Circular Economy Statement

RIBA Stage 3-4

WB Shiels Ltd.

FOR THE SITE AT:
Kneller Hall
Twickenham
TW2 7DU

Version	Revision	Date	Author	Reviewer	Project Manager
1	A	01.09.22	Grace Boatfield	Malcolm Maclean	Bo Yang
1	B	15.09.22	Grace Boatfield	Bo Yang	Bo Yang

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

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Introduction

1.0 Circular Economy Assessment

This Circular Economy Statement has been written on behalf of WB Shield Ltd. (the Client) to demonstrate the sustainability measures incorporated into the design of the development at the Kneller Hall site, Twickenham (the Proposed Development), within the London Borough of Richmond upon Thames. The Statement outlines the adoption of circular economy principles throughout the design, construction, operation, and end-of-life phases of the Proposed Development.

Through the incorporation of fundamental sustainability principles, the Proposed Development demonstrates a robust and positive response to local and regional Planning Policy, and the aspiration of the GLA to create sustainable communities, rooted in Circular Economy principles. The Proposed Development is also working against the requirements of BREEAM UK New Construction 2018 and Non-domestic Refurbishment and Fit-out 2014, of which the requirements of Management 03, Materials 01 & 03, Waste 01 & 03 and Land Use and Ecology 02~05 are of particular significance to Circular Economy. With a positive approach to these key principles, the Proposed Development aims to reduce environmental impacts at every stage of design and construction.

1.1 Introduction

This Circular Economy Statement has been written to demonstrate the sustainability measures incorporated into the design of the proposed development at Kneller Hall, situated in Twickenham, Richmond Upon Thames. The Kneller Hall project represents a multifaceted development of 6 no. buildings consisting of the demolition of various existing structures, construction of 3 new buildings as well as areas of refurbishment and renovation of a further 3 areas. The Proposed Development marks the closure of the previous Kneller Hall Royal Military School nearly 170 years after its opening in 1857, ready for conversion into a new educational facility through the development of new modern structures and the incorporation of the Grade II listed house and two ancillary curtilage listed buildings.

The Proposed Development will deliver lower energy and water use, lower carbon emissions and lower operational costs than a Building Regulations Compliant design through a ‘fabric first’ approach to the building design, in line with best practice. The site will also be assessed in accordance with the RICS ‘Whole Life Carbon Assessment for the Built Environment’ and will incorporate Circular Economy principles within the overall design, procurement, and construction process.

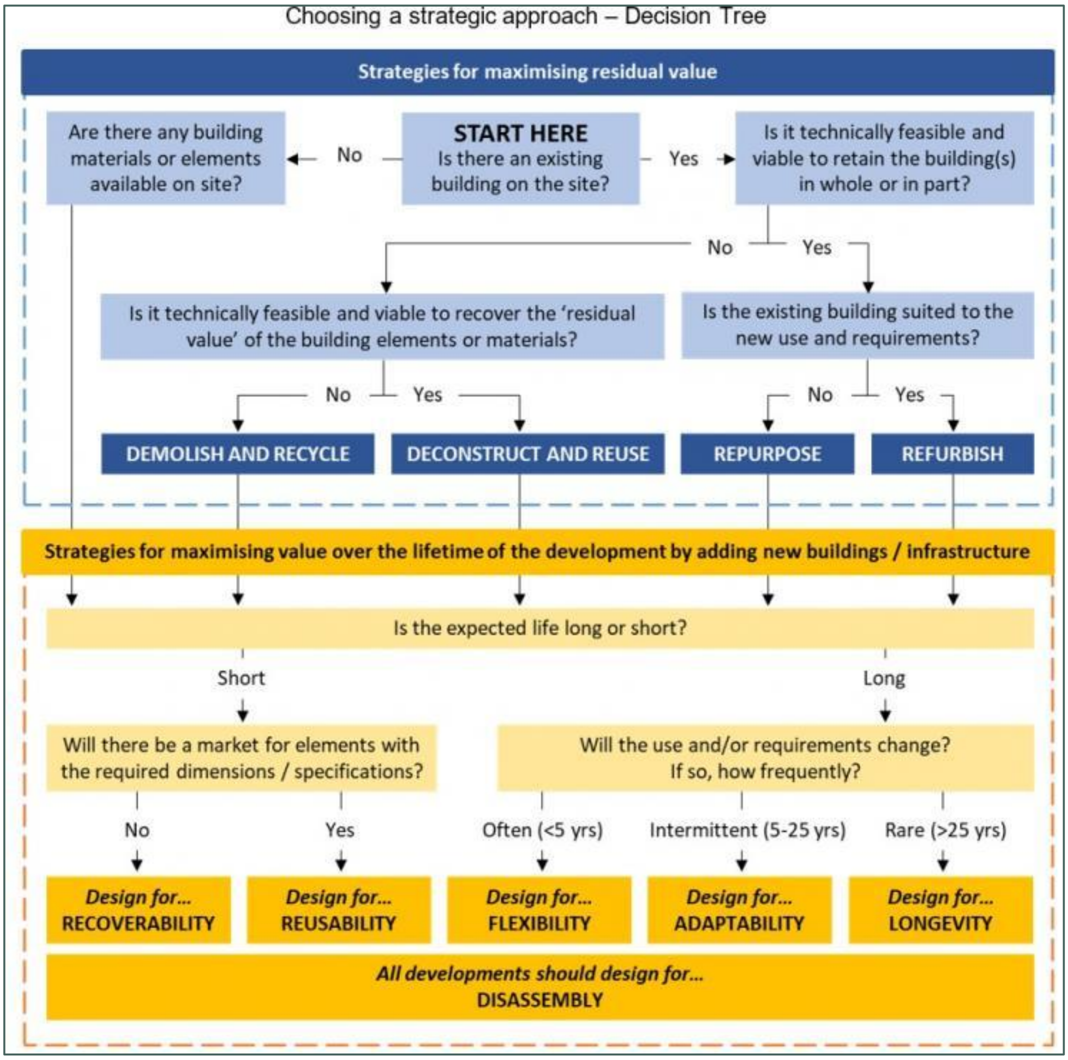
In advance of the submission of the full planning application, as part of the pre-application discussions, this Circular Economy Statement was prepared by SRE and reviewed by the Council’s independent advisors. Written feedback was received, which has been taken into consideration in the preparation of the final Circular Economy Statement.

The following strategic approach is to be adopted at each key development phase.

Aspect	Phase	Steering Approach	Explanation	Target	Supporting Analysis / Studies / surveys / Audits
Circular Economy Approach for the Proposed Development	Design	Reduction of carbon emissions and development of a flexible and durable building,	Reduction of Carbon Emissions through material selection and the undertaking of a whole life carbon assessment to clarify likely carbon output.	450 to 500 $kgCO_2e/m^2$ (modules A1-A5)	WLCA Study
	Design	Building in Layers Approach to provide robust design built for longevity	Building in Layers Assessment to confirm approach to material selection in line with the Building in Layers methodology.	Justification for the materials selection in line with the methodology	Building In Layers Appraisal – included with this document.
	Construction	Reduction in on-site emissions	Reducing impacts to the local and global environment through the limiting, reporting, and targeting of emissions and waste production and a robust site policy process	>70% of waste from site diverted from landfill. Energy and water use to be monitored on site with appropriate targets set. Waste to be reduced and diverted from landfill.	Resource Management Plan is to outline all site requirements with regards to energy, water, and waste
Circular Economy Approach for the existing Site	Demolition	As many resources as possible within the existing building to be diverted from landfill	Reducing waste to landfill. A pre-demolition waste audit will identify where materials can be reused. Soft strip to remove any items of potential future value. Demolition waste to be reused on site where possible, or elsewhere where not.	>80% of non-hazardous demolition waste (volume) to be diverted from landfill	Pre-demolition Waste Audit. Reports from waste contractor and site office confirming rate of diversion from demolition waste only.
Circular economy approach for municipal waste during operation	Operation	Enhance the ability of residents and building users to increase recycling rates.	Facilitate the easy and convenient segregation of waste by building users for the operational phase of the building.	>70% diversion from landfill	Correctly sized, located, and labelled bins to be provided within the communal bin store. Bins to be provided within the residential kitchen spaces to enhance recyclable waste segregation.

Table 1: Circular Economy Strategy Approach

To assess the Application Site the chosen strategic approach was the Decision Tree[1]. This allowed opportunities for maximising the residual value of any buildings, materials, or elements on site, before considering strategies for adding value over the lifetimes of the development.



Within this development the following route was followed:

Strategies for maximising residual value

There are a number of existing buildings on the site of which three primary ones are to be retained and repurposed: The former Guard House, the hall, and the main school building. The latter two are being partially extended. As the majority of the structures are not being demolished, all existing materials are therefore still purposed. There will be demolition taking place on the site of a number of buildings including the old accommodation block, but due to the scale and age of these buildings, many of the materials will not be appropriate for reuse. A deconstruction approach will, however, be taken where possible.

Strategies for maximising value over the lifetime of the development by adding new buildings/infrastructure

As the site is expected to have a long-life span, it has been designed for longevity with the potential for adaptability. Further details of this can be found throughout the report, particularly in Section 5.2.

[1] 'Decision Tree' Figure 3.1:Illustration 3
https://www.london.gov.uk/publications/circular-economy-statement-guidance#appendix-a-table-1-strategic-approach-

1.2 The Proposed Development

The Application Site is located at the current Kneller Hall army barracks, 65 Kneller Road, within the London Borough Tower of Richmond upon Thames. It is bounded to the North, West, and South by residential zones and to the East by Twickenham Stadium. The Proposed Development consists of the construction of 3 new buildings and the retention and conversion of three existing buildings, two of which are proposed to have new extensions to them.

The Proposed Development is to provide an educational facility with a total GIA of 13,756.58m^2.

Through the Design Team Meetings and ongoing dialogue with both the Client and wider Design Team throughout the early design stage process, established the following key aims of the site redevelopment:

- Provide good quality education and teaching space in line with the requirements and aspirations of the Local Plan.
- Provide a robust building design which is constructed for longevity.
- Flexible construction type which will allow easy rearrangements of the floor layout as required by changing needs.
- Reduce environmental impacts through consideration of the construction type and process, in addition to the materials used. Environmental impact will balance material sourcing with the lifespan of the materials chosen.

Figure 1: View of site as proposed.

Please see Appendix A for existing and proposed Site Plans and refer to the architect's plans for further details.

Circular Economy

2.0 Planning Policy Background

2.1 Strategic Policy

Richmond upon Thames Local Plan 2015-2033

This policy highlights Kneller Hall in Whitton (The Proposed Development) as a key area for development. In line with Policy note SA 14, any redevelopment proposal for the whole site will require the restoration and enhancement of the existing Grade II listed 'Kneller Hall', offering reuse of historic constructs and existing materials.

2.1.1 Strategic Objectives – West London Waste Plan

The site of Kneller falls within the West London Waste Plan and therefore is subject to the following objectives.

1. To ensure that waste is managed as far up the waste hierarchy as possible, by encouraging the minimisation of waste and the use of waste as a resource.
2. To ensure that, through appropriate policies, waste facilities meet the highest standards possible of design, construction, and operation to minimise adverse effects on local communities and the environment.

2.1.2 The London Plan – 2021

Policy SI 7 Reducing waste and supporting the circular economy[2]

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.

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

2.2 Sustainability (Circular Economy) Strategy

The World Commission on Environment and Development (WCED) report: Our Common Future[3], describes Sustainable Development as development that:

'meets the needs of the present without compromising the ability of future generations to meet their own needs'.

This principle has guided national policy since the WCED report and continues to be the foundation to which 'sustainability' is embedded within processes of all industries, including construction and development.

Over the years the policy requirements have become more prescriptive in nature, with targets on CO_2 emissions and resource use being tightened through Policy and Regulation changes as the UK moves towards zero carbon by 2050. Changes to regulations gradually aim to allow industry to adapt to new methods, whilst challenging industry leaders to provide innovative services, technologies, and other solutions to meet the ever-stricter

[2] https://www.london.gov.uk/sites/default/files/circular_economy_statements_lpg_0.pdf
[3] https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

demands. Whilst sustainable principles are key to ensuring the reduction of pollution and CO_2 emissions (the primary cause of anthropogenic Climate Change) their primary aim is to ensure that future generations have the same, if not better ability to meet their needs than the current generation. As such, wider aspects must be considered when looking at sustainability ‘in the round’.

In line with the London Plan Circular Economy Guidance, the Proposed Development will aim to be net zero-waste. Tables A, B and C in Appendix A outline the key commitments with regards to Circular Economy.

3.0 Environmental Assessment & Whole Life Carbon

The Proposed Development has undertaken a Whole Life Carbon Assessment to establish the Whole Life impact of the proposals in relation to embodied, operational and end of life CO_2 emissions.

A Whole Life Carbon Assessment (WLCA) has been undertaken in accordance with the ‘RICS Whole Life Carbon Assessment for the Built Environment’ (First Edition, November 2017) which outlines the process of WLCA, and what is / what is not included. The aim of the RICS document is to provide clarity on the EN 15978: 2011 for the sustainability assessment of buildings and to provide clarity on the approach required within this methodology.

The aim of this assessment has been to model the whole life carbon impact of the proposed design, with the results used to inform the Circular Economy criteria of London Borough of Richmond upon Thames and GLA planning policy guidance.

Overall, the Proposed Development has shown considerable effort in reducing the overall embodied and operational CO_2 emissions associated with its construction, with initial calculations showing an embodied and operational carbon as follows:

Module	Sitewide	WLC Benchmark	Aspirational WLC benchmark
Modules A1-A5	664.19 $kgCO_2e/m^2$	<750 $kgCO_2e/m^2$	<500 $kgCO_2e/m^2$
Modules B-C (excluding B6 & B7)	341.99 $kgCO_2e/m^2$	<250 $kgCO_2e/m^2$	<175 $kgCO_2e/m^2$

Table 2: WLCA Emission Results compared to GLA benchmarks

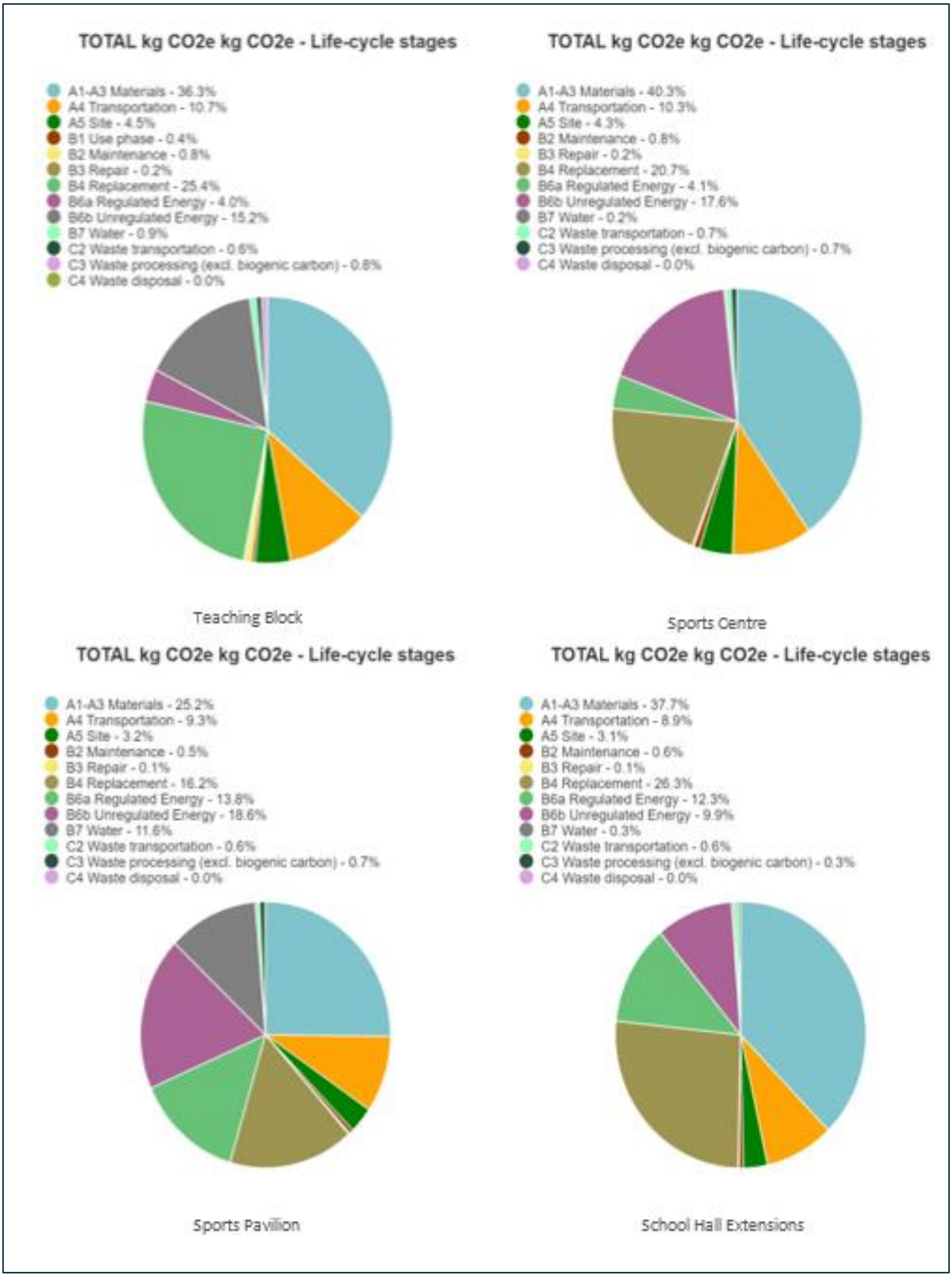


Figure 2: Outline WLCA Results and breakdown of Carbon Emissions by Lifecycle Stage

Please see the full supporting Whole Life Carbon Assessment for full details.

3.1 Operational energy

The Proposed Development has also been designed in accordance with the Energy Hierarchy to reduce operational energy demand:

Lean

Minimise the overall environmental impact and energy use through energy efficiency measures.

Clean

Ensure that energy systems on-site (heat & power) are efficient & produce minimal CO_2 emissions.

Green

Implement suitable technologies to provide renewable and emission free energy sources.

Seen

Incorporate monitoring through SMART metering and accessible displays.

The Proposed Development has been assessed using SBEM emissions factors in line with the GLA requirements. From this, the project's unregulated carbon emissions are expected to be 1,659,562 $kgCO_2$.

This is achieved through the implementation of enhanced building fabric, communal heating, and on-site renewable energy generation.

Please refer to the relevant section within the Energy Statement with regards to the overall strategy and reduction in energy use and CO_2 emissions.

4.0 The Circular Economy

The circular economy ethos is driving the move away from a 'Take – Make – Use – Discard' economy to a 'Re-make and Use Again' economy.

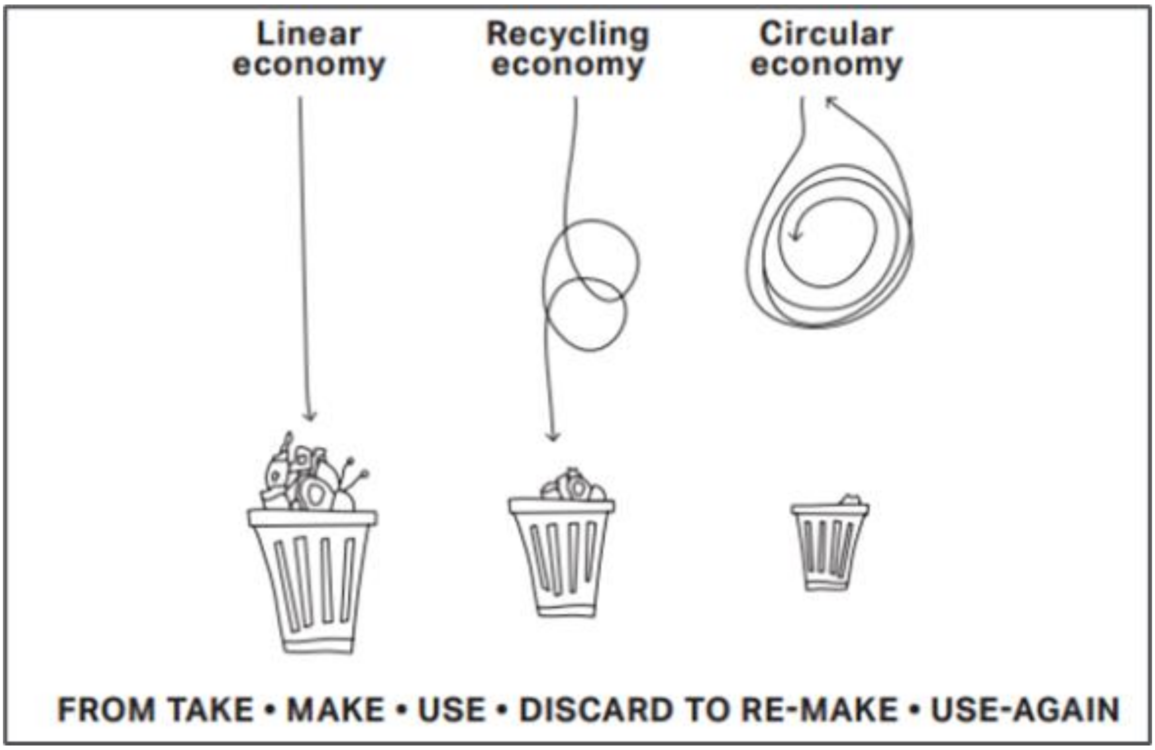


Figure 3: Linear, Recycling and Circular Economies Diagram (GLA 2022)

As part of circular economy considerations, developments should aim to:

- Design out waste – consider impacts of waste from both construction, operation, and end of life.
- Design for longevity – appropriate material specification for intended use.
- Design for adaptability and flexibility – meeting present and future needs within the building form and providing potential for the building form to be repurposed at a later stage.
- Design in layers – applying appropriate materials within the building layers which will allow them to be easily replaced when required, dependent on lifespan.
- Design for the future – individual products and services to be 'loose fit' to allow easy upgrade and replacement.
- Select appropriate materials – specifying low impact, recyclable and where possible, reused materials which have minimal impact on the environment and health and wellbeing.

For the construction industry, the impacts to the circular economy can be categorised into the following sections:

- Demolition and reclamation
- Design and construction impacts
- Site waste and its management
- Operational waste storage
- End of life disassembly and re-use

Impacts at each of these stages are required to be considered and mitigated as much as possible to ensure that the impact is minimised, and materials are fed back into the supply chain to be re-used.

4.1 Demolition and Reclamation

This element of the cycle is often the most difficult to control as existing materials on site may be unknown. The construction of 3 no. new constructed buildings will involve demolition as part of the site works.

This demolition work has been scheduled and reported accordingly.

Due to the age, construction, and size of the building on the site, the re-use of many of the building materials on the site is not likely to be possible. However, a deconstruction (rather than demolition) approach will be initially taken where this is possible, with an internal soft strip undertaken to identify materials present, and draw up a relevant plan to increase the rate of material recovery.

Materials such as metals, glass and timbers will be removed in the initial phases, and where these are not re-usable on site these will be recycled appropriately.

Where possible, materials within the current buildings primary structure will be ground down on site and re-used in situ as part of the initial landscaping and substructure preparations for the building foundations. Waste which is removed from site will be done so by a licenced contractor with a 100% recovery rate. Evidence of such a recovery rate is to be retained by the relevant contractor.

The site is constrained in terms of the space available for the storage of materials during construction works due to the maximisation in the use of the site by the Architectural Team. However, an area will be set aside for the salvaging of any materials that have the potential to be of use in the future. Although the materials salvageable from the site are anticipated to be minimal, this storage will be weatherproof and sealed to prevent degradation. Estimated waste arising from the demolition of the existing structures are outlined below.

4.2 Design and Construction Impacts Assessment

The design of the Proposed Development prior to the specification of sustainable materials and construction methods has adopted an ethos of a 'circular' design which embraces the key sustainability concepts of longevity, adaptability, and flexibility.

4.2.1 Longevity

A key element of circular economy is enhancing and extending the lifespan of a building. This is achieved through the appropriate specification of materials to secure a durable finish appropriate for its intended use. Materials which are not fit for purpose, or with inherent redundancy counter this approach and have been avoided within the design of the Proposed Development.

Material finishes both internally and externally have been chosen and evaluated to ensure a durability of finish appropriate for their intended use. Areas of high wear will be investigated further at detailed design to ensure that, where needed, adequate protection is factored into the construction – i.e. materials are within an area sufficiently robust for the area's use. Communal entrances, bin stores, corridors and communal spaces are all areas of high wear that will need a finishing strategy beyond that of a traditional residential setting. Therefore, a materials analysis will be undertaken to ensure materials are correctly specified based on the type of use expected and the damage to the material surfaces that may take place.

A durability strategy will be developed to guide materials choices where fit-out is to be undertaken as part of the overall site development.

Ensuring the durability of all materials will reduce the need for replacements and repairs and enhance the sustainability of the scheme as a whole through the promotion of resource efficiency.

Besides human factors, external materials will also suffer from environmental degradation. Material finishes on the external elevations have been chosen for their hardiness in addition to their architectural and construction qualities with facing brickwork being the preference for its robustness and the general aesthetic of this material due to its prevalence in the area and London generally. External brickwork is hardwearing with a long-expected lifespan, and resistant to fading due to sunlight or damage from pollution.

The primary structure of the Proposed Development will be reinforced concrete with foundations, floor slabs and columns all making best use of concretes inherent structural qualities. A long-lasting material, the reinforced concrete frame of the Proposed Development is likely to be one of the longest lasting elements of the overall build.

4.2.2 Adaptability

The ability of spaces to adapt to present and future needs is key to securing long-term tenure within a property, creating established communities in addition to preventing the need for people to move house when circumstances change – putting pressure on housing stocks, care systems and potentially in turn promoting further development which could be unsustainable in the area.

The use of a reinforced concrete framed construction is a key factor on ensuring that the internal space remains as flexible as possible in the future, allowing the primary structure to be repurposed in the future to meet changing local needs. While the party walls are concrete, these are kept to a minimum, with mostly stud walls between the classrooms. Furthermore, the internal partitions will generally be of steel frame construction and double-layered plasterboard, which will give some element of flexibility in the design and layout of the dwellings in the future. Additionally, the steel frames will allow the plasterboard to be removed without damage to be repurposed within another site or within different placements within this building and shell.

At the end of the building life, a framed partition will be more easily demountable and recyclable/re-usable allowing the elements to be separated (steel, plasterboard and, insulation) and disposed of appropriately.

4.2.3 Flexibility

The flexibility of a space allows differing applications to potentially use the current structure in the future.

Given the concrete foundations and substructure, there is limited flexibility within this dimension of the build. As such, these elements are likely to remain in future builds, however there is flexibility within each block to allow it to fit the needs of the occupiers. Additionally, the remodelling and reworking of the internal spaces is possible given this makeup as each floor can be repurposed.

Moreover, the need for this has been largely designed out with flexibility built into the design, as each block has adequate space for minor alterations to allow the space to fit the needs of the users. This provides flexibility of choice without additional major demolition or construction works for the occupier.

4.3 Sustainable Procurement

As part of the procurement process, the use of materials with a high recycled content and/or locally produced will be investigated. In addition, the use of the suppliers and manufacturers with a certified Environmental Management System will also form a key part of the procurement strategy.

The design specification and procurement of lower impact construction products will be enhanced through the use of Environmental Product Declarations (EPDs) on all key materials designed and procured as part of the Proposed Development. As an EPD is an independently verified environmental label in accordance with the requirements of ISO 14025, the reduced risk and environmental impact from poor supplier information will be avoided within the design and construction stages.

High recycled content is likely to be used for non-structural elements where the material content is less critical to the structural integrity of the project as a whole.

Internal finishing elements – where structural considerations are not applicable – will be sustainably sourced where this is not detrimental to the overall finish and quality of the products used.

In line with the Materials 03 and Management 03 pre-requisites for BREEAM UK New Construction 2018 and BREEAM UK Refurbishment and Fit-out 2014, all timber used on site (where this is not re-used following demolition of pre-existing structures) will be accompanied with appropriate chain of custody certification (FSC/PEFC) to ensure it is from a managed, sustainable supply.

Furthermore, as outlined above, >95% of all materials will be sourced from responsible suppliers with >95% materials used also being non-toxic to avoid localised pollution.

Re-used and recycled content within some materials has been specified in support of the reduction of embodied CO_2 emissions, with the materials specified outlined within the Whole Life Carbon Assessment.

Materials with a high content of recycled material will be prioritised within the procurement process to secure ongoing carbon savings, with a provisional target of a minimum 20% of the materials on the site being recycled from demolition.

4.3.1 Material Toxicity and Indoor Air Quality

The quality of the air inside a finished building is heavily impacted by the materials that are used in the construction process, especially the internal finishes, paints, and varnishes. After construction work has finished, and the building is in use, Volatile Organic Compounds (VOC's) escape from materials and can cause negative health impacts on all occupants, but specifically on those who are vulnerable to respiratory problems.

In recognition of this, and in line with best practice, all internal finishes will comply with the regulations outlined overleaf and, where this is not possible the next best alternative will be sought.

Continuous dwelling ventilation will be used in all units with heat recovery and will provide background ventilation to the units, removing any potential VOCs at first occupation and, where there is a requirement to do so, or where products are used which do not meet the requirements of Table 3 overleaf, internal air quality testing may well be used to confirm internal VOC levels at practical completion to ensure these are within safe and acceptable limits, in conjunction with an appropriate pre-occupation flush out procedure where necessary.

Example Product	Standard	Emission level required
Wood panels Particle and acoustic board Fibre board inc. MDF OSB Cement bonded particle board Plywood Solid wood panel	BS EN 13986:2002	Formaldehyde E11 Verify that regulated wood preservatives are absent and of minimum content.
Timber Structures Glue Laminated Timber	BS EN 14080:2005	Formaldehyde E11
Wood Flooring E.g. parquet flooring	BS EN 14342:2005	Formaldehyde E11: Verify that regulated wood preservatives are absent and of minimum content.
Floor Coverings and Resilient Layers: Vinyl/linoleum Cork and rubber Carpet Laminated wood flooring	BS EN 14041:2004	Formaldehyde E11: Verify that regulated wood preservatives are absent and of minimum content.
Suspended ceiling tiles	BS EN 13964:2004	Formaldehyde E11: No Asbestos
Flooring adhesives	BS EN 13999-1:2007	Verify that carcinogenic or sensitising volatile substances are absent. (2-4)
Wall Coverings Finished wall papers Wall vinyl's and plastics Wallpapers for decoration Heavy duty wall coverings Textile wall coverings	BS EN 233:1999 BS EN 234:1989 BS EN 259:2001 BS EN 266:1992	Formaldehyde (5) and vinyl chloride monomer (VCM) (5) release should be low and within the BS EN standard for the material. Verify that the migration of heavy metals (5) and other toxic substances are within the BS EN standard for the material
Adhesive for hanging wallcoverings	BS 3046:1981	No harmful substances and preservatives used should be of minimum toxicity
Decorative paints and varnishes	BS EN 13300:2001 Also: Decorative Paint Directive 2004/42/CE	VOC (organic solvent) content, requirement for Phase 2. Fungal and algal resistance
Testing requirements: BS EN 717-1:2004 (25) BS EN 13999-2:2007 – Volatile Organic Compounds (VOCs) (18) BS EN 13999-3:2007 – Volatile Aldehydes (18) BS EN 13999-4:2007 – Volatile diisocyanates (18) BS EN 12149:1997 (26) BS EN ISO 11890-2:2006 (27)		

Table 3: Product Standard Requirements to reduce VOC content

5.0 Building in Layers

The Proposed Development has been designed to be robust in its construction type to prolong building longevity, whilst being sensitive to the overall aims of reducing on site embodied carbon emissions in line with national and regional policy. The proposed design has adopted a 'Building in Layers' approach, maximising the durability of the Proposed Development whilst considering the whole life carbon impact of materials and processes.

To this end, it is anticipated that a minimum of 40% of the materials utilised within the Proposed Dwellings will be 'Circular by Design', allowing elements to be removed and reused elsewhere when needed.

Building in Layers is a common method of assessing the validity of certain material types and proposed lifespan of these materials. Assessments can then be made as to the appropriateness of the materials and finishes adopted, and any potential reclamation that may be possible at end of life.

Building in Layers puts all elements of a building into a timeline with various life expectancies, and therefore the likelihood of renewal or replacement can be gauged, and an appropriate strategy used to mitigate any potential predicted issues in relation to the products, materials and finishes used.

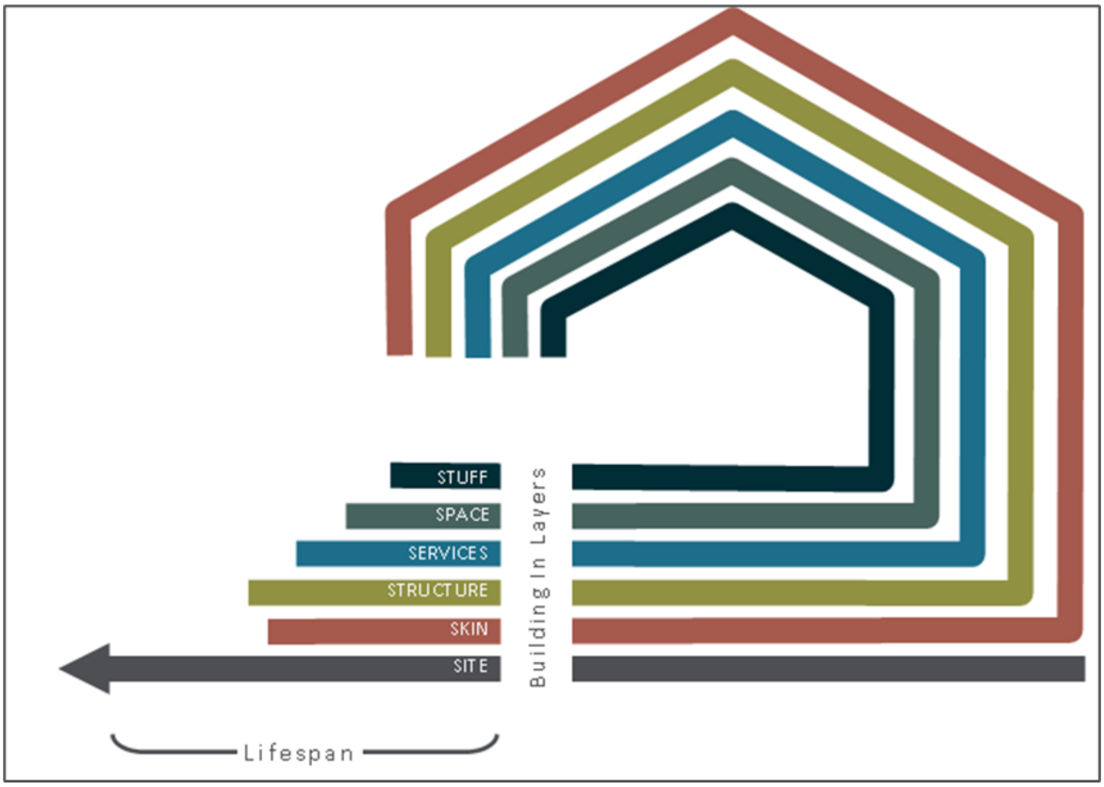


Figure 4: Building in Layers Diagram

STUFF: Including all furniture, desks, pictures, appliances, lamps, etc., which are typically supplied by the building user. Typical Lifespan: months/few years

Appliances are expected to be installed as part of the domestic kitchen fit-out, and within staffrooms and offices. These will be chosen with reliability, energy use, and environmental impact in mind. All appliances will be highly rated for energy efficiency and water use to ensure ongoing running costs are kept to a minimum. Based on the new Energy Efficiency Labelling scheme introduced in March 2021, and reflected in BREEAM New Construction 2018 and BREEAM UK Refurbishment and Fit-out 2014 Ene 08, a good performing appliance will meet the following ratings:

- Fridges/Freezers: E
- Washing Machines: B
- Dishwashers: D
- Washer-Dryers: D

Appliances will be carefully researched before specification and will take note of the available resources and reviews in relation to usability, reliability, and cost of running through the various online resources.

A kitchen is to be installed on the ground floor by the contractor and will be assembled with quality and longevity in mind, in addition to the cost implication of these considerations. All timber specified will be sustainably sourced with relevant Chain of Custody Certification from FSC or PEFC sources.

SPACE: The internal layout of the site is to be considered to provide adaptable and long-term learning space, with the potential for adaptability as use circumstances change. Typical Lifespan: 3-30 years

Being a framed construction, internal spaces are easily adaptable where needed in the future to accommodate changes in lifestyle, well-being, or occupant density.

A framed construction also allows each individual element to be removed as a whole (steel studwork, plasterboard, insulation etc) rather that the cutting, bashing and grinding associated with the fabric removal in more traditionally constructed dwellings.

SERVICES: Heating, Ventilation and Electrical installations. Typical Lifespan: 7-15 Years

Below is a summary of the ventilation, heating, and cooling measures to be installed within the different areas of the Proposed Development:

Teaching Building:

- A Ground Source Heat Pump (GSHP) system will be used for space heating, cooling, and domestic hot water (DHW).
- DHW - 1No. cylinder at 500L for the WC.
- DHW - 1No. cylinder at 1500L for the kitchen.
- 3No. MVHR units for ventilation.
- 1No. Air Hanging Unit (AHU) with Heat Recovery (HR) of a capacity of approximately 3300l/s will be used for ventilation, space heating and cooling within the Dining Hall and Kitchen.
- 1No. extract fan at 3400 l/s and 1No. supply fan at 3100 l/s will be used within the Kitchen.
- 8No. fan coil units (FCUs) will be used for cooling only.
- 2No. MVHR units (80l/s and 340 l/s) will serve the teaching block WC areas.

Sports Pavilion:

- A total of 5No. MVHR are to be installed, 4No. of which serve the changing rooms (140 L/s supply & extract capacity) and 1No. unit serving club room (400 L/s supply & extract capacity).
- No cooling.
- Building linked to a GSHP system. Space heating peak load = 106kW.
- DHW demand is to be fed from the GSHP system.

School Hall Extension:

- The existing building main auditorium will be ventilated via an Air Hanging Unit (AHU) at 5.0m3/s. This unit will have heating (45kW) and cooling (115kW) coils.
- The entire building (including the existing and new extension) will be connected to an Air Source Heat Pump (ASHP).
- Natural ventilation will be provided within the lobby area, with 1No. extract fan for the WCs at 100L/s.
- DHW is to be heated via 1No. 300L hot water cylinder with approximately 40kW heat capacity.
- The space heating load for the extension will be 16kW, constituted of approximately 8No. radiators at 2kW each.

Swimming Pool

- Hot water for the pool will be provided from a pool plant, with the energy demand estimated at 50kW/hour.
- 1No. AHU will provide heating at 5.7m^3/s.

Sports Hall

- The entire building will be connected to an ASHP for DWH. The capacity of the DWH cylinder will be 1890L, with a heat capacity of approximately 240kW.
- Ventilation, heating, and cooling in general spaces is provided via 1No. AHU at 3.3m^3/s.

- Ventilation for all building areas broken out into 3no separate AHUs, each serving designated areas of building.
- All space heating via AHUs or UFH, connected to ASHP system.
- Ventilation for the changing areas runs on its own dedicated AHU at 4.8m^3/s with heating only (using a 23kW coil).
- Space heating for changing areas will be provided through 20kW under floor heating (UFH).

The use of Mechanical Ventilation with Heat Recovery (MVHR) will provide air changes whilst maintaining internal temperatures and reducing heat losses.

High quality and durable service ducting will secure a sufficient lifespan for the system, with plant (internal and external) being appropriately located to allow easy and swift removal and replacement being a key consideration of Detailed Design.

The high density of the site makes site-wide heating feasible and given recent GLA guidance a shared ambient loop ground source heat pump (GSHP) will be used. GSHPs are recognised for their low cost and low carbon use for both heating and hot water.

There is a central energy centre on site. This centralised heating system allow for future technologies to be easily incorporated through the lifting in of new plant to the roof and/or plant room as and when this becomes available. This could include the use of future energy cells such as those powered by hydrogen, in support of future energy network growth. The centralised location of this plant results in the changeover causing as little disruption to residents as possible.

All plants installed will be designed to be removed in its entirety, without the need to dismantle prior to removal, allowing this to be removed and replaced easily in a modular manner. Access to these plant spaces will be appropriately sized to allow equipment to be removed and replaced, with the size of door openings and corner access for these items also properly considered at Detailed Design Stage.

Energy demand is shown in the table below which shows that hot water makes up the greatest contribution to the overall energy use of the scheme with the swimming pool within the Sports Hall culpable for the relative increase in hot water consumption in comparison to the other buildings. The energy requirement related to space heating and hot water has been minimised through the proposed use of efficient Ground Source Heat Pumps (GSHPs) and Air Source Heat Pumps (ASHPs). Energy generation from PV has also been considered to offset part of the regulated energy demand of the scheme. The hot water required for the swimming pool is responsible for vast amounts of operational energy and water usage.

Module	School Hall Extension (kWh/yr)	Sports Pavilion (kWh/yr)	Sports Hall (kWh/yr)	Teaching Block (kWh/yr)
Heating	1,455.45	3,011.64	17,393.01	38,957.22
Cooling	0	0	830.79	1,137.08
Auxiliary	235.60	2,620.68	29,050.87	28,772.97
Lighting	719.20	3,039.13	33,312.03	16,561.76
Hot Water	1,715.85	781.93	49,231.05	16,462.89
PV Offset (Regulated Only)	0	0	-112,210.34	-72,624.57
Total Regulated Energy	4,126.10	9,453.38	17,607.41	29,267.35
Total Unregulated (Equipment) Energy	3,330.95	12,730.74	76,030.75	111,285.16

Table 4: Operational energy by end of use within the Proposed Development

STRUCTURE: Structural Elements. Typical Lifespan: 30-300 years

A framed structure has been chosen for both the ease of assembly, and to enhance the ability of the Proposed Development to be dismantled or repurposed. Appropriate structural elements can be recycled and reused as part of this process. For instance, internal studwork and frame can be removed and recovered due to steel being a widely recyclable material during the disposal process.

Reinforced concrete has been proposed for all foundations as a result of its longevity and structural purposes. This will provide a durable and long-lasting building structure which will last beyond its initial use as an educational facility, and will have the potential to support a multitude of future uses if/when the need arises.

SKIN: Cladding, Renders, and Brickwork. Typical Lifespan: 30-300 years

External finishes often have the biggest impact on the overall durability of a development. They are exposed to the weather, are subjected to less routine maintenance and activities surrounding these elements and are generally less managed when compared to internal surfaces. The wrong specification of materials can result in reduced lifespan, increased maintenance, and a poor appearance to the exterior of the building, resulting in lower asset prices and less desirable properties.

The red brickwork and insulated metal panel facade has been chosen for longevity purposes, albeit it is recognised that the recovery of this element can be troublesome due to the separation of the mortar from the brickwork at end-of-life stage. However, due to the nature of the material, it is anticipated that this will not be required until the building reaches its end of life. Mineral wool insulation, phenolic and plasterboard provide an efficient insulation system. This build up withstands minimal degradation over time.

SITE: Location, boundaries, surrounding context, Typical Lifespan: Infinite

The site location is the one element of the Proposed Development that will last forever. Long after the current buildings have been decommissioned and replaced, the site will remain only to be redeveloped again to form something which will meet future generation's needs.

The site location has been deemed appropriate for the intended mixed uses as this is in keeping with the surrounding context of existing recent development in the area.

Being located within Twickenham, which is a heavily developed area, the proposals fit the aesthetic and current use classes of the surrounding area, and as such will 'blend' with other recent developments.

Being an urban site there is little in the way of ecology to preserve or enhance, and the Proposed Building is being built on entirely brownfield land. There is, however, a large area of playing field space (the Sports Pavilion) within the existing site layout that will be thoroughly investigated to ensure there are no species of interest prior to site clearance. No loss of ecological value is to be targeted, with any landscaping opportunities within the Proposed Development to be maximised through the provision of supplementary planting on the site and the minimisation of tree cutting. Areas will be planted with local, native species to enhance biodiversity provision where this is possible and practical.

Materials on the site will be non-toxic, and generally there is no material used on the site that would prevent the site's future use or redevelopment.

5.1 Site Waste and Its Management

Site waste will be managed on site through a Construction Management Plan which will emphasise the need to minimise waste leaving site and the reuse of materials on the site in line with the waste hierarchy, depicted below. Waste from the site will be managed via a certified waste contractor and will be monitored through best practice site management procedures.

All waste on site will be managed in accordance with the waste hierarchy, with 0% of biodegradable and/or recyclable material being sent to landfill.

Where waste must be removed from site and this is not re-usable, this will be managed through a licenced waste contractor with the following benchmarks for diversion from landfill being targeted as an absolute minimum in line with Best Practice.

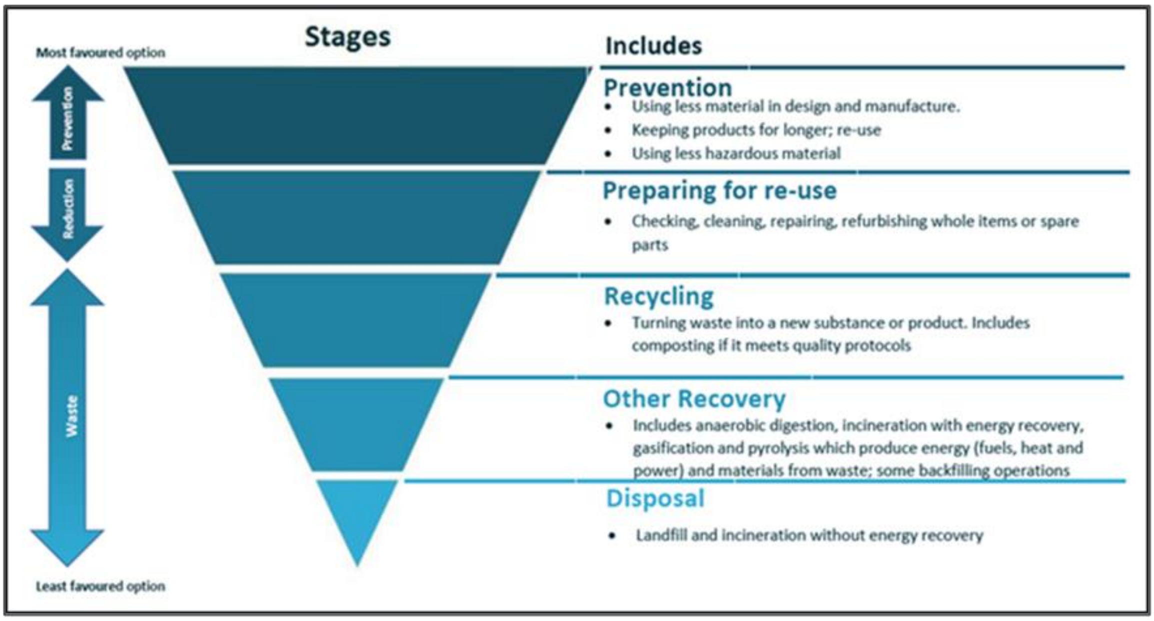


Figure 5 - The Waste Hierarchy

Type of Waste	Volume	Tonnage
Non-Demolition	70%	80%
Demolition	80%	90%
Excavation	N/A	N/A

Table 5: Diversion from Landfill Benchmarks (for 1 credit)

In line with the Waste 01 requirements of BREEAM UK New Construction 2018 (for 1 credit), the quantity of waste diverted from landfill will be in accordance with Table 5, above, as a minimum, with the overall aim that the development will be net zero waste, with all waste either being re-used on site or recycled via a licenced waste contractor. Regular reports (minimum monthly) will be provided by the waste contractor and stored as part of ongoing site monitoring and management. Where deviations from the zero-waste strategy become evident, actions will be organised to ensure that the zero-waste strategy is adhered to.

The predicted waste generated as part of the construction process is targeted at ≤ 6.5 tonnes/100m^2, a figure that is once again in line with the BREEAM New Construction 2018 Wst 01 requirements and best practice. Whilst precise waste figures are to be determined and will be reported in the site waste management plan, an indicative breakdown is given overleaf.

To facilitate the re-use of materials on the site, appropriate areas will be allocated within the Construction Works Plan, and detailed in the associated method statement, for the storage of re-usable materials from the construction phases. The aim of this materials storage will be that this material can be used elsewhere on the site and reduce the waste removed from site.

Excavation is to be undertaken on the site due to the digging out of a swimming pool and installation of a Ground Source Heat Pump (GSHP). Any 'muck away' resulting from this will be relocated on site (potentially to support the soft landscaping scheme) to reduce the transportation of waste and associated emissions where this is possible. However, due to the nature of the site and overall scheme design, the opportunities for reuse on site are minimal and this waste will need to be removed from site and recycled by a licenced contractor.

Final waste predictions and appropriate targets will be outlined by the Contractor within the Construction Management Plan.

Category	Total estimate	Of which...				
	Total tonnage	t/m2 Gross Internal Areas (GIA)	% reused or recycled onsite	% reused or recycled offsite	% not reused or recycled max 5%	
					% to landfill	% to other management (e.g. incineration)
Excavation waste	A pre-demolition audit will be completed to quantify volume of materials and waste				< 5 % Confirmed in pre-demolition audit	
Demolition waste	Predicted waste steams estimate a 95% diversion from landfill target is to be achieved.				< 5 % Confirmed in pre-demolition audit	
Construction waste	Final construction waste figures and streams to be published after completion				< 5 % Confirmed in RMP	
		t/annum	% reused on or off site	% recycled or composted, on or off site	% not reused or recycled	
					% to landfill	% to other management (e.g. incineration)
Municipal waste	Confirmed in RMP		0	65	Max. 35% and no recyclable or compostable waste (assumed at this stage)	
Industrial waste (if applicable)	n/a	n/a	n/a	n/a	Max. 35% and no recyclable or compostable waste	
					n/a	n/a

Table 6 - Recycling and Waste Reporting Form

European Waste Catalogue	Key Group	Quantity Generated (t/100m²)	Disposal (%)	Downcycling and Use as Energy (%)	Recycling and Reuse as Material (%)	Materials Returned (%)
170101	Concrete	167.74	0	100	0	50
170407	Metals	9.03	0	0	100	100
170102	Bricks & Ceramics	4.52	0	100	0	50
170802	Gypsum-Based	3.23	17	14	69	76
170604	Insulation	1.29	87	13	0	6
191205	Glass	1.29	0	0	100	100
170201	Wood & Biogenic	1.29	0	100	0	50
170504	Earth Masses & Asphalt	9.68	0	0	100	100
-	Other Materials	2.58	0	1	95	95

Table 7 - Attributed waste from Construction and Demolition (School Hall Extensions)

European Waste Catalogue	Key Group	Quantity Generated (t/100m²)	Disposal (%)	Downcycling and Use as Energy (%)	Recycling and Reuse as Material (%)	Materials Returned (%)
170101	Concrete	161.97	0	100	0	50
170407	Metals	8.85	0	0	100	100
170102	Bricks & Ceramics	4.26	0	100	0	50
170802	Gypsum-Based	15.43	0	78	22	61
170604	Insulation	1.31	59	41	0	20
191205	Glass	0.98	0	0	100	100
170201	Wood & Biogenic	0.98	0	100	0	50
170504	Earth Masses & Asphalt	9.51	0	0	100	100
-	Other Materials	6.89	75	5	20	23

Table 8 - Attributed waste from Construction and Demolition (Sports Pavilion)

European Waste Catalogue	Key Group	Quantity Generated (t/100m²)	Disposal (%)	Downcycling and Use as Energy (%)	Recycling and Reuse as Material (%)	Materials Returned (%)
170101	Concrete	119.37	0	100	0	50
170407	Metals	10.34	2	0	98	98
170102	Bricks & Ceramics	5.56	0	100	0	50
170802	Gypsum-Based	8.06	5	61	34	64
170604	Insulation	0.97	83	17	0	9
191205	Glass	0.52	0	0	100	100
170201	Wood & Biogenic	2.35	0	100	0	50
170504	Earth Masses & Asphalt	9.37	0	0	100	100
-	Other Materials	1.68	12	24	64	76

Table 9 - Attributed waste from Construction and Demolition (Sports Hall)

European Waste Catalogue	Key Group	Quantity Generated (t/100m²)	Disposal (%)	Downcycling and Use as Energy (%)	Recycling and Reuse as Material (%)	Materials Returned (%)
170101	Concrete	100.08	0	100	0	50
170407	Metals	7.02	0	0	100	100
170102	Bricks & Ceramics	7.44	0	100	0	50
170802	Gypsum-Based	18.06	7	75	18	56
170604	Insulation	0.79	79	21	0	10
191205	Glass	0.42	0	0	100	100
170201	Wood & Biogenic	0	0	0	0	0
170504	Earth Masses & Asphalt	9.36	0	0	100	100
-	Other Materials	1.68	6	47	43	56

Table 10 - Attributed waste from Construction and Demolition (Teaching Block)

5.2 Site Resource Use

5.2.1 Energy Use from Site Activities

An Energy Champion will be selected from the beginning of site works who will be responsible for the monitoring, cataloguing, and reviewing of site wide energy use.

Targets for energy use throughout the construction program will be set based on previous experience, with the actual usage tracked and reported weekly. This will then be fed back to the Site Manager who will work with the Energy Champion to reduce energy use to the lowest possible rate.

Energy Efficiency will be a significant part of the Site Induction Process with each member of the site team accountable for the enforcement of energy efficient measures, with a reporting structure in place for non-compliance.

Where possible, technology will be utilised throughout the site to reduce energy consumption such as:

- PIR lighting controls
- Thermally efficient door shutters and self-closing doors to cabins
- Timed and/or temperature-controlled heaters within welfare facilities.

Where it is possible to do so, the use of renewable energy on the site will be investigated – such as the use of solar PV – with supporting battery storage where appropriate to store energy, and power lighting and base level systems.

5.2.2 Water Use from Site Activities

As with energy use above, an appropriate person will be selected to be Water Champion to champion the water saving efforts on the site and record and monitor water use throughout the duration of the project.

Targets will be set for water use based on best practice and previous experience, with records kept at a minimum of weekly intervals to inform ongoing saving measures. Key information on the saving of water resources will be provided as part of the induction to site for all operatives.

Reporting systems will be in place for the wasting of water, and each member of the site team made accountable for the enforcement of water efficiency measures.

Water use for welfare will be reduced through the use of no water, or low water use urinals, and low flow fittings where this is appropriate. PIR and solenoid valves will also be installed where this is considered to be appropriate and effective in reducing water consumption.

5.2.3 Waste from Site Operations

The use of single use plastics will be avoided through the provision of the following welfare facilities to encourage a more sustainable and low waste operations on site:

- Chilled, fresh water made available to all, with re-usable cups or bottles – to avoid the use of single use plastic bottles.
- Refrigeration – appropriate facilities available for the storage of food and other items which would otherwise be bought – reducing the associated packaging.
- Kettle & mugs to be provided to prepare tea and coffee – reducing the need for take-aways in disposable cups.
- Appropriate wash-up facilities to wash and re-use the mugs and cups provided.

The potential for the incorporation of the above will be dependent on the precise site welfare facilities available at each construction stage, but as much as practicable will be incorporated where possible.

The precise details of the facilities to be provided will be outlined in the Contractors Construction Works Plan.

5.3 Operational Waste Storage

The ability of the occupier and/or building users to appropriately sort and store waste as part of the general operation of both residential and commercial properties is strongly influenced by the location and ease of access of the internal and external waste stores provided.

Therefore, the appropriate storage of refuse and recycling - both internal and external - will be incorporated into the overall design and layout of the scheme to facilitate a recycling rate of 65% or greater, in line with GLA requirements.

In accordance with the Richmond upon Thames Waste Management Design Guidelines[4], Richmond upon Thames Borough Council currently provide 3 weekly commercial waste collection rounds through Monday to Friday, and 1 collection round on Saturday and Sunday. Recycling is encouraged Borough wide and there are

[4] https://www.richmond.ca/__shared/assets/Waste_Management_Design_Guidelines48945.pdf

efforts to provide easy access bins and frequency of collection is continually reviewed to ensure that it is adequate. The commercial recycling service is currently available 5 days a week from Monday to Friday.[5]

5.3.1 Volume of Operational Waste Generated

The Richmond upon Thames Waste Management Design Guidelines state that all bins in communal areas must be stored in a separate internal storage room and adhere to the following guidelines:

Recycling bins:

- Mixed containers recycling – 1 cart (360 litres) for every 7 units.
- Mixed paper recycling – 1 cart (360 litres) for every 7 units.
- Glass recycling – 1 cart (240 litres) per recycling room.
- Green cart (food scraps and yard trimmings) – 1 cart (240 litres) for every 25 units, 1 kitchen container for each unit.

General rubbish bins:

- Garbage cart (non-recyclable and non-compostable materials) – 1 cart (360 litres).
- These must be standard wheeled bins with two wheels and should conform to BS EN 840:1997.

5.3.2 Operational Waste

The developer needs to recognise that waste will be generated by the site's future tenants and will take measures to ensure that this takes places as responsibly as possible. The waste hierarchy will be promoted and explained to all tenants to ensure that waste generation is minimised. Once all avenues for prevention have been examined, opportunities to maximise for re-use, recycling and recovery will be targeted. To ensure this is possible the site will provide adequate, flexible, and easily accessible space for segregating and storing waste for collection, recycling, and reuse in line with the London Plan. This will ensure that waste can be sorted and stored suitably between collections, which are detailed elsewhere within the report and will be explained to the future tenants. In addition to this storage there will be a dedicated area for food waste with bins provided in tenanted areas and kitchens. There will also be a larger communal storage point in the main refuge storeroom, to allow for storage between collection times.

Figures of expected operational waste generation will be continually managed and reported to ensure that waste storage is of an adequate size to support the needs of the building occupants and maximise potential recycling levels. Mid-week checks will be conducted to see waste levels within each of the bins and consider where additional provisions are required.

While operation waste generation is dependent on tenants, the approached taken by the developer will maximise the opportunities for tenants to make suitable and responsible choices in order to lower their waste generation while maximising the percentage of waste which is recycled.

5.3.3 Internal and External Storage for Waste

Based on the site plan, the Proposed Development at Kneller Hall, Twickenham, is estimated to constitute a total gross floor area of 13,756.58m^2. Issue Waste 03 within BREEAM UK New Construction 2018 and UK Refurbishment and Fit-out 2014 sets guidelines for the storage of operational waste. Given this, the following minimum standards for external waste storage space will be met by the Proposed Development:

1. Dedicated space(s) is provided for the segregation and storage of operational recyclable waste volumes generated by the assessed building/unit, its occupant(s), and activities. This space must be:
    - Clearly labelled, to assist with segregation, storage, and collection of the recyclable waste streams

[5] https://www.richmond.gov.uk/services/waste_and_recycling/commercial_waste_and_recycling/about_commercial_waste_service

  - Accessible to building occupants or facilities operators for the deposit of materials and collections by waste management contractors
  - Of a capacity appropriate to the building type, size, number of units (if relevant) and predicted volumes of waste that will arise from daily/weekly operational activities and occupancy rates.
2. Where the consistent generation in volume of the appropriate operational waste streams is likely to exist, e.g. large amounts of packaging or compostable waste generated by the building's use and operation, the following facilities are provided:
  - Static waste compactor(s) or baler(s); situated in a service area or dedicated waste management space.
  - Vessel(s) for composting suitable organic waste resulting from the building's daily operation and use; OR adequate space(s) for storing segregated food waste and compostable organic material prior to collection and delivery to an alternative composting facility.
  - Where organic waste is to be stored/composted on-site, a water outlet is provided adjacent to or within the facility for cleaning and hygiene purposes.

Accessible space: Accessible space is typically within 20m of a building entrance. Depending on the size of the building, site restrictions or tenancy arrangements, it may not be possible for the facilities to be within 20m of a building entrance. In such circumstances, judgement on whether the space is 'accessible' to the building occupants and vehicle collection must be made.

Compliant dedicated storage space:

- At least $2m^2$ per $1000m^2$ of net floor area for buildings < $5000m^2$
- A minimum of $10m^2$ for buildings ≥ $5000m^2$
- An additional $2m^2$ per $1000m^2$ of net floor area where catering is provided (with an additional minimum of $10m^2$ for buildings ≥ $5000m^2$).
- The net floor area should be rounded up to the nearest $1000m^2$.

As the development constitutes a total gross floor area of $13{,}756.58m^2$ which is greater than $5000m^2$, a minimum of $10m^2$ dedicated storage space for recycling and $10m^2$ storage space for general waste must be provided. This must be accessible from all buildings.

Additionally, catering areas are included within the development. These constitute of the following spaces and floor areas:

- Dining hall: $461.18m^2$
- Dishwash area: $25.9m^2$
- Servery area: $79.72m^2$
- Kitchen: $105.79m^2$
- Freezer: $12.33m^2$
- Cold store: $16.18m^2$
- Dry store: $15.30m^2$

Therefore, catering areas cover a total floor area of $716.4m^2$. Rounded up to the nearest thousand this equates to $1000m^2$, meaning an additional $2m^2$ of waste storage space must be provided for catering areas – $22m^2$ waste storage space in total.

Furthermore, The London Borough of Richmond Upon Thames Local Plan Refuse and Recycling Storage requirements[6] states that, for commercial and mixed-use developments, 2.6 cubic metres of waste storage should be provided for every $1{,}000m^2$ gross floor space. As educational buildings are defined as 'light commercial', these guidelines apply to the Proposed Development. Therefore, as the gross floor space of the Kneller Hall development is $13{,}756.58m^2$, 35.77 cubic metres of storage should be provided on site. This meets the BREEAM requirements for operational waste storage mentioned above. A waste storage area of $60m^2$ is

[6] https://www.richmond.gov.uk/media/7627/refuse_and_recycling_storage_requirements_spd.pdf

currently proposed, meaning the development will fulfil these conditions. Additionally, in compliance with the Richmond Local Plan, 50% of this capacity will be retained for the storage of separated waste for recycling.

In addition, the area must be large enough to store all recycling and garbage between designated collection days and permit movement of the containers. Designated areas must also meet fire safety requirements. To comply with the Richmond upon Thames Waste Management Design Guidelines, the storage facility should include the following considerations as a minimum standard:

Element	Design Guidelines
Floor	Must have a hard surface (concrete is required if installing a compactor) that is able to withstand a 28-tonne collection truck.
Drainage	Must drain to sanitary sewer.
Door	Must contain a double door to ensure there is enough space to move the containers.
Size	Should be able to accommodate an appropriate number of containers that will not overflow between collection days. Total area of the facility should be about 2.0 to 2.25 times the physical footprint of the containers to allow for adequate space for manoeuvring.
Configuration	Configure to allow each garbage and recycling container to be individually accessed, removed and replaced without having to take out other containers. No horizontal dimension (width or depth) is less than 2 metres to allow for access to waste containers.
Location	Ideally, recycling facilities are located in close proximity to garbage facilities so that occupants find it as convenient to recycle as it is to dispose of garbage. Within the storage area, recycling and garbage containers should be grouped separately to reduce confusion. The location must be: • Within the legal parcel. • Located at ground level, or no more than one storey below grade. Location of storage facility should not be: On publicly owned rights-of-way where it may disrupt traffic circulation patterns. Between a street-facing facade of the structure and the street if the area is located outdoors to promote pedestrian safety. • In any required driveways, parking aisles, or parking spaces for the structure (this impedes the use for pedestrians and occupants). • In any location that may block or impede fire exits, public rights-of-ways, or pedestrian and vehicular access.
Ventilation	Have adequate ventilation for reduced smell and odour, and be in compliance with the BC Building Code requirements for ventilation.
Security	Be protected from unlawful entry. Be equipped with locked doors or the containers should also be locked if they are accessible from outside the building to avoid illegal dumping.
Lighting	Be well lit, both as a security measure and for ease of access. Adequate lighting also discourages improper use of the containers and surrounding area.
Rodent Concerns	Be rodent resistant, and ensure that waste is stored in a way to not provide shelter, refuge or food for rodents.

Access for Occupants	Accessible to all occupants of the development, including those with restricted mobility.
Signage	Must have clear signage in garbage and recycling facilities and on containers to ensure that materials go in the appropriate container to help prevent contamination.

Table 11 – The Richmond upon Thames Waste Management Design Guidelines for operational waste storage.

In line with The London Borough of Richard upon Thames guidelines and the BREEAM requirements stated above, waste bins will be accompanied with appropriate signage to ensure correct waste is placed in the correct bins to maximise recycling. These signs can be requested from the council.

Additionally, dry recycling, rubbish and food waste are required to be separated to comply with the requirements of the London Borough of Richmond upon Thames. The location of this is left to the tenant to ensure that it will be within the optimal position to meet their needs and maximise reliable waste storage.

5.3.4 Occupant Information

The provision of information on the ability of occupants to recycle items is shown to strongly increase recycling uptake. Therefore, information on the waste bins provided, what can be placed in each bin, where larger items can be taken and when, will be provided to building users to inform their waste decisions during the operational phase of the development. Signage can be requested from the council, and these will be provided in communal areas and as introductory information for occupiers.

In addition, consumables within the buildings – furniture, decorations etc. – are not within the control of the contractor. These items, in accordance with the Building in Layers methodology, have the shortest lifespan and have a significant impact on the quantity and type of waste generated by the Proposed Development during operation. Therefore, further information on the impact of waste disposal, with a focus on the use of natural, biodegradable products will be provided to building occupiers, in addition to information about reusing, repurposing, and upcycling to minimise the quantity of consumables being sent to landfill.

5.4 Maintenance, Replacement and Repair

Throughout a building lifespan, elements of the building will need to be replaced and/or repaired as part of general maintenance as elements are damaged or reach the end of their natural lifespan.

In accordance with the Whole Life Carbon Assessment undertaken for the site, it is estimated that the maintenance repair and replacement of building elements (calculated under the B2, B3 and B4 RICS lifecycle stages) accounts for 2,503,397 $kgCO_2e$ which equates to 24.28% of the total CO_2 emissions of the site based on a 60-year lifespan.

Carbon which is expended here results in savings from other areas and repair, replacement and maintenance allows the life of items to be extended. Maintenance is included as the other CO_2 emissions associated with such repair work, including products such as cleaning supplies and labour and travel emissions.

5.5 End of life disassembly and re-use

The end-of-life opportunities for material recovery have been investigated as part of the design process with the requirement for disposal, recycling or repurposing considered as part of product and material selection.

The implementation of a materials inventory will be investigated by the Design Team to itemise all materials and/or products to be used, and the potential for these materials to be re-used, repurposed, recycled or otherwise disposed.

Internal fixtures, fittings and equipment are those with the shortest lifespan, and therefore the replacement of these should be considered as a high priority, and materials which are biodegradable or highly recyclable taking precedent over alternatives to minimise the impact of the more consumable items within the Proposed Development.

The consideration of the materials used on the site have been selected on multiple basis including the potential for re-use at the end of the building's useful life. Where sustainable options are not possible or available, high quality and durable materials are selected to ensure a long and maintenance free lifespan of the building, with appropriate elements being easily replaced or repaired where needed.

The predominant construction materials on the site are concrete and brickwork – all of which are potentially re-usable when the building reaches the end of its life. At present, it is estimated that ~60% of the materials used on site will be reusable, but the primary focus has been on providing a robust, durable, and long-lasting building structure.

Brickwork is to be unrendered, therefore minimising the effort required to clean up the product at end of life.

Concrete foundations are the least re-usable element of the scheme. Piled foundations can reach up to 20m into the ground and will not be easily extractable or recoverable. However, these could well form the foundation for any other structure on the site if there is desire for a refurbishment or other use at the end of the life of this building. Concrete is inert and non-toxic in nature, and therefore the presence of these in the ground causes little-to-no lasting impacts.

Internal partitions are to be of steel stud work, which will be easily demountable and allow the plasterboard to be removed in one piece, increasing the chances of re-use considerably when compared to timber studwork. Steel is readily recyclable.

The predominant construction materials proposed within the design on the site – brick, concrete, and steel – are inherently reusable at the end of the building life through their re-use as hardcore, with the main elements not re-usable being the surface finishes (plasterboard, vinyl flooring, carpeting etc). As such, the reuse of materials following the proposed building end of life has been considered. It is anticipated that the Proposed Development will meet the following targets for diversion from landfill (in line with the BREEAM New Construction 2018 Wst 01 requirements): demolition 80% by volume (90% by tonnage) and non-demolition 70% by volume (80% by tonnage), with all waste sorted into the key EU waste groups.

Outlined below are the major, predominant materials included within the Proposed Development based on the currently assumed build outs for all elements, with predicted re-use and recycling values.

Element	Material	Calculated volume (m^3)	Product density	Predicted quantity (kg)	Gross intensity (kg/m^2GIA)	Recycled Content (% by value)	Re-Used Content, by volume, Ambition (as per GLA Guidance)
Structure	Concrete Piles	42.16	303kg/m	1,277,448	158.48	20%	20
	Timber Beams and Columns	31.06	485.7kg/m3	15,085.84	1.87	0%	20
	Concrete blockwork	682.01	865kg/m3	589,938.65	3.19	20%	20
	Steel Beams and Columns	-	7850kg/m3	158,743.11	19.69	20%	20
Shell	Bricks	119.37	1,485kg/m3	177,264.45	21.99	0%	20
	Glazing	15.39	2.5kg/m2	2,564.85	0.32	20%	20
Space	Plasterboard	311.57	0.11kg/m3	34.99	0.00434	0%	20

	Steel stud work	-	7850kg/m3	9,481.65	1.18	20%	20

Table 12: Sitewide Bill of Major construction Materials and End of Life Strategy

The physical constraints of the site and the high density of the building (floor area to footprint ratio) mean that the volume of materials used within the Proposed Development will exceed the volume of materials that are able to be re-used on site. Therefore, the majority of materials will need to be recycled off site by a licenced contractor at the time of dismantling/demolition.

However, the materials selected are easily recyclable through crushing and use as recycled content for future building materials. This is the case of all concrete and steel reinforced panels on the site. Brickwork could either be reused on other sites or crushed and used as recycled content.

Steel used for the reinforcement of both the floors and structural columns can be extracted during demolition, with this then being easily recycled off site into new steel products.

Insulation will most likely be segregated and diverted from landfill through re-use elsewhere or through energy recovery.

Implementation & Conclusion

6.0 Strategy for implementation

6.1.1 Existing Site

A pre-demolition waste audit will be undertaken to identify opportunities for reuse, recycling or recovery, disposal and opportunities for reuse within the development works. Current opportunities highlighted within this statement include:

- Reuse of site materials, hoardings, boarding and cabins from previous sites.
- Soft strip of existing building to remove items of potential value and to aid recycling.
- Excavated materials (minimal) to be reused elsewhere on site (as part of planting plant for example).
- Crushing of building materials with as much as possible used within the proposed development where this is practicable.

6.1.2 New Development

The proposed new developments on site will follow best practice in terms of building design, construction methods and operational energy (and therefore CO_2 emissions) requirements. Designed with Building in Layers methodology in mind, the proposed building design will be refined throughout the building process to enhance the efficiency of the design.

The application of the Building in Layers strategy and circular economy principles will continue to be embedded within the future design process and will assist in the refinement of the overall site design and its efficiency. The circular economy ambitions outlined within this statement will be embedded within the future brief for detailed design and construction.

The engagement of key stake holders will continue to be required throughout the design process, and the materials procurement, and waste management. Consultation and engagement with Circular Economy principles will be sought from the following team members:

- Main Contractor and supporting team (estimators etc)
- Architect
- Structural Engineer
- Waste Consultant
- M&E Consultant

Please note that the above list is non-exhaustive and input from other members of the team may be required at key times

6.1.3 Operational Waste

Operational waste storage for the Proposed Development has been based on the guidance provided by the London Borough of Richmond Upon Thames, as well as the BREEAM UK New Construction 2018 and BREEAM UK Refurbishment and Fit-out 2014 requirements. This guidance was seen as the most relevant advice for the site given the proposed use and occupancy.

Internal bins – which allow for the segregation of general waste and dry recyclable waste – will be provided within the buildings to actively facilitate recycling throughout the site. This will be accompanied with appropriate signage and information provided to building users.

Communal stores will be built in line with council guidelines to provide sufficient waste storage for building users. Additionally, they will be monitored regularly to check waste levels and ensure that sufficient storage is provided for both general and recyclable waste streams. Where the storage is evidently insufficient (e.g., there is an overspill of waste onto the floor surrounding containers), investigations will be undertaken to determine the level of recycling within the building, and how this can be increased to reduce general waste output.

Further information may be required to be issued to the building users to further enhance waste reduction and recycling rates, the contents of which will be discussed within the Management Team when needed.

This waste will be continually monitored by building managers against advice from Richmond upon Thames London Borough Council to ensure waste provision is adequate.

6.1.4 Post Completion Report

In line with the requirements of the GLA, a post-completion report will be provided to show progress against all numerical targets outlined within this report with updated waste information and Bill of Materials.

7.0 Conclusion

This Circular Economy Statement demonstrates the sustainability measures incorporated into the design of the proposed mixed-use development at Kneller Hall, Twickenham, within the London Borough of Richmond upon Thames. It provides an outline of the adoption of Circular Economy principles throughout the design, construction, and operation of the Proposed Development.

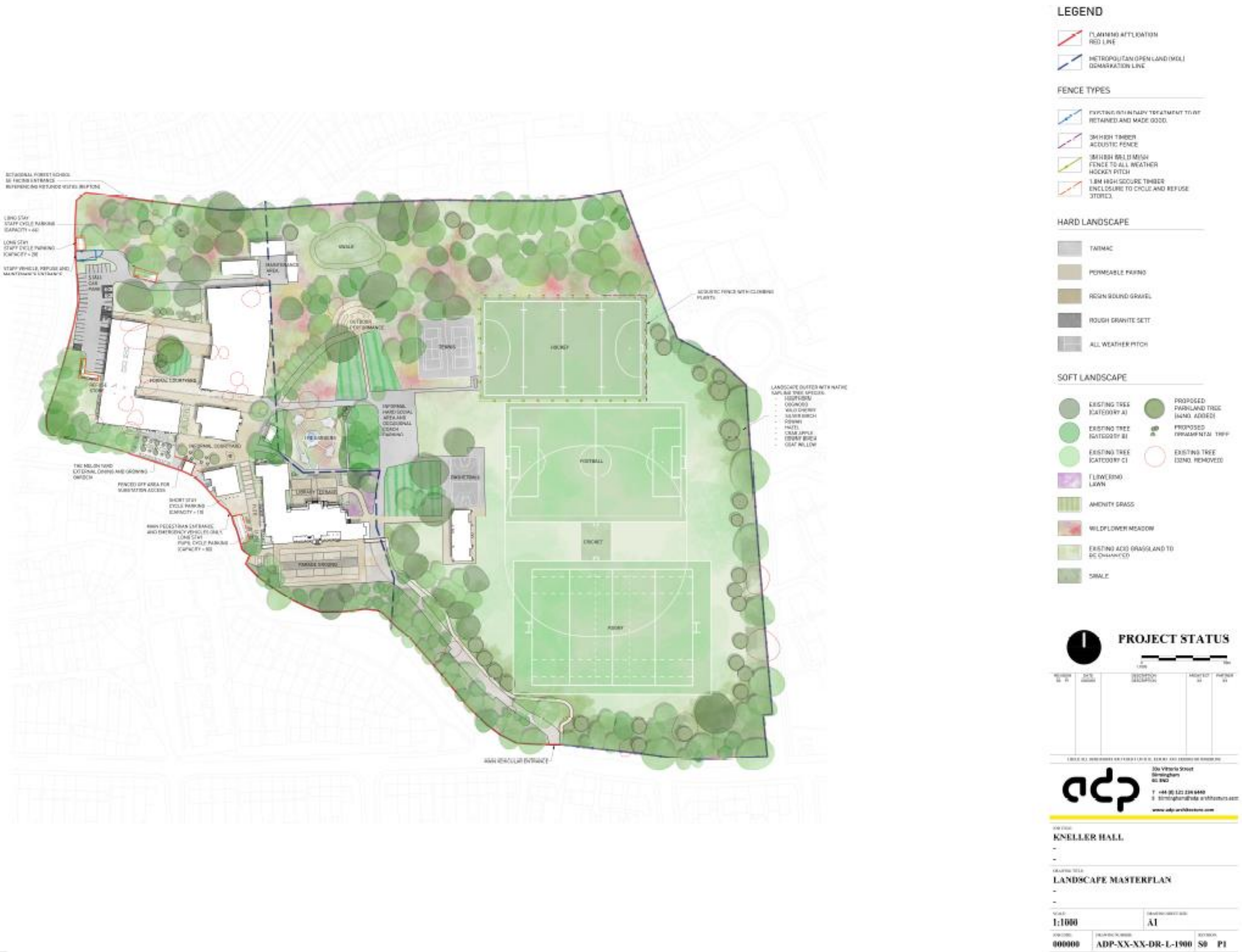
Through the incorporation of fundamental sustainability principles, the Proposed Development has:

- Demonstrated how materials have been selected on site based on longevity and/or environmental impact.
- Shown how waste generated from site will be targeted, reduced, and managed appropriately in line with the waste hierarchy.
- Adopted a flexible and adaptable design which will meet the needs of the present and future.
- Specified materials which are appropriate to their intended use and take account of durability and longevity.
- Used 'Building in Layers' principles to ensure that elements needing replacing within a shorter time period can do so easily.
- Considered operational waste generation and provided adequate internal and external storage, in addition to providing information to future occupants about the reduction of waste from consumable items and the impacts this has.
- Considered end of life impacts and the potential for material re-use following building disassembly.

Through a considered approach to fundamental sustainability principles and The Circular Economy, the Proposed Development responds positively to the requirements and principles of this policy. A combination design, construction, operation, and end-of-life measures have been adopted to ensure the Proposed Development aims to reduce impacts at every stage.

Appendix

Appendix A – Site Plan



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Appendix B Circular Economy Commitments

	Site	Substructure	Superstructure	Shell	Services	Space	Stuff	Construction Stuff	Summary	Challenges	Counter-Actions + Who + When	Plan to prove and quantify	Measures beyond standard practice
Section A: Conserve Resources													
Minimising the quantities of materials used	Maximise re-use of existing material on site where possible, however due to the age of the construction this will be limited.	Effective and efficient design of substructure to provide efficient design. Basement is currently assumed to be reinforced concrete.	Framed is constructed of reinforced concrete, effective structural design to minimise material used and maximise efficiency.. The lift shaft will be loadbearing to minimize additional column requirements. This will be cast on site to reduce waste	The shell is to be constructed of Brickwork, this allows the exact quantity of materials to be used. Efficient insulation is chosen to reduce material requirements	Community system proposed which are stored in the basement plant room – minimising levels of plant required for the site.	Lightweight internal partitioning reducing material cost to site.	Minimal 'stuff' provided throughout the construction process. This will reduce wastage is the final tenants do not want to keep those belonging.	Site cabins, hoarding, fencing and temporary structures etc all to be re-used from previous sites	Lightweight structure reduces quantity of materials used, with minimal furniture etc provided as part of the fit out. Lean design principles applied throughout, with materials quantities review regularly.	Reduction of 'stuff' associated with operation of building as this is in control of the residents/ occupiers rather than the Contractor/ Developer.	Information on the CO_2 emissions and other environmental impacts of 'stuff' purchasing and disposal to be provided to occupant by developer on completion.	Material use on site to be based on BOQ and continual monitoring to be undertaken. Material efficiency review exercise at next stage of design. Current material cost inflation will naturally put downwards pressure on excess material and waste.	Load bearing lift reduces column requirements
Minimising the quantities of other resources used (energy, water, land)	Efficient site plant to be used throughout in line with LP NRMM guidance. Ground works to be minimised.	Local materials sources to be favoured where cost effective. Effective site management to monitor and report on resource use – energy and water with CO_2 emissions calculated	Local suppliers and labour to be used where practicable. Type/speed of construction will also reduce emissions.	Minimal pre-formed elements used within the shell. Lightweight internal structure more efficient than blockwork.	High level of insulation on hot water and heating pipes to reduce ongoing emissions. High level of water and energy efficiency throughout site (operation)	Lightweight materials will result in less material/energy use and also less wet trades on site – water reduction.	High energy rated white goods will be supplied where these are to be installed. Both energy and water efficiency will be considered when purchasing communal items.	Low energy lighting, LEDs, and efficient heating options to be considered and utilised on site.	Water and electricity consumption to be monitored throughout site works. Reporting to include methods of reduction and potential, with records taken weekly	Dissemination of the need for efficiency to the site team (especially sub-contractors) which takes place on site.	Toolbox talks and site induction, with continual review (and possibly contracts) to include information on the need for resource efficiency to be practiced by all on-site.	Energy and water use to be reviewed min. monthly within Project team meetings. Targets set for reduction where required.	Targets will be set reduce operational energy during construction, these will be reviewed monthly. Secondly despite the ease of construction on greenfield land the burden on this resources is reduced through the choice of a brownfield site.

Specifying and sourcing materials responsibly and sustainably	Sustainable Procurement Plan to be implemented on site. To ensure that the ethics of the site extend the boundary.	Materials suppliers and manufacturers to have ISO14001 certification where possible. High level of recycled content for reinforcement steels.	Materials suppliers and manufacturers to have ISO14001 certification where possible. High level of recycled content for reinforcement steels.	Materials suppliers and manufacturers to have ISO14001 certification where possible.	Conductivity of insulation products to be as low as practicable to reduce heat loss. ISO 14001 certification encouraged	Recycled steel framing to be investigated. Min ISO14001 supplier and manufacturer to be required.	Timber furniture (cabinets and kitchen units) to be FSC/PEFC certified as minimum.	Re-use of the majority of facilities and site 'stuff' from previous sites.	Majority of materials will be locally or responsibly sourced where possible. High recycled content materials are to be preferred.	Securing relevant certification and product details from suppliers and manufacturers prior to order.	Supplier to provide relevant certification and documentary information prior to the placing of orders where this is possible.	Records of materials ordered, manufacturer, supplier and certification to be kept by site team.	Each supplier used will be researched and their credibility evaluated to consider their impact to ensure sustainable practices extend beyond the site.

Section B: Design to Eliminate Waste (and for ease of Maintenance)													
Designing for reusability / recoverability / longevity / flexibility	Piled foundations result in minimal excavation and site disturbance compared to other methods.	Piled foundations non-reusable but can remain below ground – low toxicity – and potentially re-used on future buildings on site.	Framed construction with a long predicted life-span. Allows for internal spaces to be rearranged easily to meet future needs.	Robust external shell to be predominantly brick. Re-usable at end of life if required. High level of longevity with minimal weathering etc.	Plant to be located in a space which is easily accessed, with access appropriate to allow the plant to be removed and individual aspects to be replaced where/when this is needed.	Partitions are lightweight and framed allowing ease of rearrangement of the floors to meet future, changing needs.	Users will be encouraged to use items with care to increase life span.	Majority of site 'stuff' is recycled from previous sites and will be recovered and reused again at site completion.	Long lasting but flexible structure proposed which can be rearranged internally to suit future changing needs.	Avoiding design solutions which constrain disassembly / recoverability.	Disassembly / recoverability review during detailed design (structural engineer, architect, contractor input).		Foundations and framer are designed for longevity to ensure that the site could be adapted in the future without the need for additional new materials.
Designing out construction, demolition, excavation, industrial and municipal waste arising	Minimal opportunity for re-use of excavation waste on site due to site constraints. Spoil is to be recycled by appropriate contractor.	Substructure assumed to be cast in situ, resulting in minimal waste as elements are cast to demand.	Super structure to be cast on site allowing materials to be carefully monitored and organised.	Brick facing to be predominant feature. Minimal waste when being constructed. Supplier take-back schemes to be considered with just-in-time delivery proposed to reduce material sitting and degrading on site.	All services to be located within dedicated plant spaces and appropriately sized. Large items of plant are to be functionally located to allow easy removal and recycling in one piece.	Material waste for space generation will be minimal due to the nature of the framed internal partitions. However, packaging for these materials can be high due to the need for the materials to be protected. Suppliers which offer to take back packaging, or those who use recyclable packaging will be prioritised.	Internal waste bins to be supplied providing waste storage for general and recyclable waste. Corresponding communal waste storage provided within communal bin stores with appropriate signage.	Accurately forecasting the amount of materials needed, using larger pack sizes to reduce the amount of packaging per unit and by using cardboard packaging instead of plastic where possible.	Designing out waste considered at every stage. Regular design principles to be considered to allow materials to be used in multiple locations throughout site. Consideration for just-in-time delivery, reducing packaging, and supplier takeback schemes.	Supplier takeback schemes still an immature market for certain materials in the UK.	Review during detailed design.	Review procurement plan with contractor during preconstruction supply chain engagement	During construction only the required materials will be purchased to minimise waste and constructers will have strict targets to reach which go beyond the BREEAM regulations.

Section C: Manage Waste													
Demolition waste (how waste from demolition of the layers will be managed)	Aim to achieve 80% diversion from landfill Majority will be brick, and concreate. Therefore, materials can be recycled or crushed and re-used either on site or off site.	The substructure of the current buildings are likely to be shallow, which will be dug out and crushed to be re-used on this site or off site.	Blockwork walls and potentially some steel will be considered for reuse. Otherwise, will be recycled. The ground floor concrete slab and foundations are most likely constructed of concrete, all will be demolished and crushed. Clean concrete will be processed back to aggregate for concrete construction.	Mainly bricks. Where possible these will be salvaged and re-used either on or off site. Where possible any insulation will be recovered at the recycling facility for reprocessing. Contaminated insulation will need to be forwarded for disposal.	Soft strip of initial services will be undertaken. Boilers etc can be recycled along with cabling and pipework..	N/A	Kitchens and other timber can be recycled and removed during soft strip. All metals can be recycled.	Waste relating to the demolition phase will be managed through the implementation of a D&SWMP to be submitted prior to above-ground works, with a primary aim to minimise waste during this period. The contractor will support the segregation of recoverable and non-recoverable waste streams and indicative vehicle routes will be mapped, focusing on reducing vehicle milage.	Pre-demolition audit will be undertaken, targeting 80% of waste diversion from landfill.	Ensuring 80% of waste is diverted from landfill.	Pre-demolition audit, precontract engagement with demolition contractor.	Demolition SWMP records.	All materials will be assessed for their reusability on site. Efforts will be made to ensure that those which cannot be used on this site will be utilised on other developments where there is a need for such materials (where possible local sites will be chosen)
Construction waste (how waste arising from construction of the layers will be reused or recycled)	>70% diversion from landfill to be targeted as a minimum. Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Target of <6.5tonnes/ 100m^2 of GIA	Dealing with the most challenging waste streams commonly sent to landfill.	Predictions of waste types to be outlined within the SWMP with anticipated streams highlighted. Any non-recyclable waste to be dealt with in line with the waste hierarchy.	Final SWMP data to highlight final locations of all waste.	Efforts will be extended to reduce construction waste beyond the initial construction by providing sufficient information to future users to ensure that repairs can be completed with minimal waste produced.

Municipal and industrial waste (how the design will support operational waste management)	Refuse storage planned in conjunction with site waste management strategy and LA	Suitable refuse storage provided to enable segregation and storage of waste both communally within bin store areas, and within individual flats and office and café areas.	N/A	N/A	N/A	N/A	Space will be provided for segregation of recyclables and bulk items so that they can be collected for recycling.	N/A	Appropriate refuse storage to enable recycling and best practise waste management.	Bulkier items are not collected by the LA.	Information on the location of the household waste recycling facility and local transport links to be provided on occupation within information pack.		Sufficient bin storage will be provided which will be in line with BREEAM NC18 Wst 03 requirements. Additional information will be provided to all future tenants upon arrival.

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