
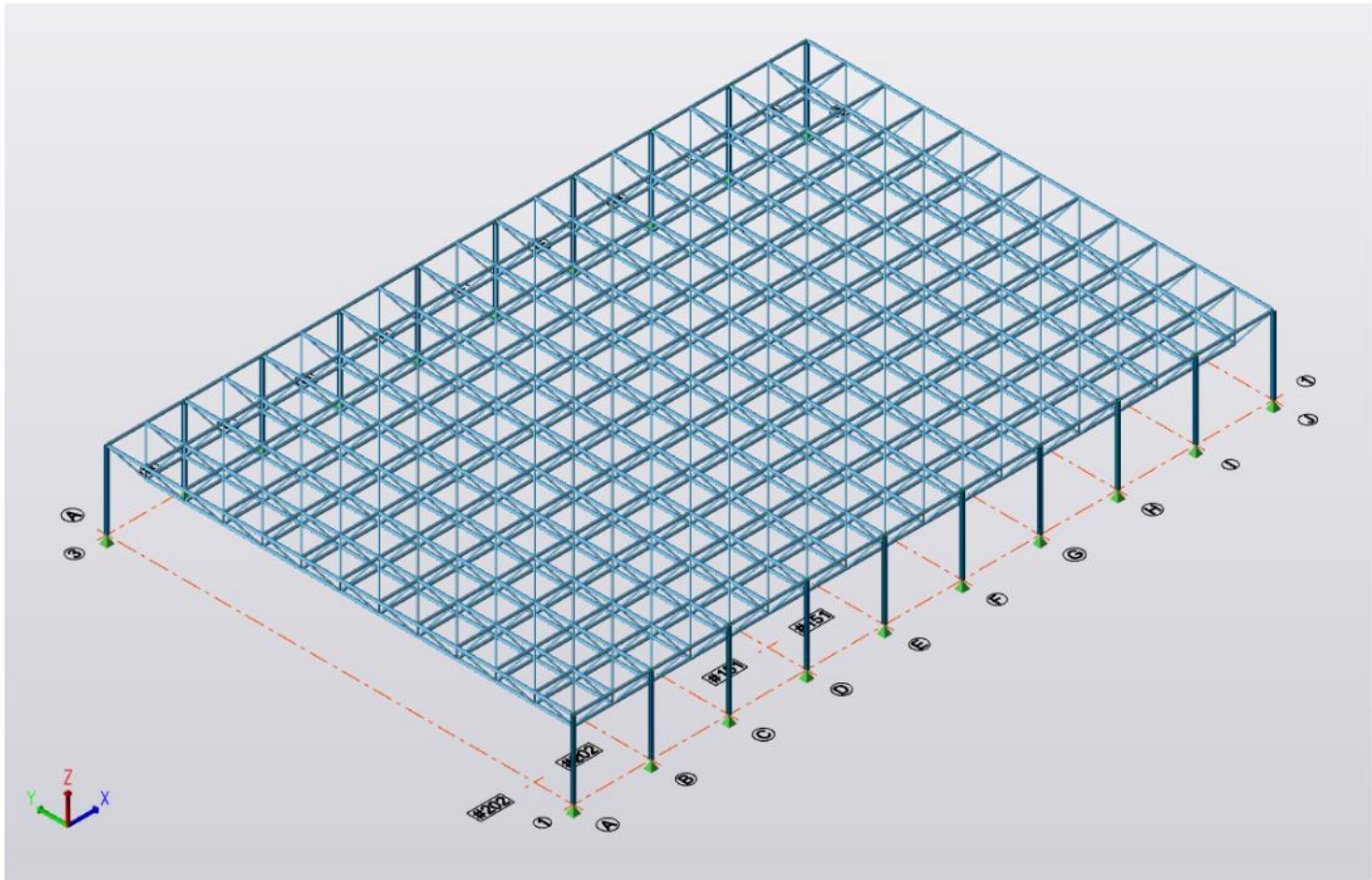
|                                     |                                        |                     |
|-------------------------------------|----------------------------------------|---------------------|
| Scheme performance against targets: |                                        |                     |
| SCORS:                              | 137 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme meets target |
| RIBA:                               | 156 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme meets target |
| LETI:                               | 168 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme meets target |



# Option 3

Steel Space Frame 1.5m Deep

Option 3 - Steel Space Frame 1.5m Deep



T SCT v1.0

Scheme name: Option 3 - Steel Frame

The Institution of  
StructuralEngineers

| Material                  | Material Type       | Material Specification | Structural Element | Description                      | Volume [m³] or Mass [kg]? | Material Quantity [m³, kg] | Reinforcement [kg/m²] | Element Embodied Carbon [tCO₂e] | A1-A3 | A4 | A5w | C2-C4 | D   | Sequestration |
|---------------------------|---------------------|------------------------|--------------------|----------------------------------|---------------------------|----------------------------|-----------------------|---------------------------------|-------|----|-----|-------|-----|---------------|
| Steel                     | Structural_sections | UK hollow sections     | 2.3 Roof beams     | Longitudinal Top Truss Chords    | Volume [m3]               | 1                          |                       | 20                              | 19    | 0  | 0   | 0     | -12 |               |
| Steel                     | Structural_sections | UK hollow sections     | 2.3 Roof beams     | Longitudinal Bottom Truss Chords | Volume [m3]               | 1                          |                       | 17                              | 17    | 0  | 0   | 0     | -10 |               |
| Steel                     | Structural_sections | UK hollow sections     | 2.3 Roof beams     | Transverse Top Truss Chords      | Volume [m3]               | 1                          |                       | 20                              | 19    | 0  | 0   | 0     | -12 |               |
| Steel                     | Structural_sections | UK hollow sections     | 2.3 Roof beams     | Transverse Bottom Truss Chords   | Volume [m3]               | 1                          |                       | 17                              | 16    | 0  | 0   | 0     | -10 |               |
| Steel                     | Structural_sections | UK hollow sections     | 2.3 Roof beams     | Diagonals                        | Volume [m3]               | 2                          |                       | 40                              | 39    | 1  | 0   | 0     | -24 |               |
| Steel                     | Structural_sections | UK open sections       | Other              | Columns                          | Volume [m3]               | 1                          |                       | 11                              | 11    | 0  | 0   | 0     | -7  |               |
|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
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|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
|                           |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |
| 1.1 Excavation-Foundation |                     |                        |                    |                                  | Mass [kg]                 | 0                          |                       |                                 |       |    |     |       |     |               |
| 1.1 Excavation-Other      |                     |                        |                    |                                  |                           |                            |                       |                                 |       |    |     |       |     |               |

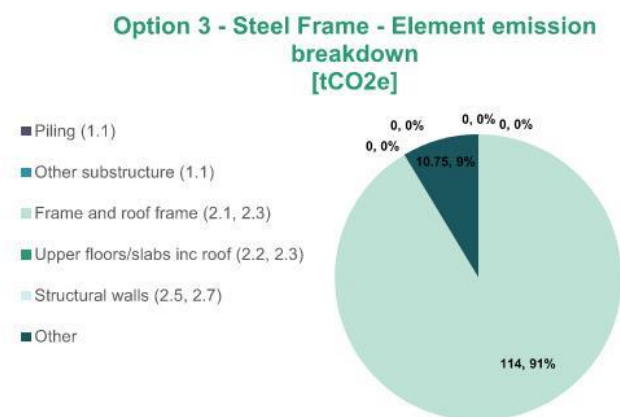
Substructure & Superstructure

A1 - A5: 124 tCO<sub>2</sub>e      144 kgCO<sub>2</sub>e/m²  
Sequestered carbon: 0 tCO<sub>2</sub>e      0 kgCO<sub>2</sub>e/m²  
  
A-C: 128 tCO<sub>2</sub>e      148 kgCO<sub>2</sub>e/m²  
Module D: -75 tCO<sub>2</sub>e      -87 kgCO<sub>2</sub>e/m²

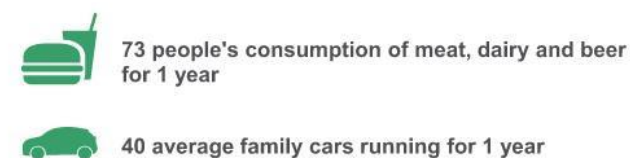
|                                    |  | A5a | C1 |
|------------------------------------|--|-----|----|
| Global Values [tCO <sub>2</sub> e] |  | 0   | 3  |

|                            |  | A   | C | D   | Sequestration |
|----------------------------|--|-----|---|-----|---------------|
| Total [tCO <sub>2</sub> e] |  | 124 | 4 | -75 | 0             |



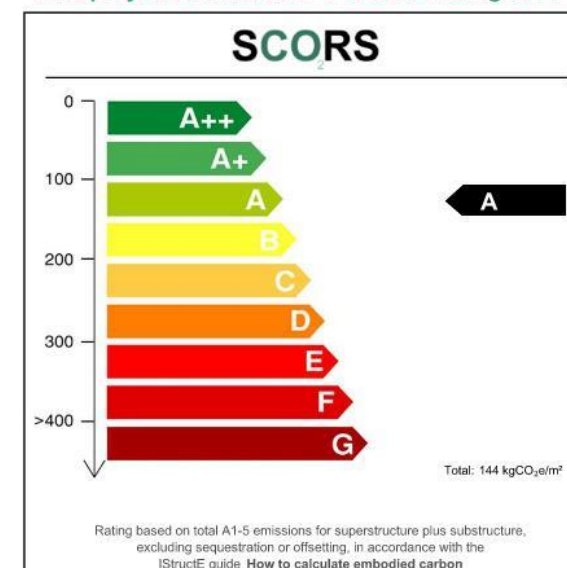
**This project scheme releases carbon equivalent to:**



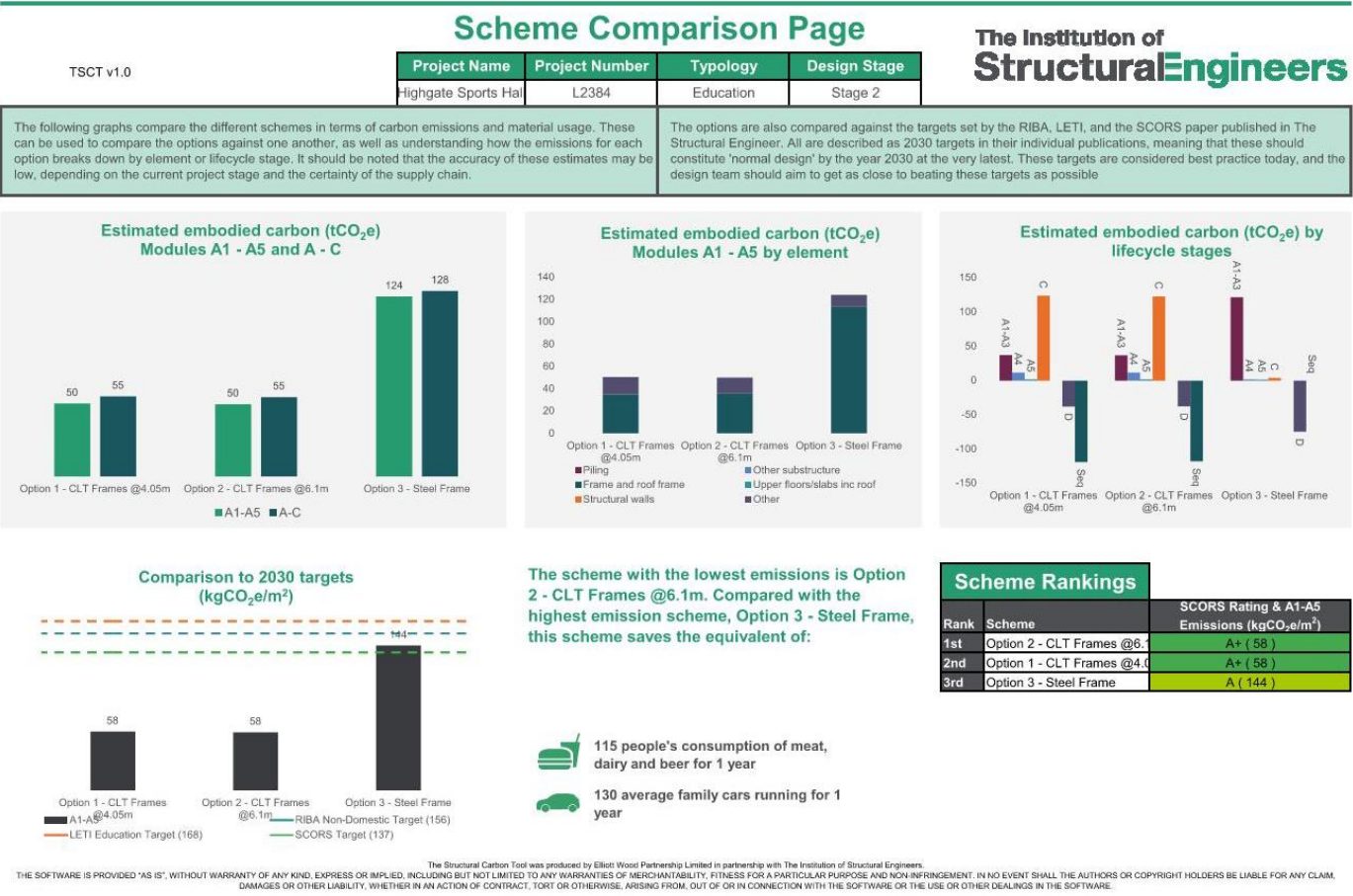
**Scheme performance against targets:**

|        |                                        |                             |
|--------|----------------------------------------|-----------------------------|
| SCORS: | 137 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme does not meet target |
| RIBA:  | 156 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme meets target         |
| LETI:  | 168 kgCO <sub>2</sub> e/m <sup>2</sup> | Scheme meets target         |

This project scheme has a SCORS rating of A



# Options Comparison



## Appendix E Recyclability of Materials

### Brick & block

Bricks have a lifespan of more than 200 years. You can reclaim or recycle bricks and blocks previously used in the construction of buildings, walls, paving and infrastructure, such as bridges and sewers. These include:

- clay bricks
- concrete precast
- aerated blocks
- stone blocks

It is expected to reclaim undamaged bricks and blocks and use them in new building projects or sell them to other businesses which deal in reclaimed bricks. It is easier to source reclaimed bricks from new projects but more difficult with demolition projects.

The brick and block from demolition work should be reclaimed on this site and recycled in compliance with waste management principles. The recycled-damaged bricks and blocks can be used:

to make aggregate for use as general fill or highway sub-base

- • in landscaping
- • to produce new bricks and blocks
- • to make sports surfaces such as tennis courts and athletics tracks
- • as plant substrate

However, there are some limitations to using recycled bricks and blocks, including:

- bricks can be contaminated by other construction waste, such as plasterboard
- new air Crete blocks are cheap to buy
- cleaning bricks is time-consuming and not always possible
- it is hard to assess the load-bearing capacity of recycled bricks

### Insulation material

Polyurethane (P.U.) insulation used in the roof is non-recyclable. Glass and stone mineral insulation used in wall structures is recyclable.

P.U. insulation boards are most often mechanically fastened. Thus, separating them from other structural elements in buildings is possible and reusing.

Appropriate processing of P.U. waste means that it can form the basis of façade elements and partition walls, doors, window frames, kitchen benchtops, and even components of trucks and trains. One of the most effective methods to manage P.U. waste involves processing it into products for thermal and acoustic insulation of floors. Such insulation material is evenly distributed over the ground. Waste foam is then the basis of granules combined with cellulose and additives. The described solution allows, among other things, lower floor height, making it easier to assemble doors and stairs.

The insulation waste can be used in several construction applications and materials, including:

- Refurbishment projects - e.g., glass and stone wool batt insulation, can be incorporated into concrete blocks or fibreglass board
- Fibreglass ceiling tiles
- Voluntary sector waste projects

### Plasterboard

In 2009, the Environmental Agency passed legislation that gypsum-based materials, such as plasterboard, must not be landfilled and should be separated for recovery and recycling. This project expects the demolition work to separate the plasterboard and send it to a specialist contractor for recycling and recovery. The potential route to recycle the plasterboard is as follows:

- sending waste to independent plasterboard recyclers to make into new plasterboard and cement
- sending waste to household waste recycling centres
- using gypsum as a soil conditioner
- using gypsum to make bathroom furniture mouldings

The recovered plasterboard can be used, including:

- New plasterboard products via suppliers' take-back schemes
- Vermicelli (dry-lining board for walls, ceilings, and floors)
- unfired clay-gypsum blocks
- mushroom compost
- slope stabilisation
- road foundation construction
- bathroom furniture mouldings

### Metal -frames sheeting and cladding

Metal is a precious material, and much of it can be easily recycled and put back into use. The contractor is expected to separate the metal and send it to a specialist to recycle and reuse or resell the metal material to another needed buyer.

### Wood and timber sheeting products

Most of the timber products are already composite materials and unsuitable for reuse. The wood materials are to be separated and removed from metal parts. The wood is chipped and can be used for energy or compositing recovery.

Most types of timber can be recycled. Reclaimed wood can be used in applications and materials, including:

- chipboard, oriented strand board and fibreboard manufacture
- bedding products for animals
- play surfaces and pathways
- remanufactured products - e.g., fibre composites
- architectural components
- landscaping
- commercial products - e.g., logs, fuel chips
- liquid fuel (ethanol and methanol)
- biofuel for combined heat and power plant

### Glazing Windows and Rooflights

The glass is to be separated from frames and crushed for backfill or as part of a tarmac non-slip road surface.

### Hard landscape Tarmac Surface

The hard-standing tarmac surface is expected to be left in place for the piling mat and removed by the end of the project completion. Rest is to be separated from other waste and sent to a specialist contractor. The uncontaminated tarmac surfaces are potentially reusable.

### Inter Floor finishes

The floor and coverings include laminated flooring, wood, ceramic and terrazzo tiles, and wallpaper. The floor and wall coverings can be sold for reusing to:

- Social enterprises which recondition and refurbish floor and wall coverings
- Specialist recycling services which recover carpet fibres as plastics recycle and sell on to the plastics and horticultural markets

Floor and wall covering waste can also be used for:

- road cone manufacture
- animal bedding material
- polypropylene bead manufacture
- Reusing carpet recycle

Recycled material from Firestone and Carlisle was used to make walkway pads for new or existing roofs. The material was removed from roofs with loose-laid Membrane covered by ballast or mechanically fastened systems. It was then transported to a grinding facility and ground into a powder-like substance.