Energy and Sustainability Statement

(inc. Passive Design Analysis and BREEAM LZC Feasibility)

Green Building Design Consultants

Dr Williams Library Extension
14 Gordon Square
Bloomsbury
London

Version	Revision	Date	Author	Reviewer	Project Manager
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1	B	26.09.2019	Iain Turrell	-	Sam Paine

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Executive Summary

SRE exists to ensure that the built environment doesn't cost the earth. This Energy and Sustainability Statement (including Passive Design Analysis and BREEAM LZC Feasibility Study) has been written to demonstrate the measures incorporated into the design of the proposed extension to Dr Williams Library, Gordon Square, London which will deliver lower energy and water use, lower carbon emissions and lower operational costs than a Building Regulations compliant design.

The energy strategy has been developed by following the GLA Energy Hierarchy of Lean, Clean, Green and Seen. Lean passive and active design measures have been included, along with Green LZC technologies to achieve a greater than 35% improvement over Baseline CO_2 emissions through one of 2 viable energy options.

At this stage it is assumed that the gas based heating and hot water solution with supplementary PV will be implemented on site with the following results.

Regulated carbon dioxide savings from each stage of the energy hierarchy for non-domestic buildings		
	Regulated carbon dioxide savings	
	Tonnes per year	%
Lean	3.91	18.39%
Clean	0.00	0.00%
Green	7.59	21.27%
Cumulative savings	5.93	35.79%

Table 1 - Summary of regulated carbon dioxide savings

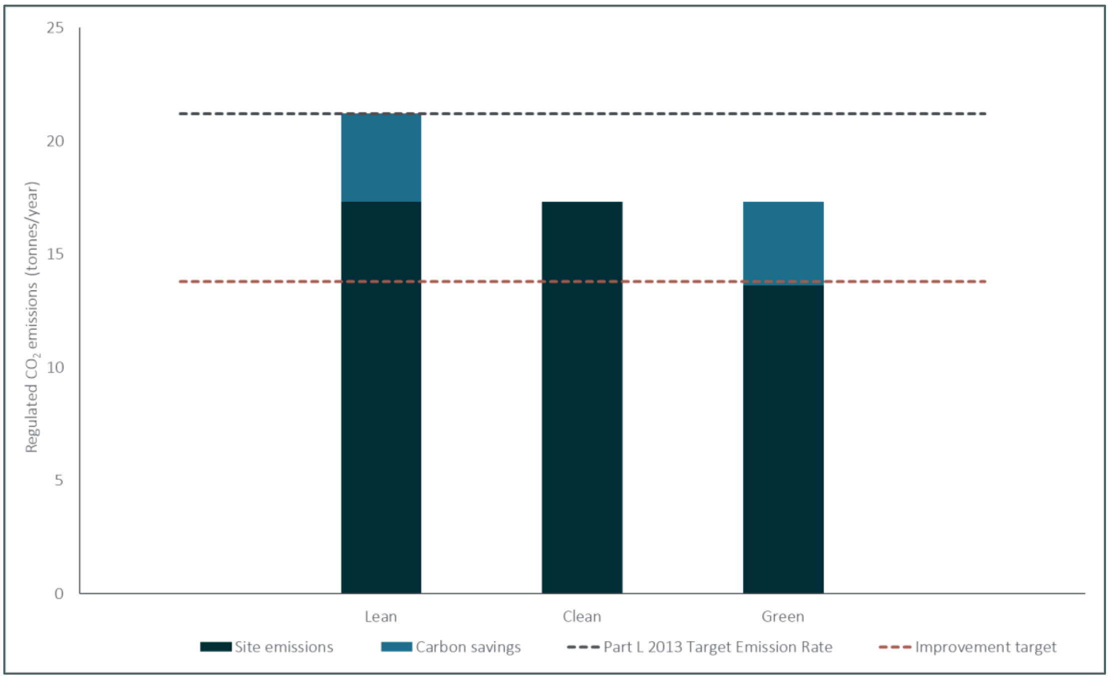


Figure 1 - Summary of regulated carbon dioxide savings

Proposed Energy Strategy

- Passive and active design measures
- Mechanical Ventialtion with Heat Recovery
- Gas fired heating and hot water provision
- 9.6kWp PV array to provide CO_2 offset

	CO_2 emissions (t/yr)	Improvement over Baseline
Green	16.12	35.79%

Table 2 - Green emissions summary

The sustainability assessment demonstrates how the energy performance of the Proposed Development achieves a meaningful reduction in CO_2 emissions allowing 5 credits to be achieved under BREEAM NC 2018 issue ENE01 and 1 credit under issue ENE04.

Introduction

1.0 Introduction

SRE exists to ensure that the built environment enhances life without costing the earth. This Energy and Sustainability Statement has been written by SRE on behalf of Green Building Design Consultants (the Client) to demonstrate the measures incorporated into the design of the proposed extension to Dr Williams Library, Gordon Square, London (the Proposed Development). The site will deliver lower energy and water use, lower carbon emissions and lower operational costs than a Building Regulations Compliant design.

The statement compares the predicted actual building energy requirement with a Building Regulations compliant design, outlines passive and active design measures, and assesses the suitability of low and zero carbon (LZC) technologies specific to this site to address the relevant planning policy requirements.

The statement analyses how the Proposed Development will integrate with its surrounding environment within the context of sustainability to ensure it benefits the surrounding area socially, environmentally and economically.

The Proposed development consists of 2 no. rear extensions to the existing 1890 library building. These will be of 4 stories in height and will reach from the lower ground floor to the 2^{nd} floor. The proposed extension will provide additional storage space for the Library's growing collection in addition to that already present within the existing building.

Figure 2 – Existing/Retained

Planning Policy	Requirement
The London Plan (2015)	Policy 5.2 Equivalent to 40% reduction over Building Regulations Part L2A 2010 (35% over BRegs 2013)
The New London Plan (2019)	Policy S12 How the zero-carbon emissions target will be met within the framework of the energy hierarchy
	Policy S12 A minimum on-site reduction of 35% with at least 15% through energy efficiency measures alone
	Policy S14 Limit internal heat gain through the cooling hierarchy
	Policy S15 BREEAM Excellent level achieved under issue 'Wat 01'
London Borough of Camden New Southwark Plan	Policy CC2 BREEAM Excellent rating

Table 3 - Summary of local planning policy requirements

As required by the London Borough of Camden Local Plan, the Proposed Developments viability to achieve an 'Excellent' rating under the BREEAM New Construction 2018 methodology has been assessed.

Due to the type of building proposed, and the intended use of the site, SRE have deemed that an 'Excellent' BREEEAM rating is unfeasible for this site to achieve. Therefore, the target has been set for a robust 'Very Good' rating with the minimum mandatory requirements for 'Excellent' achieved.

Please see the supporting *SRE BREEAM NC 2018 Pre-Assessment* for further details.

Energy

2.0 Energy

2.1 Method

The energy strategy design follows The Mayor of Londons Energy Hierarchy[1] and seeks to be:

Lean minimise the overall environmental impact and energy use through energy efficiency measures - e.g. improved insulation and glazing

Clean ensure that energy systems on-site (heat and power) are efficient and produce minimal CO_2 emissions - e.g. high efficiency boilers/heat pumps

Green implement the use of suitable technologies to provide renewable and emission free energy sources

Seen incorporate monitoring through SMART metering and accessible displays

Whilst not classified as a Major Development (floor area <1000m^2), the site is aiming to meet the requirements of the London Plan, and achieve a CO_2 emissions rate 35% lower than that of a Building Regulations compliant design. As the building is currently being assessed under Building Regulations 2013, these CO_2 Conversion Factors (Table 4) are to be used for the purposes of this modelling, rather than the New London Plan updated carbon figures.

	CO_2 Conversion Factor ($kgCO_2/kWh$)
Electricity (mains)	0.519
Electricity (offset)	-0.519
Gas (mains)	0.216
Heating Oil	0.298
Wood Pellets	0.039
Woodchip	0.016

Table 4 - CO_2 conversion factors by energy source

The energy modelling for the Proposed Development has been calculated using SBEM software in accordance with Building Regulations 2013 Part L2A. The notional building provides the energy baseline and is the exact size and shape of the Proposed Development but is based on existing and notional U-values and heating specifications outlined in Approved Document L and the Non-Domestic Building Services Compliance Guide.

	CO_2 emissions (t/yr)
Baseline	21.21

Table 5 - Baseline CO_2 emissions

[1]The draft New London Plan https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan

2.2 LEAN – Demand Reduction

The lean scenario can achieve a 15.86% reduction in CO_2 emissions using passive and active design measures, and therefore complies with the requirements of London Plan (2019) Policy SI2 of a 15% reduction from efficiency measures.

	CO_2 emissions (t/yr)	Improvement
Baseline	21.21	
Lean	17.30	18.44%

Table 6 - Lean CO_2 emissions and improvement over Baseline

Within this scenario, it is planned that the plant for the whole building will be replaced and therefore the proposed extension will be linked to this building-wide heating system.

2.2.1 Passive Design Measures

The majority of the rooms created within the new space proposed will not have windows as the primary use of the space is for storage of books and papers, and therefore natural daylight can be detrimental to their longevity. Where windows are present, the building has been positioned within the site to maximise the usable space, both for the building and the external spaces created by its construction. For the office spaces created, north facing glazing is proposed to allow light to enter the building, but minimise solar heat gain and the possibility of summer overheating. Solar gains will be further controlled through Low E glazing and internal blinds where these are deemed necessary.

The building will be very well insulated through all external elements with a low infiltration rate of <5. Proposed U-values are provided within Table 7. The overall building should have a medium thermal mass as construction will be either load-bearing masonry or a concrete and steel frame. A medium thermal mass will balance the provision of high energy efficiency and limiting overheating during the summer months.

Element	Notional Compliance (U-value)	Proposed (U-value)
External Walls	0.28	0.18
Ground Floor	0.22	0.14
Roof	0.16	0.16
Windows and rooflights	1.60	1.40
Air Tightness @ 50 N/m^2	15 ($m^3/hr/m^2$)	5 ($m^3/hr/m^2$)
Thermal Bridge	Not Applicable	Not Applicable

Table 7 - Fabric energy efficiencies

2.2.2 Active Design Measures

The Proposed Development will utilise 100% low energy/LED lighting in excess of Building Regulation requirements. All external lighting will be positioned to avoid excessive light pollution and be supported by PIR/daylight sensor and time controls with a maximum lamp capacity of 150W (equivalent) for essential security lighting.

Time, temperature and zone controls will be installed as a minimum to allow the control of individual zones/rooms throughout the building.

In modern air-tight buildings, careful consideration needs to be given to the specification of ventilation systems to ensure moisture is removed and ventilation standards are met to ensure a healthy standard of internal air.

Mechanical ventilation with heat recovery is proposed within all spaces to control temperature and air change rate within the spaces. Within the strong rooms, where books and papers are to be stored, this will also assist in controlling the humidity, which is crucial to the longevity of the items stored.

2.2.3 Cooling

The cooling hierarchy has been used to ensure that passive building design has been optimised to reduce the cooling load for the Proposed Development.

Cooling Hierarchy	Potential Design Measures
Minimising internal heat generation through energy efficient design	All primary pipework to be insulated, therefore low system losses. Low energy lighting throughout with minimal heat output.
Reducing the amount of heat entering the building in summer	Low E glass windows and internal blinds are to be provided to minimize solar gain. All walls are to be well insulated.
Use of thermal mass and high ceilings to manage the heat within the building	Thermal mass is anticipated to be medium/high with some element of exposed mass where this is possible.
Passive Ventilation	Openable windows will be provided to all lettable office space for occupant comfort.
Mechanical Ventilation	Mechanical Ventilation with Heat Recovery is proposed throughout. Automatic summer bypass also specified.

Table 8 - Design measures following the cooling hierarchy

Mechanical extraction at present is to be installed within the kitchen and bathrooms to aid moisture removal and lower internal pollution levels.

Active cooling through VRF systems is not anticipated at present.

2.3 CLEAN – Heating Infrastructure

The Proposed Development will implement a gas-fired heating strategy through the use of the existing plant room and updated plant equipment. This has been demonstrated within the Lean scenario above. As the proposal is for an extension to an existing single building, a communal system is not viable as the site consists of one building only.

Whilst connection to a district heat network is not currently possible, the installation of a 'wet' system would allow the Proposed Development to easily connect to a new network in the future.

	CO_2 emissions (t/yr)	Improvement
Lean	17.30	
Clean	17.30	0.00%

Table 9 - Clean CO_2 emissions and improvement over Lean

District Heat Networks

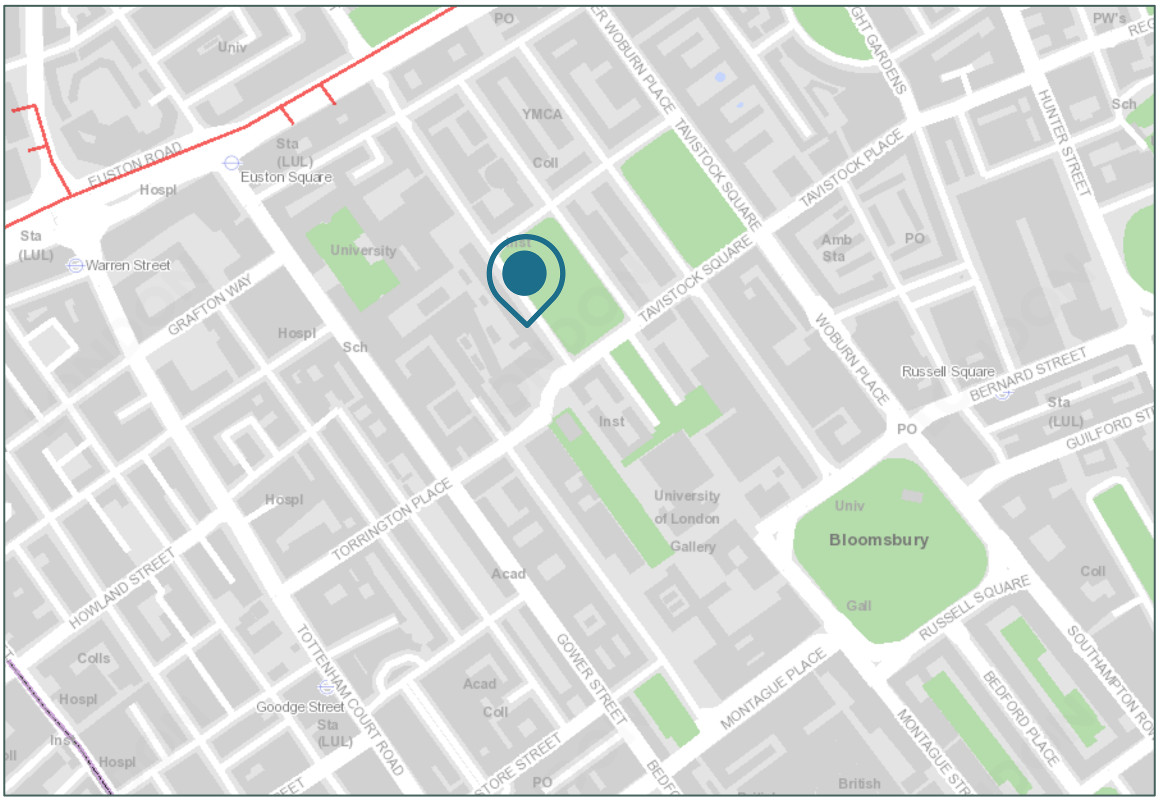


Table 10 - London Heat Map (maps.london.gov.uk/heatmap/)

The London Heat Map shows that the Proposed Development is within an area where there is potential for a heat distribution network to be put in place – shown as a red line on the above map. While the area could benefit from the installation of a district-wide network, there is not yet one installed or planned. Therefore, connection to it is not possible at this stage.

Combined Heat and Power (CHP)

The use of CHP has been investigated for the scheme in outline. However, the heat load for the proposed extension is minimal as there are minimal windows, and fabric losses have been minimised through efficient design. Therefore, the use of a CHP is not viable as the heat load would not be sufficient for the CHP to run efficiently, resulting in cycling and a significant drop in performance due to the reduced electrical generation and the resultant drop in CO_2 offset from this.

2.4 GREEN – Low Carbon and Renewable Energy

The addition of 'Green' technologies can provide a significant reduction in CO_2 emissions and enable the Proposed Development to meet the threshold of 35% improvement over Baseline emissions.

	CO_2 emissions (t/yr)	Improvement
Clean	17.30	
Green (Gas + PV)	13.62	21.27%
Green (HP + PV)	13.18	23.82%

Table 11 - Green CO_2 emissions and improvement over Clean

2.4.1 Heat Pumps

All Heat Pump (HP) systems consume electricity to operate - the Coefficient of Performance (CoP) of the system is the ratio of electrical energy consumed, to heat energy emitted. Generally, a CoP of 3 or 4 can be achieved, meaning 3/4 units of thermal energy are produced for each unit of electricity consumed.

Heat pumps will only deliver low grade heat (up to ~50°C) efficiently, and therefore HP systems alone are generally relatively inefficient in providing hot water, as this requires additional electrical input (immersion or increased compressor use).

The capital costs incurred with heat pumps can be offset through installing a system that is eligible for the Renewable Heat Incentive (RHI) scheme, whereby the owner/occupant can receive quarterly payments over seven years. The amount of income received is dependent on the technology installed, metering and the latest tariffs available.

Both ground source heat pumps (GSHP) and air source heat pumps (ASHP) operate in a similar manner, the only difference being the collector medium which is used. ASHP use the air, and GSHP use the ground to collect heat for use within the building.

For GSHP, beyond 1m below ground level, an average temperature of 15°C is maintained throughout the year. Because of the ground's high thermal mass, it stores heat from the sun during the summer. GSHP can transfer this heat from the ground into a building to provide space heating by a similar process to an air source system.

It is recommended that the ground conditions of the site be assessed in detail (through consultation with a GSHP manufacturer and/or purchase of a Ground Conditions report from the British Geological Survey) before a system is installed – the primary heat source that GSHP relies on is solar derived, and shading can affect the 're-charge' of the ground within which the ground loop is laid. This can affect year-on-year CoPs, steadily increasing running costs and reducing CO_2 offset.

Although GSHP can provide a greater efficiency performance than ASHP, it comes at a significantly higher capital cost, due to the extensive groundworks needed to install either 'slinky' ground loops or 50-100m deep boreholes.

ASHP also has the potential to supply the Proposed Developments heating and hot water load. ASHPs however, tend to generate some noise in comparison to a GSHP plant due to the fans needed to pass air over the heat exchanger. Therefore, the location/space in which the pump is positioned would need to be adequately sound insulated or positioned in order to prevent disturbances to the building's occupants and neighbours.

The application of either a GSHP and ASHP has been modelled initially within the SBEM software with a CoP (Coefficient of Performance) of 3.5, where 3.5 units of thermal energy are produced for every 1 unit of electrical energy consumed. Therefore, the results for either GSHP or ASHP are broadly similar and can vary based on manufacturer and precise ground conditions (GSHP only).

The use of a heat pump provides the following CO_2 emissions improvement.

	CO_2 emissions (t/yr)	Improvement
Baseline	21.21	
Green (HP only)	16.12	23.00%

Table 12 - Green CO_2 emissions and improvement over Clean

As can be seen, the use of a heat pump only will not meet the 35% CO_2 offset requirement for the site. Therefore, further technologies will need to be adopted as outlined below.

2.4.2 Photovoltaics

As illustrated above, the Proposed Development will need to adopt further technologies to meet the 35% improvement required regardless of whether a gas boiler or heat pump is utilised on site. Photovoltaic (PV) panels are one of the viable options to do this.

PV panels convert energy from daylight into direct (DC) electrical current. These are generally roof mounted and provide electrical generation which can either be utilised directly on-site (or nearby), stored in batteries, or exported back to the National Grid.

The installation of PV could be used to offset electrical demand within the Proposed Development. The PV array would be connected into the electrical system via an inverter or series of inverters, depending on system size and setup.

Noise will not be an issue – A PV system does not feature moving parts and is silent during operation.

An indicative investigation into the roof area of the Proposed Development shows that there is approximately 130m^2 of available flat roof area, highlighted in red within Figure 3 on the upper floor plan.

Based on a 400W monocrystalline module as requested by the Client (~1.7m^2 in area[2]), and allowing for spacing for access, there is the potential for an overall ~20kWp PV array (~6m^2/kWp) to be installed horizontally. However, installation of PV horizontally will not provide optimal performance and would void the manufacturer warranty. As such, panels should be installed south-facing at a minimum 15-degree pitch, which would increase the required spacing to prevent the panels shading each other and decrease the available active area by about half.

Within both the gas (Lean) scenario and the heat pump scenario above, indications show that <10kWp of PV would be needed to achieve the required 35% CO_2 offset. Therefore, while a maximum of >20kWp could be installed on the available roof space, <10kWp is currently proposed to achieve the required building improvement and allow plenty of space for installation.

Indications show that for the gas scenario, 9.6kWp would be required. Whilst 7.8kWp would be required should ASHP be specified. The performance of these two potential arrays is shown below.

[2] Such as the Sun Power Maxeon 400W: https://www.sunpowercorp.co.uk/sites/default/files/sunpower-maxeon-3-residential-solar-panels-400-390-370.pdf - this does not constitute a product endorsement.

Proposed Array (kWp)	Approximate no. Panels @400W	Active Area (m^2)	Pitch (degrees)	Orientation	Annual Generation (kWh/yr)	Annual CO_2 offset ($kgCO_2$/yr)
9.6 (with Gas)	24	40.8	15	South	~7,056	~3,662
8.0 (with ASHP)	20	34.0	15	South	~5,640	~2,927

Table 13 - Proposed PV Array Summaries

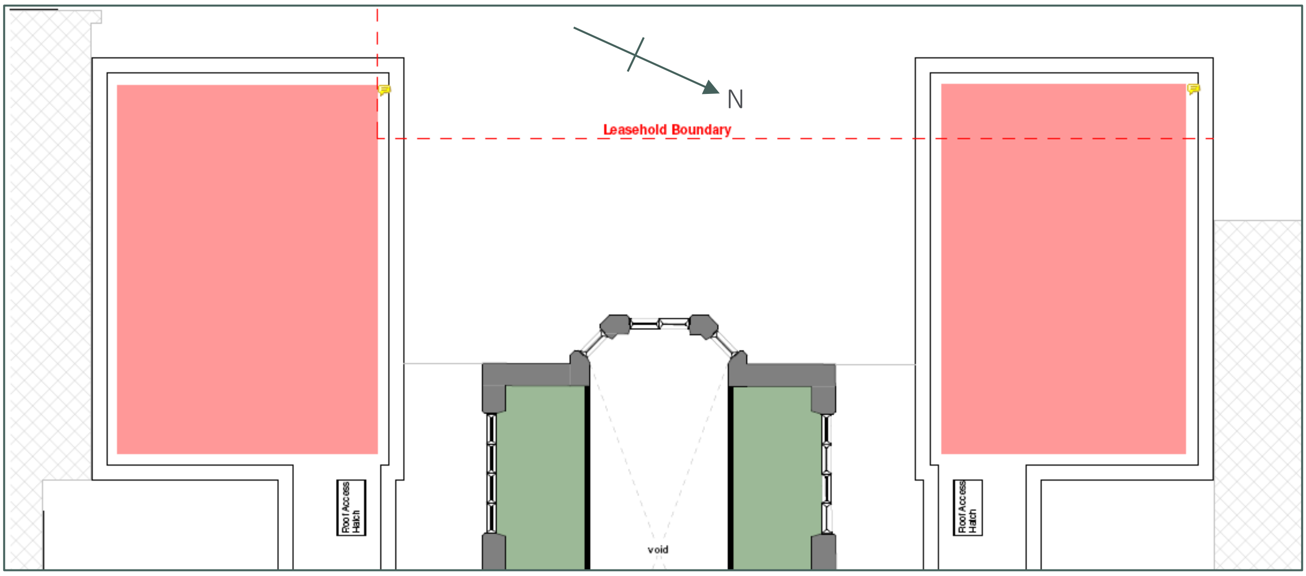


Figure 3 –Roof space at the Proposed Development – area available for PV highlighted in red

2.4.3 Energy Storage

While the Proposed Development could include battery energy storage, it is believed that the PV generation will not exceed usage at the site, therefore it is unlikely that generation would not be used on-site.

2.5 Carbon Offsetting

The London Plan requires all ‘major residential developments’ to be net-zero carbon.

The Proposed Development is not a residential development and is not required to meet the zero-carbon target.

2.6 SEEN – In-use monitoring

It is recommended that the Proposed Development will be supplied with Smart Meters (where available from the utility supplier) and a building energy management system (BEMS) along with associated internal energy displays. This will further improve energy efficiency by allowing building managers to observe their energy use in ‘real time’ and manage it more effectively.

2.7 Conclusions

The Proposed Development will deliver passive and active energy demand reduction measures along with low and zero carbon technologies in order to reduce energy demand and associated CO_2 emissions resulting from the Proposed Development’s operation.

The calculations undertaken demonstrate that the Proposed Development will successfully exceed Building Regulations Part L2A compliance by 35% through one of 2 viable energy options, achieving the emissions reductions requirements set by the London Plan.

The energy performance of the Proposed Development and meaningful reduction in CO_2 emissions allows 5 credits to be achieved under BREEAM NC 2018 issue ENE01 and 1 credit under issue ENE04. This exceeds the minimum standards for BREEAM 'Excellent' within these issues.

	CO_2 emissions (t/yr)	Improvement	Improvement over baseline
Baseline	21.21		
Lean	17.30	18.39%	18.39%
Clean	17.30	0.00%	18.39%
Green (HP Only)	16.12	6.82%	23.00%
Green (gas + PV)	13.62	21.27%	35.79%
Green (HP + PV)	13.18	23.82%	37.86%
Net Zero Carbon	n/a	n/a	n/a

Table 14 - Summary of CO_2 emissions, incremental improvement and improvement over Baseline

Based on the strategies outlined above, it is deemed that the Proposed Development will most likely implement the following strategy to provide the best value for the client, and prevent noise nuisance to the surrounding buildings, and other parts of the library itself:

- Mechanical Ventilation with Heat Recovery
- Passive and active design measures
- Gas fired heating and hot water provision
- A 9.6kWp PV array to provide CO_2 offset

Sustainability

3.0 Sustainability

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

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

3.1 Environmental Assessment

BREEAM

The BREEAM family of environmental assessment methods (BRE’s Environmental Assessment Method) is a scheme that aims to quantify and reduce the environmental burdens of buildings by rewarding those designs that take positive steps to minimise their environmental impacts.

The scheme will be assessed under the BREEAM New Construction 2018 methodology.

The assessment process results in a report covering the issues assessed together with a formal certification giving a rating on a scale of PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING.

IT has been deemed for this site that an ‘Excellent’ rating will not be possible die to the building design and proposed use and construction. Therefore a robust ‘Very Good’ rating is proposed for the extension, with the minimum mandatory standards for an ‘Excellent’ rating met in full.

This includes an ‘Excellent’ level under issues ENE01 and WAT01. The achievement of an ‘Excellent’ level under issue WAT01 is a requirement of the New London Plan.

For full details please see the supporting *SRE BREEAM NC 2018 Pre-Assessment*.

3.2 Pollution

Air

The Proposed Development will aim to limit its contribution to local air pollution by installing low NO_x gas boilers or heat pump technology. The heat pump will emit no onsite NO_x emissions but consumes grid electricity (when not consuming electricity generated by the PV). As the NO_x emissions resulting from the production of electricity decreases at the national scale, the resulting theoretical emissions from the Proposed Development will do also. Furthermore, the use of PV panels will decrease the import of electricity from the national grid and replace it with PV electricity which produces no emissions during operation.

If using a gas boiler solution, the boiler will have a NO_x emissions rate of <40mg/kWh in line with best practice.

Noise

The Proposed Development is located rear of an existing library facility and will not produce any greater noise pollution that that which is currently produced by the site. Furthermore, the Proposed Development will be a highly insulated building with excellent air-tightness which should limit any noise from inside the building far below that of the existing.

The Proposed Development provides no car parking for the building users, instead, encouraging visitors to use public transport rather than personal vehicles which may contribute to general noise pollution in the area.

An external noise impact assessment has been carried out and forms part of the Planning Application. An assessment will also be undertaken post construction to ensure background ambient noise levels are not impacted through external plant and machinery once the site is operational. This assessment is required as part of the BREEAM assessment, and will meet the relevant standards outlined within the supporting Pre-Assessment.

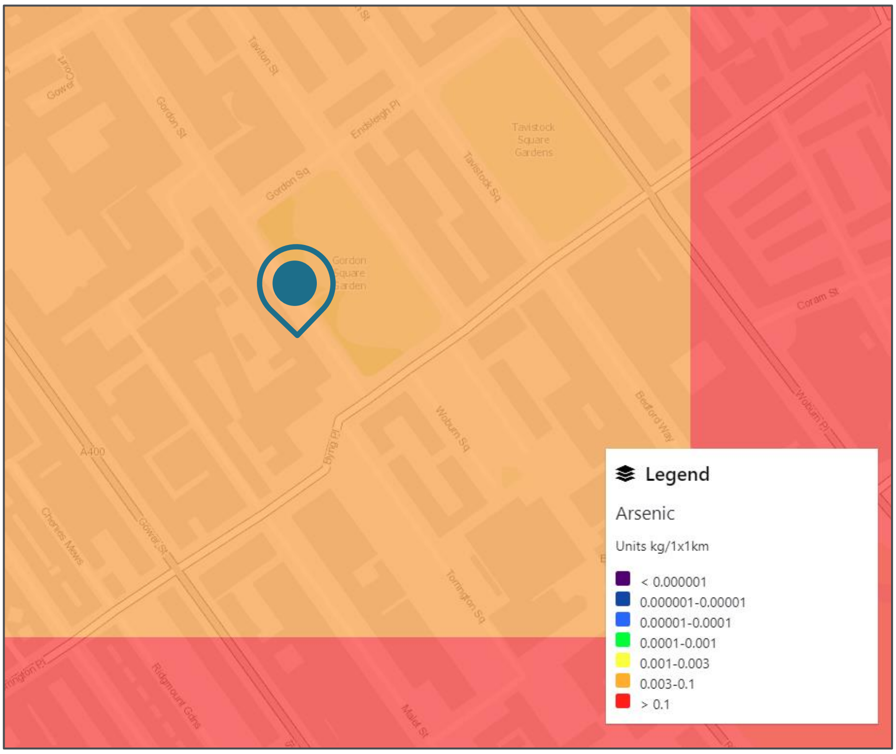


Figure 4 - UK Air Pollution Map showing pollution from Nitrogen Oxides as NO_2 (https://naei.beis.gov.uk/emissionsapp/)

Light

The design and layout of the site for practical use has been considered while trying to maximise internal daylight levels. All spaces permanently occupied by people (the lettable office space) have glazing to provide natural daylight, and light-coloured curtains or roller blinds will be provided to enable glare control and privacy.

Light Pollution will be minimised where possible through the careful specification and positioning of external lighting around the Proposed Development, ensuring minimal light pollution from the site. Special attention will be given to security lighting (where fitted) to ensure it is appropriately focussed and controlled.

All external space lighting will be provided through low energy fittings, with security lighting being PIR and daylight/timer controlled. Any external signage, where installed and lit, will be installed and controlled in line with best practice and BREEAM requirements.

3.3 Flood Risk

The selected site lays outside any zone at risk from flooding from rivers and seas (Figure 5). However, the Proposed Development site is shown at being of risk from surface water flooding (Figure 6).

The Proposed Development will undertake a full flood risk assessment and will include SuDS as part of the measures to reduce surface water run-off from the site. This will be assessed under the BREEAM issue Pol03.

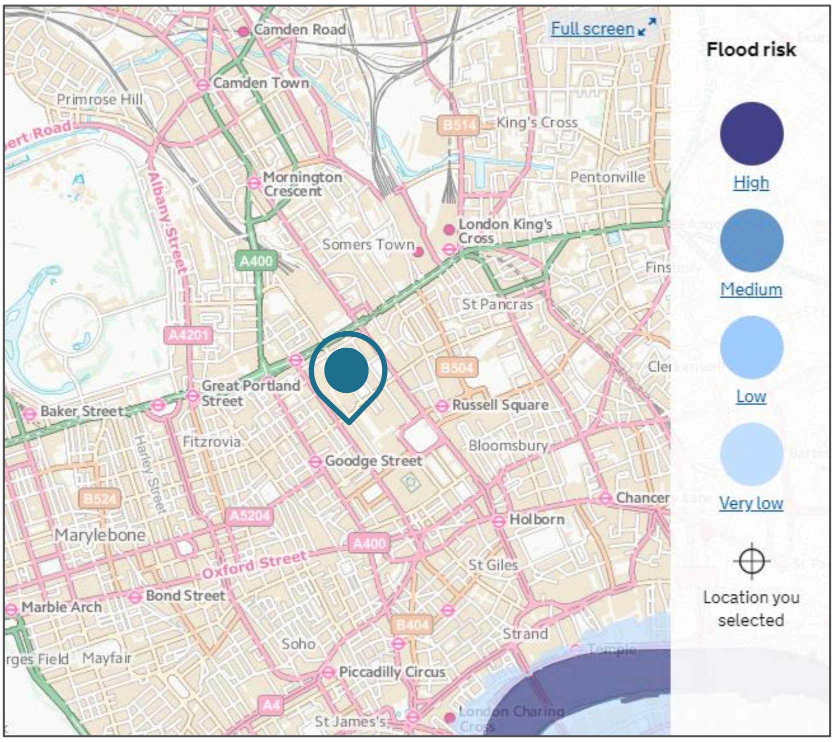


Figure 5 - Flood map showing risk of flooding from rivers or the sea (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

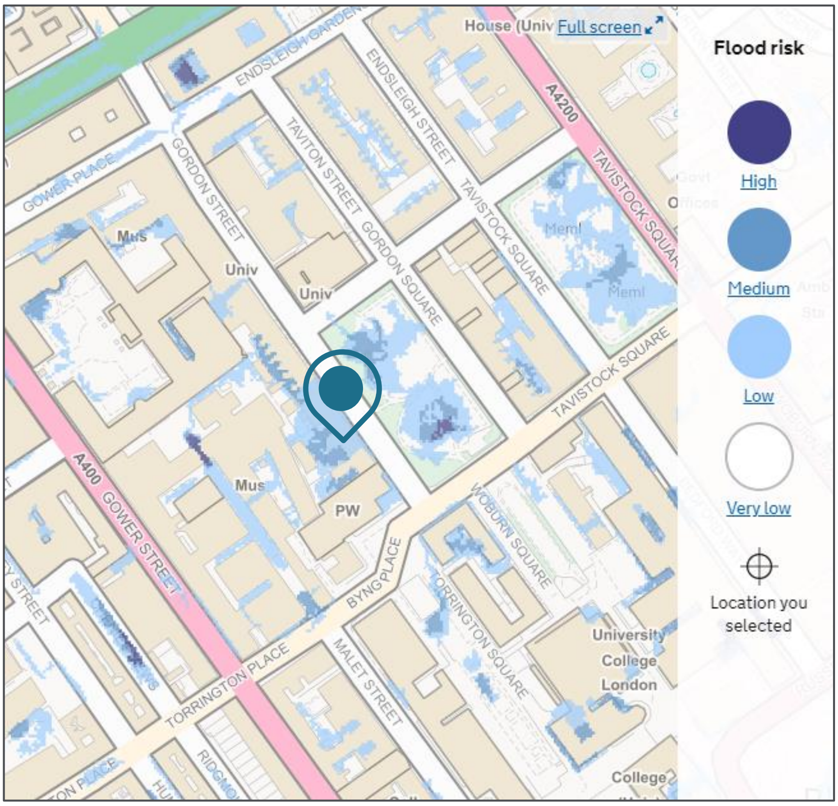


Figure 6 - Flood map showing risk of flooding from surface water (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

3.4 Transport

Public Transport

The site has multiple bus stops in the surrounding area, with several on Camberwell Road, a 7-minute walk to the east and stops on Southampton Way and Wells Way, 5-minutes' walk to the west.

The nearest train station for overground services is Denmark Hill, a 19-minute walk to the south, while the closest underground service is Kennington (Northern Line), a 25-minute walk to the north east.

Parking

No onsite parking will be provided as part of the extension. Therefore, the site will promote the use of public transport by visitors and staff.

Electric Vehicle Charging

No parking is provided on site and therefore no electric car charging points are to be included. The nearest public car charging point is located on Malet Street, 200m to the south of the Proposed Development site.

Car-Pooling

There is a car-pooling service provided by Zip Car, located 200m away on outside Euston Station. To use this service, you must be a member of the Zip Car scheme (join online for free). Proximity to a car-pooling service will allow residents access to cars without the need to own one.

Cycle Storage

The Proposed Development is not able to incorporate any cycle storage within the extension. However, the existing building does provide limited storage facilities for cycles which are to be retained. Public cycle parking is provided on Byng Place, to the south, where cycle hoops are provided for pubic use.

Cycle Rental

The nearest 'Santander Cycle' point is located on Endsleigh Place, 100m north. Alternatively, Bedford Way to the south also has a cycle station, which is readily available.

3.5 Biodiversity

Biodiversity is generally considered to be the variety of life forms within a certain ecosystem. The Proposed Development is an extension to the existing building and will be constructed on the existing courtyard to the rear of the site.

Within this courtyard there are some trees and hedges. It is not possible to state at this time whether these are of inherent ecological value. However, a BREEAM compliant full ecological report must be undertaken by a suitably qualified ecologist in order to determine the initial findings of this report and advise if there is any potential of enhancing the biodiversity elements on site.

3.6 Resource efficiency

Construction Phase Waste Management

The Proposed Development will aim to minimise the waste produced from the site during the construction phase.

A comprehensive Construction Management Plan will be implemented from the outset of site works and will meet the BREEAM requirements for waste management and will follow the principles of the waste hierarchy.

Targets have been set in relation to volume of construction waste and diversion from landfill, and these can be viewed within the respective Pre-Assessments for each building.

The construction waste generated as part of the redevelopment will be segregated and monitored as per best practice, with suitable materials being recycled as part of this process, either to be reused on site or introduced back into the supply chain through recycling by a Licensed Contractor, therefore minimising the amount of waste being disposed of in landfill sites.

Reusing materials on site will reduce the embodied energy of the development through the reuse of the energy that exists in that material. Transportation of new material to the site will be reduced, reducing the CO_2 emissions associated with transportation and material manufacture.

Where waste will need to be disposed of, this will be done in line with the Waste Hierarchy, with as much as practicable being recycled, and the remainder being dealt with through a specialist waste recycling contractor. Nominal construction waste should be sent to landfill or for incineration unless this is unavoidable due to the materials found on the existing site.

Appropriate targets and benchmarks will be set, and documentation and evidence retained to fulfil the relevant BREEAM requirements.

Resource Management

Policies will be put in place for management of site impacts such as air and water pollution in line with industry best practice. Monitoring and reporting on carbon emissions and water use from site related activities will take place in line with national benchmarks.

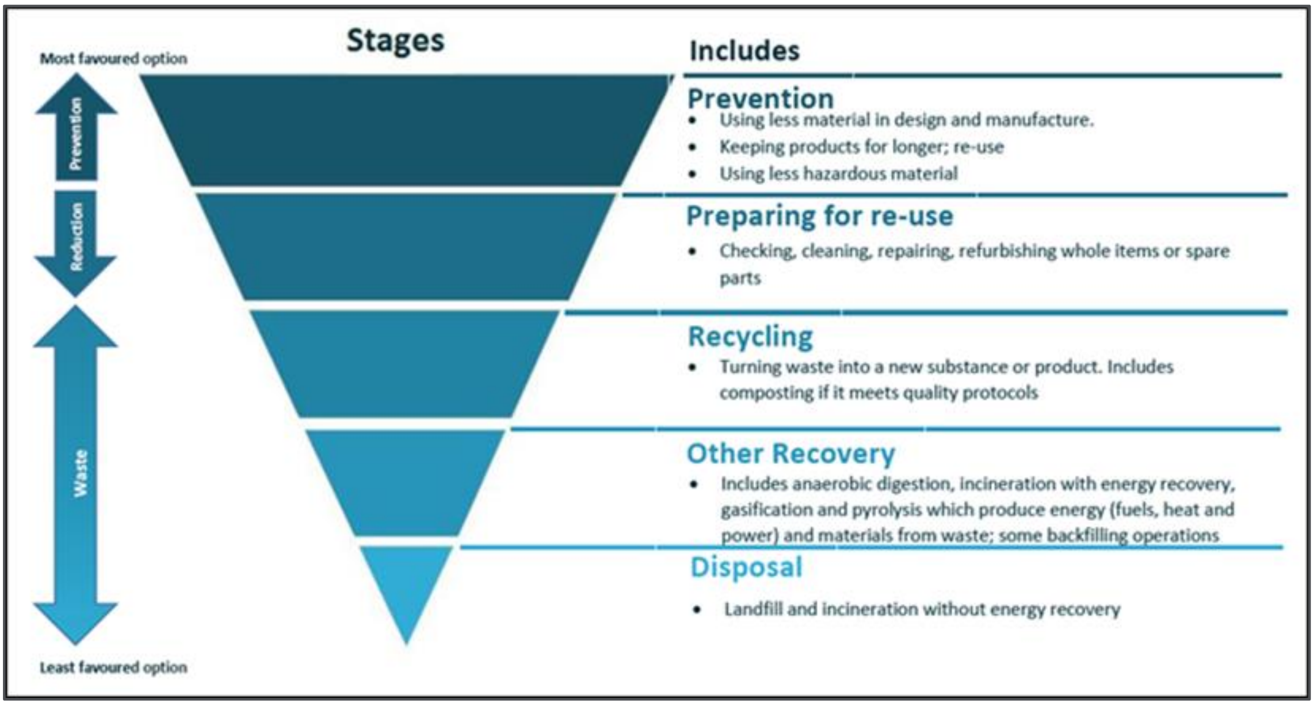


Figure 7 - The waste hierarchy

The overall management of the construction waste will be monitored through the Considerate Constructors Scheme as part of Best Practice Site Management.

Materials

The Proposed Development is to use high quality, low impact materials in order to minimise the overall impact on the environment as far as possible.

The form of construction is anticipated to be of either traditional load bearing masonry or a concrete and steel frame construction.

All timber materials for finishing elements will be sourced from FSC and/or PEFC sources and all other materials sourced from suppliers who have an accredited Environmental Management System (EMS) (ISO14001, BS8555 or BES6001) for the extraction and process stages of the material manufacturing, ensuring that any environmental impact caused by the building materials is analysed and mitigated where possible.

All timber and timber-based products use on-site will be legally sourced with appropriate Chain of Custody certification to confirm this.

As standard industry best-practice, all insulation on the site will have an Ozone Depletion Potential (ODP) of zero, and a Global Warming Potential (GWP) of <5, further minimising the Proposed Developments effect on global Climate Change.

Water

Areas of the South East of England have been declared areas of 'serious water stress', particularly Greater London. Water is a vital resource and efficient usage should be encouraged in all new buildings. The Proposed Development aims to significantly reduce mains water use through a combination of efficiency measures, including the use of fittings with a low capacity or flow restrictors to reduce water use and PIR sensors linked to water shut-offs valves to reduce the chances of water waste.

Internal water use will be reduced in line with BREEAM standards and an indicative specification has been given below, but the BREEAM Pre-Assessment should be consulted for definite targets.

- WCs: 4.00 litre effective flush volume
- If 1 urinal only: 2.00 litres/bowl/hour
- If 2 or more urinals at the site: 1.50 litres/bowl/hour
- Hand wash basin taps: 4.50 litres/min
- Kitchenette taps: 5.00 litres/min
- Showers: 6.00 litres/min
- Baths: 140 litres
- Domestic sized dishwashers (if installed) 12.00 litres/cycle
- Domestic sized washing machines (if installed) 40.00 litres/use
- Commercial sized dishwashers (if installed) 5.00 litres/rack
- Commercial sized washing machines (if installed) 7.50 litres/kg dry load

Passive Design Analysis

4.0 Passive Design Analysis

4.1 Site location

The Proposed Site is in the London Borough of Camden, Central London on Gordon Square and is an extension to an existing library facility.

The site is surrounded primarily by residential buildings and buildings associated with University College London, and is adjacent to Gordon Square which is a public open space. Other 'green' park areas can be found to the east at Tavistock Square Gardens and to the south at Russell Square.

4.2 Site weather

The overall climate of the South East of the UK does not vary greatly. The UK climate is classified as temperate (C), without a dry season (f), with a warm summer (b) – Cfb - by the Köppen climate classification scheme. This temperate region has the coldest months averaging between 0°C and 18°C and at least one month averaging above 10°C.

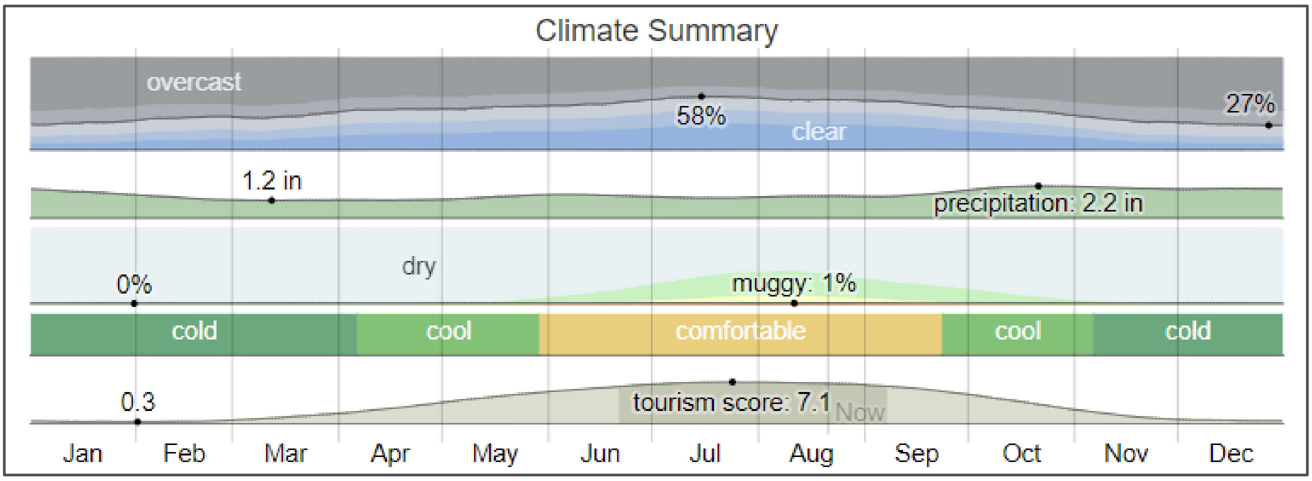


Figure 8 - Climate summary - London, UK (weatherspark.com)

The warmest months on average are July and August, which see the highest average maximum (Figure 9) and minimum (Figure 10) temperatures, while January and February are the coldest months with the lowest maximum and minimum temperatures.

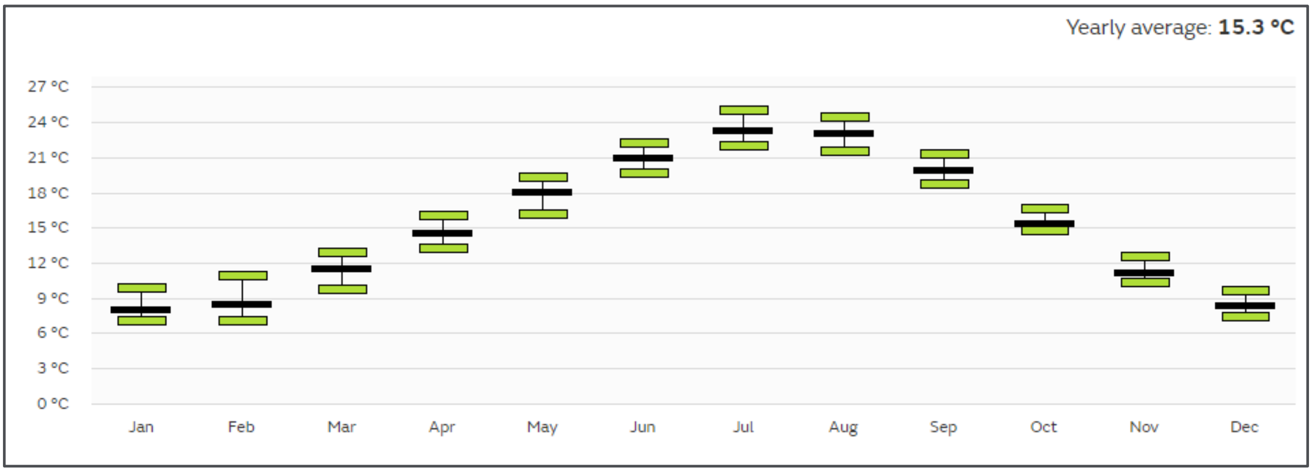


Figure 9 - Average maximum temperature - 80th percentile, average, 20th percentile – Greenwich Observatory, UK (metoffice.gov.uk)

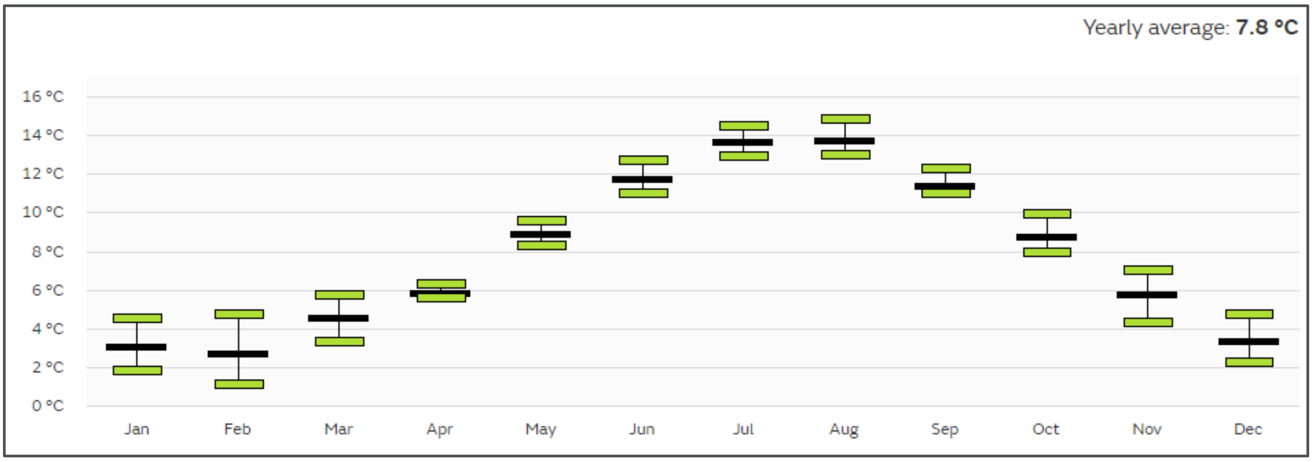


Figure 10 - Average minimum temperature - 80th percentile, average, 20th percentile – Greenwich Observatory, UK (metoffice.gov.uk)

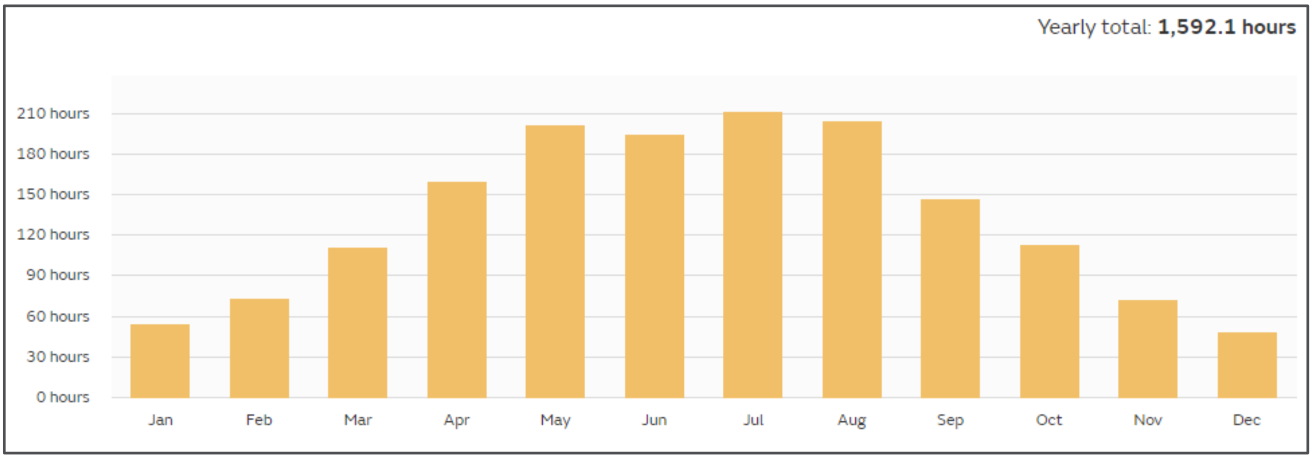


Figure 11 - Average sunshine hours - South East and Central South, England (metoffice.gov.uk)

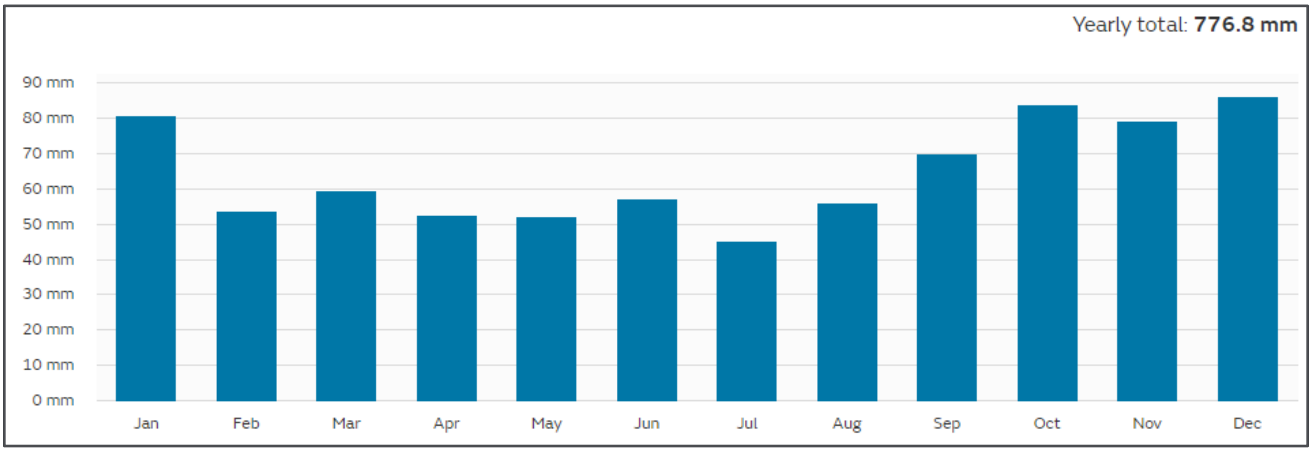


Figure 12 - Average rainfall - South East and Central South, England (metoffice.gov.uk)

Sunshine hours provide an indication of cloudiness vs sunshine hours. The South East and Central South England data shows that the Proposed Development will receive a yearly average of 1,592 hours of sunshine each year. This is higher than the UK average of 1,355 hours. July sees the most sunshine hours, averaging over 6 hours per day, while December sees the fewest, averaging just 1.5 hours per day.

Similarly, the South East and Central South England data shows that the Proposed Development will receive yearly average rainfall of 776.8mm per year, which is lower than the UK average of 1,126mm per year. The significantly lower rainfall than the UK average, coupled with the high population density of the area contributes to the water stress in the region.

4.3 Microclimate

An understanding of the characteristics of the urban microclimates allows Architects and Developers to make informed strategic design decisions with respect to not only the climatic impacts of their buildings, but also the effect of the resulting microclimatic variables on the performance of buildings. Particularly, the urban microclimates that will affect passive and low energy designs and the use of renewable technologies in urban areas. The urban wind and solar radiation data can be used for developing better design options for renewable energy technologies within urban environment.

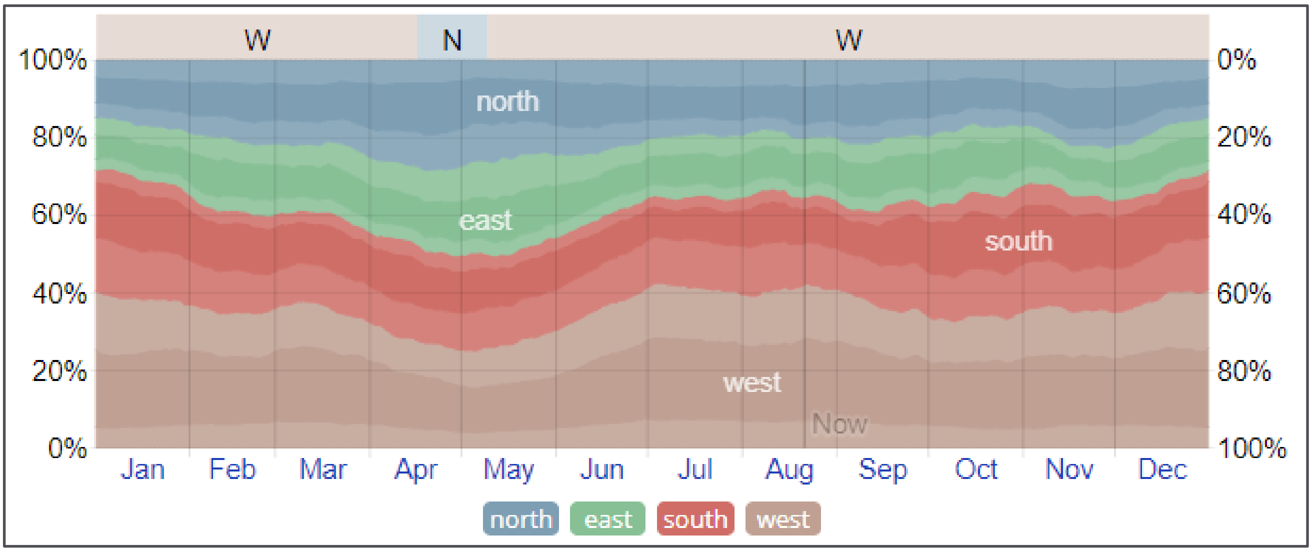


Figure 13 - Average wind direction (percentage of hours above 1mph), London, UK (weatherspark.com)

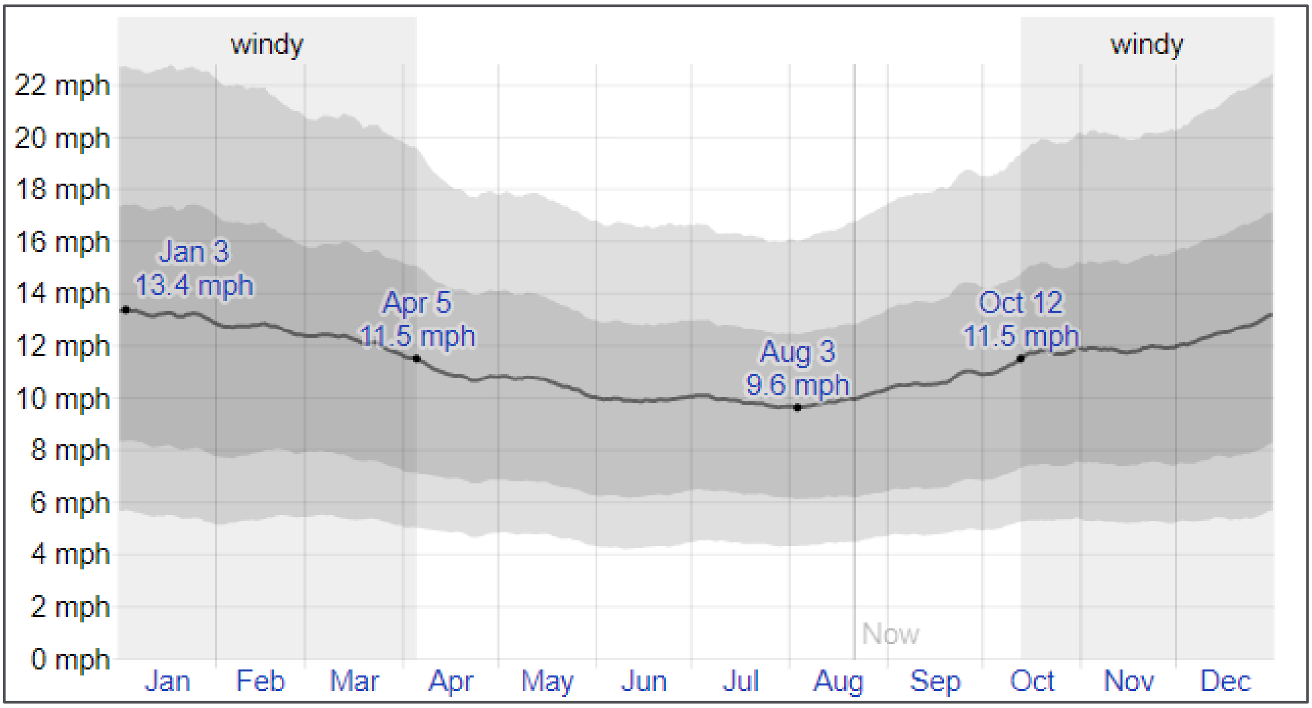


Figure 14 - Average wind speed - London, UK (weatherspark.com)

- The site is surrounded predominantly by medium-rise buildings.
- The Proposed Development is 4 storeys high (medium-rise).

- The overall forms of the buildings will have a limited impact on any surrounding buildings in terms of overshadowing and will not limit the available solar radiation.

Figure 13 and Figure 14 show that the predominant wind direction is from the west and south with average wind speeds varying between 13.4mph in December/January to 9.6mph in July/August. This seasonal variation needs to be considered when analysing the activities likely to be undertaken in a particular area. i.e. it is unlikely that outdoor seating areas will be used frequently in colder winter months, whilst in warmer, less windy summer months, it is expected that these areas would be used throughout the day.

As the area is predominantly low to medium-rise buildings, the wind acceleration caused by the built environment will be minimal. Without considering acceleration caused by the built environment, wind speeds are likely to be comfortable for long-term sedentary activities most of the time.

4.4 Building Layout

The proposed extension has been designed to allow easy flow between different areas with no change in level evident. Areas such as the stairwells which are to be created are to allow east vertical transportation of people, with large lobby spaces created on each floor, lit through the large opening provided facing the rear courtyard.

As the majority of the Proposed Development is to be for storage purposes, the orientation is inconsequential as there are no windows present. The lettable office space is provided with large, north facing windows which will provide adequate light for working, but reduce the potential risk of overheating.

4.5 Building orientation and form

The proposed extension has been positioned within the site boundary so that a rear courtyard is created. Surrounded by medium-rise buildings on all sides, this will help to screen the communal outdoor space from excessive winds.

The building form has been designed to provide shading to the glazed areas during the summer months when overheating risk is high. Additionally, high ceilings and large airy communal areas are intended to reduce the requirement for active cooling.

4.6 Building fabric

The exact construction method is yet to be decided, however, it will be either load bearing masonry or a concrete and steel frame. All elements of the thermal envelope will be highly insulated to reduce the heating requirement throughout the year. A low design infiltration rate ($5m^3/hr/m^2$) will also help to reduce the building heating requirement while openable windows in some areas will allow resident rooms to purge or manually ventilate as required and preferred. Mechanical ventilation will also be provided through the extension to provide background ventilation and maintain a comfortable internal environment.

4.7 Thermal mass

The overall building should have a medium thermal mass as construction will be either load-bearing masonry or a concrete and steel frame. A medium thermal mass will balance providing high energy efficiency and limiting overheating during the summer months.

4.8 Building occupancy type

Due to the nature of the building type, occupancy will never greatly exceed the design levels.

The number of visitors to the building at any one time is not expected to be increased due to the extension, albeit more comprehensive facilities are to be provided. High occupancy levels could be expected on odd occasions where small events or functions might be held. These are not expected to be overly frequent or excessive in attendees and will not affect the building design or overall energy strategy.

4.9 Daylighting strategy

All communal areas will have glazed areas to maximise natural daylight and enhance wellbeing. Most communal areas have large glazed areas, while storage rooms are to have no windows to preserve the documentation contained, and are to be artificially lit. The lettable office space provided will have large openings on the north elevation, providing good levels of daylight (whilst reducing overheating risk) to reduce the electrical lighting load in these areas. Roller blinds to control daylight and glare as required will also be provided.

The high levels of natural daylight within lettable areas and communal space will help to minimise the need for internal lighting, helping to reduce the energy use and subsequent carbon emissions of the site.

4.10 Ventilation strategy

In modern air-tight buildings, careful consideration needs to be given to the specification of ventilation systems to remove moisture and meet minimum ventilation standards, ensuring a healthy quality of internal air for building occupants.

Mechanical ventilation will be provided with heat recovery. Openable windows will allow the natural intake of fresh air directly where needed.

Active cooling is not proposed at this stage, with the internal temperature being managed through the ventilation system with summer bypass, and openable windows where these are provided.

No overheating risk has been identified at present but will be investigated further as part of the BREEAM assessment.

4.11 Adaptation to climate change

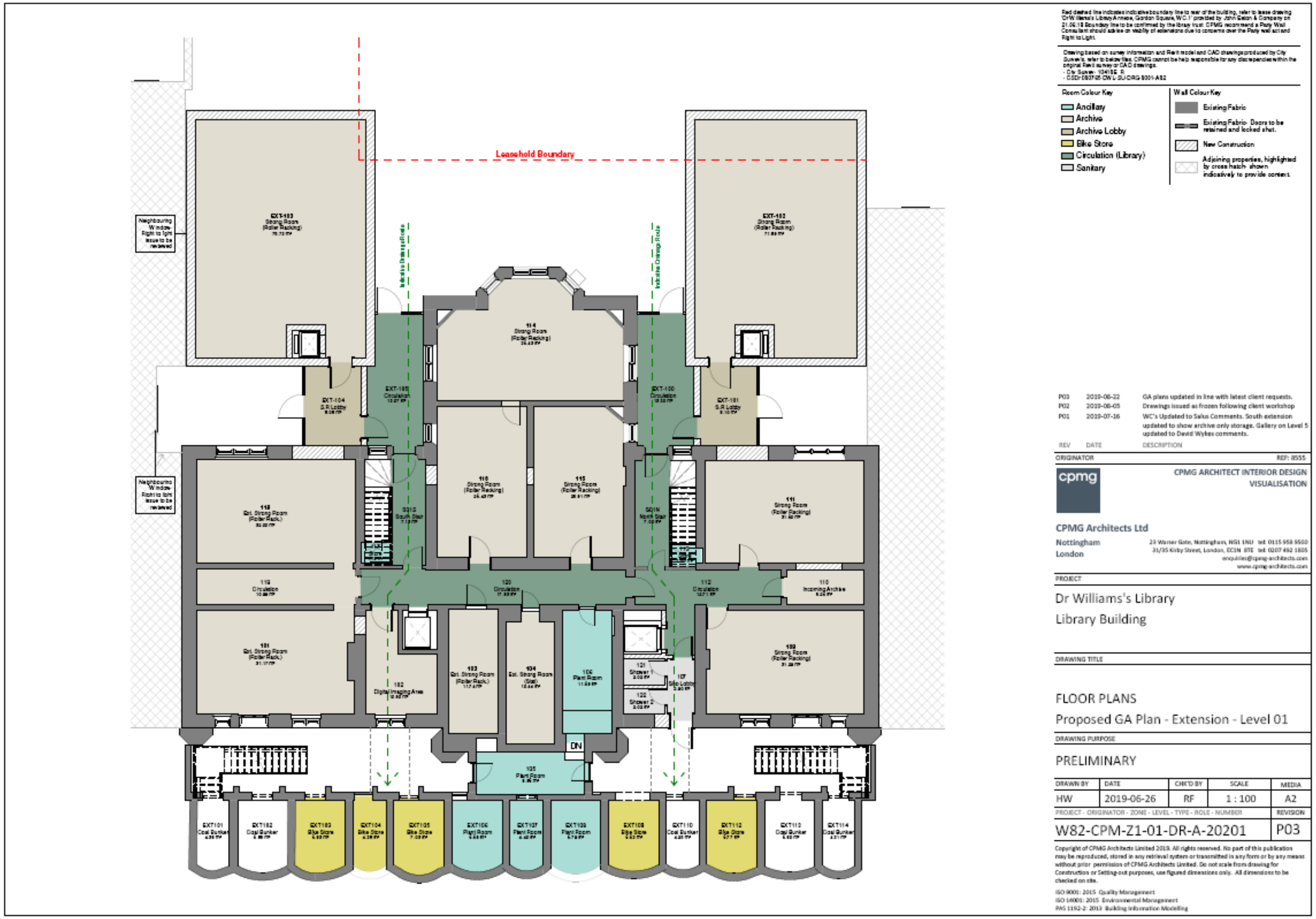
The proposed medium thermal mass and highly insulated thermal envelope will provide some protection from fluctuations in short-term outside temperature, including extreme weather events. The combination of mechanical and natural ventilation will provide efficient control of the indoor thermal environment which is important for health and wellbeing.

A full over-heating analysis compliant with CIBSE TM52 will be undertaken as part of the BREEAM Assessment of the site, and will look at the potential overheating of the site in extreme 2020 and 2050 scenarios.

The BREEAM compliant flood risk assessment will detail the site's approach to flood risk and drainage strategies for 1-year and 100-year return period events, accounting for any projected changes in precipitation and future flood risk as a result of climate change.

Appendix A

Appendix A – 'Level 1' Floor Plan



SRE

Appendix B – SBEM Summary Sheet (Gas Boiler and PV)

Building Regulations 2013 L2A

Dr. Williams Library Extension

Building Type	Address	As-Designed/As-Built Drawings	SBEM Level	Asset Rating (A-G) (0-150)	BER	TER	BER/TER Improvement (%)
D1: Library, museum or gallery	14 Gordon Square, Bloomsbury, London WC1H 0AR	As-designed	5	TBC	18.50	28.80	35.76%

Construction Element	U-Value	Description
External Wall	0.18	Cladding wall system, 150mm Rainscreen Duo Slab with 140mm Rockwool Flexi/100mm Celotex RS5100.
Ground Floor	0.14	20mm floor finish, 200mm RC slab, 150mm PIR insulation, 50mm sand, 300mm clay. TBC
Roof	0.16	120mm PU/PIR insulation. TBC

Construction Element	U-Value	G Value	Frame Factor	Description (manufacturer, make and model)
External Window	1.40	0.63	10%	Light Transmittance 71%. Average value for U and G-Value

Construction Notes	Description (manufacturer, make and model)
Construction Details	Standard
Air-permeability	5

Heating and Cooling	System Details	Emitter	Controls
Heating System 1	Gas Boiler, 93% efficiency	Underfloor	Time, temperature and zone control.
CHP	none		

Hot Water	System Details	Secondary Circulation	Circulation Losses (W/m)	Pump Power (kW)	Loop Length (m)	Storage Tank (l)	Storage Losses (kWh/l.day)
Hot Water System	Gas boiler, 93% efficiency	N	n/a	n/a	n/a	n/a	n/a

Ventilation	System Details	SFP (W/l/s)	Leakage tested ductwork CEN Classification	AHU CEN leakage standards class	Heat Recovery	Heat Recovery Efficiency (%)	Heat Recovery Type	Variable HR
Mechanical Ventilation (MVHR)	In lettable office, strong rooms and lobbies.	1.20	n/a	n/a	N	80%	Plate heat exchanger	n/a

Electrical Flow Control		Description
Power Correction Factor	N	<0.9
Separate Metering	Y	Separate sub metering for lighting and small power, with "out-of-range"

Renewables	Description
PV	9.6 kWp of PV to achieve 35% BER/TER improvement. Based on 30 no. 320W panels, 230 degree clockwise from north @ 10 degree pitch. 48 sq. m active panel area.
Solar Water Heating	N
Wind Turbine	N

Lighting	Description
Lighting	100 lm/W
Lighting Controls	Combined daylight and PIR sensor in areas with adequate daylight (lettable office and lobby areas), PIR sensors in all other areas.
Parasitic power	0.1 W/m^2

Sign Off of details	Name	Xinlong Wang	Date	19.09.2019	By signing this document, I declare that the aforementioned details are all correct as per the final "As-Built" specifications:	Name		Date	
						Sign			

Appendix C – Unfeasible Low and Zero Carbon Technologies

Communal Systems

The Proposed Development is a single building, and therefore the use of a communal system is not possible.

Biomass Boiler

Biomass boilers generate heat from the burning of renewable or 'waste' fuels. They require a regular feed of fuel and regular heat demand to operate efficiently. A flue taller than the surrounding buildings must be incorporated into the design to minimise air pollution impacts at ground level from particulate emissions.

The use of a biomass boiler system to supply space heating and DHW has been deemed unsuitable as the low DHW demand would not provide a stable heating demand during the summer months.

Wind Power

Wind power is a developed and productive method of renewable energy generation, however the main limiting factor to its implementation is opposition at a local public and local government level.

To generate a meaningful amount of electricity, large-scale turbines are required which have noise and the visual impacts for the local area. The use of wind turbines has therefore been deemed unsuitable.

Solar Water Heating

Solar Water Heating (SWH) can be used to offset a proportion of the domestic hot water demand (DHW) within a building.

However, due to the low DHW demand at the Proposed Development it is likely to provide minimal CO_2 emissions reductions, while takin up roof-space, better utilised for photovoltaics.

Appendix D – BRUKL (Gas Boiler and PV)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Dr Williams Library Extension

As designed

Date: Thu Sep 19 11:14:59 2019

Administrative information

Building Details

Address: 14 Gordon Square, London, WC1H 0AR

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.12

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.12

BRUKL compliance check version: v5.6.a.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Xinlong Wang

Telephone number: 01730 710044

Address: SRE Ltd, Greenforde Farm, Stoner Hill Road, Froxfield, Petersfield, GU32 1DY

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	18.5
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	XT00000D:Surf[0]
Floor	0.25	0.14	0.14	XT000001:Surf[0]
Roof	0.25	0.16	0.16	XT000017:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.4	1.4	XT000012:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- Gas Boiler Mech Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.93	-	0.2	0	0.8
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- Gas Boiler DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.93	-
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
EXT-105-Circulation	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-100-Circulation	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-107-Ext Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-101-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-202-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-201-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-203-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-200-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-303-Circulation	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-300-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-302-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-301-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-403-Circulation	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-400-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-402-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
EXT-401-Strong Room	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-103-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A
EXT-100-Strong Room Lobby	-	-	-	1.2	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
EXT-105-Circulation	-	100	-	33
EXT-100-Circulation	-	100	-	32
EXT-107-Ext Strong Room	-	100	50	251
EXT-101-Strong Room	-	100	50	241
EXT-202-Strong Room	-	100	50	246
EXT-201-Strong Room	-	100	50	236
EXT-203-Strong Room Lobby	-	100	-	16
EXT-200-Strong Room Lobby	-	100	-	16
EXT-303-Circulation	-	100	-	23
EXT-300-Strong Room Lobby	-	100	-	23
EXT-302-Strong Room	-	100	50	261
EXT-301-Strong Room	-	100	50	251
EXT-403-Circulation	-	100	-	21
EXT-400-Strong Room Lobby	-	100	-	21
EXT-402-Strong Room	-	100	50	257
EXT-401-Strong Room	-	100	50	247
EXT-103-Strong Room Lobby	-	100	-	53
EXT-100-Strong Room Lobby	-	100	-	53

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
EXT-107-Ext Strong Room	N/A	N/A
EXT-101-Strong Room	N/A	N/A
EXT-202-Strong Room	N/A	N/A
EXT-201-Strong Room	N/A	N/A
EXT-302-Strong Room	N/A	N/A
EXT-301-Strong Room	N/A	N/A
EXT-402-Strong Room	N/A	N/A
EXT-401-Strong Room	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	736.3	736.3
External area [m²]	1491.9	1491.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	491.19	878.21
Average U-value [W/m²K]	0.33	0.59
Alpha value* [%]	10.08	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
100	**D1 Non-residential Institutions: Libraries, Museums, and Galleries**
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	20.68	26.35
Cooling	0	0
Auxiliary	11.42	5.41
Lighting	24.9	39.84
Hot water	0.89	0.87
Equipment*	13.12	13.12
TOTAL**	**57.89**	**72.46**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	9.58	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	65.03	81.78
Primary energy* [kWh/m²]	137.81	168.65
Total emissions [kg/m²]	18.5	28.8

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	65	0	20.7	0	11.4	0.87	0	0.93	0
	Notional	81.8	0	26.3	0	5.4	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	- Heating energy demand
Cool dem [MJ/m2]	- Cooling energy demand
Heat con [kWh/m2]	- Heating energy consumption
Cool con [kWh/m2]	- Cooling energy consumption
Aux con [kWh/m2]	- Auxiliary energy consumption
Heat SSEFF	- Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	- Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	- Heating generator seasonal efficiency
Cool gen SSEER	- Cooling generator seasonal energy efficiency ratio
ST	- System type
HS	- Heat source
HFT	- Heating fuel type
CFT	- Cooling fuel type

Page 6 of 7

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.18	XT00000D:Surf[0]
Floor	0.2	0.14	XT000001:Surf[0]
Roof	0.15	0.16	XT000017:Surf[0]
Windows, roof windows, and rooflights	1.5	1.4	XT000012:Surf[0]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

U_{i-Typ} = Typical individual element U-values [W/(m²K)] U_{i-Min} = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

Appendix E – GLA SAP 10 tables

Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	15	
After energy demand reduction	12	
After heat network / CHP	0	
After renewable energy	10	

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	3	20%
Savings from heat network / CHP	12	80%
Savings from renewable energy	-10	-66%
Total Cumulative Savings	**5**	**34%**

Table 5: Shortfall in regulated carbon dioxide savings

	Annual Shortfall (Tonnes CO_2)	Cumulative Shortfall (Tonnes CO_2)
Total Target Savings	5	-
Shortfall	0	5
Cash in-lieu contribution (£)	**320**	-

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