WHOLE LIFECYCLE CARBON ASSESSMENT

71 Avenue Road, Camden

Produced by XCO2 for Private Client

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EXECUTIVE SUMMARY

A Whole Lifecycle Carbon assessment has been undertaken for the proposed development at 71 Avenue Road. The site is within the London Borough of Camden. This assessment has been carried out in accordance with the latest published GLA Life-Cycle Carbon Assessments guidance (March 2022); RICS Whole Life Carbon Assessment for the Built Environment Guidance (2nd Edition, september 2023)

A planning application (2022/2529/P) was submitted in June 2022 for the redevelopment of this property. The agent subsequently commissioned a Whoel Life Carbon Assessment Comparative Study from this firm, and this was submitted in June 2023. Unfortunately, our brief was to compare the proposed new build with a simple refurbishment of the existing house, taking no account of the fact that the proposed new build would be c.2.5x larger. Hence the comparison compared "apples with pears", and it led to the application being refused, essentially on sustainability grounds, in December 2023.

This report has been prepared to support the appeal. It rectifies the deficiency in the previous brief, in that we have now compared the same proposed new build scheme with a scheme that both refurbishes the existing house and extends it to approximately the same floorspace. It has not been possible to seek the Council's endorsement of the extensions, but they are judged by the planning consultants to be extensions for which permission would be likely to be forthcoming (a matter that is explained fully in the appeal statement). Hence this report can be considered to compare "apples with apples.

Reduction measures have been assessed where appropriate across both the two proposed scenarios for a comparison of Whole Life Carbon performance between refurbishing the building and conducting a full demolition and construction.

Following the implementation of these reduction measures (Proposed Scenario), the performance of the New Build scenario out performs the Refurbishment scenario by 20tCO_2e for Whole Life Carbon.

The methodology used to determine the expected embodied carbon outlined in this report has been developed according to the requirements set out in the the Royal Institute of Chartered Surveyors (RICS) professional statement (PS) and London Plan Guidance on Whole Life-cycle Carbon Assessments.

WHOLE LIFECYCLE CARBON ASSESSMENT SUMMARY

The estimated Whole Lifecycle Carbon of the proposed development are shown in Table 1.

Table 1: Estimated Whole Life-Cycle Carbon for the Proposed Development

Proposed Assessment		Sequestered (biogenic) Carbon	Module A1-A5	Module B1-B5	Module B6-B7	Module C1-C4	Module D
Refurbishment	TOTAL kg CO_2e	-153,371	1,382,141	104,171	114,189	403,326	7,639
	TOTAL kg CO_2e/m^2 GIA	-200	1,300	100	200	400	100

WHOLE LIFECYCLE CARBON ASSESSMENT

Proposed Assessment		Sequestered (biogenic) Carbon	Module A1-A5	Module B1-B5	Module B6-B7	Module C1-C4	Module D
New Build	TOTAL kg CO_2e	-164,158	1,392,627	104,168	114,505	372,817	14,830
	TOTAL kg CO_2e/m^2 GIA	-200	1,400	100	200	400	100

INTRODUCTION

This section introduces the key principles that a Whole Lifecycle Carbon Assessment for the built environment should adopt. It provides a brief description of the development, the policy framework and the methodology employed for this WLC assessment.

As buildings become more energy efficient, operational carbon emissions will make up a smaller proportion of a development's whole life-cycle carbon emissions. It is therefore becoming increasingly important to calculate and reduce carbon emissions associated with other aspects of a development's life cycle; namely, embodied carbon.

Following the review of the previous Whole Life Carbon assessment of the building by the planning inspector, concerns regarding the Whole Life Carbon performance were raised. Therefore, the design team have reviewed the design and have taken measures to reduce the Whole Life Carbon performance.

This has informed the assessment presented in this report, which has been conducted using accurate data provided by the Quantity Surveyor as opposed to less accurate data utilised for the previous assessment, due to a lack of information at that stage. This assessment looks to compare the Whole Life Carbon performance on a Refurbishment and New Build scenario.

SITE & PROPOSAL

The previous assessment compared a smaller scale Refurbishment over part of the existing building with a full demolition and New Build scenario. Conversely, this assessment allows for a comparable footprint across both the Refurbishment and New Build scenarios to allow for a fair comparison of performance. Therefore, both scenarios would achieve the same footprint.

The increase in size of the development as part of the new build proposal was noted as acceptable in the case officers report.

The two scenarios are summarised as follows:

NEW BUILD

This proposal is that shown in planning application 2022/2529/P, which is the basis of this appeal.

That application proposed to demolish the existing dilapidated home and replace it with a two storey home with rooms in the roof space and a new basement construction, occupying a larger footprint within the site than the current house. The extent of the building footprint, massing and overall scale has effectively been accepted by Camden council. During demolition works, as many of the extant materials would be salvaged for reuse as is practical. Comprehensive testing of the façade bricks has been carried out with these found to be unsuitable for reuse as facing bricks, instead these will be crushed onsite for use as aggregate in the new concrete and as hard core for formation of the piling rig mat. The basement would be formed using contiguous piled walls drilled from this mat, with a lining wall poured following excavation. Waterproofing, insulation and linings sit within this box. The lid for the basement box is built in concrete suitable to support the low carbon steel frame superstructure. All concrete used in this proposal includes GGBS within the concrete mix as a carbon reduction. Floor and roof structures and partitions are created with timber, a natural carbon sink. External walls will be masonry cavity walls to current building standards. The property will benefit from a luxury standard of finishes and services installation.

REFURBISHMENT

The principal of matching the massing and area of the new build scheme through refurbishment and extension is acknowledged in the planning officers report as being acceptable and allows us to provide a like for like comparison in terms of embodied carbon.

Unlike the new build scheme, a complicated steel temporary works frame is required to support the existing external walls to be retained throughout the demolitions and reconstruction phases. The installation of this temporary support and the complications of working around it will significantly increase the length of the construction programme, as will the requirement of having to replace the defective brickwork within the retained facades and underpin them, rather than provide a piled solution. These underpins will be reinforced and carried out in two phases in order to reach the basement depth shown on the planning application drawings. Once the basement box is formed a lid and liners walls similar to the new build scheme will be provided, although using GGBS in the underpins may not be possible due to the slower rate of curing. A steel frame and timber infill superstructure broadly aligning with the new build scheme is proposed. Finishes and sanitaryware will broadly match the new build scheme in terms of quality, as will a new landscaping and boundary wall scheme.

The approximate location and boundary of the application site is shown in Figure 1 on the next page.

Figure 1 Approximate location of application site

POLICY FRAMEWORK

This Whole Life-cycle Carbon Assessment responds to the relevant Whole Life-cycle Carbon Policies of the London Plan and Camden Local Plan. The most relevant applicable embodied carbon policies in the context of the proposed development are presented below.

THE LONDON PLAN (2021)

The London Plan (2021) published 2nd March 2021 sets out the Mayor's overarching strategic spatial development strategy for greater London and underpins the planning framework from 2019 up to 2041. This document replaced the London Plan 2016.

The London Plan has a strong sustainability focus with many policies addressing the concern to deliver a sustainable and zero carbon London, particularly addressed in chapter 9 - Sustainable Infrastructure.

The following policies, related to embodied carbon are of relevance for the proposed development:

POLICY SI 2 MINIMISING GREENHOUSE GAS EMISSIONS

The London Plan (2021) includes, under Policy SI 2 Minimising greenhouse gas emissions, a requirement for a Whole Life-cycle Carbon Assessment for all referable development proposals.

> *F. Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.*

While it is acknowledged that this assessment does not include the requisite B6 – Operational Carbon and B7 – Operational Water modules to form a fully compliant GLA Whole Life-cycle Carbon Assessment, a

comparison with the GLA's WLC benchmark & aspirational benchmark is still possible, as is the demonstration of actions taken to reduce life-cycle carbon emissions.

Other supporting polices under the London Plan (2021) include SI 1 Improving Air Quality, SI 4 Managing Heat Risk, SI 5 Water Infrastructure and SI 7 Reducing Waste & Supporting the Circular Economy:

POLICY SI 1 IMPROVING AIR QUALITY

A. Development Plans, through relevant strategic, site-specific and area-based policies, should seek opportunities to identify and deliver further improvements to air quality and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality.
B. To tackle poor air quality, protect health and meet legal obligations the following criteria should be addressed:

1) Development proposals should not:

a) lead to further deterioration of existing poor air quality
b) create any new areas that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits
c) create unacceptable risk of high levels of exposure to poor air quality.

2) In order to meet the requirements in Part 1, as a minimum:

a) development proposals must be at least Air Quality Neutral
b) development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality in preference to post-design or retro-fitted mitigation measures
c) major development proposals must be submitted with an Air Quality Assessment. Air quality assessments should show how the development will meet the requirements of B1
d) development proposals in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people should demonstrate that design measures have been used to minimise exposure.

C. Masterplans and development briefs for large-scale development proposals subject to an Environmental Impact Assessment should consider how local air quality can be improved across the area of the proposal as part of an air quality positive approach. To achieve this a statement should be submitted demonstrating:

1) how proposals have considered ways to maximise benefits to local air quality, and
2) what measures or design features will be put in place to reduce exposure to pollution, and how they will achieve this.

D. In order to reduce the impact on air quality during the construction and demolition phase development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions from the demolition and construction of buildings following best practice guidance.
E. Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on-site. Where it can be demonstrated that emissions cannot be further reduced by on-site measures, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated within the area affected by the development.

POLICY SI 5 WATER INFRASTRUCTURE

A. In order to minimise the use of mains water, water supplies and resources should be protected and conserved in a sustainable manner.
B. Development Plans should promote improvements to water supply infrastructure to contribute to security of supply. This should be done in a timely, efficient, and sustainable manner taking energy consumption into account.
C. Development proposals should:

1) through the use of Planning Conditions minimise the use of mains water in line with the Optional Requirement of the Building Regulations (residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption)
2) achieve at least the BREEAM excellent standard for the 'Wat 01' water category160 or equivalent (commercial development)
3) incorporate measures such as smart metering, water saving and recycling

measures, including retrofitting, to help to achieve lower water consumption rates and to maximise future-proofing.

D. In terms of water quality, Development Plans should:

1) promote the protection and improvement of the water environment in line with the Thames River Basin Management Plan, and should take account of Catchment Plans

2) support wastewater treatment infrastructure investment to accommodate London's growth and climate change impacts. Such infrastructure should be constructed in a timely and sustainable manner taking account of new, smart technologies, intensification opportunities on existing sites, and energy implications. Boroughs should work with Thames Water in relation to local wastewater infrastructure requirements.

E. Development proposals should:

1) seek to improve the water environment and ensure that adequate wastewater infrastructure capacity is provided

POLICY SI 7 REDUCING WASTE AND SUPPORTING THE CIRCULAR ECONOMY

A. Resource conservation, waste reduction, increases in material re-use and recycling, and reductions in waste going for disposal will be achieved by the Mayor, waste planning authorities and industry working in collaboration to:

1) promote a more circular economy that improves resource efficiency and innovation to keep products and materials at their highest use for as long as possible

2) encourage waste minimisation and waste prevention through the reuse of materials and using fewer resources in the production and distribution of products

3) ensure that there is zero biodegradable or recyclable waste to landfill by 2026

4) meet or exceed the municipal waste recycling target of 65 per cent by 2030

5) meet or exceed the targets for each of the following waste and material streams:

a) construction and demolition – 95 per cent reuse/recycling/recovery

b) excavation – 95 per cent beneficial use

6) design developments with adequate, flexible, and easily accessible storage space and collection systems that support, as a minimum, the separate collection of dry recyclables (at least card, paper, mixed plastics, metals, glass) and food.

B. Referable applications should promote circular economy outcomes and aim to be net zero-waste. A Circular Economy Statement should be submitted, to demonstrate:

1) how all materials arising from demolition and remediation works will be re-used and/or recycled

2) how the proposal's design and construction will reduce material demands and enable building materials, components and products to be disassembled and re-used at the end of their useful life

3) opportunities for managing as much waste as possible on site

4) adequate and easily accessible storage space and collection systems to support recycling and re-use

5) how much waste the proposal is expected to generate, and how and where the waste will be managed in accordance with the waste hierarchy

6) how performance will be monitored and reported.

C. Development Plans that apply circular economy principles and set local lower thresholds for the application of Circular Economy Statements for development proposals are supported.

. CAMDEN DRAFT LOCAL PLAN (2024)

Camden Draft Local Plan (2024) published January 2024 sets out the Bouroughs overarching strategic spatial development strategy, with a focus on sustainability in the Responding to Climate Change chapter.

The following policies, related to embodied carbon are of relevance for the proposed development:

POLICY CC1 RESPONDING TO CLIMATE CHANGE

The Council will prioritise the provision of measures to mitigate and adapt to climate change and require all development in Camden to respond to the climate emergency by:

i. Supporting the retrofitting of existing buildings to make them more energy efficient and reduce the energy needed to occupy the building;

ii. *Prioritising and enabling the repurposing and re-use of existing buildings over demolition;*
iii. *Following circular economy principles, minimising waste and increasing re-use;*
iv. *Reducing whole life carbon emissions, by taking a whole life carbon approach, considering both embodied carbon and operational carbon;*
v. *Being designed and constructed to be net zero carbon in operation;*
vi. *Utilising low carbon technologies and maximising opportunities for renewable energy generation, and heat networks;*
vii. *Being designed to be resilient to climate change and meet the highest standards of sustainable design and construction;*
viii. *Minimising the risk of overheating through design and avoiding reliance on air conditioning;*
ix. *Improving water efficiency;*
x. *Minimising and avoiding the risk of flooding from all sources, and incorporating multifunctional Sustainable Urban Drainage Systems (SuDS) to reduce surface water run-off;*
xi. *Protecting and enhancing existing green spaces and water sources, enhancing biodiversity, strengthening nature recovery and providing multi-functional green infrastructure; and*
xii. *Prioritising sustainable transport.*

POLICY CC3 - CIRCULAR ECONOMY AND REDUCTION OF WASTE

The Council will seek to ensure that developments minimise waste, use resources efficiently, and are designed to facilitate easy maintenance and adaptability of use. The Council will:

i. *Require all developments to optimise resource efficiency by:*
   a. *Reducing waste through the application of the waste hierarchy (Prevention, Preparing for reuse, Recycling, Other recovery, Disposal);*
   b. *Reducing energy and water use during demolition and construction, whilst effectively mitigating air quality impacts;*
   c. *Minimising the amount of materials required;*
   d. *Using materials with low embodied carbon content; and*
   e. *Enabling low energy and water demands once the building is in use.*
ii. *Require all developments to be designed for:*
   a. *easy maintenance and renovation;*
   b. *flexibility and adaptation; and*
   c. *longer life and facilitating deconstruction for future re-use.*
iii. *Require applicants to submit a Sustainability Statement with all applications documenting how the requirements set out in criteria (i) and (ii) have been met*
iv. *Require new build major applications, or major applications which involve substantial demolition and rebuild, to submit a Circular Economy (CE) Statement, following GLA guidance. The following details must be included in the CE Statement:*
   a. *an accurate record of all the materials used in the building's construction;*
   b. *the proportion of materials and elements reused on-site;*
   c. *materials reused from other sites;*
   d. *recycled materials;*
   e. *new materials by mass and material intensity (kg per m2); and*
   f. *a calculation of the development's overall 'material circularity'.*
v. *Require applicants needing to submit a Circular Economy Statement (as set out in criteria (iv) above) to explore opportunities to use the site, or other local sites, for the temporary storage of re-usable materials, during the construction phase, to enable other developments coming forward in the locality to use those materials.*
vi. *Safeguard Camden's existing waste site at Regis Road unless a suitable compensatory waste site is provided that replaces the maximum throughput achievable at the existing site.*

POLICY CC4 - MINIMISING CARBON EMISSIONS

The Council will seek to ensure that all development minimises carbon emissions over the lifespan of the building(s). The Council will:

i. Require applicants for all new build development and all development proposing substantial demolition to:
  a. submit a whole life carbon emissions assessment (including operational and embodied carbon), following the GLA Whole Life Cycle Carbon Assessment template, as part of the planning application; and
  b. demonstrate that they have done all they can to minimise carbon emissions over the lifespan of the building/s, targeting the GLA Whole Life Carbon aspirational benchmarks in modules B – C.

ii. Require new build developments to meet embodied carbon limits of less than 500kg CO2/m2 for residential, and less than 600kg CO2/m2 for nonresidential.

iii. Require applicants to demonstrate what action they have taken to reduce embodied carbon in the development, as part of the Energy or Sustainability Statement.

POLICY CC6 - ENERGY REDUCTION IN NEW BUILDINGS

The Council will ensure that all new buildings are designed and built to be net zero carbon in operation. The Council will:

I. Require new buildings to be fossil fuel free (that is, not connected to the gas grid, use non-combustion energy systems), ultra-low energy, use low carbon heat, and contribute to the generation of renewable energy on-site.

II. Require new buildings to use as little energy as possible to heat them. The Council will require all new residential and non-residential buildings to achieve a space heating demand of 15 or less kWh/m2 GIA/yr.

III. Require new buildings to use as little (total) energy as possible (expressed as EUI – Energy Use Intensity). For each of the building types set out below (or nearest equivalent), the Council will require development to meet the following standards, unless it is demonstrated to the Council's satisfaction that it is not technically feasible:
  a. Residential buildings must achieve an EUI of no more than 35 kWh/m2GIA/yr.
  b. Offices, Retail, Higher Education Teaching facilities, GP surgeries must achieve an EUI of no more than 70 kWh/m2 GIA/year.
  c. Student accommodation, care homes, extra care homes must achieve an EUI of no more than 35 kWh/m2 GIA/year.
  d. Hotels must achieve an EUI of no more than 160 kWh/m2 GIA/year.
  e. Light industrial units must achieve an EUI of no more than 35 kWh/m2 GIA/year.
  f. Schools must achieve an EUI of no more than 65 kWh/m2 GIA/year.

IV. Require renewable energy generation on-site to match, or be in excess of, the predicted total annual energy demand of the building (EUI), in accordance with the following requirements:
  a. the proposed building must not use fossil fuels on-site;
  b. it must have a level of space heating demand and energy use intensity (EUI) compliant with levels in this policy; and
  c. on-site renewable energy generation (e.g. through photovoltaics (PVs) has been maximised and achieves at least 80 kWh/m2 building footprint for all building types (at least 120 kWh/m2 for industrial buildings).

V. Require a payment in lieu to be made where it can be evidenced to the Council's satisfaction that it is not technically feasible for the amount of energy generated in a year through onsite renewable energy production to match the predicted annual energy demand of the building. The payment in lieu will be expected to be equivalent to this shortfall.

VI. Require applicants/landowners to monitor the total energy use and renewable energy generation of the development for the first 5 years of occupation and submit the annual figures to the Local Planning Authority

VII. Require applicants to demonstrate that the development will deliver all the requirements

of this policy through the provision of a detailed Energy Statement and through the use of an energy assured performance method.

METHODOLOGY

The methodology followed in preparing this report is in line with the Royal Institute of Chartered Surveyors (RICS) professional statement (PS) and London Plan Guidance on Whole Life-cycle Carbon Assessments for undertaking detailed carbon assessments. The RICS Whole life carbon assessment for the built environment (2023), follows the European standard EN 15978.

This report summarises the comparison between a refurbishment and new build option for the house at 71 Avenue Road. This also includes actions taken under both scenarios to reduce Whole Life Carbon

The applicant recognises that the Whole Life-cycle Carbon calculations presented in this report will need to be revisited and if appointed, amended at post-construction stage (upon commencement of RIBA Stage 6).

The four main modules are Product stage [A1 – A3], Construction Process stage [A4 – A5], Use stage [B1 – B7] and End of Life stage [C1 – C4]. Module D consists of the potential environmental benefits or burdens of materials beyond the life of the project, and this is usually reported separately to the cradle to grave modules [A – C].

Table 2 shows the life-cycle stages that were considered for the assessment and the assumptions made for some stages due to limitations of the software used.

LIFE CYCLE STAGES

The life cycle stages covered by the RICS methodology refer to EN 15978, which includes a modular approach to a built asset's life cycle, breaking it down into different stages, as shown in Table 2.

Table 2: Life-cycle Stages considered for this analysis.

Product Stage			Construction Process Stage		Use Stage							End-of-Life Stage				Benefits and loads beyond the system boundary		
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use/application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/demolition	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

BUILDING ELEMENTS

The WLC assessment covers all building elements listed in Table 3 (where applicable). Material quantities have been provided by the Quantity Surveyor. A minimum of at least 95% of the cost allocated to each building element category has been accounted for where information has been given, in line with GLA policy.

Table 3: Building elements as per RICS NRM

Group	Building Element	Included	
		Refurbishment	New Build
0. Demolition & facilitating works	0.1. Toxic / hazardous / contaminated material treatment	N	N
	0.2. Major demolition works	Y	Y
	0.3. & 0.5. Temporary / enabling works	Y	Y
	0.4. Specialist groundworks	N	N
1. Substructure	1.1. Substructure	Y	Y
2. Superstructure	2.1. Frame	Y	Y
	2.2. Upper floors incl. balconies	Y	Y
	2.3. Roof	Y	Y
	2.4. Stairs & ramps	Y	Y
	2.5. External walls	Y	Y
	2.6. Windows & external doors	Y	Y
	2.7. Internal walls & partitions	Y	Y
	2.8 Internal doors	Y	Y
3 Finishes	3.1 Wall finishes	Y	Y
	3.2 Floor finishes	Y	Y
	3.3 Ceiling finishes	Y	Y
4 Fittings, furnishings & equipment	4.1 Fittings, furnishings & equipment	Y	Y
5 Building services / MEP	5.1–5.14 Services	Y	Y
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building unit	N	N
7 Work to existing building	7.1 Minor demolition and alteration works	N	N
8 External works	8.1 Site preparation works	Y	Y
	8.2 Roads, paths, paving and surfacing	Y	Y
	8.3 Soft landscaping, planting and irrigation systems	Y	Y
	8.4 Fencing, railings and walls	Y	Y
	8.5 External fixtures	Y	Y
	8.6 External drainage	Y	Y
	8.7 External services	N	N

Group	Building Element	Included	
		Refurbishment	New Build
	8.8 Minor building works and ancillary buildings	N	N

SOFTWARE TOOLS

The tool used for this assessment is eTool which follows BS EN 15978, is IMPACT-compliant, BRE certified, and listed in the GLA Life-Cycle Carbon Assessments Guidance, Appendix 1 as an acceptable tool.

MATERIALS & PRODUCTS

WLC calculations have been carried out using:

- Type III environmental declarations (Environmental Product Declaration (EPD)[1] and equivalent) and datasets in accordance with BS EN 15804; and,
- EPDs and datasets in accordance with ISO 14025 and ISO 14040/44.

Sequestered (biogenic) carbon from the use of timber has been reported separately for A1-A3 stages.

Embodied carbon is difficult to calculate for many MEP systems due to a lack of available data. Where manufacturer specific data was not available, figures for embodied carbon have been taken from the closest matching system within the eTool database. In cases where there are no comparable systems, embodied carbon has been calculated based on the key materials used to manufacture the equipment, by weight.

[1] An Environmental Product Declaration (EPD) is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products in a credible way. (Environdec)

BIOGENIC CARBON SEQUESTRATION

Biogenic carbon is the carbon that is stored in biological materials, such as timber. This process is commonly referred to as sequestration.

Carbon accumulates in plants through the process of photosynthesis and therefore wood products can contribute to reducing the levels of carbon dioxide in the atmosphere and help mitigate climate change.

When a bio-based material is used for a building product, the carbon will be stored as long as the material service life or until the end of life of the building.

Biogenic carbon must be reported separately if reporting only upfront carbon, but should be included in the total if reporting embodied carbon or whole life carbon.

RESULTS

The substructure consists of a concrete piling foundation & pile cap, RC ground floor & basement floor slab, concrete and concrete basement retaining wall. Both scenarios have concrete underpinning though the refurbishment scenario has a significantly higher volume. The superstructure consists of steel columns and beams with timber flooring spanning between timber joists of which 30% is reclaimed from the demolition material (whilst the previous assessment was based upon a concrete frame). The existing brickwork being crushed on site an used as aggregate in the concrete and also as hardcore fill for the piling mats and slab substrate. The external walls consist partially retained brickwork for the Refurbishment and new KBRIQ brickwork on the New Build scenario. The roofs of the scenarios consist of a pitched and flat timber roof, with 50% reused timber from the demolition material.

Efforts have been made to reduce whole life carbon of concrete elements by utilising 50% GGBS within concrete mixtures used for the piled foundations, basement & ground floor slab as well as basement liner walls, lightwell walls and pool walls. This is in addition to specifying low carbon steel reinforcement (XCarb) for both schemes and low carbon brickwork (KBRIQ) to the New Build scheme only.

It should be noted that whilst for this assessment it has been assumed operational energy use is the same across the two scenarios, it is highly likely that the New Build scheme will have improved energy performance over the Refurbishment scheme due to the specification of higher quality materials with increased performance over the existing retained materials.

REFURBISHMENT

Figure 2 shows the results for the Refurbishment scenario. The results show that the highest contribution to the whole life carbon of the project is produced at Stage A1-A5 the Product Stage, accounting for about 69% of the total embodied carbon of the building during its lifetime.

Following the Product stage, the *End-of-Life Stage* accounts for 20% over the lifetime, whilst the Operational and Use stage account for 6% and 5% respectively over the lifetime of the building.

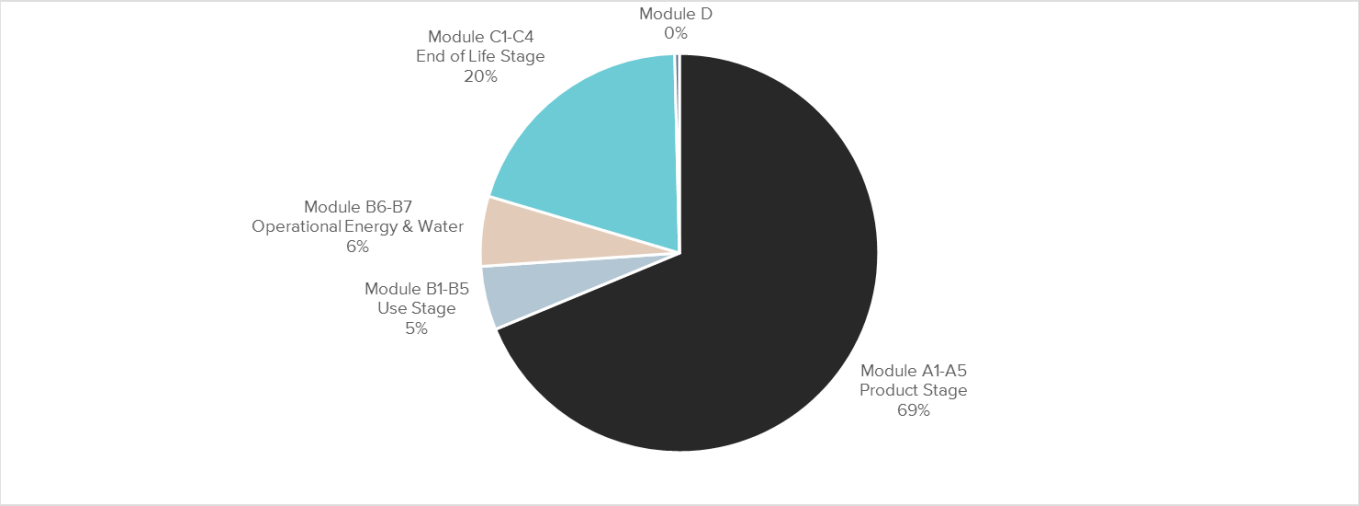


Figure 2: Estimated Whole Life-cycle Carbon by Life-cycle Assessment Module for the Refubishment scenario ($kgCO_2e$)

Figure 3 & Figure 4 overleaf show the embodied carbon by building element type. As can be seen from the figures, the element type that has the highest contribution to the embodied carbon for the project is the Substructure as a result of the significant underpinning and piled foundation solution containing the carbon intensive concrete and steel. This is followed by External Wall elements and then the Services building elements.

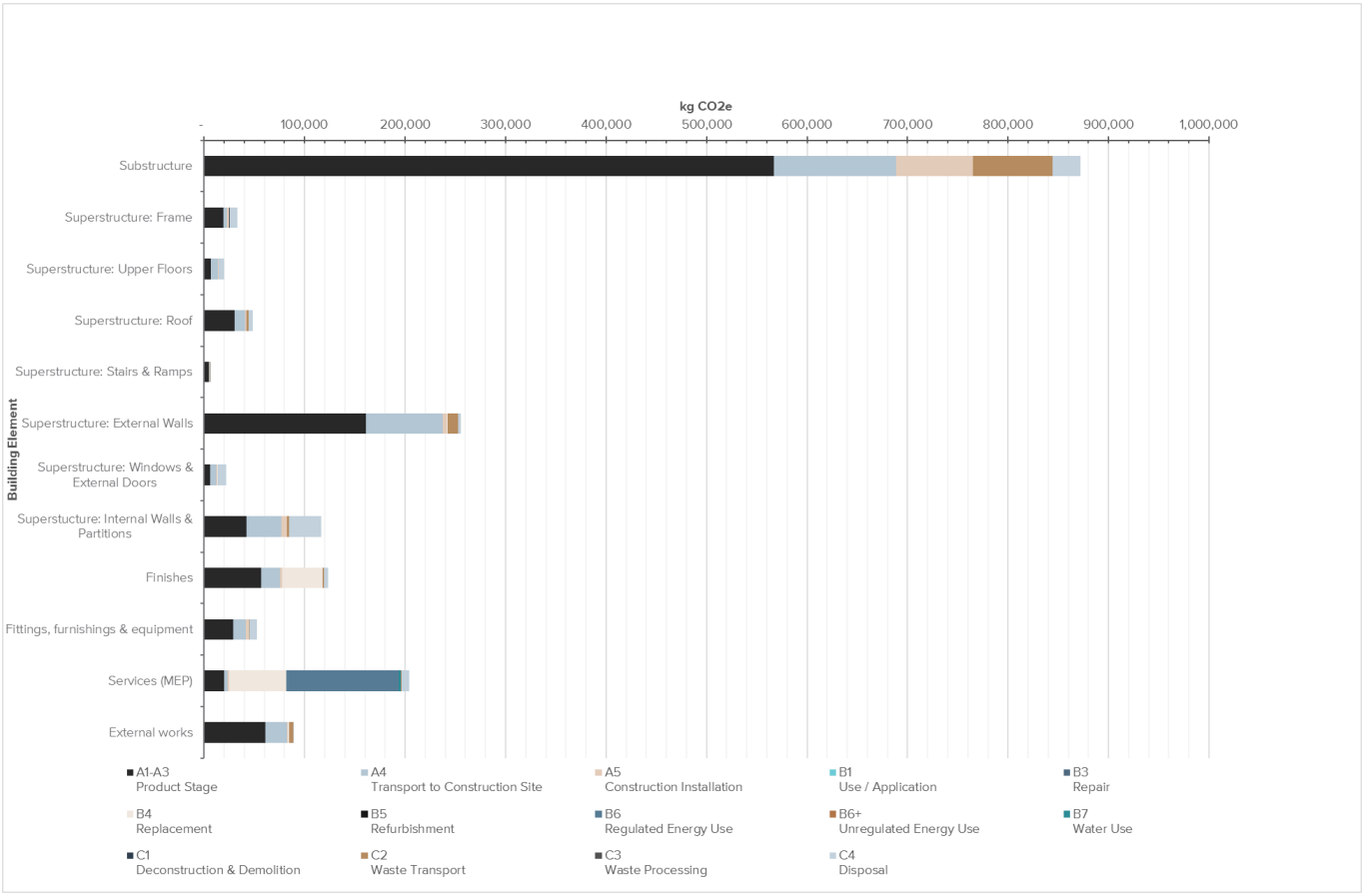


Figure 3: Estimated Whole Life-cycle Carbon by building element category for the Refubishment scenario ($kgCO_2e$)

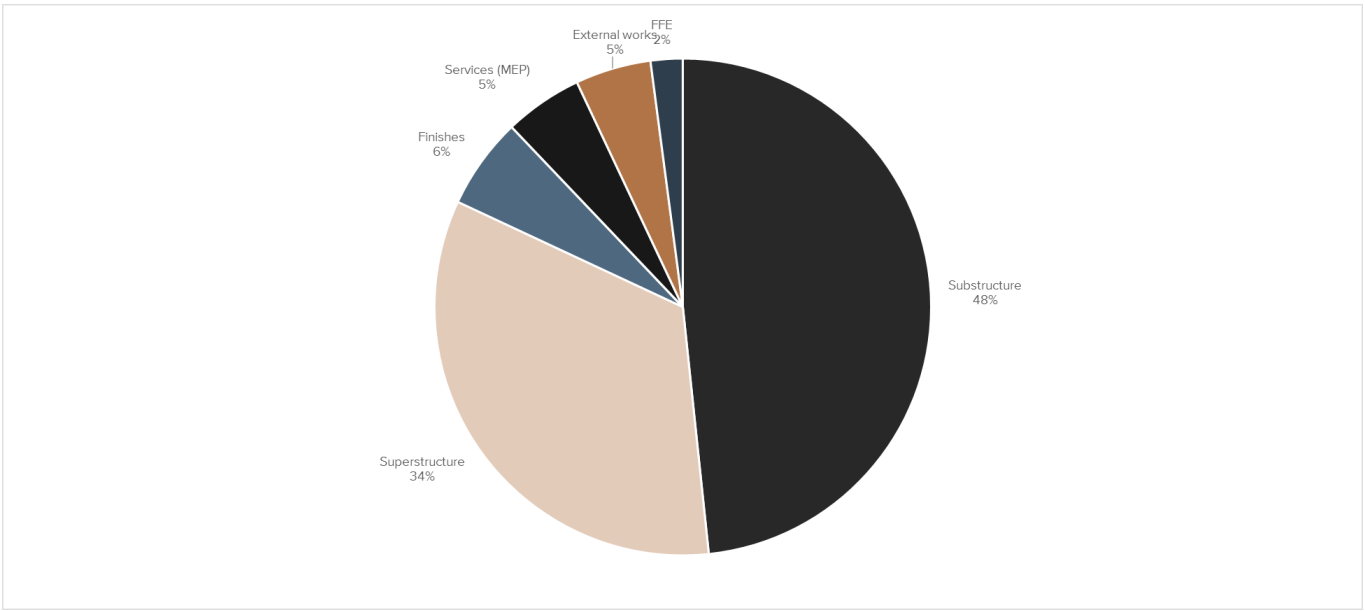


Figure 4: Estimated Embodied Life-cycle Carbon by building element category for the Refubishment scenario (%)

NEW BUILD

Figure 5 shows the results of the New Build scheme. The results show that the highest contribution to the whole life carbon of the project is produced at Stage A1-A5 the Product Stage, accounting for about 70% of the total embodied carbon of the building during its lifetime.

Following the Product stage, the *End-of-Life Stage* accounts for 18% over the lifetime, whilst the Operational and Use stage account for 6% and 5% respectively over the lifetime of the building.

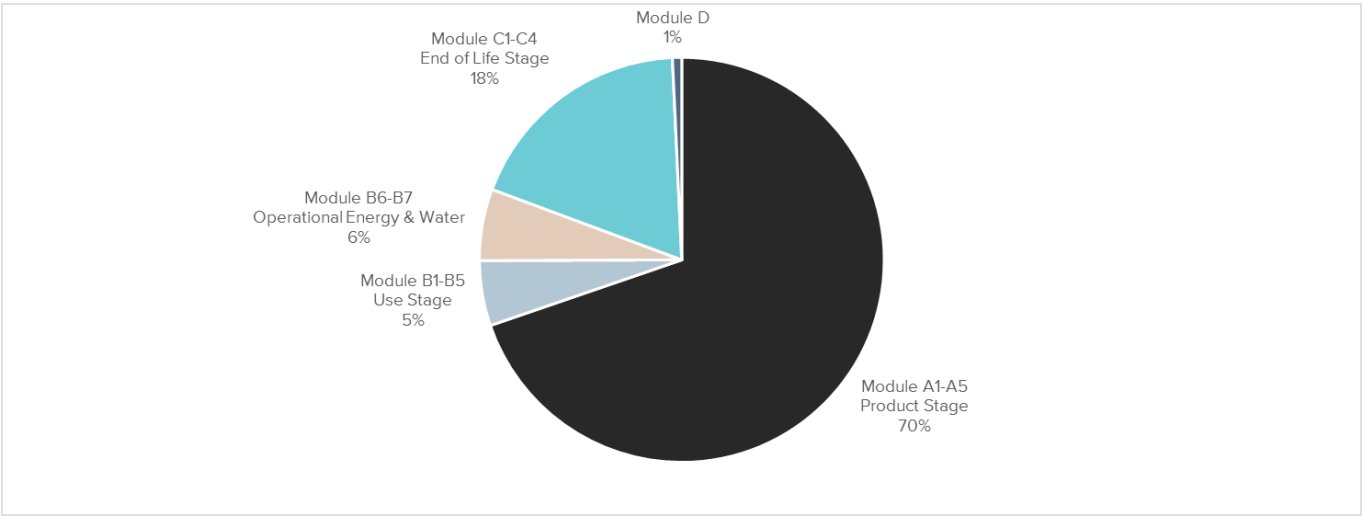


Figure 5: Estimated Whole Life-cycle Carbon by Life-cycle Assessment Module for the New Build scenario ($kgCO_2e$)

Figure 6 & Figure 7 overleaf show the embodied carbon by building element type. As can be seen from the figures, the element type that has the highest contribution to the embodied carbon for the project is the Substructure as a result of the piled foundation solution containing the carbon intensive concrete and steel. This is followed by Services elements and then the External walls building elements.

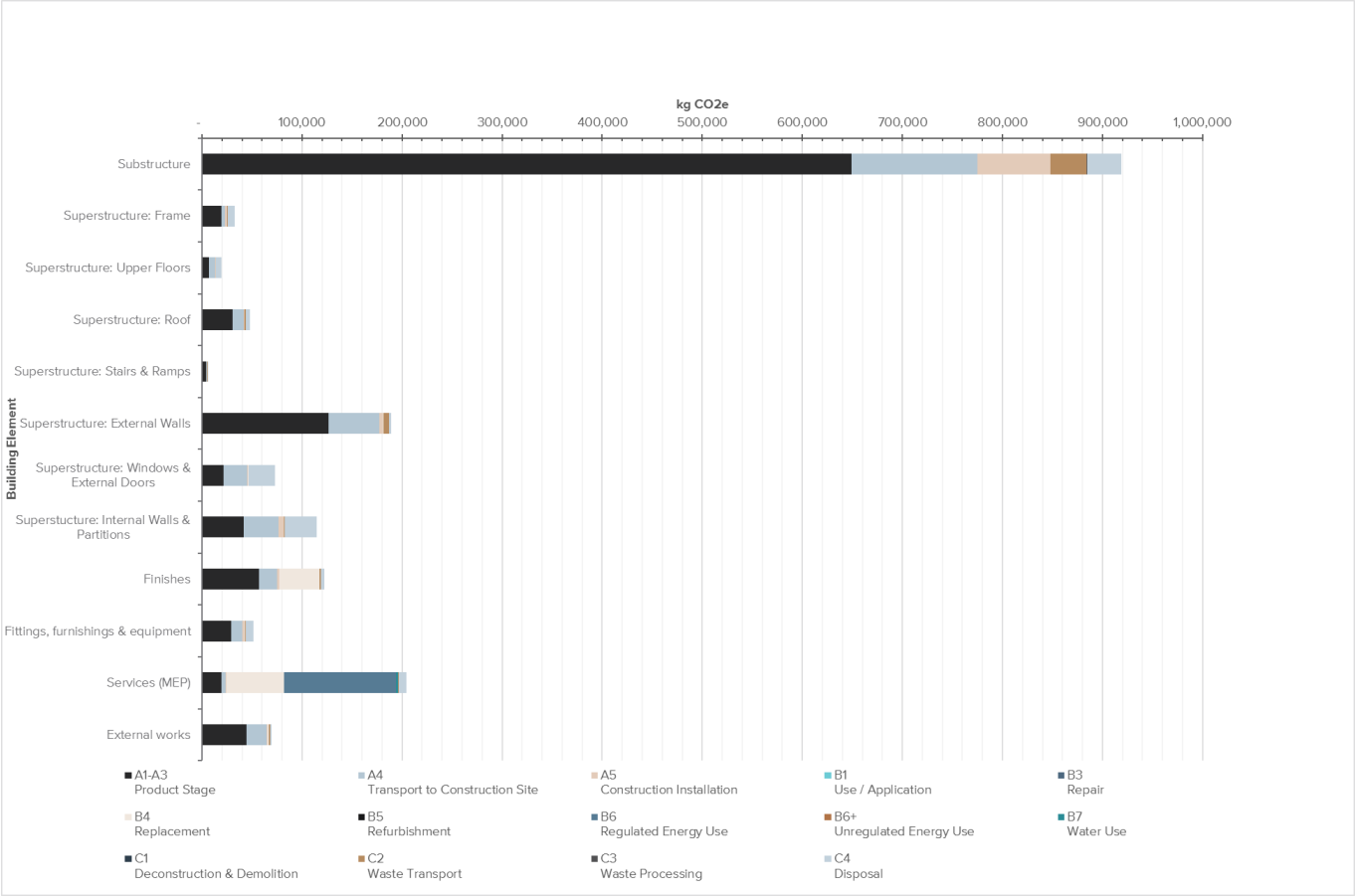


Figure 6: Estimated Whole Life-cycle Carbon by building element category (Kg CO_2e)

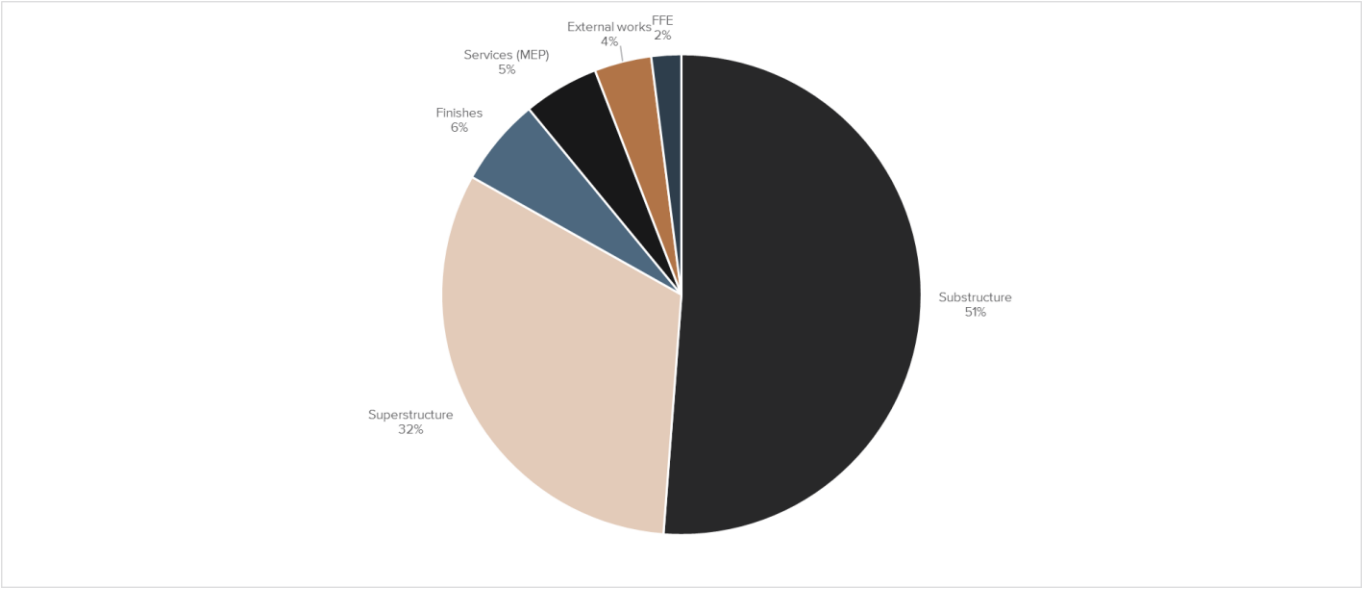


Figure 7: Estimated Embodied Life-cycle Carbon by building element category (%)

REDUCTION MEASURES UNDERTAKEN

Following the review of the previous Whole Life Carbon assessment of the building by the planning officer, the design team have reviewed the design and have taken measures to reduce the Whole Life Carbon performance.

This has been assessed across both the proposed scenarios for a comparison of Whole Life Carbon performance between refurbishing the building and conducting a full demolition and new build.

Proposed carbon reduction measures were discussed with the team, and carbon reductions were incorporated into the proposed scheme as follows:

1. The specification of 50% GGBS within concrete mixtures used for the piled foundations, basement & ground floor slab as well as basement liner walls, lightwell walls and pool walls.
2. Implementation of XCarb reinforcement bars in place of standard 97% recycled content reinforcement bar.
3. Specifying KBRIQ for the New Build scheme. KBRIQ could not be specified for the Refurbishment scheme, as these could not be aesthetically matched to the existing wall which is being retained.

Other measures such as a full Cross Laminated Timber (CLT) frame were considered, however the use of CLT was not structurally efficient for the beam and column spans or building layout. Therefore, steel was specified in place of CLT. However, this is offset by the specification of low carbon steel, which was specified prior to the baseline scenario.

The implementation of these reduction measure results in carbon reductions of 211,000 and 314,000 kg CO_2e over the projects lifetime for the Refurbishment and New Build schemes respectively. This equates to a 11% saving within the Refurbishment scheme and a 14% saving in the New Build scheme.

Whilst it is expected the New Build scheme would be significantly higher in Whole Life Carbon than the Refurbishment scheme, it is show that from the baseline position the New Build scheme is 72 tCO_2e higher. This is largely due to the increased volume of concrete and reinforcement required for the substructure piles in addition to the larger area brickwork.

Detailed results can be found in Table 4 below comparing the 'Business as Usual' assessment, (the assessment where no improvements to the design have been implemented to reduce the whole life carbon of the design), and the 'Proposed' assessment (the assessment where the measures detailed above have been implemented). Table 4 below evidences that through efforts by the design team to implement reduction measures the New Build scheme outperforms the Refurbishment scheme by 20tCO_2e.

Table 4: Implemented Life Cycle carbon reduction measure(s) (A-C (excluding B6 & B7, including sequestration))

Scenario		Total Kg CO_2e	TOTAL kg CO_2e/m^2 GIA	Reduction - Kg CO_2e	Percentage Reduction %
Refurbishment	Business as Usual Assessment	2,112,000	2,000	-	-
	Proposed Assessment	1,890,000	1,800	-222,000	-11%
New Build	Business as Usual Assessment	2,184,000	2,100	-	-
	Proposed Assessment	1,870,000	1,800	-314,000	-14%

SUPPLEMENTARY CEMENTITIOUS MATERIAL BLENDS

Cement within concrete is one of the most carbon-intensive materials within the project, and the specification of Supplementary Cementitious Material Blends or SCMs has had a large impact in reducing the embodied carbon associated with its use. Further detail can be found within Table 5 and Figure 8

Supplementary Cementitious Material Blends, is a catch all term used to describe a wide variety of materials that can be added to concrete mixtures, these include:

- Fly Ash; a by-product of coal combustion in electricity generating power plants.
- Ground Granular Blast Furnace Slag (GGBS); a by-product of the manufacture of iron and steel. (Our chosen option)
- Silica Fume; also known as micro silica this is a by-product material created from the reduction of high purity steel with coal in an electric arc furnace
- Calcium Carbonate Fines (CCF's); a limestone filler material that can help to accelerate the hydration of cement leading to earlier strengths and improving durability of concrete.
- Natural Pozzolans (Such as calcined clays, shale and metakaolin); a variety of naturally occurring materials that have pozzolanic qualities.

In addition to reducing the associated embodied carbon intensity of concretes they are added to, these materials have a variety of other reasons for use such as improving durability, decreasing permeability, aiding pumpability and finishability, mitigating alkali reactivity and improving the overall hardened properties of concrete through hydraulic and pozzolanic activity or both.

Through the use of GGBS rates of 50% in piled foundations, basement & ground floor slab as well as basement liner walls, lightwell walls and pool walls, a reduction of 135,000 and 149,000 kg CO_2e in embodied carbon has been achieved in the Refurbishment and New Build scenarios respectively.

XCARB CONCRETE REINFORCEMENT

The design team has also implemented XCarb steel for the concrete reinforcement.

XCarb is a low carbon steel produced using an Electric Arc Furnace powered by renewable energy instead of a Blast Oxygen Furnace. Consequently, this method, not only utilses a high recycled amount of steel but also reduces the reliance on fossil fuels to fuel the production process.

The manufacture of steel reinforcement is carbon & energy intensive process, through the implementation of XCarb reinforcement bar, a reduction of 87,000 and 97,000 kg CO_2e in the Refurbishment and New Build scenarios respectively. s. Further detail can be found within Table 5 and Figure 8.

KBRIQ

Finally, the design team looked to the brickwork as part of both schemes, coming to the conclusion KBRIQ could be implemented in place of standard bricks for the New Build scenario only.

KBRIQ is a low carbon alternative to bricks, where up to 90% recycled aggregates are pressed under high pressure to form the bricks. This consumes 10% of the energy compared with firing of traditional bricks and reduces the input for raw materials.

As the aesthetics for the KBRIQ cannot be matched to the existing walls to be retained, specifying KBRIQ under the Refurbishment scheme was not possible.

Bricks are carbon intensive to produce, and thus specifying KBRIQ bricks, which contain high recycled content and do not require firing, could result in a notable reduction of around 68,000 kg CO_2e in embodied carbon associated with those elements within the New Build scheme. Further detail can be found within Table 5 and Figure 8.

Table 5: Estimated life-cycle embodied carbon savings for the implemented reduction measures for both schemes (Modules A-C, excluding B6-B7, including sequestration) (kg CO_2e)

Description	Refurbishment		New Build	
	Total kgCO2e	Reduction - kgCO2e	Total kgCO2e	Reduction - kgCO2e
Baseline	2,112,000	-	2,184,000	-
50% GGBS in concrete mixes	1,977,000	-135,000	2,035,000	-149,000
XCarb concrete reinforcement	2,025,000	-87,000	2,087,000	-97,000
KBRIQ	-	-	2,116,000	-68,000
Proposed	1,890,000	-222,000	1,870,000	-314,000

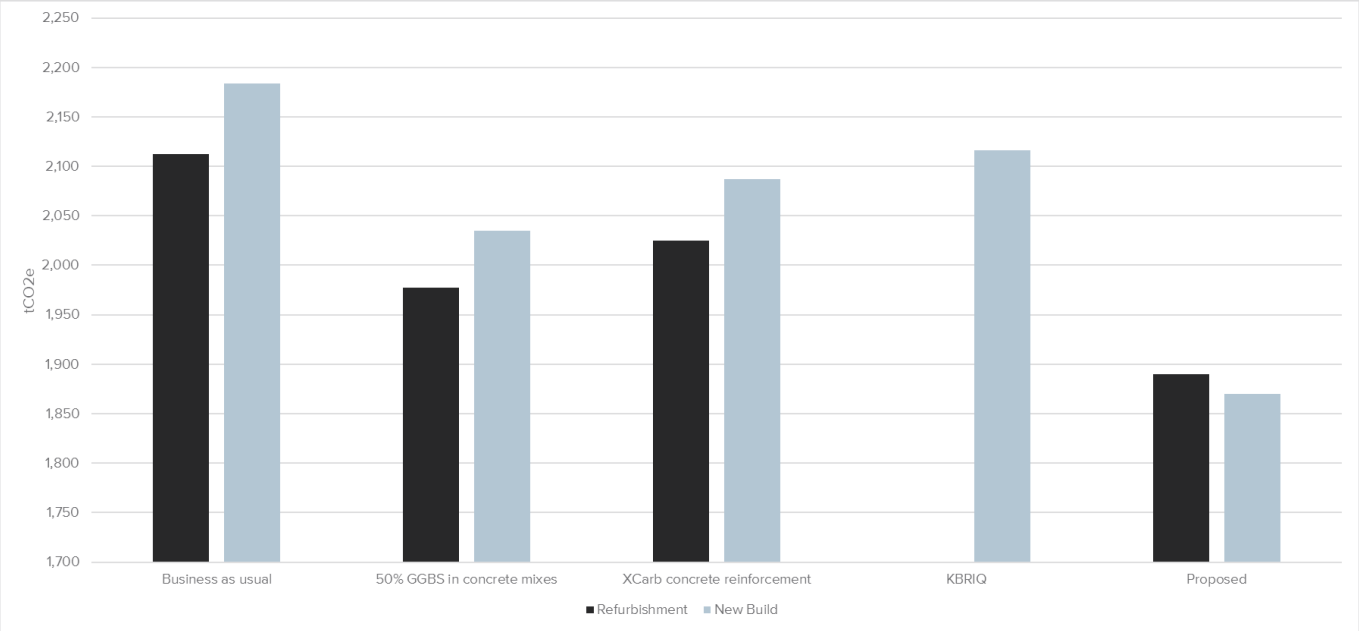


Figure 8: Estimated Life-Cycle Embodied Carbon under each reduction measure (Modules A-C, excluding B6 & B7, including sequestration)

CONCLUSION & RECOMMENDATIONS

A planning application (2022/2529/P) was submitted in June 2022 for the redevelopment of this property. The agent subsequently commissioned a Whoel Life Carbon Assessment Comparative Study from this firm, and this was submitted in June 2023. Unfortunately, our brief was to compare the proposed new build with a simple refurbishment of the existing house, taking no account of the fact that the proposed new build would be c.2.5x larger. Hence the comparison compared "apples with pears", and it led to the application being refused, essentially on sustainability grounds, in December 2023.

This report has been prepared to support the appeal. It rectifies the deficiency in the previous brief, in that we have now compared the same proposed new build scheme with a scheme that both refurbishes the existing house and extends it to approximately the same floorspace. It has not been possible to seek the Council's endorsement of the extensions, but they are judged by the planning consultants to be extensions for which permission would be likely to be forthcoming (a matter that is explained fully in the appeal statement). Hence this report can be considered to compare "apples with apples.

Proposed carbon reduction measures were discussed with the team, and carbon reductions were incorporated into the proposed scheme as follows:

1. The specification of 50% GGBS within concrete mixtures used for the piled foundations, basement & ground floor slab as well as basement liner walls, lightwell walls and pool walls.
2. Implementation of XCarb reinforcement bars in place of standard 97% recycled content reinforcement bar.
3. Specifying KBRIQ for the New Build scheme.

Through the implementation of these measures, Whole Life Carbon savings of 222,000 and 314,000 $kgCO_2e$ has been achieved across the Refurbishment and New Build scenarios respectively.

Following these reduction measures the Refurbishment achieves a Life Cycle Carbon figure of 1,890,000 $kgCO_2e$, whilst the New Build achieves 1,870,000 $kgCO_2e$.

Consequently, whilst the New Build scenario would be expected to be higher than the Refurbishment option, through efforts by the design team the Whole Life Carbon emissions have been significantly reduced to a position where the New Build outperforms the Refurbishment scheme by 20tCO_2e.

Table 6: Estimated life-cycle embodied carbon for the proposed assessment (A-C (excluding B6 & B7, including sequestration))

Proposed Assessment		Sequestered (biogenic) Carbon	Module A1-A5	Module B1-B5	Module B6-B7	Module C1-C4	Module D
Refurbishment	TOTAL kg CO_2e	-153,371	1,382,141	104,171	114,189	403,326	7,639
	TOTAL kg CO_2e/m^2 GIA	-200	1,300	100	200	400	100
New Build	TOTAL kg CO_2e	-164,158	1,392,627	104,168	114,505	372,817	14,830
	TOTAL kg CO_2e/m^2 GIA	-200	1,400	100	200	400	100

Table 7: Estimated life-cycle embodied carbon savings for the implemented reduction measures for both schemes (Modules A-C, excluding B6-B7, including sequestration) (kg CO_2e)

Description	Refurbishment		New Build	
	Total kgCO2e	Reduction - kgCO2e	Total kgCO2e	Reduction - kgCO2e
Baseline	2,112,000	-	2,184,000	-
50% GGBS in concrete mixes	1,977,000	-135,000	2,035,000	-149,000
XCarb concrete reinforcement	2,025,000	-87,000	2,087,000	-97,000
KBRIQ	-	-	2,116,000	-68,000
Proposed	1,890,000	-222,000	1,870,000	-314,000

RECOMMENDATIONS

The 71 Avenue Road development is currently achieving the GLA benchmark Whole-life carbon targets.

As such, next steps for the project should the following recommendations to ensure that the GLA benchmarks for Whole-life carbon are considered and to increase the accuracy of reporting at subsequent stages:

1. *Adopt additional options into design.*

   Furthermore, it is recommended that as many as possible of the additional WLC reduction options explored are adopted. The adoption of voided slabs would result in huge carbon savings for example, through the reduction of concrete, and XCO2 recommend that this is explored in more detail in subsequent stages.

2. *Work with contractor to accurately calculate formwork reuse quantities.*

   For the accurate calculation of reused formwork, it is recommended to have a workshop early from the appointment of the main contractor to understand the optimum minimum quantities of plywood required based on the construction programme and concrete drying times. This will enable a more accurate assessment of the savings possible through reuse throughout the construction process.

3. *Third-Party Assessment*

   To further ensure the robustness of this assessment, 3rd party verification of the embodied carbon life-cycle analysis (LCA) referenced in this report would provide a level of additional rigor to the model and results.

APPENDIX A – SCOPES OF THE REFURBISHMENT AND NEW BUILD SCHEMES

SHH
ARCHITECTURE
& INTERIORS

71 Avenue Road

EMBODIED CARBON BRIEF

PREPARED FOR

Mr Gareh

DATE

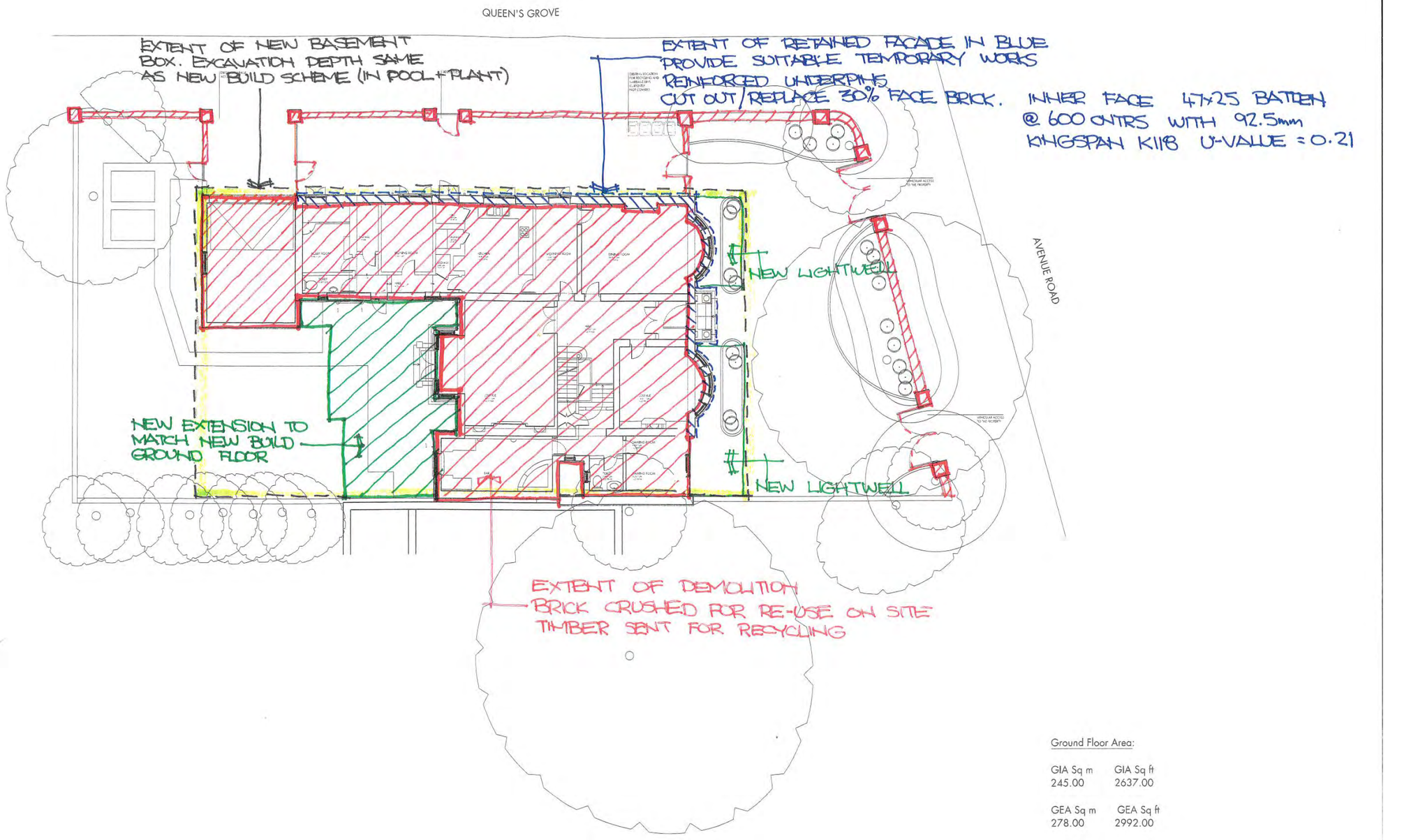
17 June 2024

REFURBISHMENT SCOPE

DATE
17 June 2024

71 Avenue Road

GROUND



Ground Floor Area:

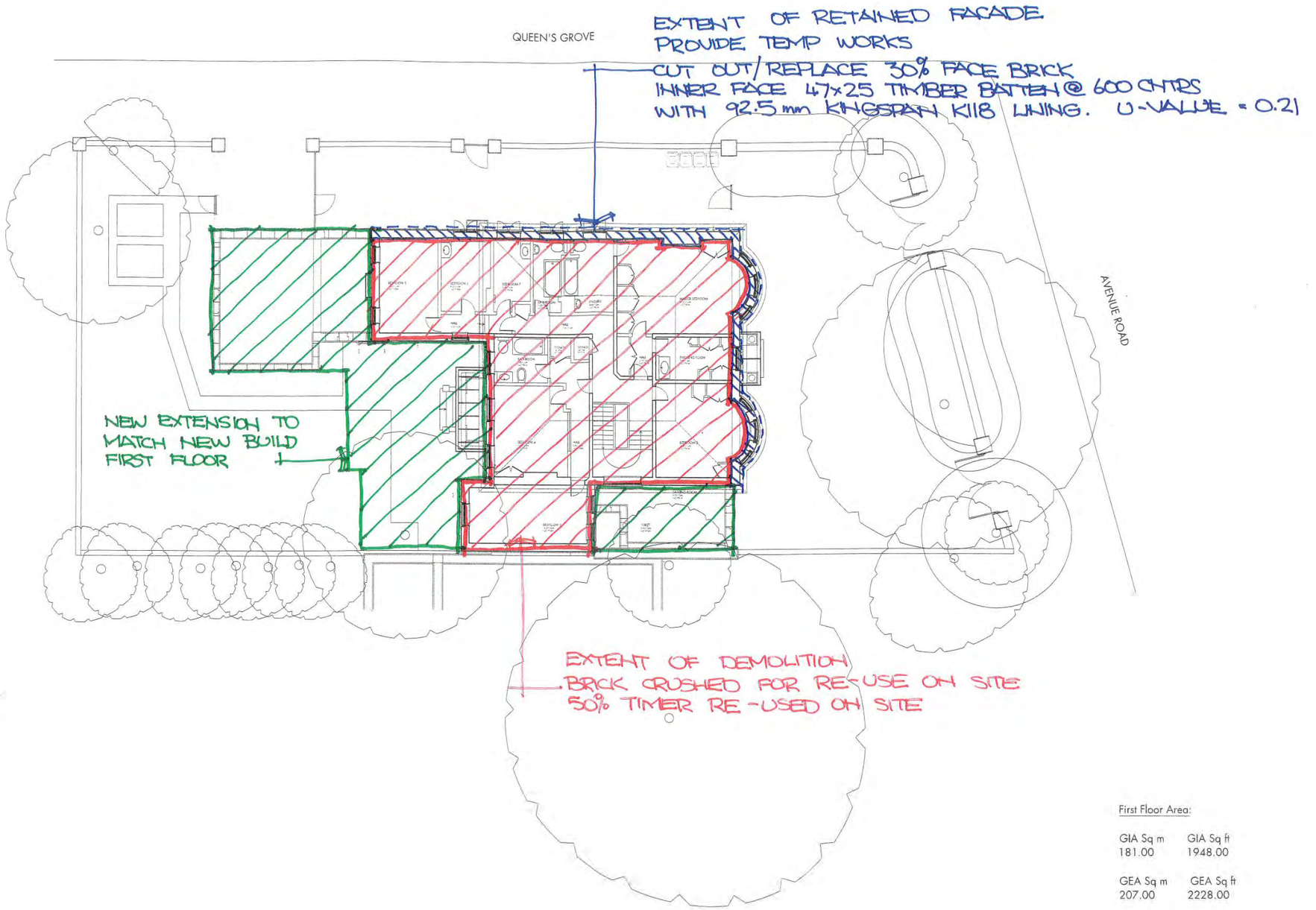
GIA Sq m	GIA Sq ft
245.00	2637.00

GEA Sq m	GEA Sq ft
278.00	2992.00

GROUND FLOOR PLAN

71 Avenue Road

FIRST FLOOR



FIRST FLOOR
PLAN

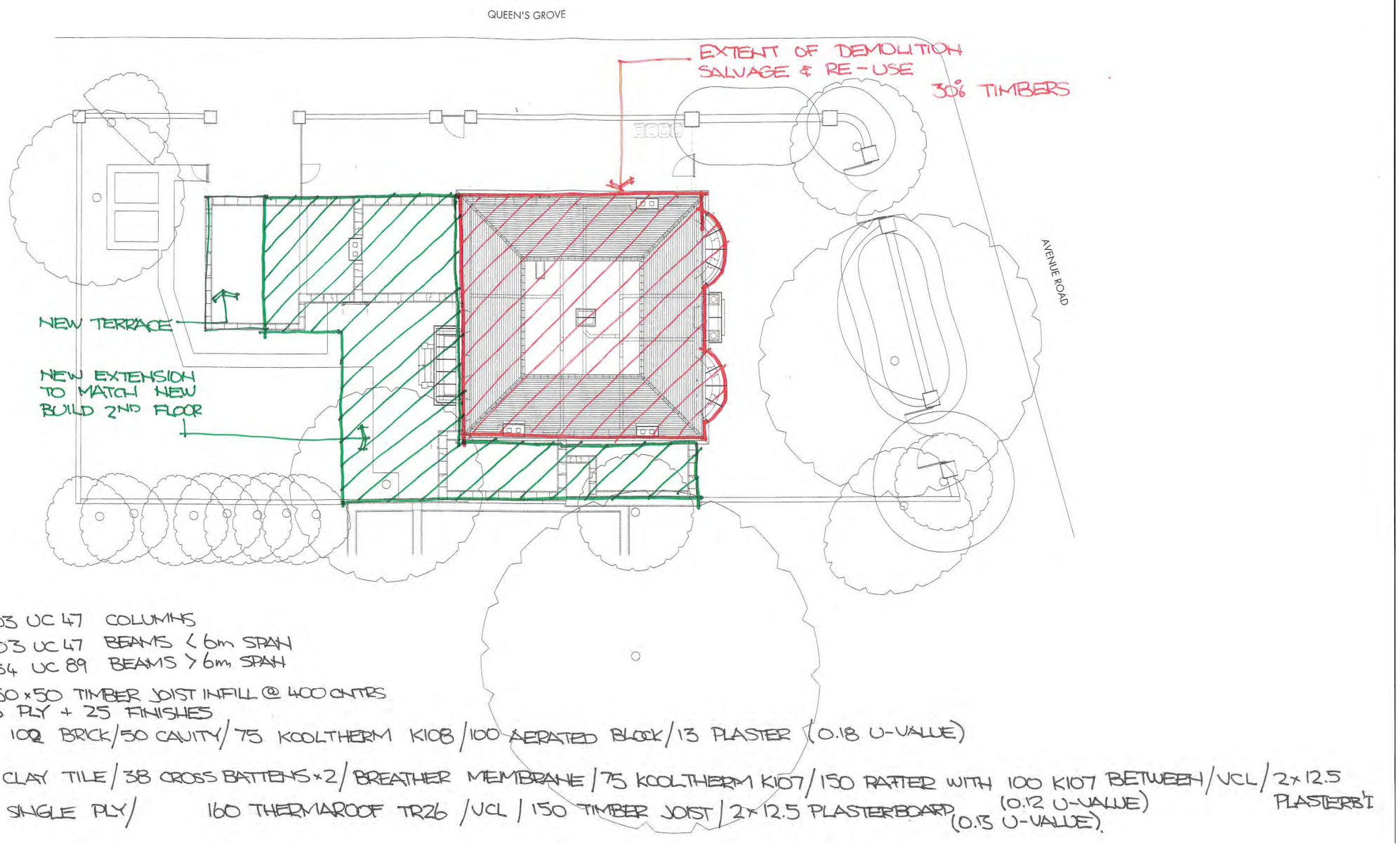
First Floor Area:

GIA Sq m	GIA Sq ft
181.00	1948.00

GEA Sq m	GEA Sq ft
207.00	2228.00

71 Avenue Road

SECOND FLOOR



ROOF PLAN

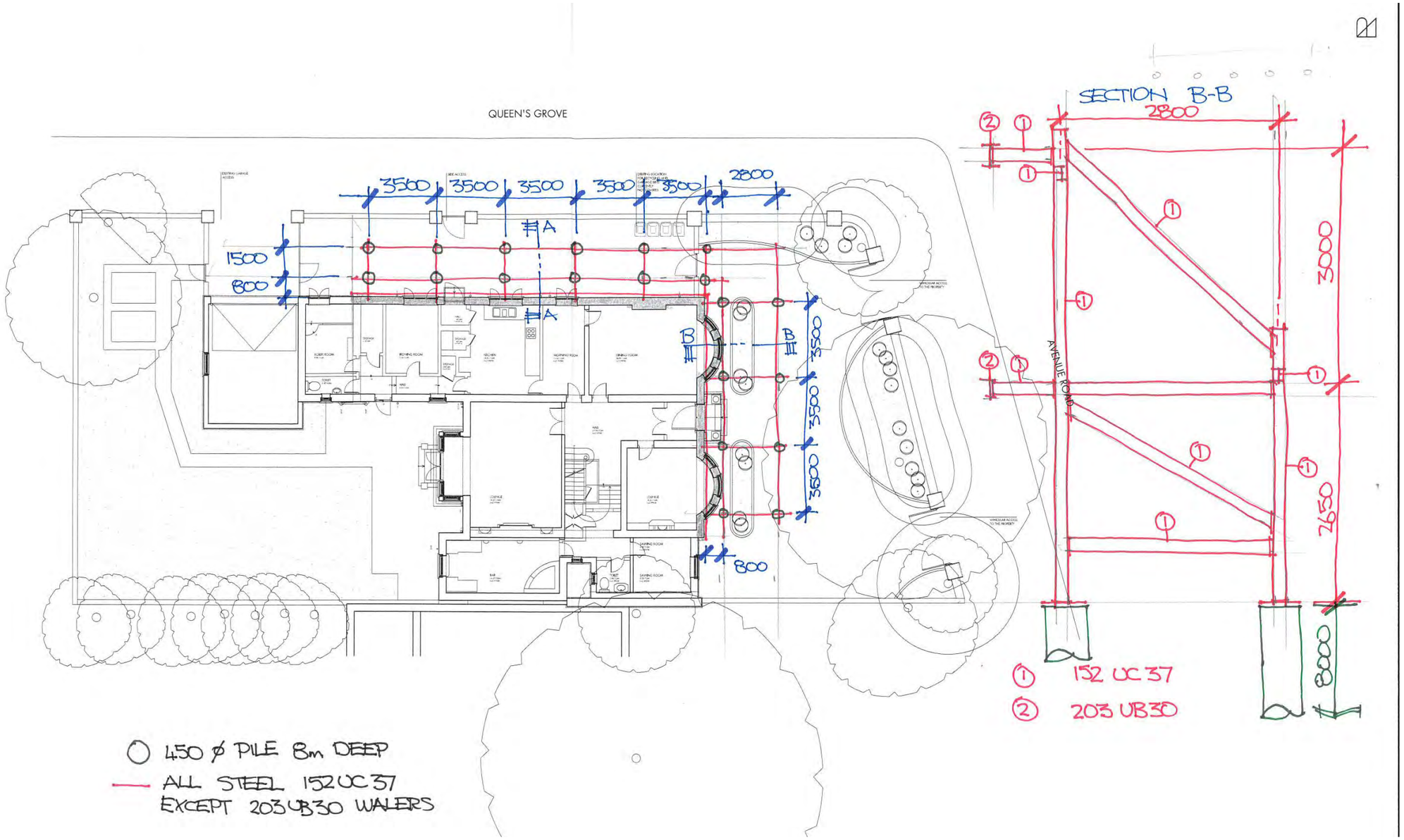
TEMPORARY WORKS SCHEME

DATE

17 June 2024

71 Avenue Road

TEMPORARY WORKS SCHEME

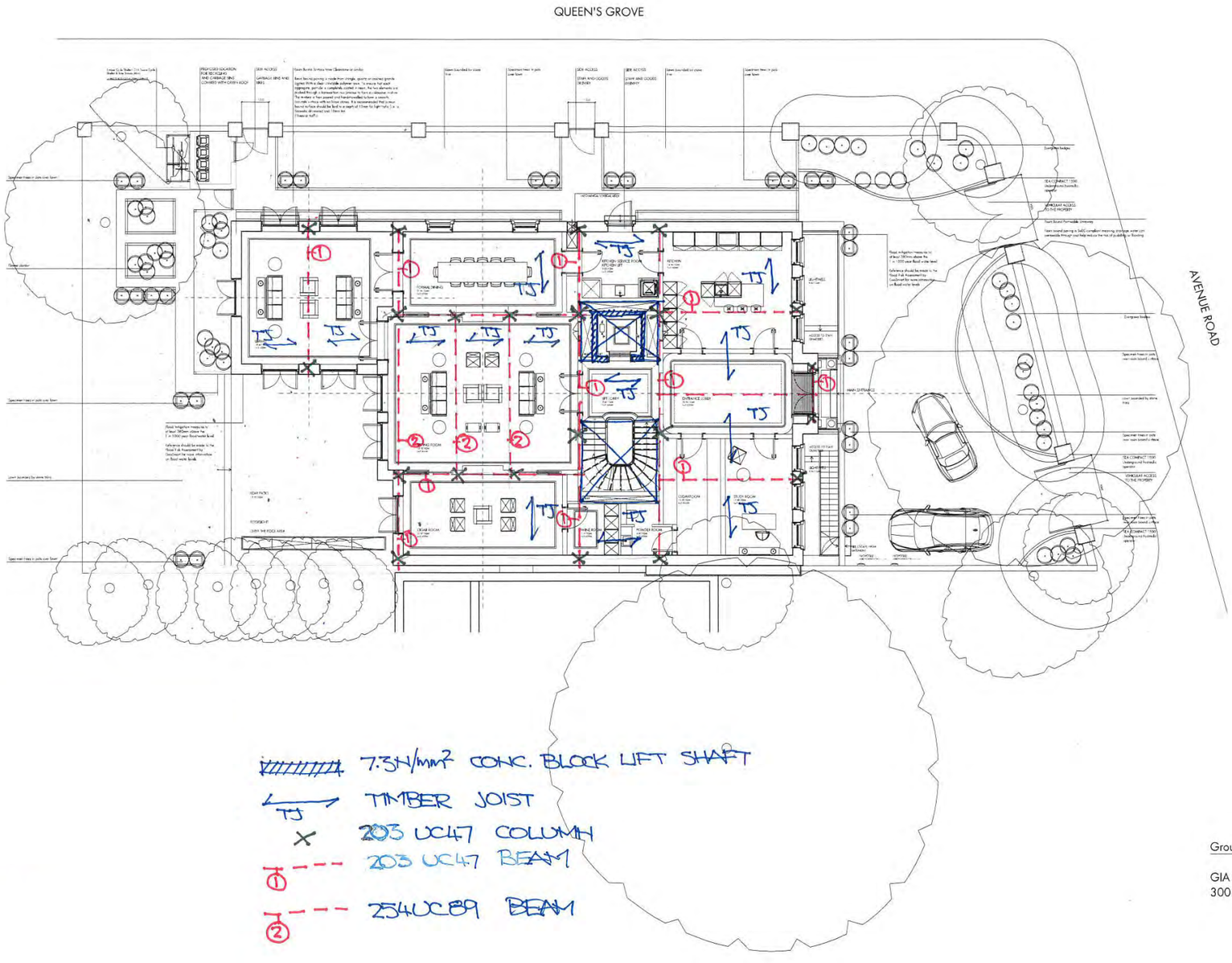


STRUCTURAL SCHEME

DATE
17 June 2024

71 Avenue Road

GROUND



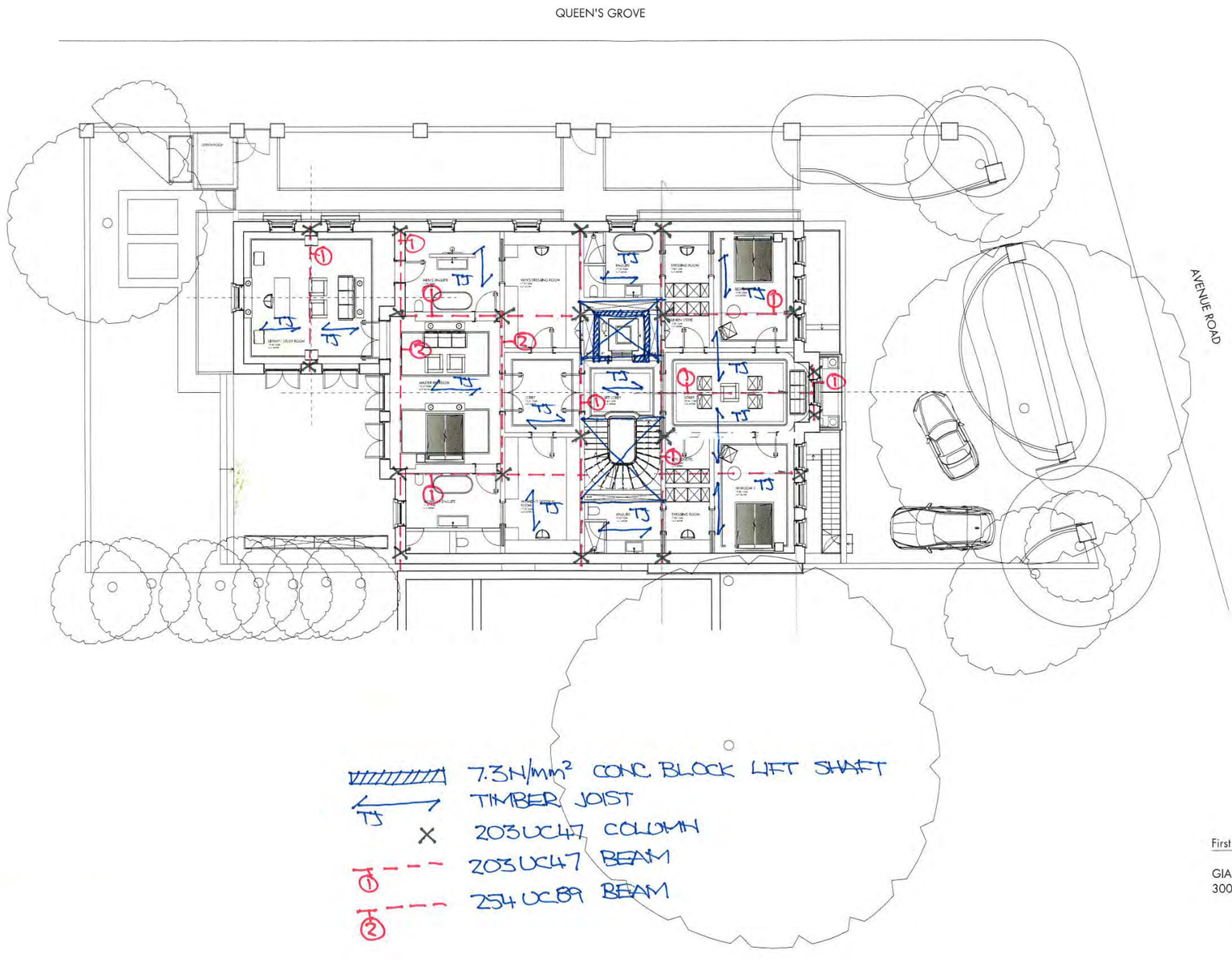
Ground floor Area:

GIA Sq m	GIA Sq ft
300.00	3229.00

GROUND FLOOR PLAN

71 Avenue Road

FIRST FLOOR



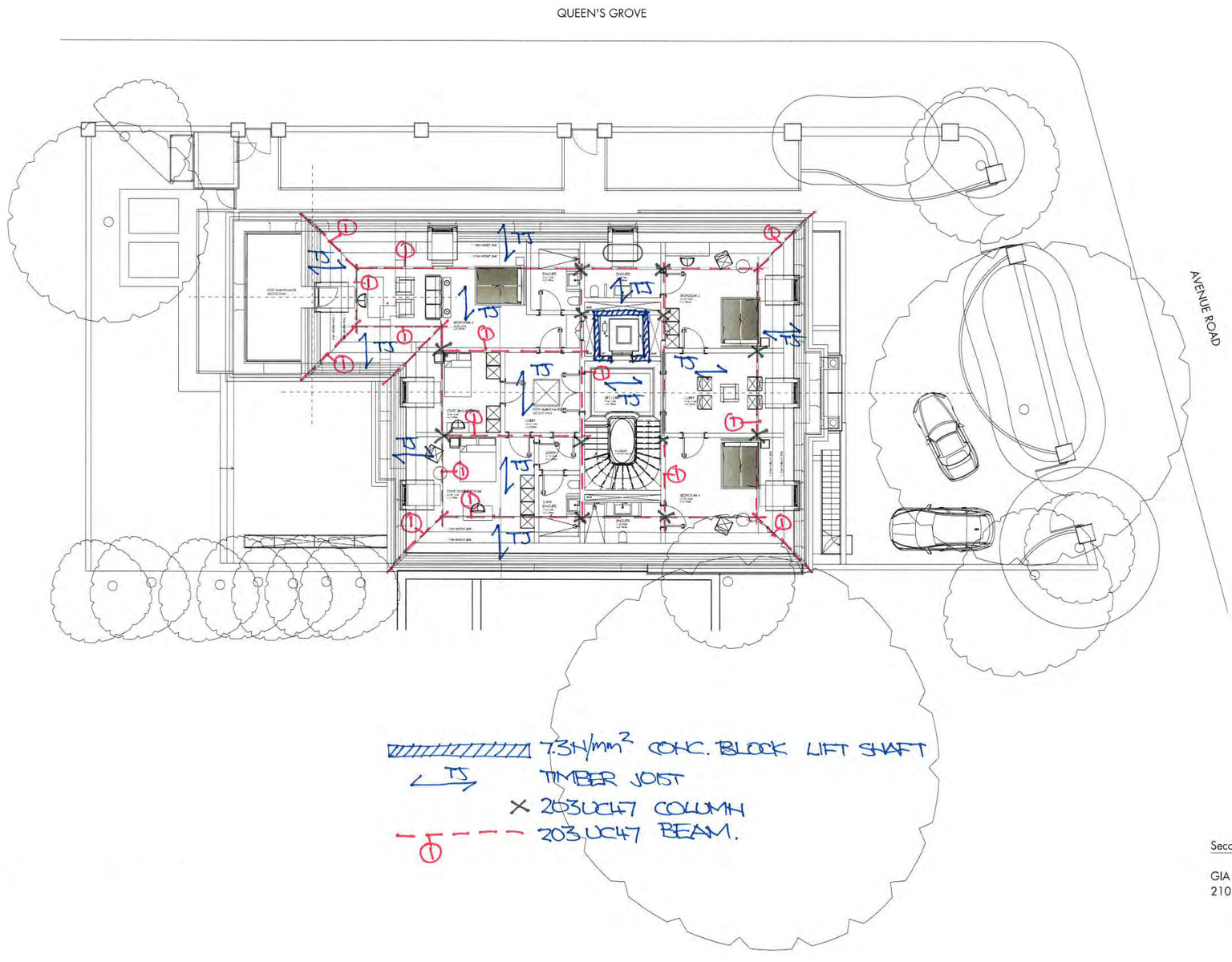
First floor Area:

GIA Sq m	GIA Sq ft
300.00	3229.00

FIRST FLOOR
PLAN

71 Avenue Road

SECOND FLOOR



Second floor Area:

GIA Sq m	GIA Sq ft
210.00	2260.00

SECOND FLOOR
PLAN

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British Institute of Interior Design

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APPENDIX B – ESTIMATED EMBODIED CARBON ASSESSMENT RESULTS IN FULL FOR THE REFUBISHMENT SCENARIO

Building element		KG's of carbon dioxide equivalent																
		Biogenic carbon	A1-A3 Product Stage	A4 Transport to Site	A5 Construct. works	B1 Use	B2 Maintenance	B3 Repair	B4 Replace	B5 Refurbish	B6 Regulated Energy Use	B6+ Unreg. Energy Use	B7 Water Use	C1 Deconst. & Demo.	C2 Waste Transport	C3 Waste Process	C4 Disposal	D Benefits & loads beyond system boundary
0.1	Demolition: Toxic / Hazardous / Contaminated Material Treatment	-	-	-	-	-	-	-	-	-	-	-	-	-	23,345	-	7,023	-
0.2	Major Demolition Works	-	-	-	-	-	-	-	-	-	-	-	-	50,745	-	-	-	-
0.3	Temporary Support to Adjacent Structures	-25	12,611	1,531	61	-	-	-	-	-	-	-	-	-	1,215	-	14	-4,078
0.4	Specialist Ground Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.5	Temporary Diversion Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	Substructure	-5,507	566,945	121,813	76,606	-	-	-	-	-	-	-	-	-	78,610	189	27,937	5,143
2.1	Frame	-9,900	19,400	3,535	2,059	-	-	-	-	-	-	-	-	143	275	44	7,426	266
2.2	Upper Floors	-10,812	6,909	6,632	904	-	-	-	-	-	-	-	-	-	191	-	5,490	389
2.3	Roof	-8,741	30,573	10,433	942	-	663	-	-	-	-	-	-	-	2,026	-	4,085	-355
2.4	Stairs & Ramps	-431	4,322	682	174	-	-	-	-	-	-	-	-	-	491	-	308	-156
2.5	External Walls	-2,726	160,674	76,648	4,261	-	-	-	736	-	-	-	-	-	10,091	-	3,296	-794
2.6	Windows & External Doors	-10,895	5,775	6,456	461	-	-	-	633	-	-	-	-	-	280	-	8,356	348

2.7	Internal Walls & Partitions	-69,996	42,070	34,707	5,719	-	-	-	-	-	-	-	-	-	2,111	-	32,049	2,213
2.8	Internal Doors	-	32,803	51,576	19,692	-	-	-	-	-	-	-	-	-	3,247	-	107,007	7,624
3	Finishes	-17,081	56,917	18,625	1,940	-	409	-	40,413	-	-	-	-	-	1,358	-	3,988	-31
4	Fittings, furnishings & equipment	-15,955	29,010	12,584	1,894	-	562	-	371	-	-	-	-	172	1,022	-	7,719	-1,377
5	Services (MEP)	-30	19,726	3,787	1,014	-	1,768	-	57,202	-	111,910	-	2,279	-	499	-	7,397	-1,468
6	Prefabricated Buildings & Building Units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Work to Existing Building	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	External works	-1,272	61,156	21,062	825	-	-	-	1,414	-	-	-	-	-	4,031	-	1,144	-84
-	Other or overall site construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	Unclassified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

ESTIMATED EMBODIED CARBON ASSESSMENT RESULTS IN FULL FOR THE NEW BUILD SCENARIO

Building element		KG's of carbon dioxide equivalent																
		Biogenic carbon	A1-A3 Product Stage	A4 Transport to Site	A5 Construct. works	B1 Use	B2 Maintenance	B3 Repair	B4 Replace	B5 Refurbish	B6 Regulated Energy Use	B6+ Unreg. Energy Use	B7 Water Use	C1 Deconst. & Demo.	C2 Waste Transport	C3 Waste Process	C4 Disposal	D Benefits & loads beyond system boundary
0.1	Demolition: Toxic / Hazardous / Contaminated Material Treatment	-	-	-	-	-	-	-	-	-	-	-	-	-	23,345	-	7,023	-
0.2	Major Demolition Works	-	-	-	-	-	-	-	-	-	-	-	-	50,745	-	-	-	-
0.3	Temporary Support to Adjacent Structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.4	Specialist Ground Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.5	Temporary Diversion Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	Substructure	-5,504	649,214	125,892	72,958	-	-	-	-	-	-	-	-	-	36,153	254	34,232	7,108
2.1	Frame	-9,900	19,400	3,535	2,059	-	-	-	-	-	-	-	-	143	275	44	7,426	266
2.2	Upper Floors	-10,812	6,909	6,263	875	-	-	-	-	-	-	-	-	-	6	-	5,490	389
2.3	Roof	-8,741	30,885	10,622	851	-	663	-	-	-	-	-	-	-	1,358	-	4,093	-355
2.4	Stairs & Ramps	-431	4,322	682	174	-	-	-	-	-	-	-	-	-	489	-	308	-156
2.5	External Walls	-383	126,781	50,728	2,939	-	-	-	736	-	-	-	-	-	5,964	-	1,812	-796
2.6	Windows & External Doors	-24,998	21,455	23,444	848	-	-	-	633	-	-	-	-	-	206	-	26,650	1,499
2.7	Internal Walls & Partitions	-69,996	42,066	34,706	5,496	-	-	-	-	-	-	-	-	-	419	-	32,049	2,213

2.8	Internal Doors	-	32,803	51,576	19,692	-	-	-	-	-	-	-	-	-	3,247	-	107,007	7,624
3	Finishes	-17,081	56,917	18,480	1,910	-	409	-	40,409	-	-	-	-	-	954	-	3,988	-31
4	Fittings, furnishings & equipment	-15,955	29,010	11,675	1,727	-	562	-	371	-	-	-	-	-	1,022	-	7,719	-1,377
5	Services (MEP)	-30	19,726	3,787	1,009	-	1,768	-	57,202	-	111,910	-	2,594	-	478	-	7,397	-1,468
6	Prefabricated Buildings & Building Units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Work to Existing Building	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	External works	-328	44,358	20,334	681	-	-	-	1,414	-	-	-	-	-	1,375	-	1,144	-84
-	Other or overall site construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	Unclassified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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