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Daylighting Analysis

North Kensington New Library Youth Centre & Educational Establishment

London, W11 1QS

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1.0 EXECUTIVE SUMMARY

This report has been produced to assess the daylighting credit criteria associated with the BREEAM New Construction 2014 of the North Kensington Library Youth Centre and Educational Establishment. The aim of the daylighting analysis study is to advise on the proposed development's performance in achieving the Daylighting component of the Hea 01 – Visual Comfort criteria.

The results show that **1 credit can be achieved** for BREEAM Hea 01 - Daylighting.

2.0 INTRODUCTION

This report has been produced to summarise the results of the daylighting analysis for the proposed North Kensington Library Youth Centre and Educational Establishment. The objective of this study is to advise on the buildings performance against the '*Daylighting'* BREEAM credit under Hea 01 –Visual Comfort. It is understood the project is being assessed under the BREEAM New Construction 2014 Scheme.

2.1 Background

The CIBSE Lighting Code suggests that when the average Daylight Factor (DF) is below 2%, in a building which is used mainly during the day, supplementary electric lighting will be needed almost permanently to achieve adequate lighting levels. However, a DF exceeding 5% should significantly reduce the requirement for electric lighting, providing reduced energy consumption and good daylight within spaces.

The level of daylighting within a space needs to be balanced against the negative effect of high heat gains, and an average DF of between 2% and 5% is therefore recommended. When this is achieved, the electric lighting design should be planned to take full advantage of the available daylight, through design and the specification of controls.

The uniformity ratio defines the ratio between the minimum illuminance and average illuminance on a defined working plane. A higher uniformity ratio indicates that light levels on the working plane will not vary considerably, and if a good daylight factor is achieved, this can be assumed to be consistent throughout the space.

An alternative method of showing adequate natural light can be achieved throughout the room is demonstrating a view of sky can be achieved from desk height and a room depth criterion is satisfied.

2.2 BREEAM Daylighting Criteria

The following is extracted from the BREEAM New construction 2014 technical manual for the Hea 01 – Daylighting credit guidance.

The spaces shall be considered under Teaching, lecture and seminar spaces in Table 10 of the BREEAM New Construction 2014 Technical Manual.

Up to one credit - Daylighting

1. Up to one credit is awarded for this building area type (Teaching, lecture and seminar spaces) depending on the relevant building areas that comply with either A) or B) of the following daylighting criteria:

EITHER;

A. The relevant building areas achieve an **average daylight factor** (ADF) of 2% for 80% net lettable area (NLA) for all relevant spaces.

AND EITHER;

a. A **uniformity ratio** of at least 0.3 **or a minimum point daylight factor** of at least 0.3 times the relevant average daylight factor value in Table 10. Spaces with glazed roofs, such as atria, must achieve a uniformity ratio of at least 0.7 or a minimum point daylight factor of at least 0.7 times the relevant daylight factor in Table 10.

OR

b. At least 80% of the room has a **view of sky** from desk or table top height (0.7m for this building).

AND

c. The **room depth criterion** is satisfied;

$$d/w + d/H_W < 2/(1-R_B)$$

Where:
d = room depth
w = room width
H_W = window head height from floor level
R_B = average reflectance of surfaces in the rear half of the room

OR;

B. The relevant building areas meet good practice criteria as follows;
   a. **Average daylight illuminance** of at least 300 lux for 2000 hours per year or more
   b. **Minimum daylight illuminance at worst lit point** of at least 90 lux for 2000 hours per year or more

3.0 METHODOLOGY

The building has been modelled using IES, Virtual Environment software. This software creates a dynamic thermal model, within which FlucsDL® can be used to model the effect of daylighting on the building.

FlucsDL® is a recognised tool, which uses a three-dimensional geometric model of the physical environment which can be used for point-by-point analysis to determine daylighting levels within a room, or group of rooms.

For this study, FlucsDL® has been used to calculate the Average Daylight Factor (ADF) and the uniformity ratio within each of the assessed internal spaces.

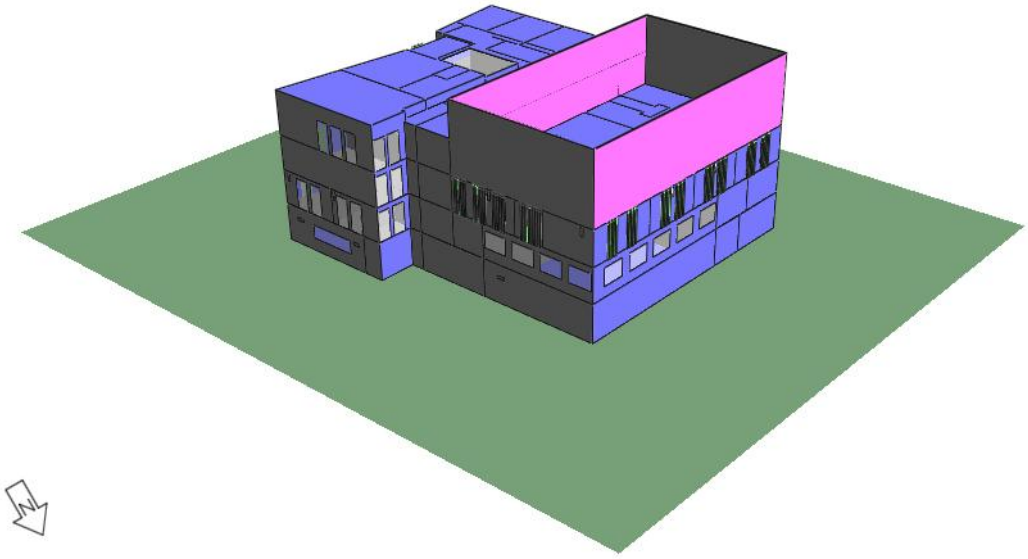

Figure 1: Axonometric North view of IES model

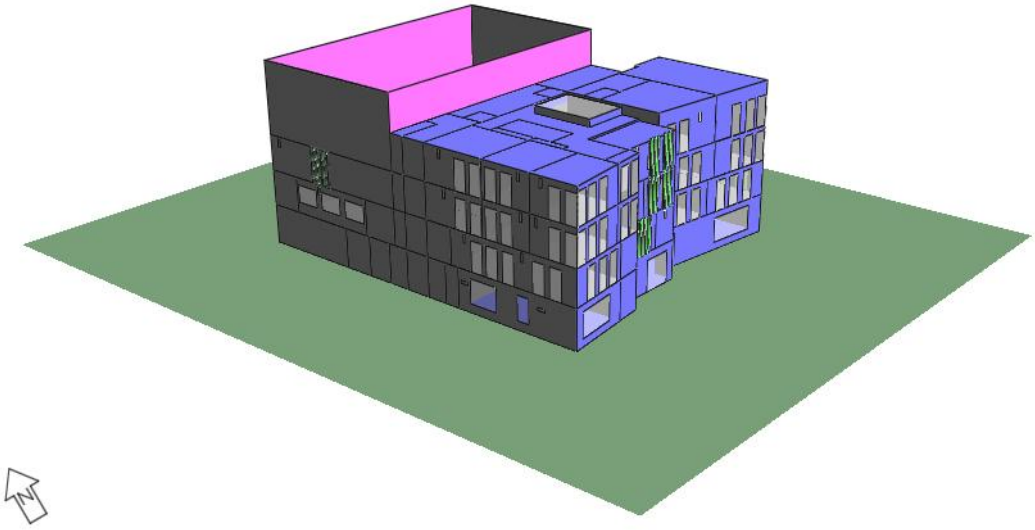

Figure 2: Axonometric South view of IES model

When assessing the view of sky and room depth criterion, the latest architectural drawings dated 02/09/16 have been referred to and used to determine dimensions.

The approach taken within this study is described below:

1. **Define areas to be assessed and modelled**
   - The assessment in relation to BREEAM requires the daylight analysis to be conducted in spaces that are expected to be occupied for a minimum of 30 minutes. The proposed development will constitute open-plan library and youth centre space, administrative and staff offices and teaching spaces. All these spaces have been modelled in the daylighting study. Appendix A shows a list of the rooms analysed in this report.

   - The areas selected and modelled are considered to give an accurate representation of all occupied spaces within the development requiring assessment.

2. **For each of the relevant modelled areas, the following have been calculated:**
   a) Average Daylight Factor;
   b) Percentage floor area above threshold;
   c) Uniformity ratio;
   d) View of sky;
   e) Average daylight illuminance; and
   f) Minimum daylight illuminance.

3. **Assess compliance with the BREEAM criteria**
   - Each area identified within the BREEAM assessment has been checked to determine whether it meets the daylighting criteria for the targeted number of credits.

4.0 ASSUMPTIONS

A number of assumptions have been made during the modelling and these are summarised below:

4.1 Sky Conditions

A CIE (Commission Internationale de L'Eclairage) Overcast Sky has been assumed. This is the standard used throughout Northern Europe for calculating daylight and it is considered to be:

- Three times brighter overhead than it is on the horizon; and
- Of the same brightness in all compass directions.

Convention assumes that if a building is designed for daylighting according to the CIE Overcast Sky conditions then, when outdoor illuminance is brighter, the natural lighting performance will be significantly better.

It is assumed that the minimum yearly average outdoor illumination is 5,000 lux for 85% of a normal working day. This represents a dull day. By the same standard a sunny day is assumed to be 100,000 lux. This is the maximum design illuminance.

4.2 Working Plane

The simulation calculates the illuminance on a notional working pane. For this assessment, a working pane of 0.7m above floor level has been assumed for each room, which is in line with the desk height assumed within the BREEAM criteria.

4.3 Surface Properties

The following gazing and internal surfaces properties have been assumed:

Table 1- Surface Materials Assumptions

Building Element	Material Types	Light Reflectance Value		Transmittance
		Inside	Outside	
Internal Partition	Default value - Light coloured walls	50%	50%	N/A
Internal Floor/Ceiling	White emulsion on acoustic tiles	20% (floor) 70% (ceiling)	N/A	N/A
External Wall	Default value	50%	10%	N/A
External Glazing and Skylight	Default value	7%	7%	70%
Ground/Exposed Floor	Oak timber	25%	N/A	N/A

5.0 RESULTS

The following images show the variation in Daylight Factor across each relevant space on each floor of the Building.

Ground Floor

This image shows that there is a high daylight factor in the double height reading room and around the lightwell which is to be expected as there is a higher proportion of glazing in these spaces.

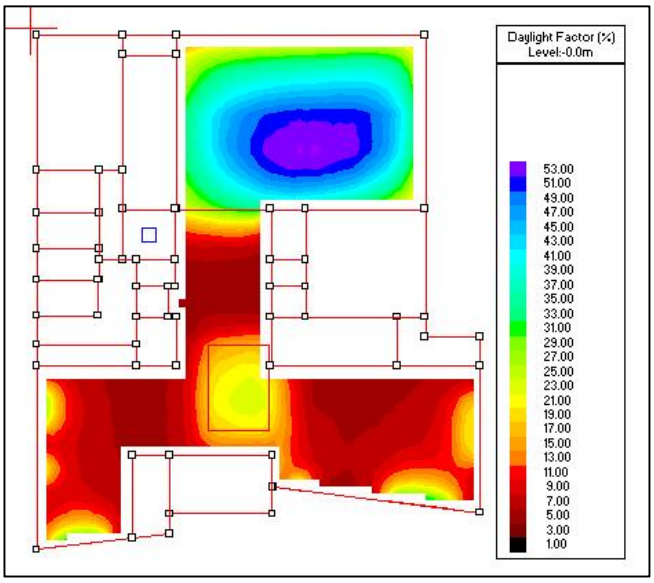

Figure 3: Ground Floor Library Plan Daylight Factor Results

First Floor

This image shows a high level of light filtering from the double height reading room into the central zone of the Youth Centre Flexible Space. Predictably, there is a higher daylight factor concentrating around glazed areas of the perimeter.

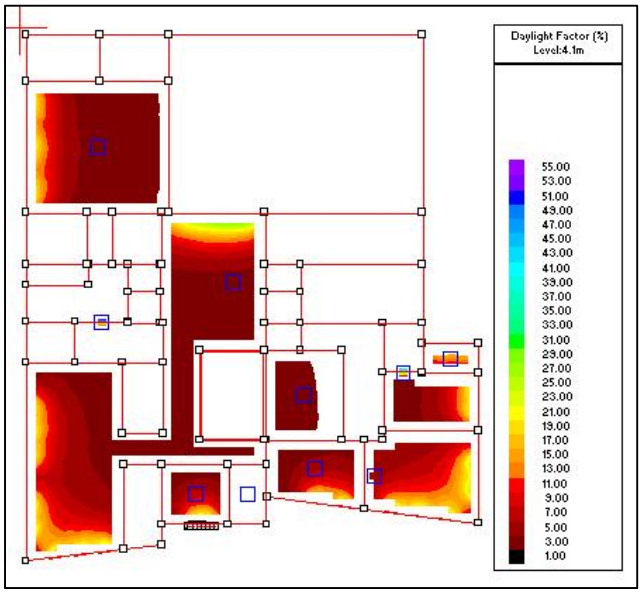

Figure 4 – First Floor Daylight Factor Results

Second Floor
The second floor shows a high daylight factor in the dance hall space. This is to be expected as the space is double height with a higher proportion of glazing per m² floor area than single height spaces.

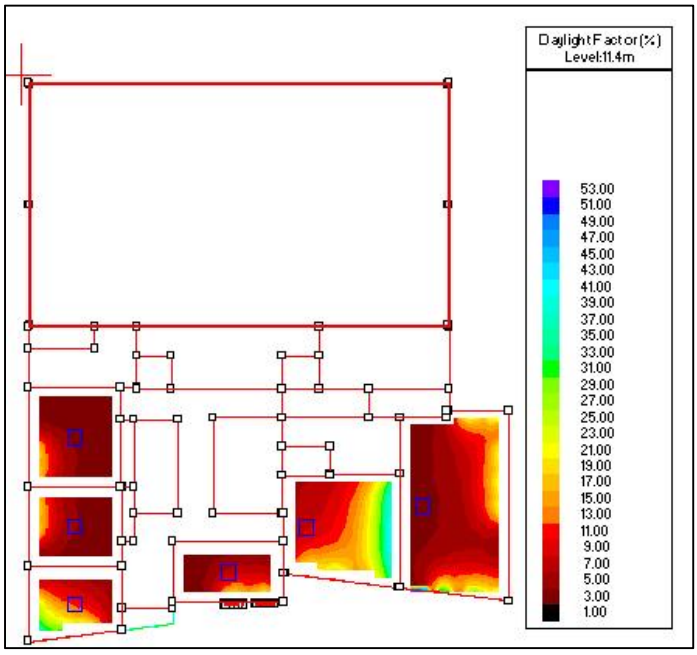

Figure 5 - Second Floor Classroom Daylight Factor Results

Third Floor
This image shows a high level of daylight in the double height dining area and around the perimeter where there is glazing.

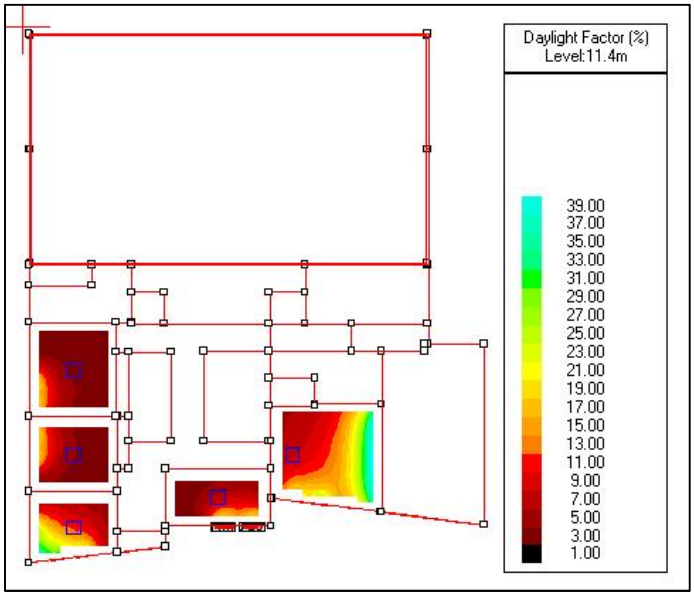

Figure 6 - Third Floor Classroom Daylight Factor Results

A detailed set of results is shown in Appendix A. A summary of the ADF and percentage floor area above threshold can be seen in Table 1 below. This table shows a summary whereby 98% of relevant areas are meeting the criteria to

achieve the Hea 01 Daylighting credit that is available for this development under BREEAM New Construction 2014.

Table 2 – Summary/Average of Results for Relevant Areas

% floor area above threshold	98%
Area Weighted Average Daylight Factor	12.4%
Average Daylight Illuminance	817 lux
Average Minimum Daylight Illuminance	270 lux
Average Minimum Point DF	2.2%
Average Uniformity Ratio	0.31

The results from the analysis show that this Building **complies** with both Criteria A and Criteria B for 98% of the NLA. Appendix A includes a full set of tabulated results and thresholds that the results are analysed against.

6.0 CONCLUSION AND RECOMMENDATIONS

This daylighting study for the proposed North Kensington Library Youth Centre and Educational Establishment has been conducted to assess the daylighting performance of all relevant areas.

In accordance with BREEAM's definition of *relevant areas*, the study has assessed the daylight performance of the Library, Youth Centre, Teaching Classrooms and Administrative Office Spaces to assess the criteria required to achieve the credits.

The Ground Floor Library has an Average DF of 20% which can be interpreted as an area requiring little or no artificial lighting provided external conditions are similar to that simulated within the model (worst case scenario of an overcast sky). Further up the building daylight factors reduce but are still significant to take advantage of daylight and reducing the amount of artificial light used.

Typically, areas further from the perimeter had lower average DF though sufficient daylight factors were still being achieved in these spaces. Artificial lighting may be required in these areas to enable occupants to carry out tasks though this may be able to be reduced depending on localised use of the space. Artificial lighting will be required for daytime use, however, the floor should utilise daylight through daylight/artificial lighting control measures (e.g. daylight sensing-dimming luminaires), to reduce energy usage.

6.1 Average Daylight Factor (ADF)

The ADF is 12.4% for 98% of the spaces analysed, which exceeds the minimum 2% ADF for 80% floor area requirement defined in BREEAM. Detailed results showing the ADF for each relevant area in the building is shown in Appendix A.

6.2 Minimum point DF

The average Minimum Point Daylight Factor is 2.2% and exceeds 0.6 for all relevant spaces. Results for each room are shown in the table of results in Appendix A.

6.3 Uniformity Ratio

The average Uniformity Ratio is 0.31 which does meet the threshold value of 0.3 (0.7 for GF library with Atria). Results for each space are shown in the table of results in Appendix A. It should be noted that there are many spaces which fall below the 0.3 threshold.

6.4 View of Sky (VOS)

The view of sky minimum requirement of 80% has been achieved in all spaces assessed through this study, as 98% of the NLA for relevant areas complies with this criterion.

6.5 Room Depth Criterion

The room depth criterion has not been analysed as the Building already meets the Hea 01 – Daylighting criteria without this analysis.

6.6 Average Daylight Illuminance (lux)

The average of the Average Daylight Illuminance for each relevant space analysed across the building is 817lux. Detailed results for each space are shown in Appendix A.

6.7 Minimum Daylight Illuminance (lux)

The Building achieves an average Minimum Daylight Illuminance of 270lux which meets the 90lux minimum required by BREEAM New Construction 2014. Detailed results for each space can be found in Appendix A.

6.8 BREEAM Hea 01 Credits

The results show that 1 credit can be achieved for BREEAM New Construction 2014 Hea 01 – Daylighting.

APPENDIX A

DETAILED RESULTS

THRESHOLDS SUMMARY

	Spaces without Atria/ Rooflights	*with atria/ rooflights
Average Daylight Factor	2%	2%
Floor area compliant	80%	80%
Minimum point DF	0.6%	1.4%
Uniformity ratio	0.3	0.7
Visible sky	80%	80%
Room depth criterion	Not analysed	Not analysed
Avge Daylight Illuminance / lux	300	300
Min Daylight Illuminance / lux	90	90

RESULTS

			A						B		
Room	Room ref	Area m2	Average Daylight Factor	Floor area complies	Min point DF	Uniformity Ratio	Visible Sky	Room depth criterion	Average Daylight Illuminance	Minimum Daylight Illuminance	Criteria Met
First Floor - kitchen staff spacing and hot desks	FR000007	82.65	3.70%	100%	1.0%	0.26	100%	-	457.44	120	A
First floor - classroom	FR000013	26.32	1.20%	0.00%	0.2%	0.21	100%	-	145.61	30.36	-
First floor - Art	FR000014	38.103	9.50%	100%	3.2%	0.34	100%	-	1161.25	391.27	A & B
First Floor Classroom	FR000017	22.485	5.20%	100%	1.8%	0.35	100%	-	632.83	219.21	A & B
First floor Headteachers office	FR00000E	3.72	11.80%	100%	8.8%	0.74	100%	-	1444.66	1072.54	A & B
First floor Administration	FR000019	19.39	5.60%	100%	2.0%	0.4	100%	-	687.6	247.52	A & B
First Floor - Music Room	FR00000D	13.26	5.90%	100%	1.9%	0.33	100%	-	720.53	236.77	A & B
Second Floor - Classroom	SC00000F	20.935	11.80%	100%	3.9%	0.33	100%	-	1447.65	481.54	A & B
Second Floor - Staff	SC000011	12.16	8.10%	100%	3.3%	0.41	100%	-	991.76	405.05	A & B
Second floor - Head teacher's office	SC000012	6.08	0.00%	0.00%	0.0%	0	0%	-	0	0	-
Second floor - classroom	SC000009	32.64	4.00%	100%	1.1%	0.27	100%	-	490.38	132.84	A & B
Second floor - classroom	SC00000D	27.36	4.70%	100%	1.2%	0.25	100%	-	576.48	146.72	A & B
Second floor - classroom	GR000020	33.6	4.00%	100%	1.1%	0.27	100%	-	485	130.75	A & B
Second floor - classroom	SC000022	27.36	4.70%	100%	1.2%	0.26	100%	-	579.3	148.61	A & B
Second floor - classroom	SC000023	29.92	5.70%	100%	1.8%	0.3	100%	-	698.05	220.97	A & B
Second Floor - Science	SC000024	31.86	3.30%	100%	1.1%	0.32	100%	-	405.04	130.33	A & B
Second floor - classroom	SC000025	24.37	4.30%	100%	1.4%	0.3	100%	-	524.32	174.71	A & B

Third floor - classroom	TH000008	21.44	5.60%	100%	1.4%	0.25	100%	-	683.88	174.21	A & B
Third floor - classroom	TH00000A	20.935	11.90%	100%	4.0%	0.34	100%	-	1448.6	488.13	A & B
Third floor - classroom	TH000009	24.75	4.30%	100%	1.4%	0.3	100%	-	523.23	169.06	A & B
Third floor - classroom	TH00000C	31.86	3.30%	100%	1.1%	0.32	100%	-	404.89	130.18	A
Third floor - MUSIC/PERI	TH000013	45.138	15.40%	100%	4.6%	0.3	100%	-	1879.43	560.59	A & B
Third Floor – double height dance	TH000012	78.217	7.50%	100%	1.6%	0.2	100%		914.54	197.5	A & B
Ground Floor - library*	GR000009	567.814	21.00%	100%	4.0%	0.19	100%	-	2566.26	493.55	A & B
Youth Centre Flexible Space	FR000005	164.559	5.30%	100%	1.5%	0.27	100%	-	652.16	177.72	A & B
AVERAGES					2.2%	0.31			817	270	