SHD Development at Drumbiggle, Ennis, Co. Clare

Daylight & Sunlight Assessment

Project Ref: 20191

Client: Glenveagh

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Report by:
Building Performance Consulting Engineers

BPC ENGINEERS

BUILDING PERFORMANCE CONSULTING

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P4-01	Final Analysis: Issue for Comment	21/07/2022	S. O'Riordan	S. O'Riordan
P5-01	Site description updated	15/08/2022	S. O'Riordan	S. O'Riordan

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Glossary

Illuminance
A measure of the amount of light falling on a surface, usually measured in lux.

Target illuminance (E_T)
Illuminance from daylight that should be achieved for at least half of annual daylight hours across a specified fraction of the reference plane in a daylit space.

Minimum target illuminance (E_{TM})
Illuminance from daylight that should be achieved for at least half of annual daylight hours across 95% of the reference plane in spaces with vertical and/or inclined daylight apertures.

Daylight factor (D)
Ratio of total daylight illuminance at a reference point on the working plane within a space to outdoor illuminance on a horizontal plane due to an unobstructed CIE standard overcast sky. Thus a 1% DF would mean that the indoor illuminance at that point in the space would be one hundredth the outdoor unobstructed horizontal illuminance.

Daylight, natural light
Part of global solar radiation capable of causing a visual sensation. (CIE, 2020) (Combined skylight and sunlight.)

No sky line
The outline on the working plane of the area from which no sky can be seen.

Obstruction Angle
The angular altitude of the top of an obstruction above the horizontal, measured from a reference point in a vertical plane in a section perpendicular to the vertical plane.

Skylight
Part of *diffuse* sky radiation capable of causing a visual sensation. (CIE, 2020)

Sunlight
Part of direct solar radiation capable of causing a visual sensation. (CIE, 2020)

Annual Probable Sunlight Hours (APSH)
The long-term average of the total number of hours during the year in which direct sunlight reaches the unobstructed ground (when clouds are considered).

Winter Probable Sunlight Hours (WPSH)
The long-term average of the total number of hours between the 21st of September and the 21st of March in which direct sunlight reaches the unobstructed ground (when clouds are considered).

Vertical Sky Component (VSC)
Ratio of that part of illuminance, at a point on a given vertical plane, that is received directly from a sky of assumed or known luminance distribution (usually CIE standard overcast sky), to illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. Usually the 'given vertical plane' is the outside of a window wall. The VSC does not include reflected light, either from the ground or from other buildings.

Reference plane or working plane
Horizontal, vertical or inclined plane in which a visual task lies. Normally the working plane may be taken to be horizontal, 0.85 m above the floor in houses and factories, 0.7 m above the floor in offices.

Spatial Daylight Autonomy (sDA)
Spatial Daylight Autonomy (sDA) is a metric describing annual sufficiency of ambient daylight levels in interior environments. It is defined as the percent of an analysis area that meets a minimum daylight illuminance level for a specified fraction of the operating/daylight hours per year. The sDA value is expressed as a percentage of area.

1 Executive Summary

The results show that the proposed development will have a negligible impact on surrounding buildings with respect to:

- access to skylight,
- access to sunlight, and
- sunlight to gardens/open spaces.

All rooms tested in the proposed development meet the minimum recommendations for internal daylight provision as set out in the BRE Guide and BS EN 17037 (National Annex).

The results show that all maisonette units meet the minimum recommendation for sunlight. 11 out of 12 apartment units (92%) meet the minimum recommendation for sunlight. All of the house types tested also meet the minimum recommendation for sunlight.

With respect to the apartments and maisonette units, for which all units were tested, the results show that the number of units meeting the sunlight criteria has been maximised with only one 1 out 18 of these units failing.

All communal amenity spaces and the creche amenity space in the proposed development should receive more than 2 hours of sunlight on March 21st. Therefore, the proposed amenity spaces exceed the BRE 's recommendation for sunlight to open spaces and should appear adequately sunlit throughout the year.

Overall, the development has been designed with due consideration for sunlight and daylight and meets the recommendations as set out in the BRE Guide – BR 209 "Site Layout Planning for Daylight and Sunlight, A guide to good practice (2022)."

2 Introduction

Site layout planning to achieve good daylighting and sunlighting, within buildings and in the open spaces around them is an important aspect in designing new buildings or developments. Daylight animates an interior and makes it attractive and interesting, as well as providing light to work or read by. Good daylight and sunlight can contribute to making a building energy-efficient; they can reduce the need for electric lighting, while winter solar gain can reduce heating requirements.

This report provides information on the daylight and sunlight analysis undertaken for the proposed Strategic Housing Development (SHD) at Drumbiggle, Ennis Co. Clare.

The proposed development site is a greenfield site located between the N85 and R474 (Circular Road) about 2km southwest of Ennis town centre. The site is adjacent to Ennis Golf Club to the north and east. There are some residential houses adjacent to the site to the east. These are detached bungalow and dormer type houses.

The proposed development involves the construction of 289 no. residential units, 1 no. childcare facility, as well as amenity areas and open spaces.

The analysis and assessments in this report have been carried in line with the recommendations of BRE's "Site Layout Planning for daylight and sunlight, a Guide to good practice" (BRE Building Technology Group, 2022) and BS EN 17037. The aforementioned BRE guide is also know as BRE Guide BR 209 and may be referenced as such or simply as the "BRE Guide" hereafter in this document.

This report assesses the proposed development's impact on daylight and sunlight to the existing buildings by the following means:

- Obstruction Angle Check (25 degree Line test)
- Vertical Sky Component (VSC)
- Sunlight to Gardens/Open Spaces

The report also assesses access to daylight and sunlight for the proposed development by means of:

- Target Illiminance (E_T)/Spatial Daylight Autonomy (sDA)
- 1.5hrs sunlight exposure test
- Sunlight to Gardens/Open Spaces

Additionally, Appendix C provides shadow images for the proposed development.

3 Site Description

3.1 Location & Context

The site is a greenfield site located approximately 2 km southwest of Ennis Town Centre, in the Drumbiggle neighbourhood. The area is primarily characterized by low density suburban housing. Ennis Golf Club is located north of the site and to the east on the other side of the R474.

Figure 1: Site Plan

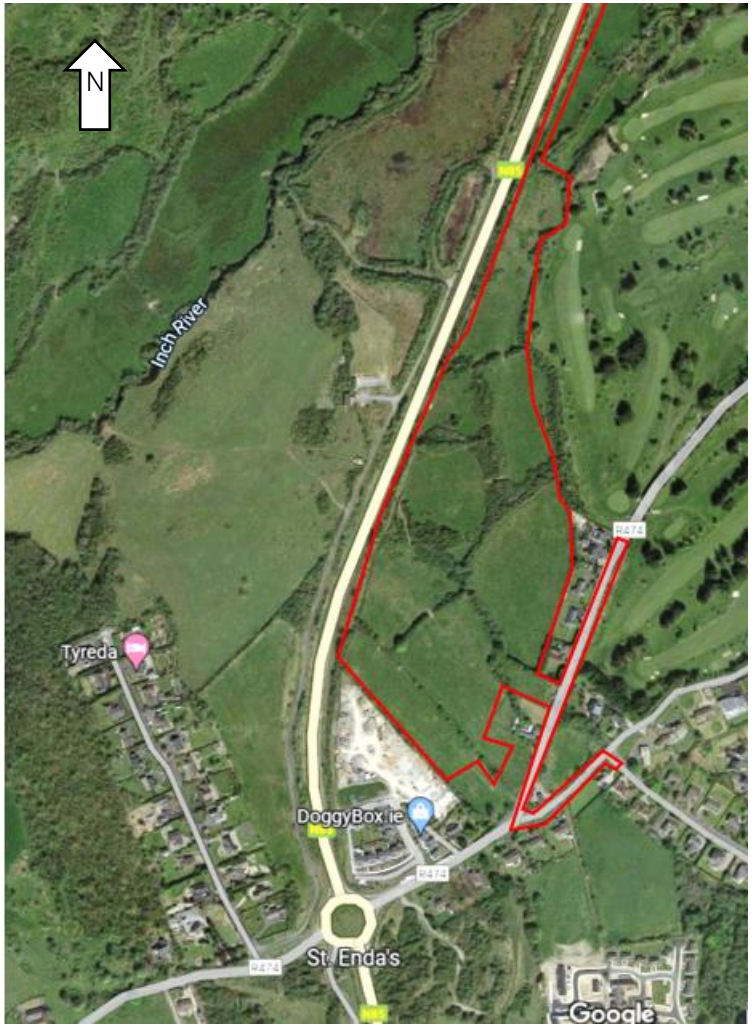


Figure 2: Aerial View of Site (Courtesy Google Maps) (Site boundary is only indicative of main site extents. Architectural drawings should be referenced for accurate site boundary.)

3.2 Proposed Development

The proposed development involves the construction of 289 no. residential units, 1 no. creche/childcare facility, the provision of landscaping, open space and amenity areas, including play/exercise equipment, a linear amenity walkway, informal play areas and local play areas and all associated ancillary infrastructure and services including 1 no. vehicular access point onto Circular Road, parking, lighting, 2 no. ESB substations, drainage and 1 no. pumping station.

The residential units comprise a mixture of 12 no. 1 bed apartments, 78 no. 2 bed townhouse/duplex units, 165 no. 3 bed dwelling houses, and 34 no. dwelling houses which will have an option of a 3 or 4 bedroom house-type.

Figure 3: 3 Storey Duplex Apartment Elevation

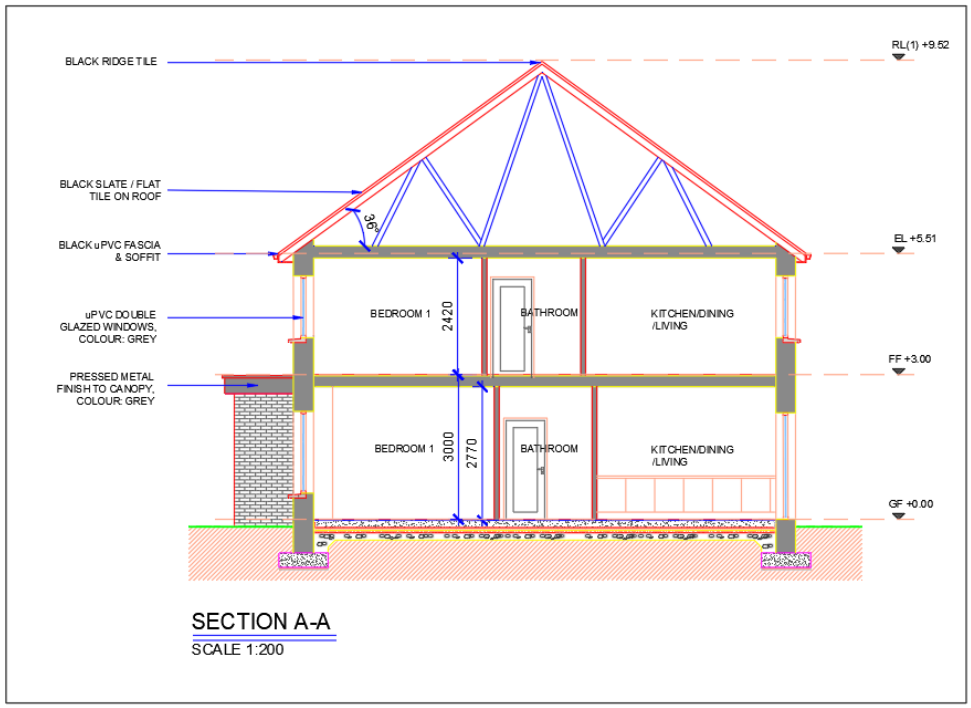


Figure 4: Section through Maisonette type unit

3.3 Sensitive Receptors

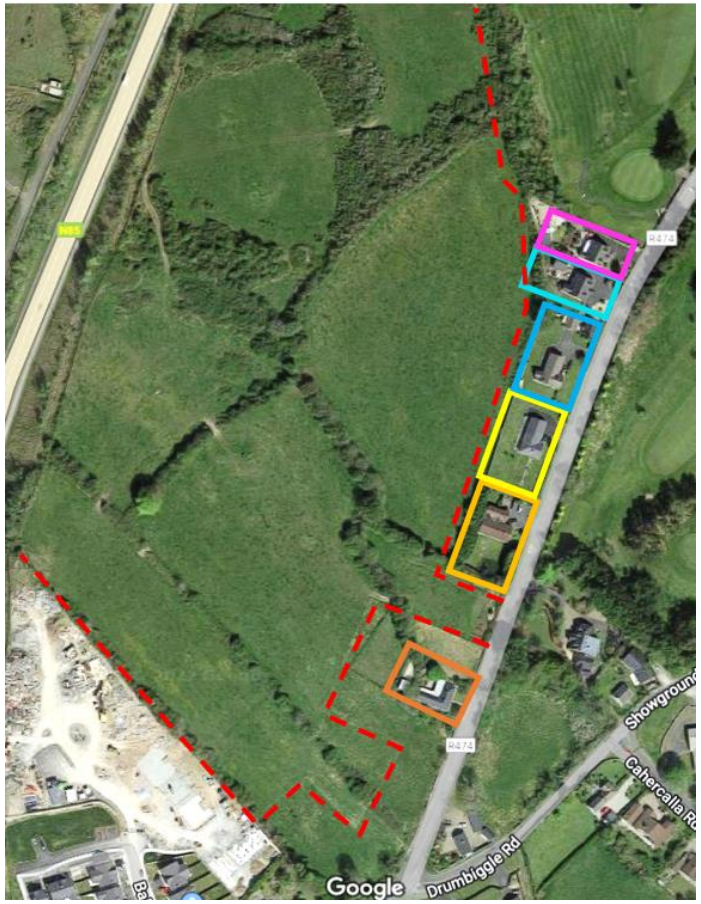
The BRE guide states that when assessing the potential effects of a proposed development on existing buildings, only those windows and rooms that have a 'reasonable expectation' of daylight and sunlight need to be considered. Windows and rooms which meet this criteria are considered to be 'sensitive receptors'. Paragraph 2.2.2 of the BRE guide clarifies what are considered sensitive receptors with respect to sunlight and daylight as follows:

"The guidelines given here are intended for use for rooms in adjoining dwellings where daylight is required, including living rooms, kitchens and bedrooms. Windows to bathrooms, toilets, storerooms, circulation areas and garages need not be analysed. The guidelines may also be applied to any existing non-domestic building where the occupants have a reasonable expectation of daylight; this would normally include schools, hospitals, hotels and hostels, small workshops and some offices."

Outdoor amenity spaces which have a reasonable expectation of sunlight, whether they are private gardens, communal open spaces or outdoor public amenity areas, are also considered sensitive receptors.

Sensitive receptors that may be affected by the proposed development are highlighted in Table 1 below.

Table 1: Sensitive Receptors

Sensitive Receptors Image/Map	Legend
	Site Boundary (partial) Cusheen Banner Lodge Rusheen Inisfail Golf Links Cottage Golf Links Road

4 Methodology & Assessment Criteria

The analyses and assessments are based on the guidelines set out in the BRE guide (BR 209) "Site Layout Planning for Daylight and Sunlight, A Guide to Good Practice" (BRE Building Technology Group, 2022). This guide is intended to be used in conjunction with interior lighting recommendations in BS EN 17037 Daylight in buildings, and in the CIBSE publication LG 10 Daylighting – a guide for designers.

It should also be noted that although the BRE guide gives numerical guidelines, "*these should be interpreted flexibly since natural lighting is only one of many factors in site layout design.*" (BRE Building Technology Group, 2022)

Advanced lighting simulation software is used to perform the analysis. The software combines 3D modelling capabilities with a suite of programs which employ advanced ray-tracing. The software fully meets all relevant guidelines set out in the BRE Guide BR209. The software has the ability to perform annual simulations based on hourly climatic data. This type of simulation is used for the assessment of internal daylight provision in new buildings and is discussed further in section 4.2.

Throughout this report an effort will be made to differentiate between metrics used to assess skylight versus sunlight. As defined in the glossary of the BRE Guide, "Daylight" is an umbrella term that includes both skylight and sunlight—the diffuse and direct components of light from the sky respectively. Unfortunately, the terms daylight and skylight are often used interchangeably but this report will aim to specify when daylight specifically refers to skylight or when it also encompasses sunlight.

The following sub-sections outline the methodology and assessment criteria used.

4.1 Existing Buildings

The impact of the proposed development on the existing buildings (sensitive receptors only) with respect to daylight is assessed using the following methodologies. The methodologies are grouped into sub-sections based on whether they are "Light from the sky" analysis or "Sunlighting" analysis.

4.1.1 Light from the Sky

4.1.1.1 Obstruction Angle Check

The BRE guide states that:

"Loss of light to existing windows need not be analysed if the distance of each part of the proposed development from the existing window is three or more times its height above the centre of the existing window. In these cases the loss of light will be small." (BRE Building Technology Group, 2022)

Therefore, in Figure 5, if the distance s1 was at least 3 times greater than h1, loss of light to the existing windows would not need to be analysed.

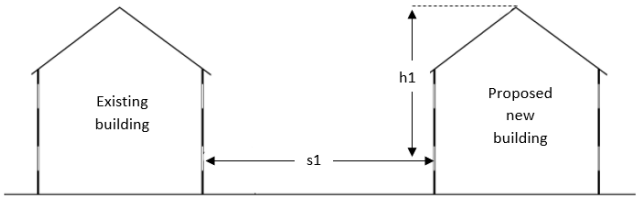


Figure 5: Obstruction Angle Check

If the development is taller or closer than this, then the obstruction angle of the new development can be checked, where the obstruction angle is the angle subtended by the new development at the level of the centre of the lowest window in the existing building.

"If this angle is less than 25° for the whole of the development then it is unlikely to have a substantial effect on the diffuse skylight enjoyed by the existing building." (BRE Building Technology Group, 2022)

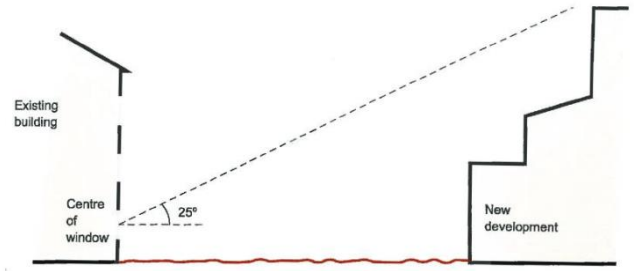


Figure 6: 25 Degree Line Test

The obstruction angle is measured from the 3D CAD model. This check is suitable for existing windows where the proposed development is directly opposite an existing window, i.e. proposed development is cut by a vertical section drawn perpendicular to the window.

If, for any part of the new development, this angle is more than 25°, a more detailed check is needed to find the loss of skylight to the existing building. This may also be required in cases where the existing windows are not opposite the proposed development.

4.1.1.2 Vertical Sky Component (VSC)

Any reduction in the total amount of skylight for the existing properties can be calculated by finding the VSC at the centre of each main window. The Vertical Sky Component (VSC) is the ratio of the direct sky illuminance at the vertical reference point, to the simultaneous illuminance on an unobstructed horizontal plane. Reflected light is not included.

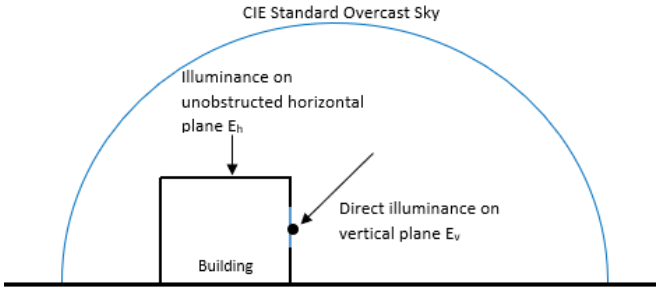


Figure 7: Vertical Sky Component

In the case of a floor-to-ceiling window such as a patio door, a point 1.6 m above ground (or balcony level for an upper storey) on the centre line of the window is used. The reference point is in the external plane of the window wall. Windows to bathrooms, toilets, storerooms, circulation areas and garages are not analysed.

Note that because the CIE standard overcast sky model is used, VSC is independent of orientation and location. (It is a *skylight* metric.)

The diffuse daylighting of any existing building may be adversely affected if:

"the VSC measured at the centre of an existing main window [or 1.6m above bottom of glazed door] is less than 27%, and less than 0.8 times its former value." (BRE Building Technology Group, 2022)

4.1.1.3 No Sky Line

While VSC provides an indication of skylight availability, it does provide any information on the distribution of light within a space. In addition to external obstructions, the distribution of daylight within a space is dependent on window sizes and positioning, and room layouts. The no sky line divides points on the working plane which can and cannot see the sky.

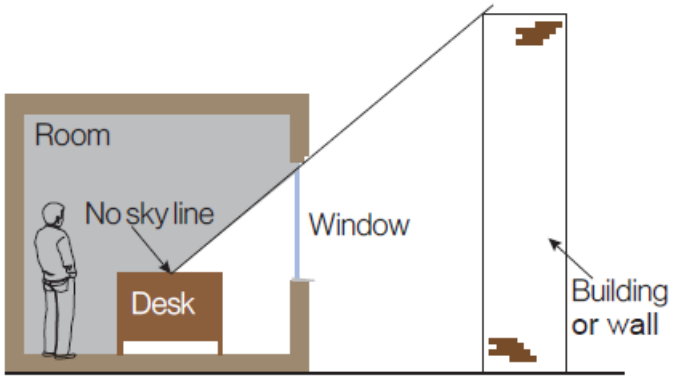


Figure 8: No Sky Line [courtesy (BRE Building Technology Group, 2022)]

Areas beyond the no sky line, since they receive no direct daylight, usually look dark and gloomy compared with the rest of the room.

Where room layouts are known, the impact on the daylighting distribution in the existing building should be found by plotting the no sky line in each of the main rooms.

The diffuse daylighting of an existing building may be adversely affected if:

"the area of the working plane in a room which can receive direct skylight is reduced to less than 0.80 times its former value." (BRE Building Technology Group, 2022)

(Room layouts for neighbouring buildings are often not readily available, hence VSC is often the only analysis performed.)

4.1.2 Sunlighting

"In designing a new development or extension to a building, care should be taken to safeguard the access to sunlight both for existing dwellings, and for any nearby non-domestic buildings where there is a particular requirement for sunlight." (BRE Building Technology Group, 2022)

Obstruction to sunlight may become an issue if:

- Some part of a new development is situated within 90° of due south of a main window wall of an existing building.
- In the section drawn perpendicular to this existing window wall, the new development subtends an angle greater than 25° to the horizontal measured from the centre of the lowest window to a main living room.

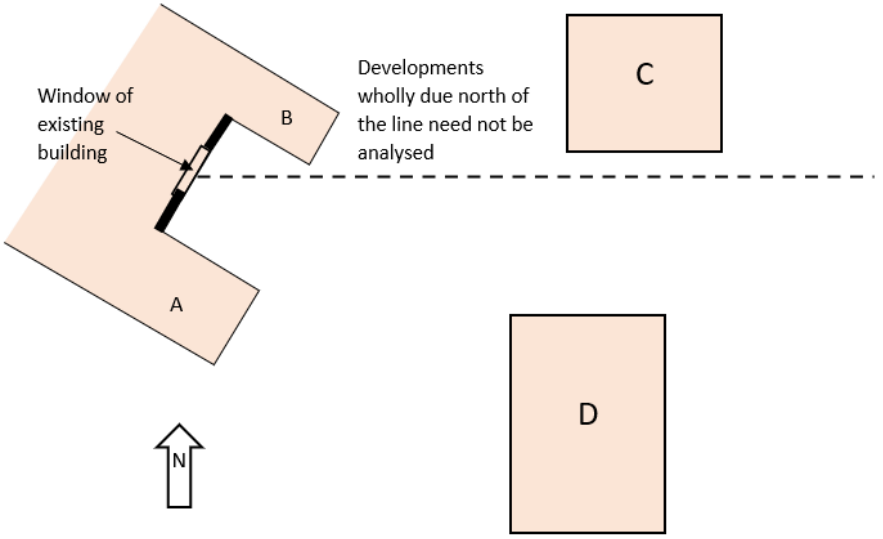


Figure 9: Sunlight Analysis Scenarios for Existing Buildings

No sunlight check is required on the existing window for proposed extension B and new building C, as they lie within 90° of due north of the window. The impact on sunlight to the existing window should be checked for proposed extension A, and new building D if it subtends more than 25° to the horizontal, measured in section from the centre of the window.

To assess loss of sunlight to an existing building, it is suggested that all main living rooms of dwellings, and conservatories, should be checked if they have a window facing within 90° of due south.

4.1.2.1 Probable Sunlight Hours

To calculate the loss of sunlight to an existing building over the year, the annual probable sunlight hours (APSH) metric can be used. "*Here 'probable sunlight hours' means the total number of hours in the year that the sun is expected to shine on unobstructed ground, allowing for average levels of cloudiness for the location in question (based on sunshine probability data). The sunlight reaching a window is quantified as a percentage of this unobstructed annual total.*" (BRE Building Technology Group, 2022)

Sunlight to an existing dwelling may be adversely affected if the centre of a main living room window (which faces within 90° of due south):

- receives less than 25% of annual probable sunlight hours (APSH) and less than 0.80 times its former annual value;
- or less than 5% of annual probable sunlight hours between 21 September and 21 March (often referred to as winter probable sunlight hours - WPSH) and less than 0.80 times its former value during that period;
- and also has a reduction in sunlight received over the whole year greater than 4% of annual probable sunlight hours.

4.1.2.2 Basic Assessment

It is not always necessary to do a full calculation using Annual Probable Sunlight Hours APSH (section 4.1.2.1). The same obstruction angle checks discussed in section 4.1.1.1 can be used to determine if a more detailed calculation is necessary or not. Additionally, depending on the VSC and orientation of the existing windows an APSH assessment may not be required. The recommendation for safeguarding sunlight to existing neighbouring buildings will be met if:

- *"the distance of each part of the new development from the existing window is three or more times its height above the centre of the existing window [see Figure 5] (note: obstructions within 90° of due north of the existing window need not count here).*
- *The window wall faces within 90° of due south and no obstruction, measured in the section perpendicular to the window wall, subtends an angle of more than 25° to the horizontal [Figure 6]. Again, obstructions within 90° of due north of the existing window need not be counted.*
- *The window wall faces within 20° of due south and the reference point has a VSC of 27% or more."* (BRE Building Technology Group, 2022)

4.1.3 Sunlight to Existing Gardens & Open Spaces

Good site layout planning for daylight and sunlight should not limit itself to providing natural lighting inside buildings. Sunlight in the spaces between buildings has an important impact on the overall appearance and ambience of a development.

"It is recommended that for it to appear adequately sunlit throughout the year, at least half of a garden or amenity area should receive at least two hours of sunlight on 21 March. If as a result of new development an existing garden or amenity area does not meet the above, and the area which can receive two hours of sun on 21 March is less than 0.8 times its former value, then the loss of sunlight is likely to be noticeable." (BRE Building Technology Group, 2022)

4.1.3.1 Shadow Plots

The BRE guide states:

"Where a large building is proposed which may affect a number of gardens or open spaces it is often illustrative to plot a shadow plan showing the location of shadows at different times of day and year."

4.1.4 Impact Classification

Appendix H of the BRE Guide – "Environmental Impact Assessment" states that the impact of a new building on its surroundings can be classified as negligible, minor, moderate or major adverse. Where the loss of skylight or sunlight fully meets the guidelines in the BRE guide, the impact is assessed as negligible or minor adverse. Where the loss of skylight or sunlight does not meet the BRE guidelines, the impact is assessed as minor, moderate or major adverse.

Table 2 provides a more detailed description of the impact classification.

Table 2: Environmental Impact Assessment: Impact Classification

Negligible adverse impact	• *Loss of light well within guidelines,* ***or*** • *only a small number of windows losing light (within the guidelines)* ***or*** • *limited area of open space losing light (within the guidelines)*

Minor adverse impact (a)	• *Loss of light only just within guidelines* ***and***
	  ○ *a larger number of windows are affected* ***or***
	  ○ *larger area of open space is affected (within the guidelines)*

Minor adverse impact (b)	• *only a small number of windows or limited open space areas are affected* • *the loss of light is only marginally outside the guidelines* • *an affected room has other sources of skylight or sunlight* • *the affected building or open space only has a low level requirement for skylight or sunlight* • *there are particular reasons why an alternative, less stringent, guideline should be applied*
Major adverse impact	• *large number of windows or large open space areas are affected* • *the loss of light is substantially outside the guidelines* • *all the windows in a particular property are affected* • *the affected indoor or outdoor spaces have a particularly strong requirement for skylight or sunlight (living rooms / playground)*

A moderate adverse impact obviously falls between the criteria for *"Minor Adverse Impact (b)"* and *"Major Adverse Impact"*.

4.2 New Buildings

The daylight provision was also checked for the proposed development.

4.2.1 Light from the Sky

Section 2.1.8 of the BRE Guide states that:

"Daylight provision in new rooms may be checked using either of the methods in BS EN 17037 Daylight in Buildings: direct prediction of illuminance levels using hourly climate data, or the use of the daylight factor (D)".

Both methods are measures of the overall amount of daylight in a space.

The daylight factor (D) method addresses daylight provision as a ratio of unobstructed external illuminance under overcast sky conditions. This method involves calculating the daylight factor (D) that would be exceeded over half of the room, i.e. the median daylight factor (this is not the same as the average daylight factor used in the previous standard, BS8206-2). The recommended daylight factor values are location specific. This method will not be discussed in any more detail in this report as the illuminance method is the preferred option.

4.2.1.1 Illuminance Method (Target Illuminance E_T)

The illuminance method "*involves using climatic data for the location of the site (via the use of an appropriate, typical or average year, weather file within the software) to calculate the illuminance from daylight at each point on an assessment grid on the reference plane at an at least hourly interval for a typical year."*

"A target illuminance (E_T) should be achieved across at least half of the reference plane in a daylit space for at least half of the daylight hours. Another target illuminance (E_{TM}) should also be achieved across 95% of the reference plane for at least half of the daylight hours; this is the minimum target illuminance to be achieved towards the back of the room." (BRE Building Technology Group, 2022)

(Note that since hourly climatic data is used based on the location of the site, location and orientation are accounted for. The target illuminance can therefore be considered a *daylight* metric, i.e. incorporating both skylight and sunlight.)

BS EN 17037 gives three levels of recommendation for daylight provision in interior spaces: minimum, medium and high. For compliance with the standard, a daylit space should achieve the minimum level of recommendation.

Table 3 gives the target illuminances for side lit rooms. Different targets, given in Table A2 of BS EN 17037, apply in spaces with horizontal rooflights.

Table 3: EN 17037 Target Illuminances

Level of recommendation	Target illuminance E_T (lx) for half of assessment grid	Target illuminance E_{TM} (lx) for 95% of assessment grid
Minimum	300	100
Medium	500	300
High	750	500

The guidance contained in BR 209 is intended to be used with BS EN 17037 and its UK National Annex. The UK National Annex gives specific minimum recommendations for habitable rooms in dwellings in the UK. Although Ireland adopted EN17037 directly as IS EN EN17037, it is expected that all councils in Ireland will adopt the UK National Annex recommendations. The Dubin City Council Development Plan 2022-2028 states:

"is important to note that no amendments were made to [the IS EN 17037] document and unlike BS EN 17037, it does not contain a national annex. It offers only a single target for new buildings (there are no space by space targets – e.g. a kitchen would have the same target as a warehouse or office).[…] These limitations make it unsuitable for use in planning policy or during planning applications. BR 209 must still be used for this purpose."

Even if a predominantly daylit appearance is not achievable for a room in a dwelling, the National Annex NA recommends that the target illuminance values given in Table 4 are exceeded over 50% of the points on a reference plane 0.85 m above the floor, for at least half of the daylight hours.

Table 4: BS EN 17037 NA Target Illuminances for dwellings

Room type	Target illuminance E_T (lx)
Bedroom	100
Living Room	150
Kitchen	200

Where one room in a dwelling serves more than a single purpose, it is recommended that the target illuminance is that for the room type with the highest value – for example, in a space that combines a living room and a kitchen the target illuminance is recommended to be 200 lx.

However, it is recommended that local authorities use discretion here. For example: *"the target for a living room could be used for a combined living/dining/kitchen area if the kitchens are not treated as habitable spaces.."* (BRE Building Technology Group, 2022) This may be appropriate in instances where small internal kitchens are unavoidable in apartment developments.

The minimum target illuminance level to be achieved across 95% of the reference plane within a space need not be applied to rooms in dwellings.

To avoid any confusion, the targets in Table 4 are those used for the purposes of this analysis.

The illuminance method is detailed and calculation intensive. It can take some time to process depending on the software, detail of the calculation model and the available computing power hence why the daylight factor (D) method may be preferred by some. However, it can provide additional information beyond the limits of the Daylight Factor method due to the use of hourly climate data.

There are a few ways the results of this type of analysis can be presented. One method is to report the % *area* of the reference plane exceeding the target illuminance E_T (for half of the daylight hours.) (This area should be greater than 50% to meet the BS EN 17037 recommendations.) This is equivalent to Spatial Daylight Autonomy (sDA)[1]. BR209 recommends reporting the median illuminance (exceeded over 50% of the reference plane) as this enables comparison with the different recommendations in BS EN 17037. It says that "*As an optional extra, the proportional area of the reference plane exceeding a particular target value may be presented".* It should be noted that the calculation methodology and results are the same in both instances. It is only the *presented* result that differs. For completeness, the results will be presented in both ways, i.e. both of the below metrics will be presented:

- The ***median illuminance*** (the illuminance exceeded over 50% of the reference plane), presented as E_{MED} (lux).
- The ***% area*** of the reference plane exceeding a particular target illuminance (lux).

The presentation of the internal daylight provision results and how the various metrics are related are discussed in more detail in Appendix D.

The settings used in the computational model for the illuminance calculations are outlined below:

- The reference/working plane is taken to be 0.85m above the floor.

[1] Some additional information on sDA is provided in Appendix D.

- The grid spacing is 0.1m.
- A band of 0.3m from the walls is excluded from the grid.
- Window frame factor is set to 20% (This is based on the size of the window openings and the area of the window which is framing.)
- The glazing transmittance (normal) was set to 0.70.
- The glazing maintenance factor is set to 96% (This accounts for the reduction in glazing transmittance due to dirt. 4% loss of daylight compared with clean glazing.)
- The illuminance calculations take account of light which has been reflected from both external and internal surfaces. In the absence of detailed information on surface reflectances the recommended default reflectances from BR209 2022 have been used. These are detailed in Table 5 below.

Table 5: Surface Reflectances

Surface Type	Reflectance
Interior walls	0.50
Floors	0.20
Ceilings	0.70
Exterior walls and obstructions	0.20
Exterior Ground	0.20

Table 6: Balcony Glazing Properties

Surface Type	Properties
Balcony Glazing	Transmittance: 0.80 Refractive Index: 1.52

4.2.2 Sunlighting

For interiors, access to sunlight can be quantified based on the methodology set out in BS EN 17037.

"In general a dwelling, or non-domestic building that has a particular requirement for sunlight, will appear reasonably sunlit provided:

- *at least one main window wall faces within 90° of due south and*
- *a habitable room, preferably a main living room, can receive a total of at least 1.5 hours of sunlight on 21 March. This is assessed at the inside centre of the window(s); sunlight received by different windows can be added provided they occur at different times and sunlight hours are not double counted.*

Where groups of dwellings are planned, site layout design should aim to maximise the number of dwellings with a main living room that meets the above recommendations." (BRE Building Technology Group, 2022)

There are 3 levels of recommendation provided in EN 17037 relating to sunlight to a room:

- 1.5 hours is the minimum level,
- 3 hours is the medium level, and
- 4 hours is the high level

For dwellings, as outlined above, at least one habitable room, preferably a main living room, should meet at least the minimum criterion.

4.2.3 Sunlight to Proposed Open Spaces

The BRE Guide recommends:

"that for it to appear adequately sunlit throughout the year, at least half of a garden or amenity area should receive at least two hours of sunlight on 21 March."

The communal open spaces and amenity space associated with the creche are analysed and assessed against the above criterion.

5 Analysis

5.1 Overview of Computational Models

3D models of the existing the proposed scenarios were created. The site plans and 2D drawings provided by the architect were used to correctly position the surrounding buildings relative to the existing and proposed buildings.

3D models of the existing the proposed schemes were created. The existing and analysed (surrounding) models are based on 2D drawings provided by the architect supplemented by Google Street Maps and OS maps. The proposed model is based on the 2D CAD drawings provided by the architect:

In the following figures the beige/buff elements represent the existing surrounding buildings that were analysed and the blue elements are the proposed development.

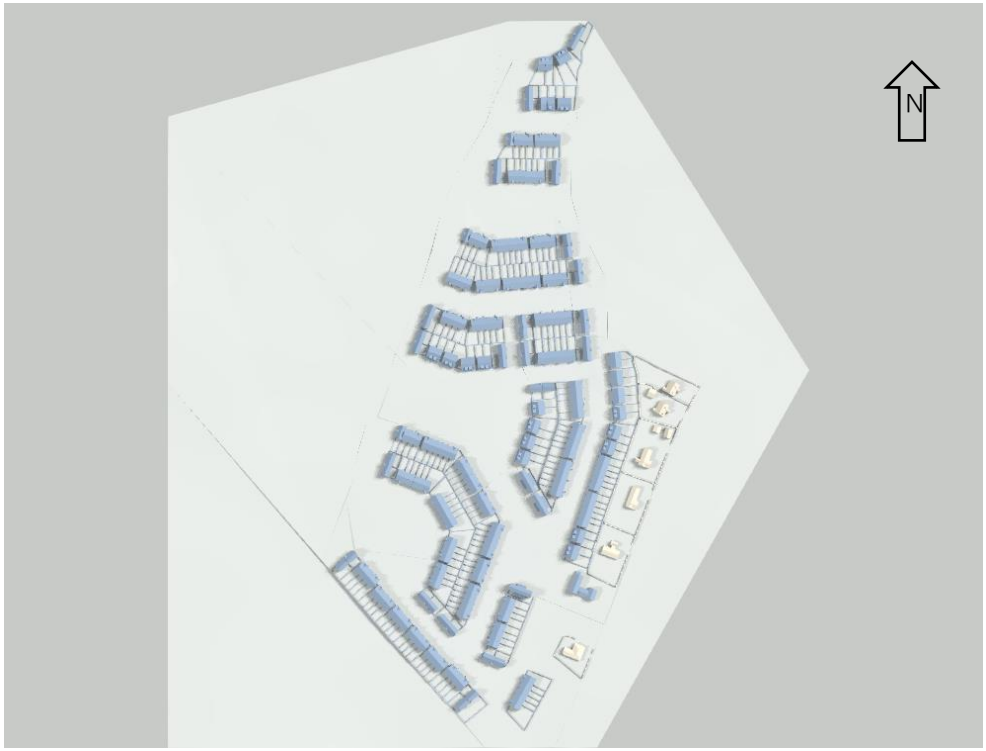


Figure 10: Proposed Model (Plan View)

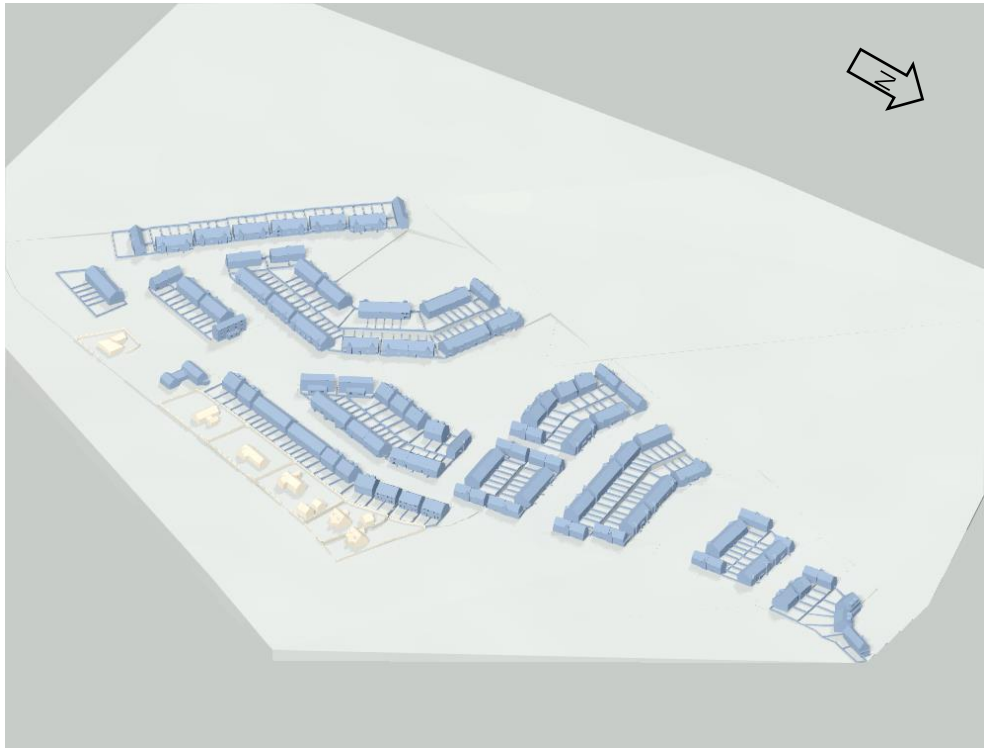


Figure 11: Proposed Model (View from northeast)

5.2 Existing Buildings

5.2.1 25 Degree Line Test

The obstruction angle was checked for the closest properties to the site that have windows directly opposite the proposed development. The only properties in close proximity to the site, as identified in Table 1, are located on Circular Road to the east of the site. The obstruction angle for the closest windows to the new development were tested. These were at:

- Banner Lodge
- Inisfail
- Golf Links Cottage (Granny Flat)

No drawings or images were available for the windows to the rear of these properties so assumptions were made for window positions. The planes were drawn from 1.6m above ground level which should correspond roughly to the centre of the windows. As these windows are the closest to the proposed development, if they are not adversely impacted, then it follows that the other adjacent neighbouring properties on Circular Road will not be adversely impacted.

The results for each neighbouring property listed above are shown in the following figures.

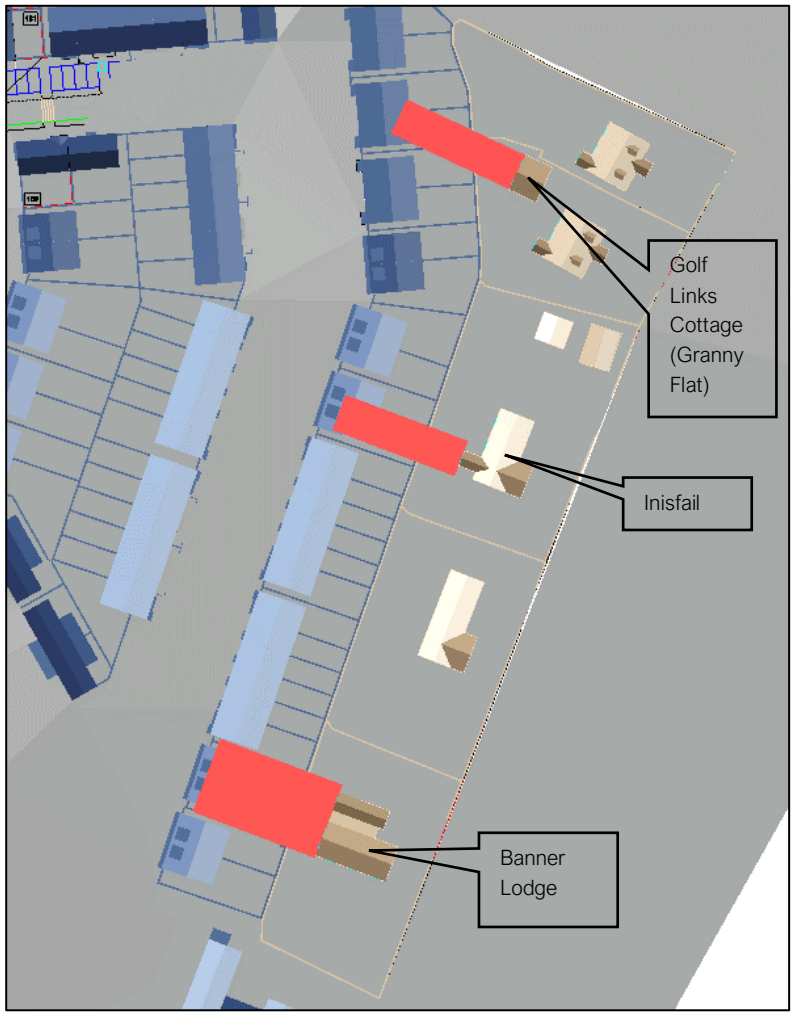


Figure 12: 25 degree planes Plan View

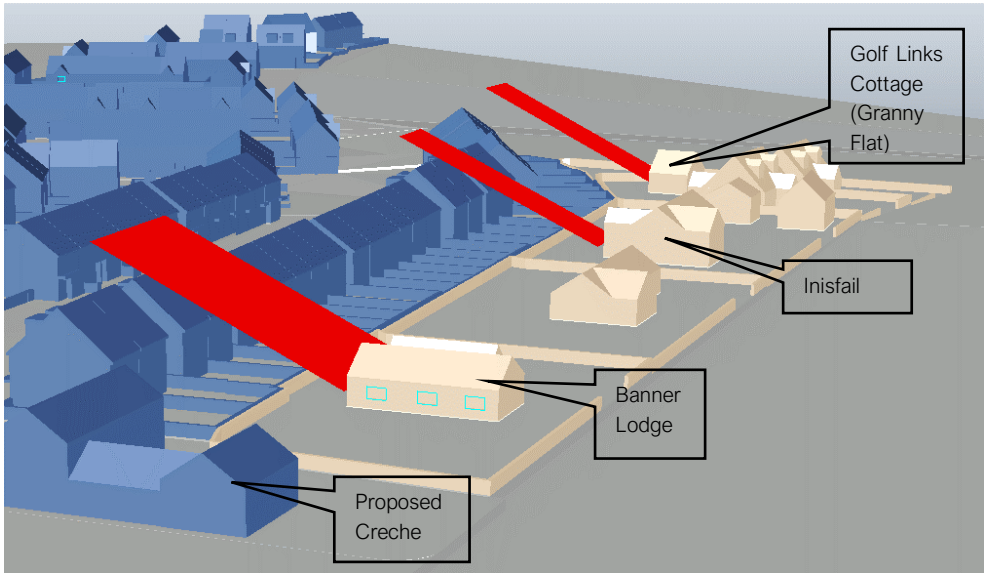


Figure 13: 25 degree planes Perspective View

The analysis shows that none of the 25 degree planes cut the proposed development. That is to say, the obstruction angle is less than 25 degrees for all of the properties/windows tested. Therefore, the proposed development will have a negligible impact on the diffuse skylight enjoyed by the existing neighbouring dwellings on Circular Road.

5.2.2 VSC Analysis

The 25 degree plane test shows that the development will have a negligible impact on the houses on Circular Road. No further analysis is required, but as additional confirmation of the 25 degree plane results, VSC analysis has also been performed for all of the properties on Circular Road.

As outlined in the previous section, assumptions had to be made for window positions at the rear of these properties. Some information could be gleaned from Google Street View on windows at the side of the properties. Multiple VSC points spaced evenly across each facade facing the proposed development were used for each property. Points where skylight availability may change considerably, e.g. because of self obstruction, were also considered. The VSC points for each property are shown in the following figures.

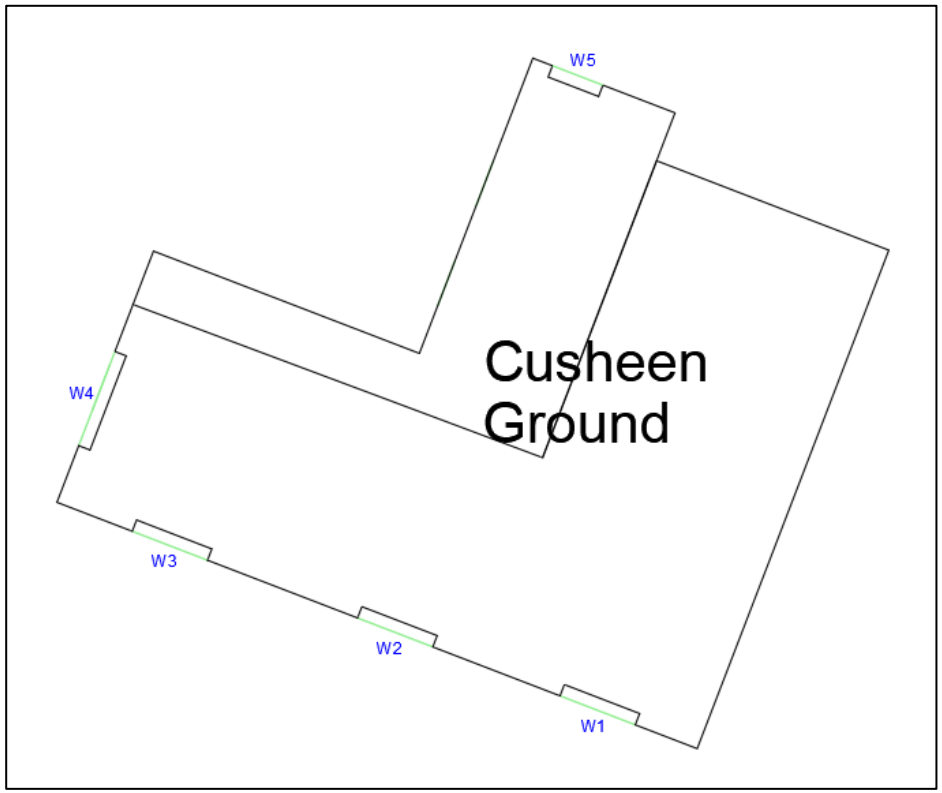


Figure 14: Cusheen Window Labels

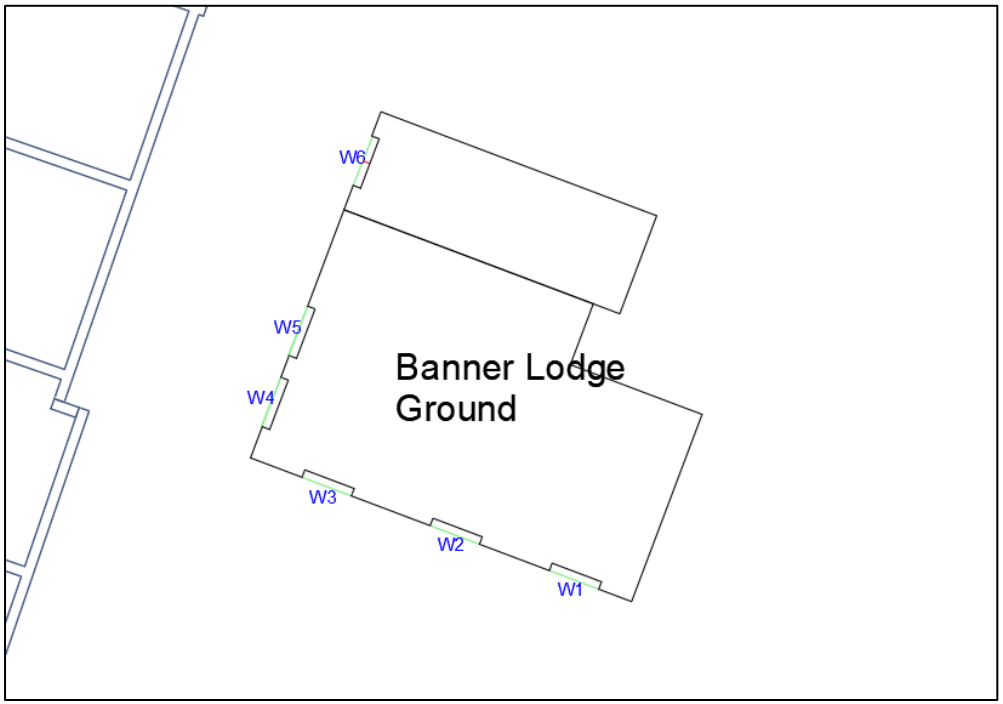


Figure 15: Banner Lodge Window Labels

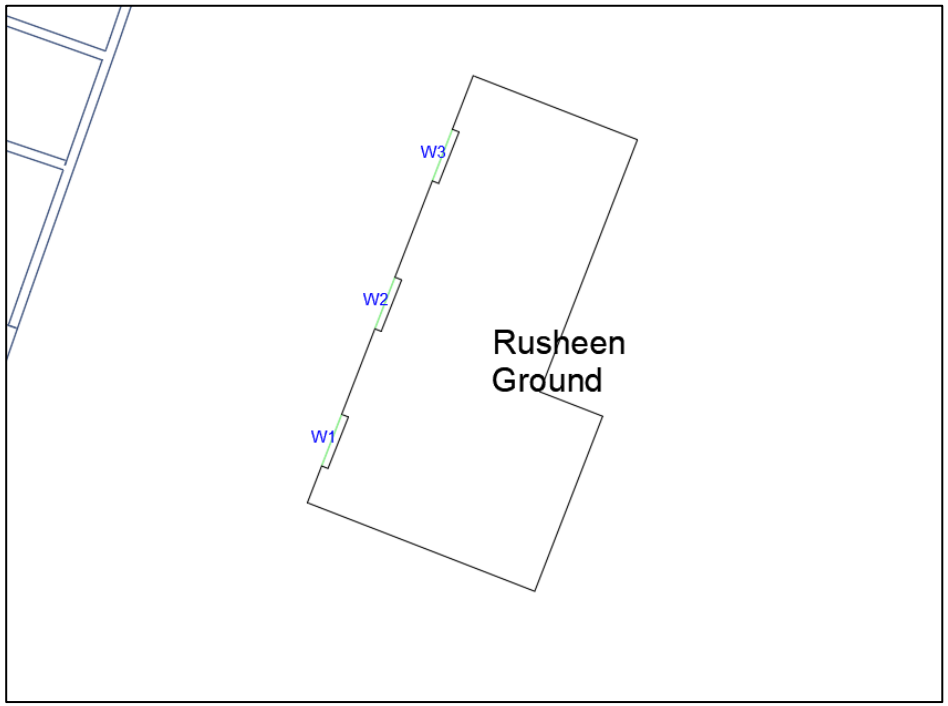


Figure 16: Rusheen Window Labels

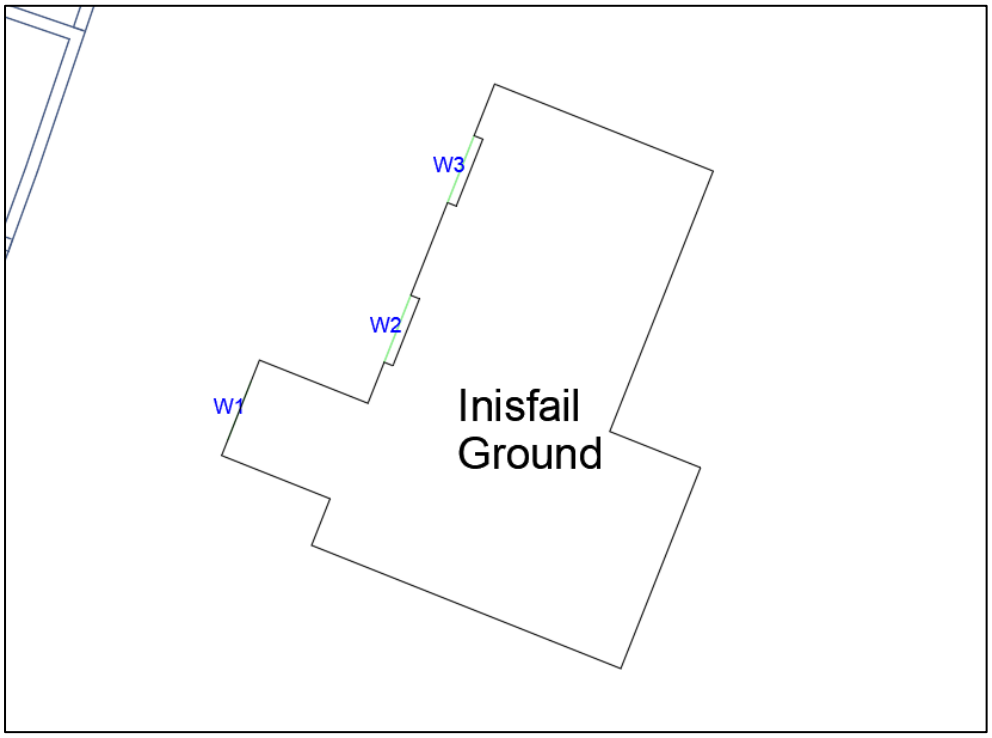


Figure 17: Inisfail Window Labels

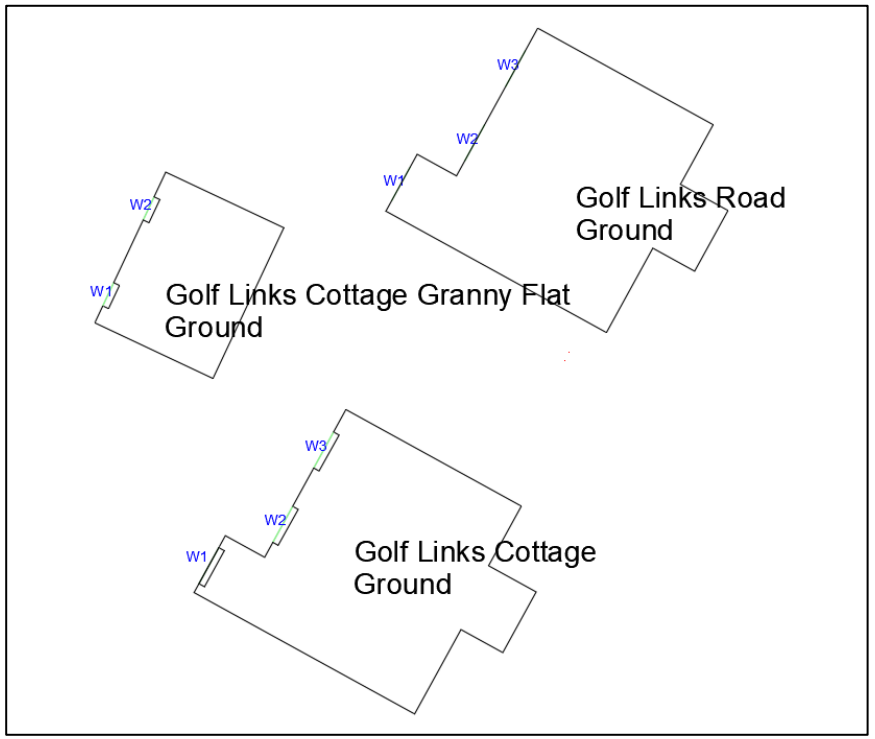


Figure 18: Golf Link Cottage (incl. Granny Flat) & Golf Links Road Window Labels

Table 7: VSC Results

Floor Ref.	Window Ref.		VSC	Pr/Ex	Meets BRE Criteria
Golf Links Road					
Ground	W1	Existing	34.80	0.96	YES
		Proposed	33.46		
	W2	Existing	34.72	0.95	YES
		Proposed	33.14		
	W3	Existing	37.97	0.95	YES
		Proposed	36.16		
Golf Links Cottage Granny Flat					
Ground	W1	Existing	39.52	0.85	YES
		Proposed	33.74		
	W2	Existing	39.52	0.88	YES
		Proposed	34.59		

Table 8: VSC Results Ctd...

Floor Ref.	Window Ref.		VSC	Pr/Ex	Meets BRE Criteria
Golf Links Cottage					
Ground	W1	Existing	37.70	0.87	YES
		Proposed	32.64		
	W2	Existing	32.60	0.91	YES
		Proposed	29.80		
	W3	Existing	34.39	0.92	YES
		Proposed	31.52		
Inisfail					
Ground	W1	Existing	39.52	0.81	YES
		Proposed	31.82		
	W2	Existing	33.79	0.84	YES
		Proposed	28.41		
	W3	Existing	38.81	0.84	YES
		Proposed	32.78		

Table 9: VSC Results Ctd...

Floor Ref.	Window Ref.		VSC	Pr/Ex	Meets BRE Criteria
Rusheen					
Ground	W1	Existing	39.50	0.85	YES
		Proposed	33.58		
	W2	Existing	39.48	0.85	YES
		Proposed	33.61		
	W3	Existing	39.45	0.85	YES
		Proposed	33.62		
Banner Lodge					
Ground	W1	Existing	39.48	0.96	YES
		Proposed	37.76		
	W2	Existing	39.48	0.95	YES
		Proposed	37.34		
	W3	Existing	39.47	0.93	YES
		Proposed	36.78		
	W4	Existing	39.49	0.80	YES
		Proposed	31.49		
	W5	Existing	39.49	0.79	YES
		Proposed	31.25		
	W6	Existing	39.39	0.79	YES
		Proposed	31.29		

Table 10: VSC Results Ctd...

Floor Ref.	Window Ref.		VSC	Pr/Ex	Meets BRE Criteria
Cusheen					
Ground	W1	Existing	39.57	0.98	YES
		Proposed	38.70		
	W2	Existing	39.57	0.97	YES
		Proposed	38.54		
	W3	Existing	39.57	0.97	YES
		Proposed	38.33		
	W4	Existing	39.41	0.92	YES
		Proposed	36.20		
	W5	Existing	39.44	0.97	YES
		Proposed	38.14		

As expected, based on the obstruction angles observed in section 5.2.1, all windows tested still have a VSC value greater than 27% with the proposed development in place.

The results meet the recommendations of the BRE Guide and show that the proposed development will have a negligible impact on skylight to the neighbouring dwellings.

5.3 Impact on Sunlight to Existing Buildings

It's not evident that any living rooms in the existing buildings on Circular Road face the new development, but even if some living rooms do face the new development, no detailed sunlight analysis is required for a number reasons:

1. The majority of existing windows face within 90 degrees of due north so they are unlikely to meet the APSH criteria for the existing scenario.
2. Because the obstruction angle of the new development is less than 25 degrees for all windows there will be a negligible impact on sunlight to the existing dwellings.
3. (It follows, based on point 2 above, that the VSC is greater than 27% for all existing windows with the new development in place, indicating that there will be a negligible impact on sunlight to the existing dwellings.)

5.4 Impact on Sunlight to Neighbouring Gardens.

The sunlight availability was checked for rear and side gardens which have a view of the proposed development before and after the proposed development. The garden areas were estimated from Google Maps. The gardens analysed are shown in the following figures. (North is vertically up for all figures shown.)

Legend	
	> 2hrs for Existing & Proposed
	< 2hrs for Existing & Proposed
	Loss
	Gain

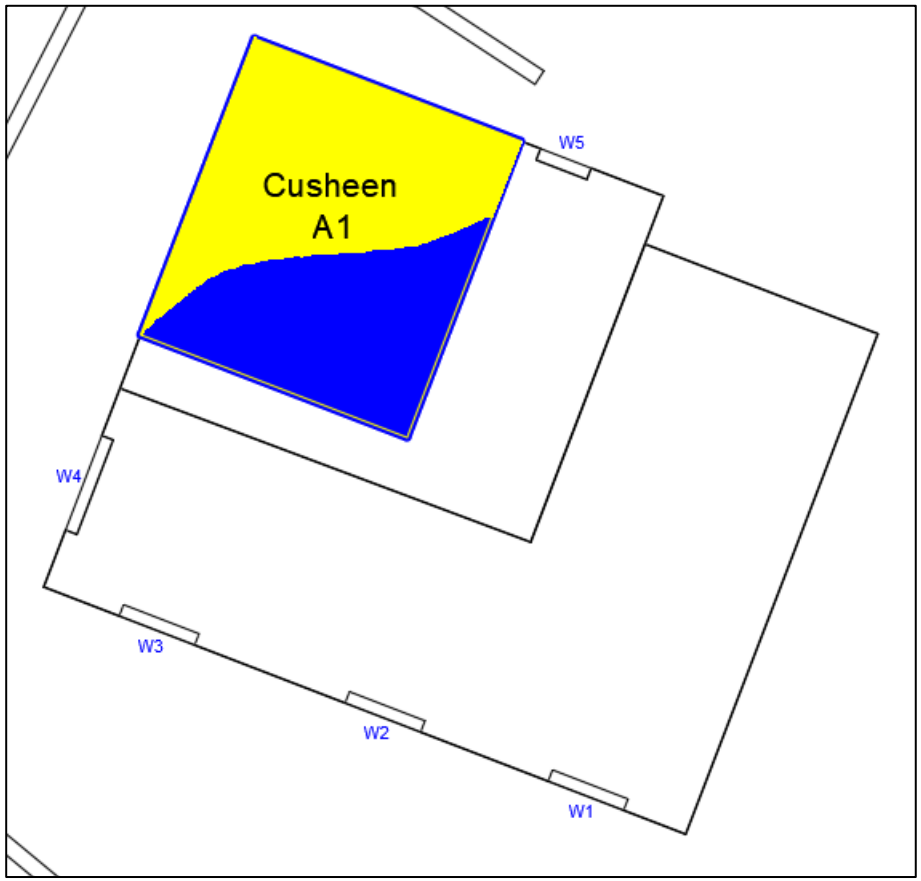


Figure 19: Sunlight Test - Cusheen Neighbouring Garden

Figure 20: Sunlight Test - Banner Lodge Neighbouring Garden

Figure 21: Sunlight Test - Rusheen Neighbouring Garden

Figure 22: Sunlight Test - Inisfail Neighbouring Garden

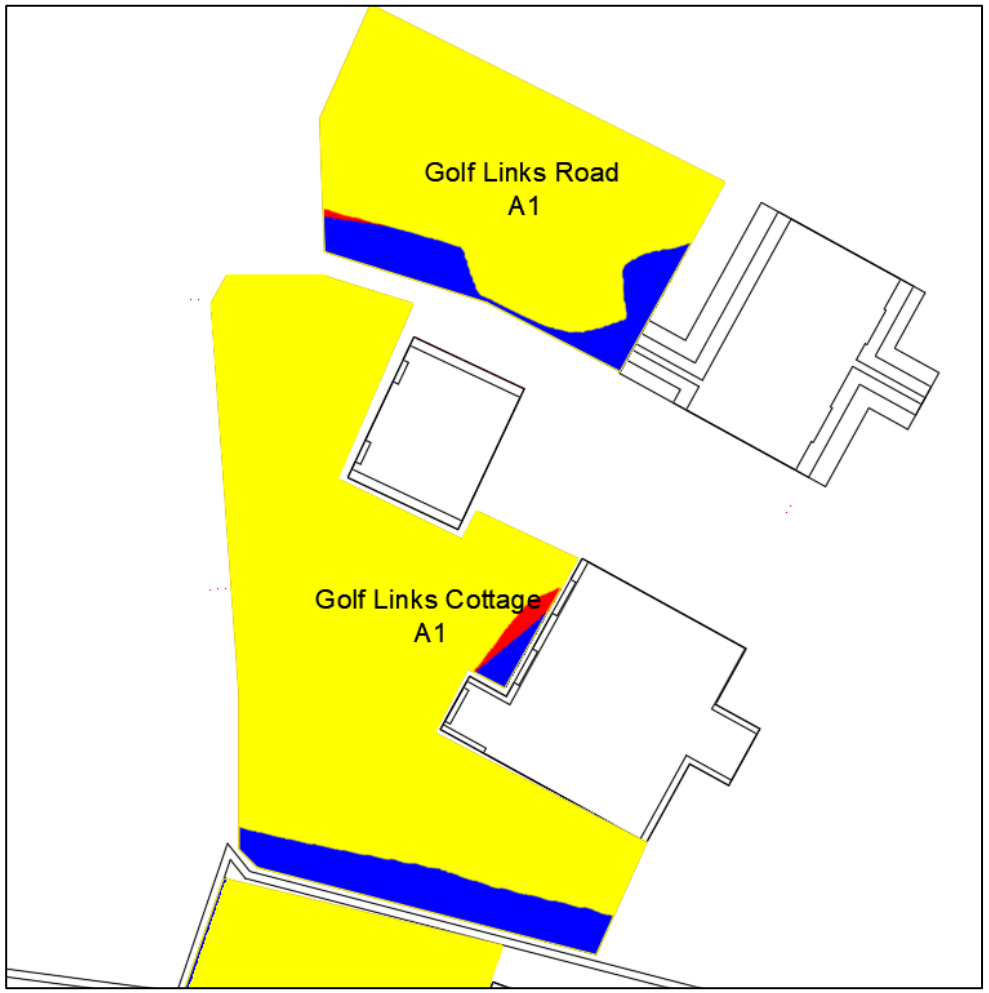


Figure 23: Sunlight Test - Golf Links Cottage Neighbouring Garden

Table 11: Sunlight to Amenity - Neighbour Analysis Results

Amenity Ref		Amenity Area	Lit Area Existing	Lit Area Proposed	Pr/Ex	Meets BRE Criteria
Golf Links Road						
A1	Area m2	213.73	181.40	180.80	1.00	YES
	Percentage		85%	85%		
Golf Links Cottage						
A1	Area m2	403.72	361.52	358.01	0.99	YES
	Percentage		90%	89%		
Inisfail						
A1	Area m2	691.30	663.67	663.67	1.00	YES
	Percentage		96%	96%		
Rusheen						
A1	Area m2	691.11	668.24	668.24	1.00	YES
	Percentage		97%	97%		
Banner Lodge						
A1	Area m2	755.00	724.87	724.28	1.00	YES
	Percentage		96%	96%		
Cusheen						
A1	Area m2	55.37	31.55	31.55	1.00	YES
	Percentage		57%	57%		

The analysis shows more than 50% of each garden tested receives at least 2hrs of sunlight on March 21st before and after the proposed development. The reduction in the area receiving 2hrs of sunlight on March 21st is less than 1% in all cases. Based on the results, there will be a negligible impact on sunlight to the gardens due to the proposed development.

5.5 Proposed Development

5.5.1 Daylight Analysis for Proposed Development

The daylight provision in the proposed development was checked using the target illuminance (E_T) method. The internal daylight provision in all apartment blocks and maisonette units was checked and a sample of houses was also checked. The results are presented in the following tables. (The median illuminance is not presented in the table as this parameter is not currently output by the software. This is under development and will be included once it becomes available. The percentage area achieving the target illuminance for 50% of daylight hours is presented. This is the sDA metric. As previously discussed in section 4.2.1.1, the two metrics are just two different ways of presenting the same result.)

Table 12: Illuminance Results – Apartment Block 2G_1 (Northwest 2G Block)

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
2G_1							
Ground	R1	LKD	57%	200	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES
	R5	Bedroom	99%	100	50%	50%	YES
	R6	LKD	55%	200	50%	50%	YES
First	R1	LKD	100%	200	50%	50%	YES
	R2	LKD	96%	200	50%	50%	YES
Second	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES

Table 13: Illuminance Results – Apartment Block 2G_2 (Southeast 2G Block)

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
2G_2							
Ground	R1	LKD	52%	200	50%	50%	YES
	R2	Bedroom	99%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES
	R5	Bedroom	100%	100	50%	50%	YES
	R6	LKD	58%	200	50%	50%	YES
First	R1	LKD	98%	200	50%	50%	YES
	R2	LKD	100%	200	50%	50%	YES
Second	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES

Table 14: Illuminance Results – Apartment Block 3G

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
3G							
Ground	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	98%	100	50%	50%	YES
	R4	LKD	50%	200	50%	50%	YES
	R5	LKD	74%	200	50%	50%	YES
	R6	Bedroom	100%	100	50%	50%	YES
First	R1	LKD	100%	200	50%	50%	YES
	R2	LKD	91%	200	50%	50%	YES
Second	R1	Bedroom	99%	100	50%	50%	YES
	R2	Bedroom	99%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES

Table 15: Illuminance Results – Maisonette Units 2P

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
2P							
Ground	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	97%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES
	R5	Bedroom	100%	100	50%	50%	YES
	R6	Bedroom	100%	100	50%	50%	YES
	R7	LKD	98%	200	50%	50%	YES
	R8	LKD	98%	200	50%	50%	YES
	R9	LKD	100%	200	50%	50%	YES
	R10	LKD	100%	200	50%	50%	YES
	R11	LKD	100%	200	50%	50%	YES
	R12	LKD	100%	200	50%	50%	YES
First	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES
	R4	Bedroom	100%	100	50%	50%	YES
	R5	Bedroom	100%	100	50%	50%	YES
	R6	Bedroom	100%	100	50%	50%	YES
	R7	Bedroom	100%	100	50%	50%	YES
	R8	Bedroom	100%	100	50%	50%	YES
	R9	Bedroom	100%	100	50%	50%	YES
	R10	Bedroom	100%	100	50%	50%	YES
	R11	Bedroom	100%	100	50%	50%	YES
	R12	Bedroom	100%	100	50%	50%	YES

Table 16: Illuminance Results – House Type 1.B/C

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
1BC							
Ground	R1	Living Room	59%	150	50%	50%	YES
	R2	KD	66%	200	50%	50%	YES
First	R1	Bedroom	98%	100	50%	50%	YES
	R2	Bedroom	92%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES

Table 17: Illuminance Results – House Type 3.E8

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
3E8							
Ground	R1	Living Room	70%	150	50%	50%	YES
	R2	KD	100%	200	50%	50%	YES
First	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES

Table 18: Illuminance Results – House Type 1.F3

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
1F3							
Ground	R1	KD	100%	200	50%	50%	YES
	R2	Living Room	100%	150	50%	50%	YES
First	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES

Table 19: Illuminance Results – House Type 3.F5m

Floor Ref	Room Ref	Room Use	% of Area Meeting Req Lux	Criteria			Meets Criteria
				Req Lux	Req % of Effective Area	Req % of Daylight Hours	
3F5m							
Ground	R1	KD	99%	200	50%	50%	YES
	R2	Living Room	100%	150	50%	50%	YES
First	R1	Bedroom	100%	100	50%	50%	YES
	R2	Bedroom	100%	100	50%	50%	YES
	R3	Bedroom	100%	100	50%	50%	YES

A summary of the results is provided below for the apartment and maisonette units. All of these types of units were tested so this is an accurate summary of the results for these units in the context of the overall site. As only a sample of houses were tested, it would not be appropriate to provide a summary for these units as it would not be representative of every house type and the overall site.

Table 20: Illiminance Results Summary (for maisonette and apartment type units)

Property	Number of Rooms Tested	Rooms satisfying Criteria		Rooms not satisfying Criteria
		No.	%	
2G	24	24	100%	0
2P	24	24	100%	0
3G	12	12	100%	0
Total	**60**	**60**	**100%**	**0**

The results show that all rooms tested meet or exceed the BRE's minimum recommendations for internal daylight provision in dwellings.

5.5.2 Sunlight Analysis for Proposed Development

The access to sunlight for proposed development was checked based on the guidance and recommendations in BR209 and EN 17037.

With respect to the overall site, analysis of the units and site layout shows that nearly all units have a main window wall facing within 90° of due south and the majority have a main living room window facing within 90° of due south.

The maisonette units do not have a living room window facing within 90° of due south but the main bedrooms to the front of the units all have windows facing within 90° of due south which meets the BRE recommendation that "*at least one main window wall faces within 90° of due south*".

3 out of 4 apartments in Block 3G have a main window to the LKD spaces facing within 90° of due south. Similarly, 3 out of 4 apartments in each 2G Block have a main window to the LKD spaces facing within 90° of due south (a total of 6/8 LKDs for Block Type 2G.)

EN 17037 recommends that a habitable room, preferably a main living room, can receive a total of at least 1.5 hours of sunlight on 21 March. Sunlight received by different windows can be added provided they occur at different times and sunlight hours are not double counted. (Note that although it is preferable that a main living room meets the criterion, the criterion is also met if any habitable room, e.g. kitchen or bedroom, meets the criterion.)

A summary of the results are shown in the following tables. Table 21 provides the results for all rooms tested.

Table 21: Summary of Sunlight Exposure for all rooms tested

Property	Number of Rooms Tested	Rating				No. of Rooms Satisfying Criteria
		High	Medium	Minimum	Failed	
3F5m	5	5	0	0	0	5
3E8	4	2	2	0	0	4
2P	24	15	6	3	0	24
1F3	5	2	1	2	0	5
1BC	5	3	0	0	2	3
3G	12	5	0	0	7	5
2G_1	12	10	0	2	0	12
2G_2	12	10	1	1	0	12

Certain rooms may fail but the criterion is still met if any habitable room in a unit/house meets the criterion. Therefore, Table 22 provides the number of units (whole apartment or house) passing. The percentage of units passing is omitted for the houses as only one house for each type listed was checked, but the percentage passing is provided for the maisonettes and apartments as all units in these blocks have been tested.

Table 22: Summary of Sunlight Exposure for all units tested

Property	No. of Units Tested	No. of Units Satisfying Criteria	% of Units Satisfying Criteria
3F5m	1	1	-
3E8	1	1	-
2P	6	6	100%
1F3	1	1	-
1BC	1	1	-
3G	4	3	75%
2G_1	4	4	100%
2G_2	4	4	100%

The results show that all maisonette units meet the minimum recommendation for sunlight. 11 out of 12 apartment units (92%) meet the minimum recommendation for sunlight.

A detailed breakdown of the solar exposure results is provided in Appendix B.

5.5.3 Sunlight to Proposed Amenity Spaces

The BRE guide recommends:

"that for it to appear adequately sunlit throughout the year, at least half of a garden or amenity area should receive at least two hours of sunlight on 21 March."

The main communal open spaces and the open space associated with the creche were was analysed. These areas are identified in red below and labelled for reference in the results.

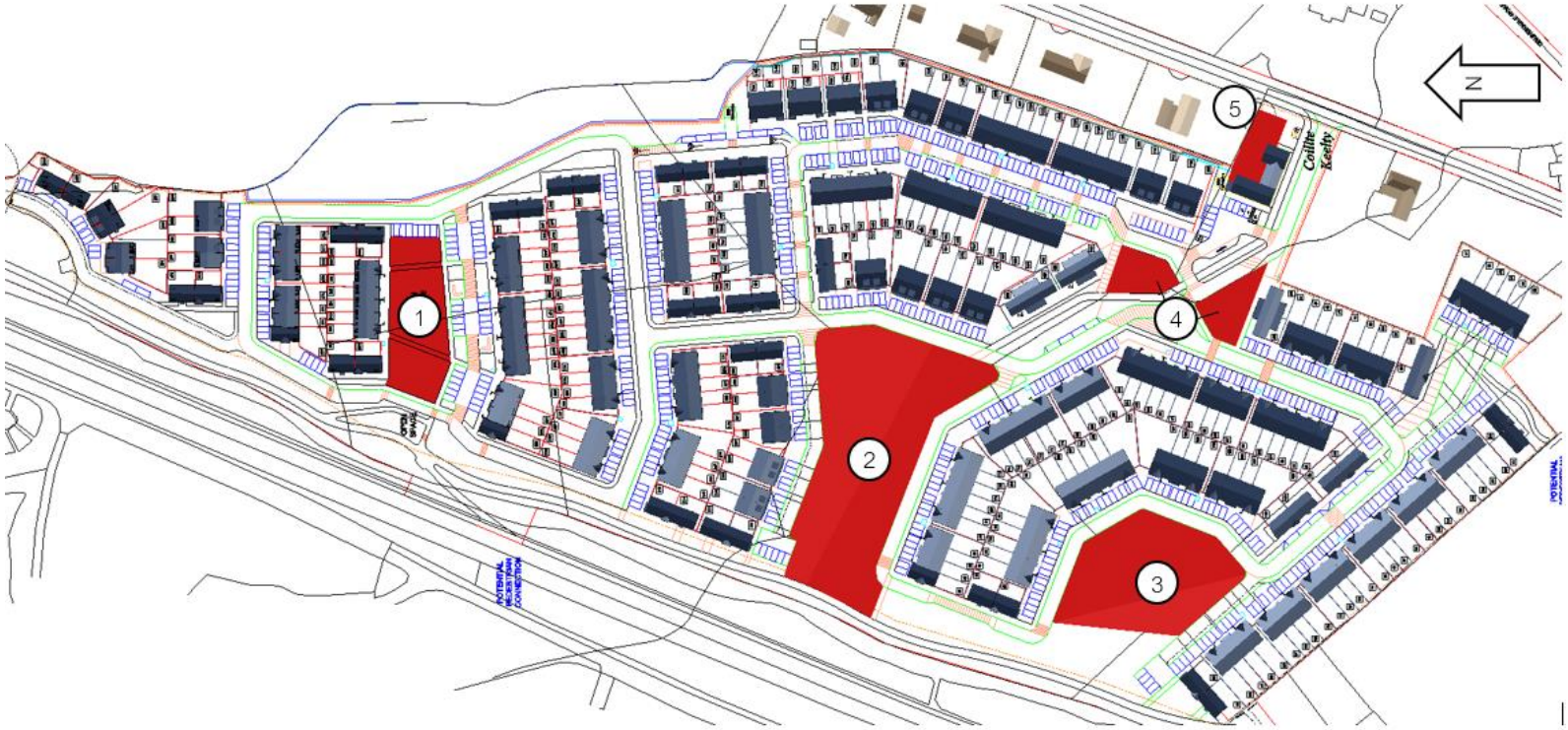


Figure 24: Proposed Communal Open Spaces (1-4) and Creche Open Space (5)

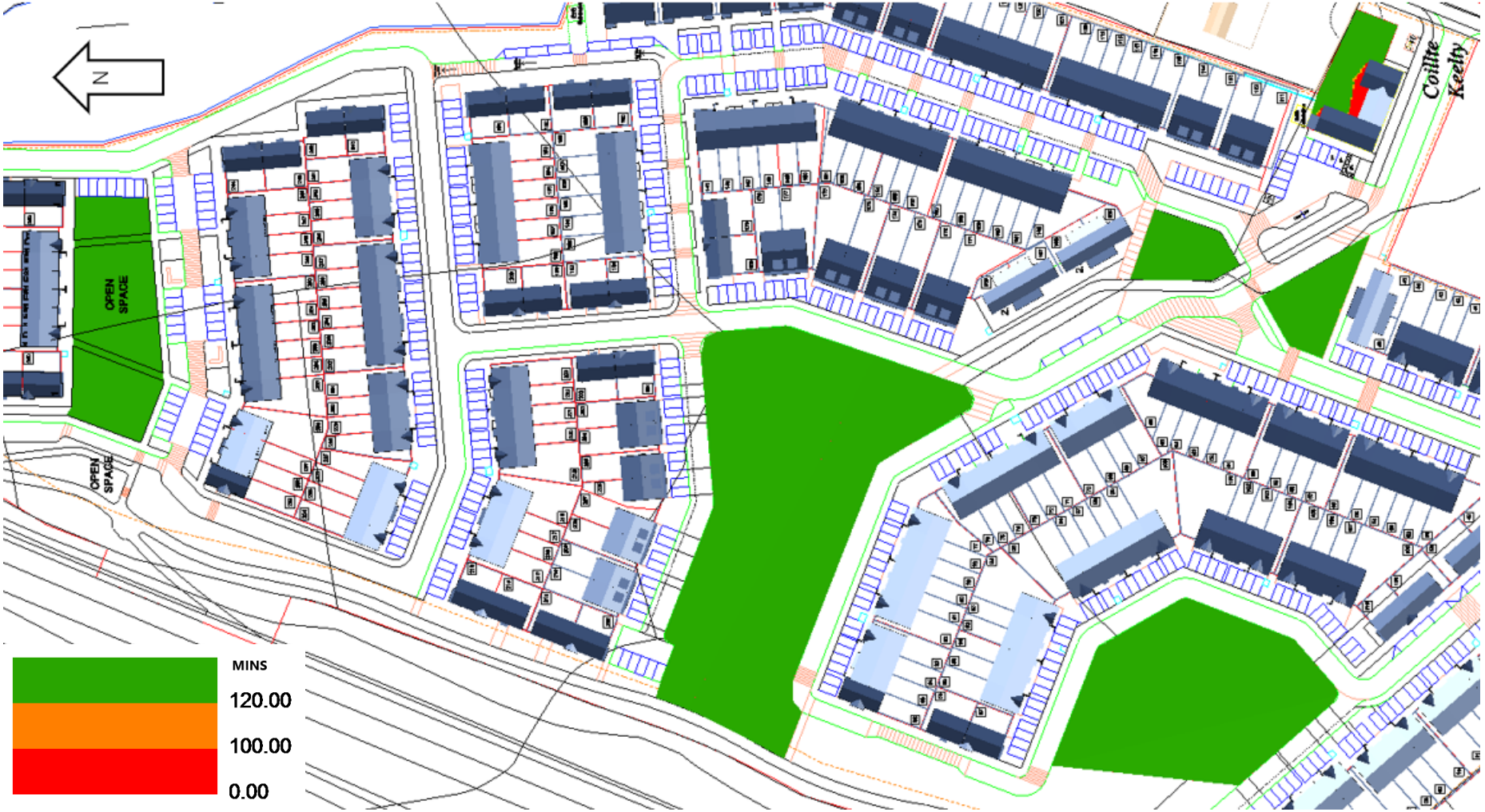


Figure 25: Proposed Open Spaces 2hr Sunlight Test

Table 23: Open Spaces 2hr Sunlight Test Results

Open Space	Area (m^2)	2hr Sun Area (m^2)	% Area	Meets Criteria
1	1444.42	1444.42	100	Yes
2	9912.80	9912.80	100	Yes
3	2639.94	2639.94	100	Yes
4	826.67	826.34	99.96	Yes
5 (Creche)	326.49	285.29	87.38	Yes

The results show that all of the open spaces should receive greater than 2 hours of sunlight on March 21st. Therefore, the proposed open spaces exceed the BRE's recommendation for sunlight and should appear adequately sunlit throughout the year.

Trees/Shrubs, including the existing trees, have not been modelled as the shadows they produce are almost impossible to predict and "*the dappled shade of a tree is more pleasant than the deep shadow of a building (this applies particularly to deciduous trees).*" (BRE Building Technology Group, 2022) As per the BRE guidance, in assessing the impact of buildings on sunlight in gardens, trees are not normally included in the calculation unless a dense belt of evergreens is specifically planned. Nevertheless, the location for planting trees should be chosen with care. "*The aim should normally be to have some areas of partial shade under trees while leaving other parts of the garden or amenity area in full sun.*" (BRE Building Technology Group, 2022)

6 Conclusion

The results show that the proposed development will have a negligible impact on surrounding buildings with respect to:

- access to skylight,
- access to sunlight, and
- sunlight to gardens/open spaces.

All rooms tested in the proposed development meet the minimum recommendations for internal daylight provision as set out in the BRE Guide and BS EN 17037 (National Annex).

The results show that all maisonette units meet the minimum recommendation for sunlight. 11 out of 12 apartment units (92%) meet the minimum recommendation for sunlight. All of the house types tested also meet the minimum recommendation for sunlight.

With respect to the apartments and maisonette units, for which all units were tested, the results show that the number of units meeting the sunlight criteria has been maximised with only one 1 out 18 of these units failing.

All communal amenity spaces and the creche amenity space in the proposed development should receive more than 2 hours of sunlight on March 21st. Therefore, the proposed amenity spaces exceed the BRE 's recommendation for sunlight to open spaces and should appear adequately sunlit throughout the year.

Overall, the development has been designed with due consideration for sunlight and daylight and meets the recommendations as set out in the BRE Guide – BR 209 "Site Layout Planning for Daylight and Sunlight, A guide to good practice (2022)."

Appendix A Proposed Illuminance Contours (with Room & Window Legends)

A.1 Block 2G_1 & 2G_2

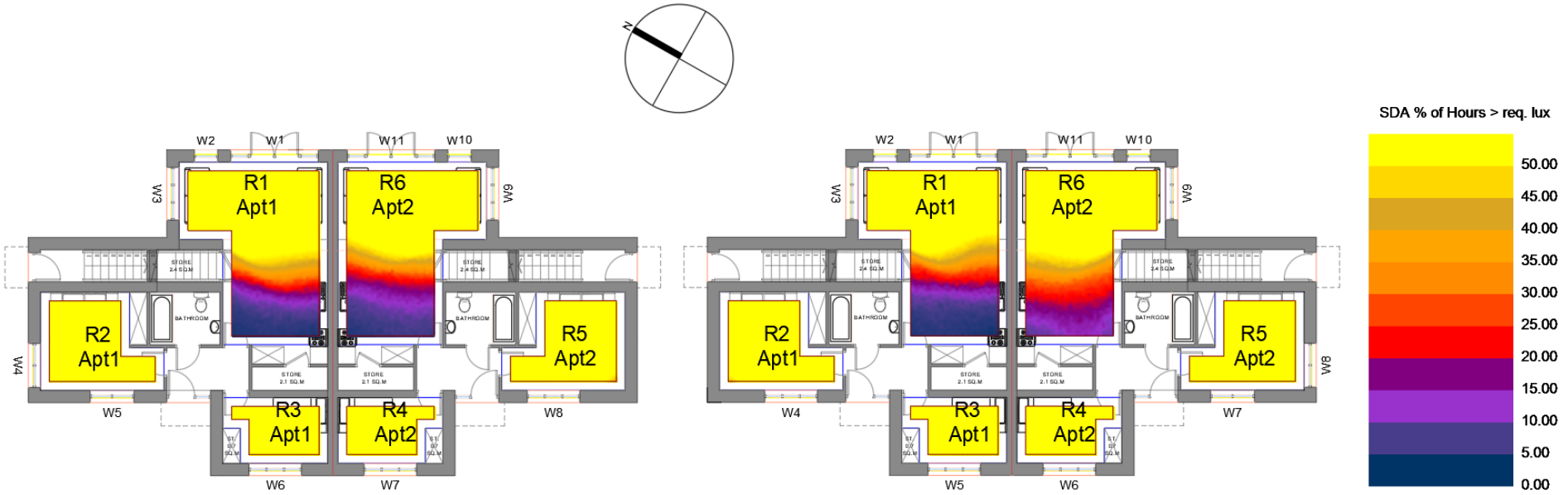


Figure 26: Block 2G_1 & 2G_2 Ground Floor sDA Contours

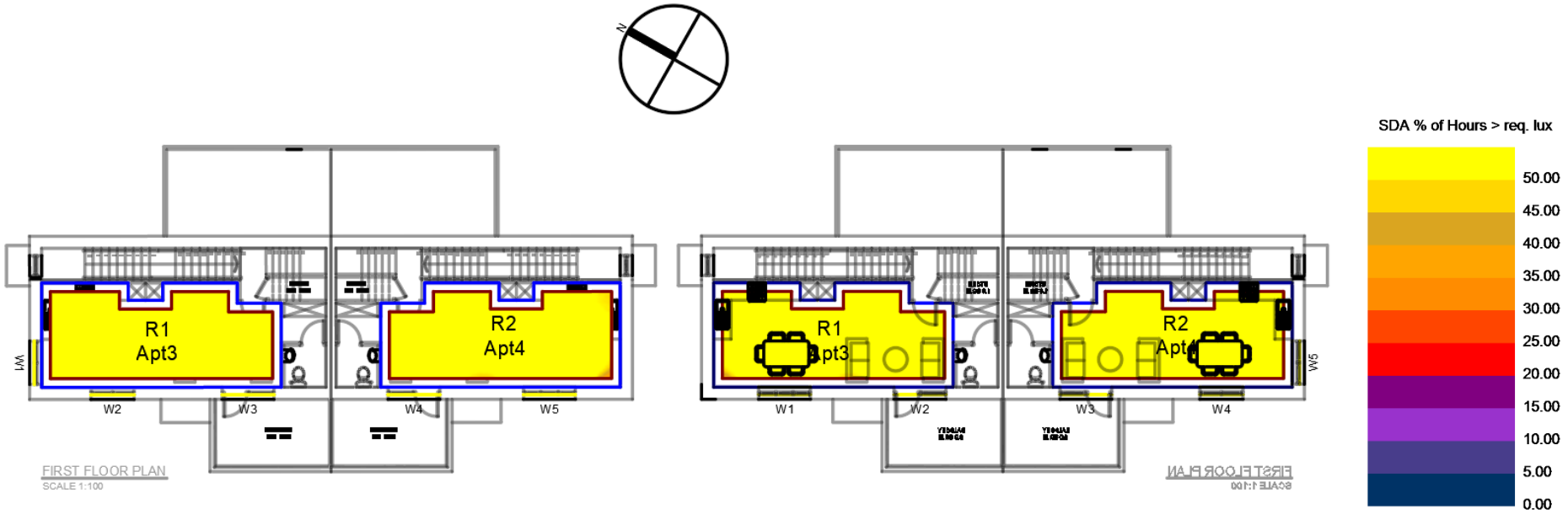


Figure 27: Block 2G_1 & 2G_2 First Floor sDA Contours

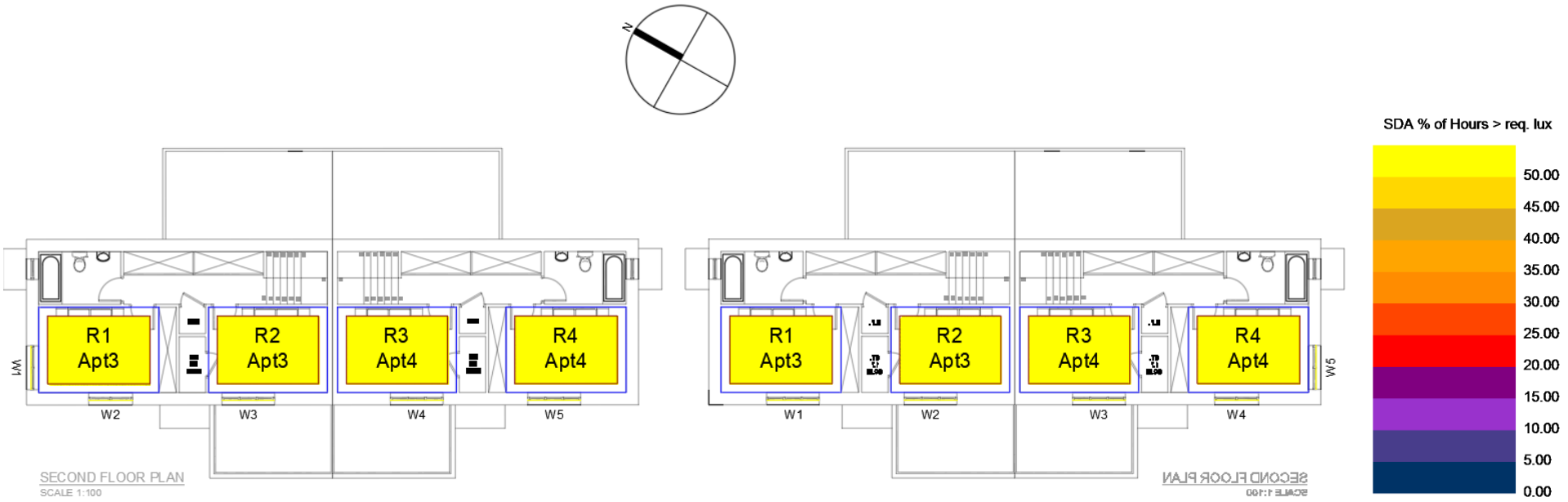


Figure 28: Block 2G_1 & 2G_2 Second Floor sDA Contours

A.2 Apartment Block 3G

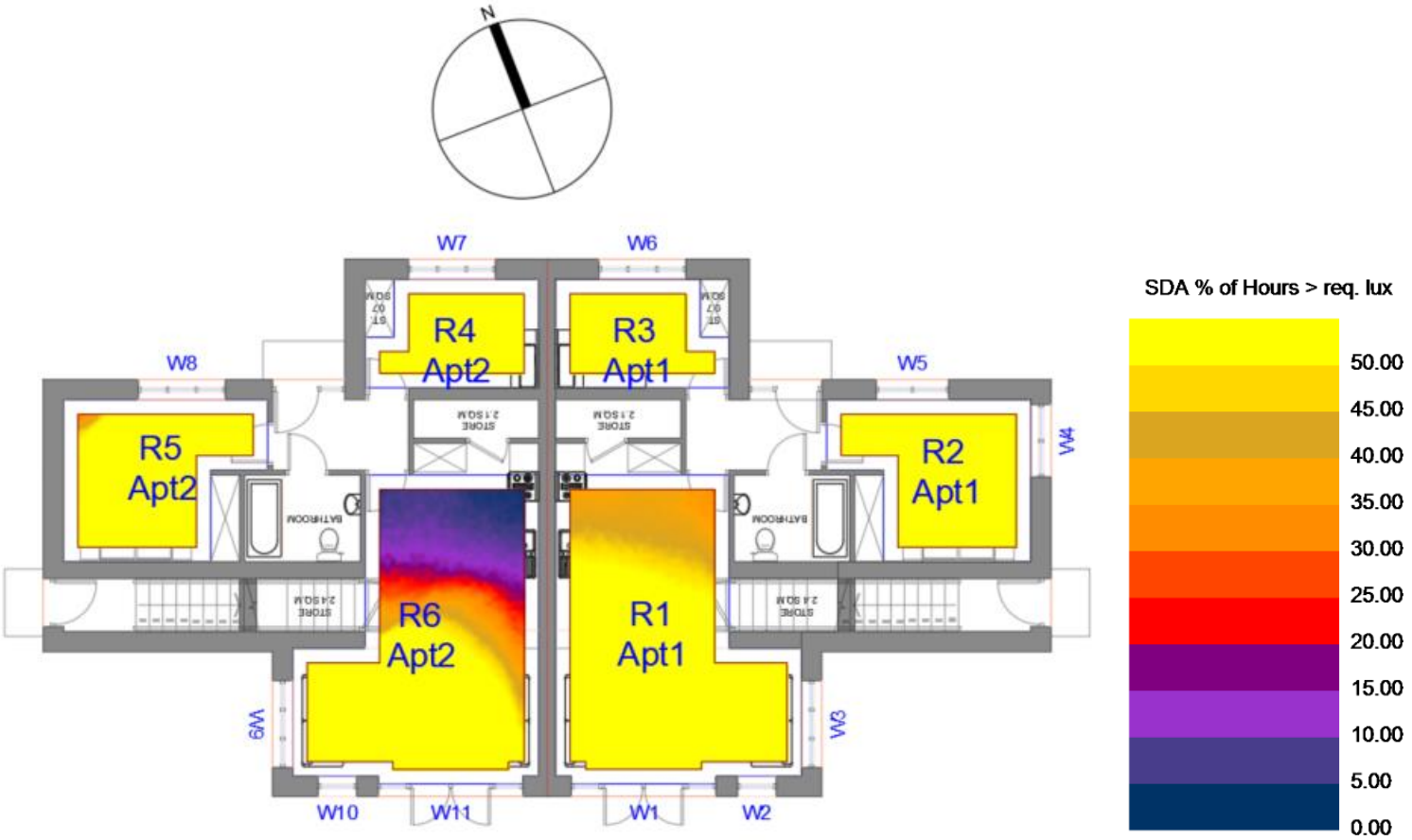


Figure 29: Apartment Block 3G Ground Floor

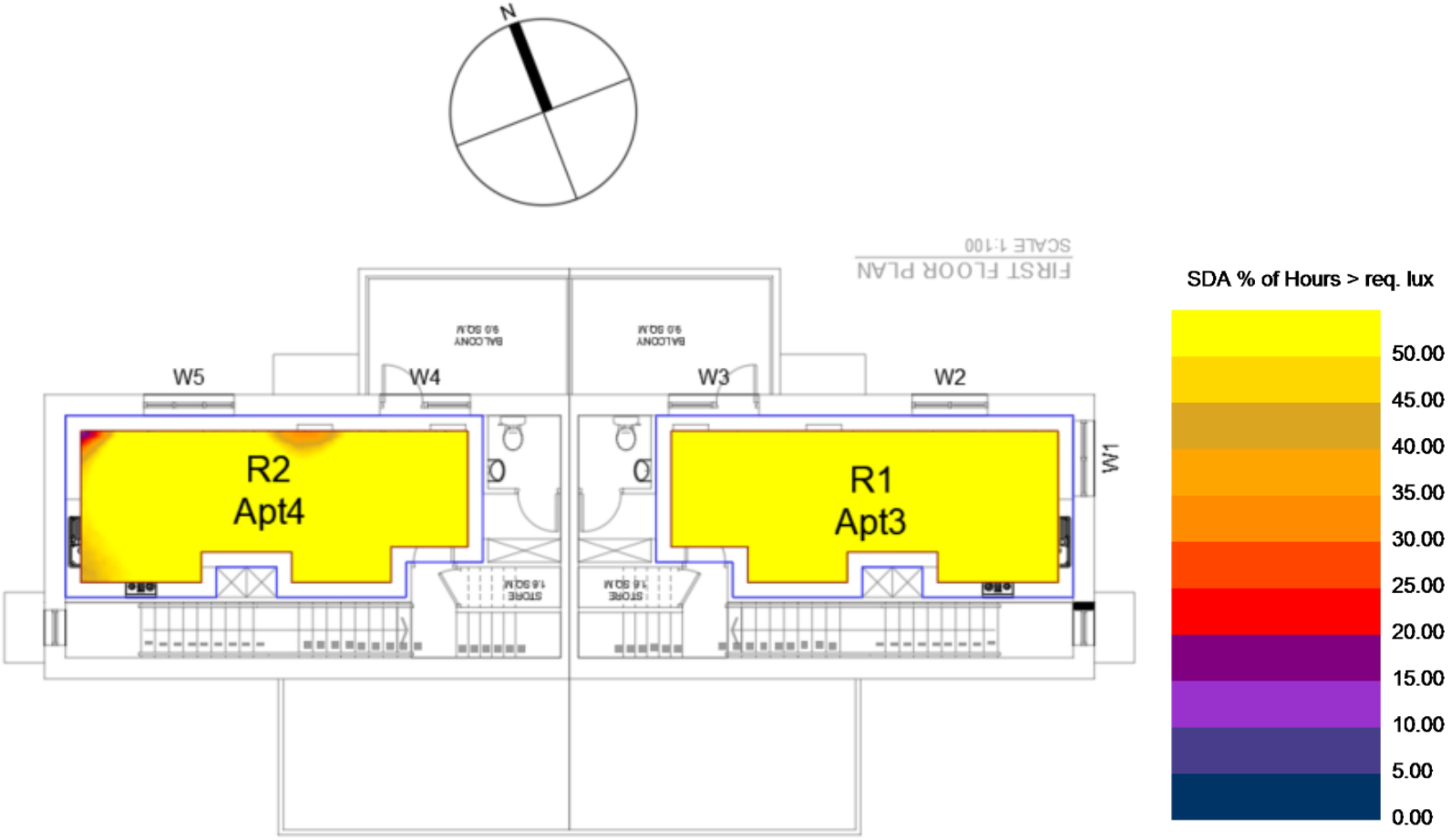


Figure 30: Apartment Block 3G First Floor

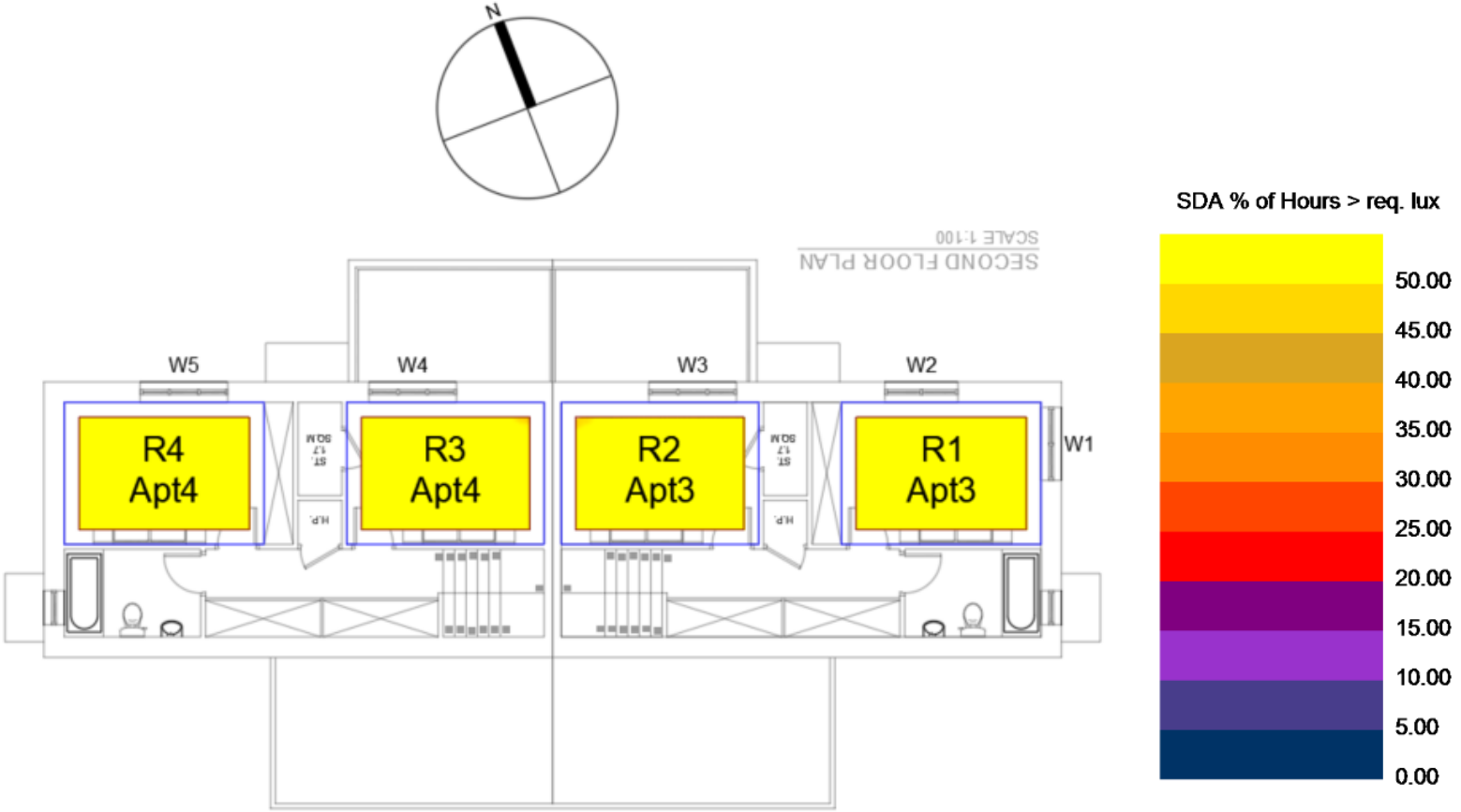


Figure 31: Apartment Block 3G Second Floor

A.3 Maisonette Units 2P

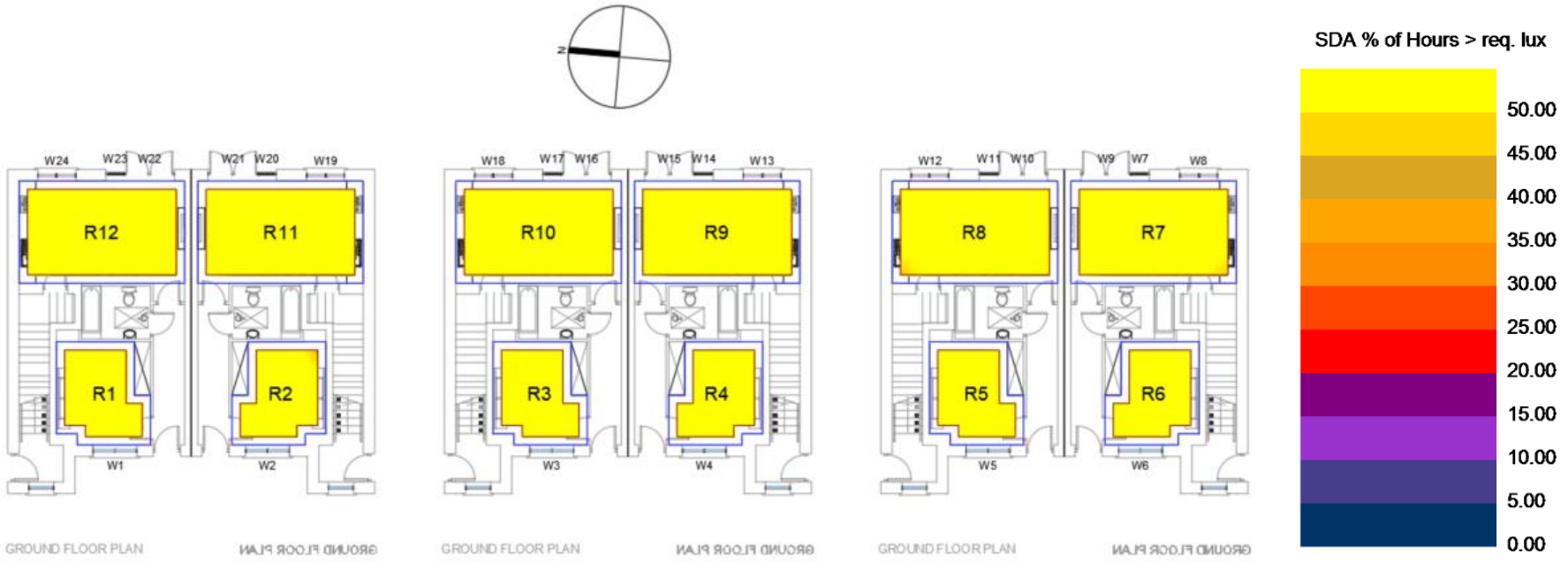


Figure 32: Block Type 2P (Maisonette Units) Ground Floor

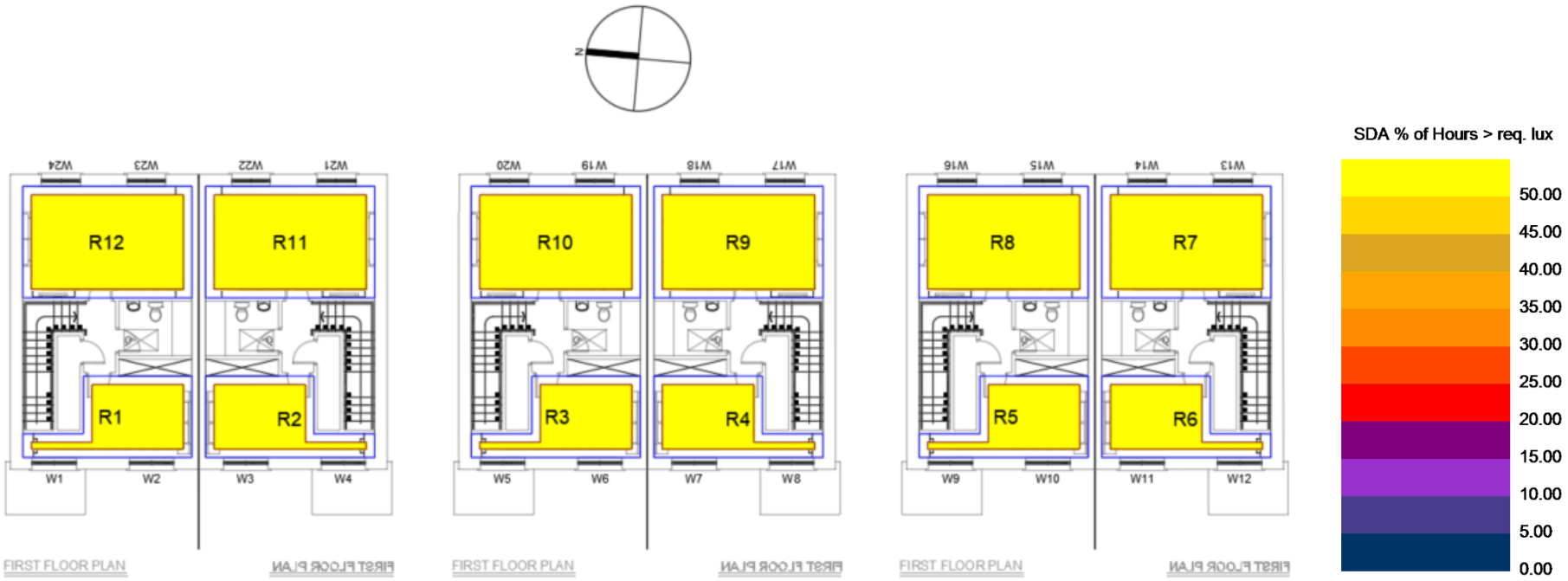


Figure 33: Block Type 2P (Maisonette Units) First Floor

A.4 House Type 1.B/C

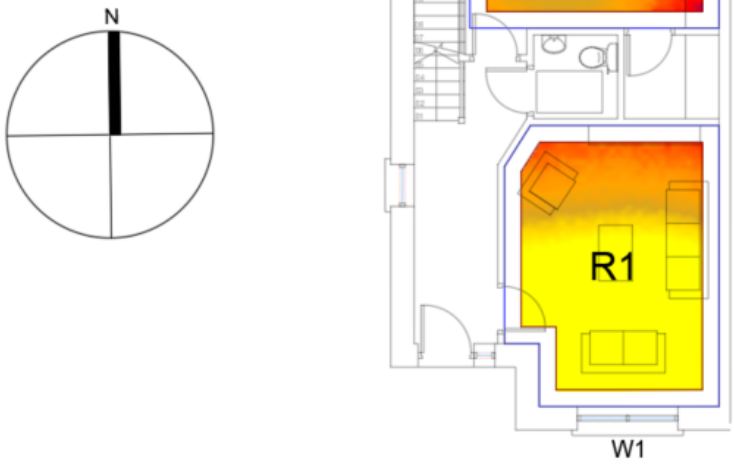


Figure 34: House Type 1.B/C Ground Floor

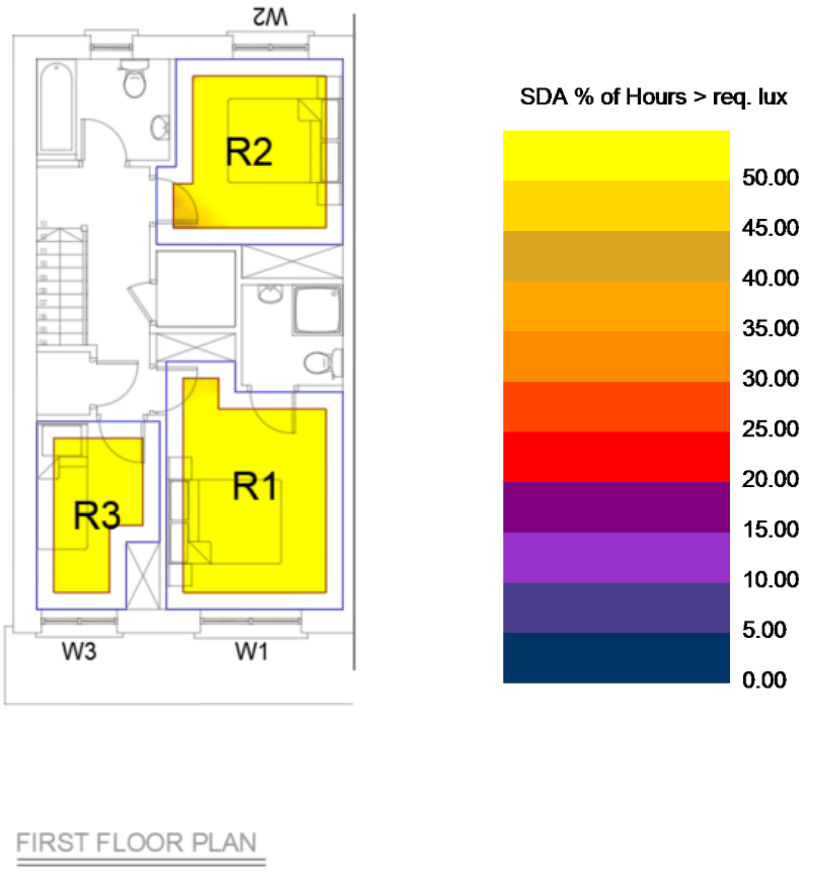


Figure 35: House Type 1.B/C First Floor

A.5 House Type 3.E8

Figure 36: House Type 3.E8 Ground Floor

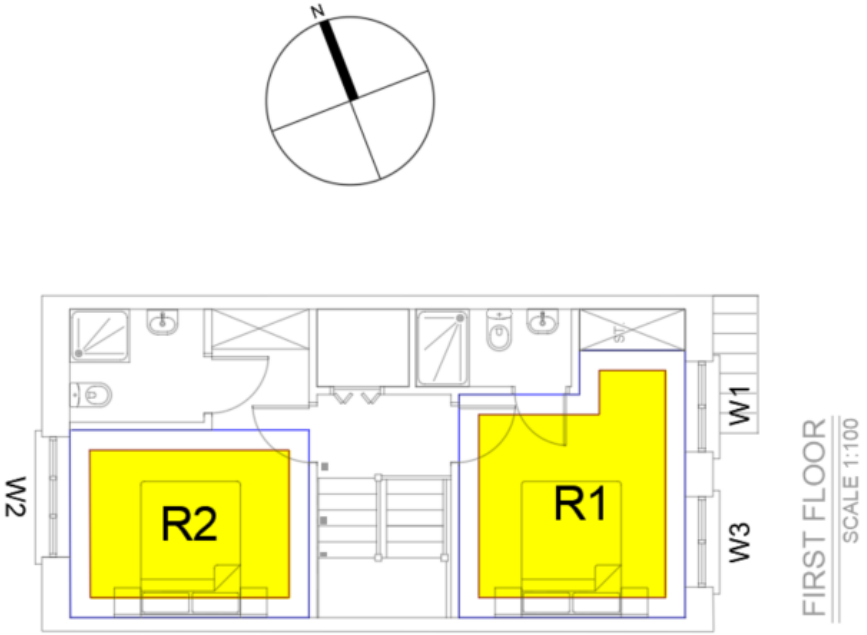
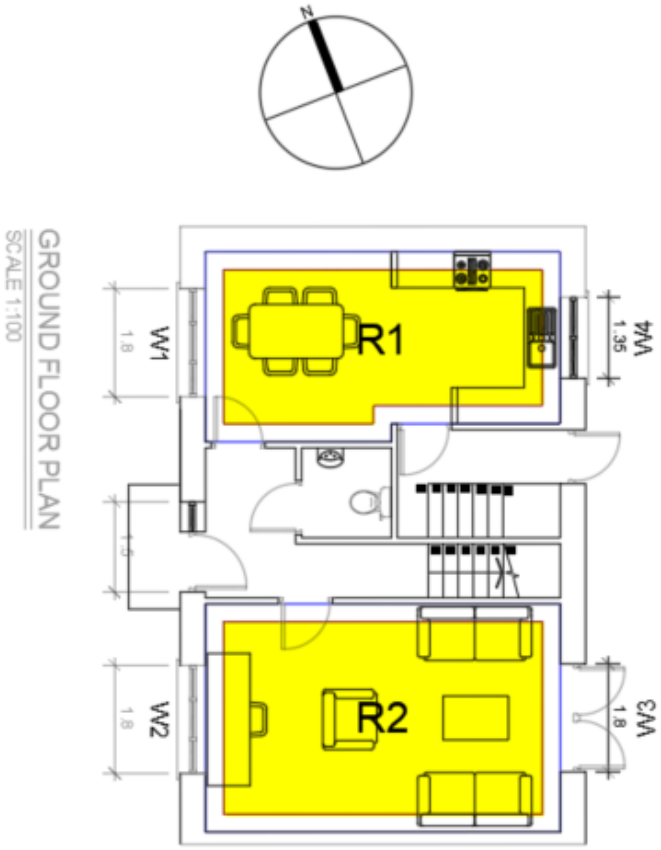
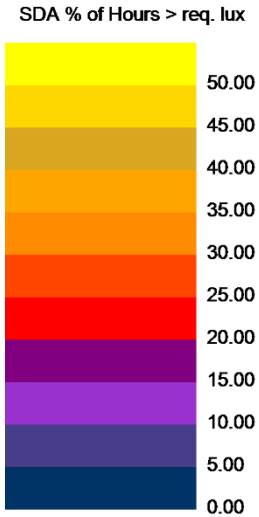


Figure 37: House Type 3.E8 First Floor

A.6 House Type 1.F





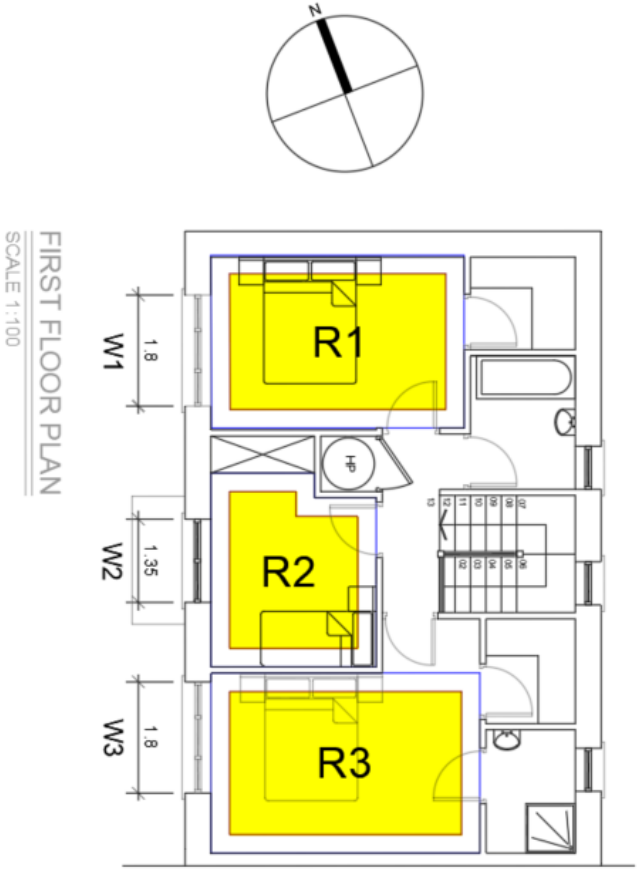


Figure 38: House Type 1.F3 Ground Floor

Figure 39: House Type 1.F3 First Floor

A.7 House Type 3.F5m

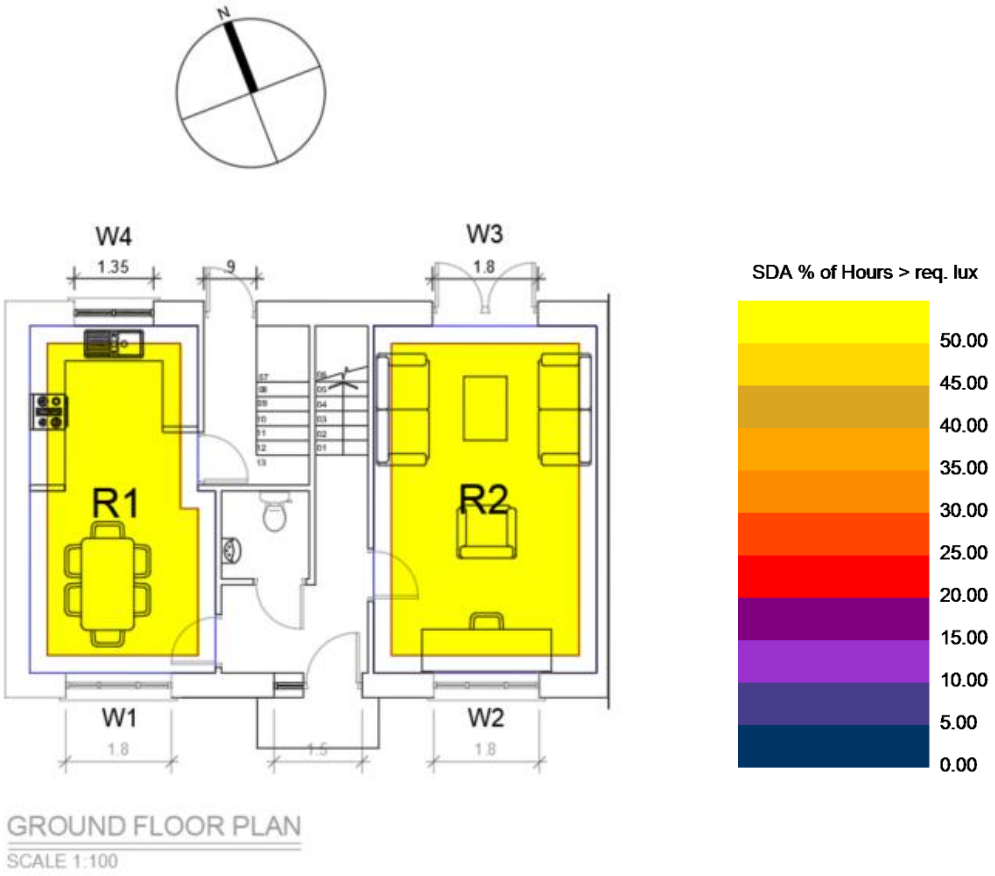


Figure 40: House Type 3.F5m Ground Floor

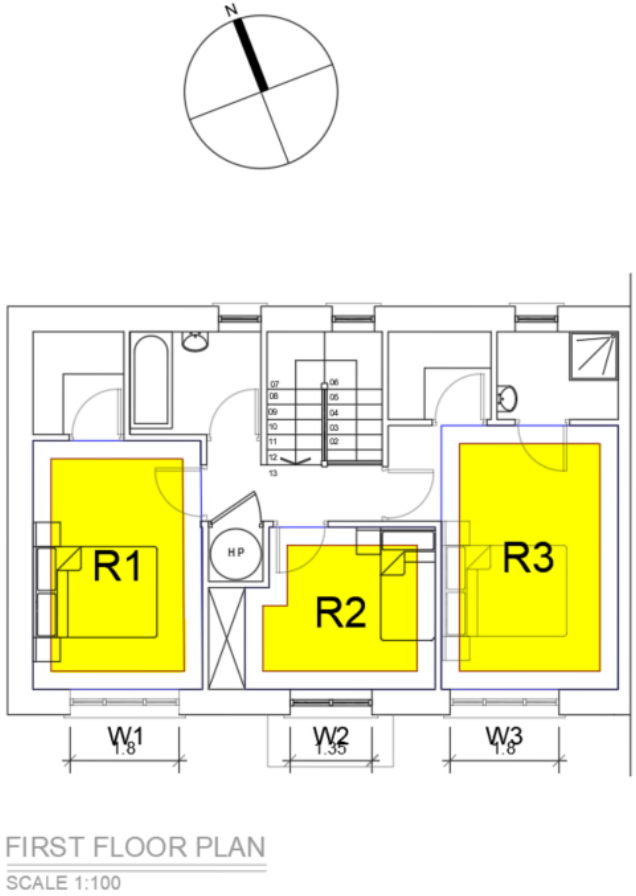


Figure 41: House Type 3.F5m First Floor

Appendix B Solar Exposure - Detailed Results

Understanding the Tables

- In the following tables, rooms which belong to *units* (apartments or houses) that fail the solar exposure test are highlighted.
- For a unit to fail, *all* rooms in that unit must fail the test. (If any habitable room meets the criterion, then the criterion for that unit is met, regardless if some rooms fail.)
- The last row for each room is the sunlight exposure for the room, which is the sum of sunlight exposure for each window to that room at non-concurrent times.
- The window and room labels from Appendix A should be used as the legend for the tables.

B.1 Apartment Type 2G

Table 24: Apartment Type 2G_1 Sunlight Exposure Results

Floor Ref	Room Ref	Room Attribute	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
2G_1						
Ground	R1	Apt1	LKD	W1	1.9	
				W2	1	
				W3	0	
					2	Minimum
Ground	R2	Apt1	Bedroom	W4	0.2	
				W5	5.7	
					5.7	High
Ground	R3	Apt1	Bedroom	W6	5.8	
					5.8	High
Ground	R4	Apt2	Bedroom	W7	5.8	
					5.8	High
Ground	R5	Apt2	Bedroom	W8	5.8	
					5.8	High
Ground	R6	Apt2	LKD	W9	2.4	
				W10	0.4	
				W11	1.6	
					2.4	Minimum
First	R1	Apt3	LKD	W1	0.2	
				W2	5.7	
				W3	5.8	
					5.8	High
First	R2	Apt4	LKD	W4	5.8	
				W5	5.8	
					5.8	High
Second	R1	Apt3	Bedroom	W1	0.2	
				W2	5.7	
					5.7	High
Second	R2	Apt3	Bedroom	W3	5.7	
					5.7	High
Second	R3	Apt4	Bedroom	W4	5.7	
					5.7	High
Second	R4	Apt4	Bedroom	W5	5.7	
					5.7	High

Table 25: Apartment Type 2G_2 Sunlight Exposure Results

Floor Ref	Room Ref	Room Attribute	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
2G_2						
Ground	R1	Apt1	LKD	W1	2.7	
				W2	1.7	
				W3	0	
					2.7	Minimum
Ground	R2	Apt1	Bedroom	W4	5.8	
					5.8	High
Ground	R3	Apt1	Bedroom	W5	5.8	
					5.8	High
Ground	R4	Apt2	Bedroom	W6	5.8	
					5.8	High
Ground	R5	Apt2	Bedroom	W7	5.6	
				W8	7.4	
					9.3	High
Ground	R6	Apt2	LKD	W9	3.9	
				W10	1.6	
				W11	2.7	
					3.9	Medium
First	R1	Apt3	LKD	W1	5.8	
				W2	5.8	
					5.8	High
First	R2	Apt4	LKD	W3	5.8	
				W4	5.6	
				W5	7.5	
					9.4	High
Second	R1	Apt3	Bedroom	W1	5.7	
					5.7	High
Second	R2	Apt3	Bedroom	W2	5.7	
					5.7	High
Second	R3	Apt4	Bedroom	W3	5.7	
					5.7	High
Second	R4	Apt4	Bedroom	W4	5.6	
				W5	7.5	
					9.4	High

B.2 Apartment Type 3G

Table 26: Apartment Type 3G Sunlight Exposure Results

Floor Ref	Room Ref	Room Attribute	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
			3G			
Ground	R1	Apt1	LKD	W1	6	
				W2	5.7	
				W3	5.3	
					7.7	High
Ground	R2	Apt1	Bedroom	W4	5.2	
				W5	0	
					5.2	High
Ground	R3	Apt1	Bedroom	W6	0	
					0	Failed
Ground	R4	Apt2	Bedroom	W7	0	
					0	Failed
Ground	R5	Apt2	Bedroom	W8	0	
					0	Failed
Ground	R6	Apt2	LKD	W9	0.7	
				W10	1.2	
				W11	3.6	
					4.2	High
First	R1	Apt3	LKD	W1	5.2	
				W2	0	
				W3	0	
					5.2	High
First	R2	**Apt4**	LKD	W4	0	
				W5	0	
					0	Failed
Second	R1	Apt3	Bedroom	W1	5.2	
				W2	0	
					5.2	High
Second	R2	Apt3	Bedroom	W3	0	
					0	Failed
Second	R3	**Apt4**	Bedroom	W4	0	
					0	Failed
Second	R4	**Apt4**	Bedroom	W5	0	
					0	Failed

B.3 House Type 1.B/C

Table 27: House Type 1.B/C Sunlight Exposure Results

Floor Ref	Room Ref	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
1BC					
Ground	R1	Living Room	W1	9.4	
				9.4	High
Ground	R2	KD	W2	0	
			W3	0	
				0	Failed
First	R1	Bedroom	W1	9.4	
				9.4	High
First	R2	Bedroom	W2	0	
				0	Failed
First	R3	Bedroom	W3	9.4	
				9.4	High

B.4 House Type 3.E8

Table 28: House Type 3.E8 Sunlight Exposure Results

Floor Ref	Room Ref	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
3E8					
Ground	R1	Living Room	W1	4.7	
				4.7	High
Ground	R2	KD	W2	3.1	
				3.1	Medium
First	R1	Bedroom	W1	5.3	
			W3	5.3	
				5.3	High
First	R2	Bedroom	W2	3	
				3	Medium

B.5 House Type 1.F3

Table 29: House Type 1.F3 Sunlight Exposure Results

Floor Ref	Room Ref	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
1F3					
Ground	R1	KD	W1	3	
			W4	5.2	
				8.2	High
Ground	R2	Living Room	W2	2.4	
			W3	2.7	
				5	High
First	R1	Bedroom	W1	3	
				3	Medium
First	R2	Bedroom	W2	2.8	
				2.8	Minimum
First	R3	Bedroom	W3	2.4	
				2.4	Minimum

B.6 House Type 3.F5m

Table 30: House Type 3.F5m Sunlight Exposure Results

Floor Ref	Room Ref	Room Use	Window Ref	Proposed Sunlight Exposure	Rating
3F5m					
Ground	R1	KD	W1	8.1	
			W4	0	
				8.1	High
Ground	R2	Living Room	W2	8.2	
			W3	0	
				8.2	High
First	R1	Bedroom	W1	8.2	
				8.2	High
First	R2	Bedroom	W2	8.1	
				8.1	High
First	R3	Bedroom	W3	8.2	
				8.2	High

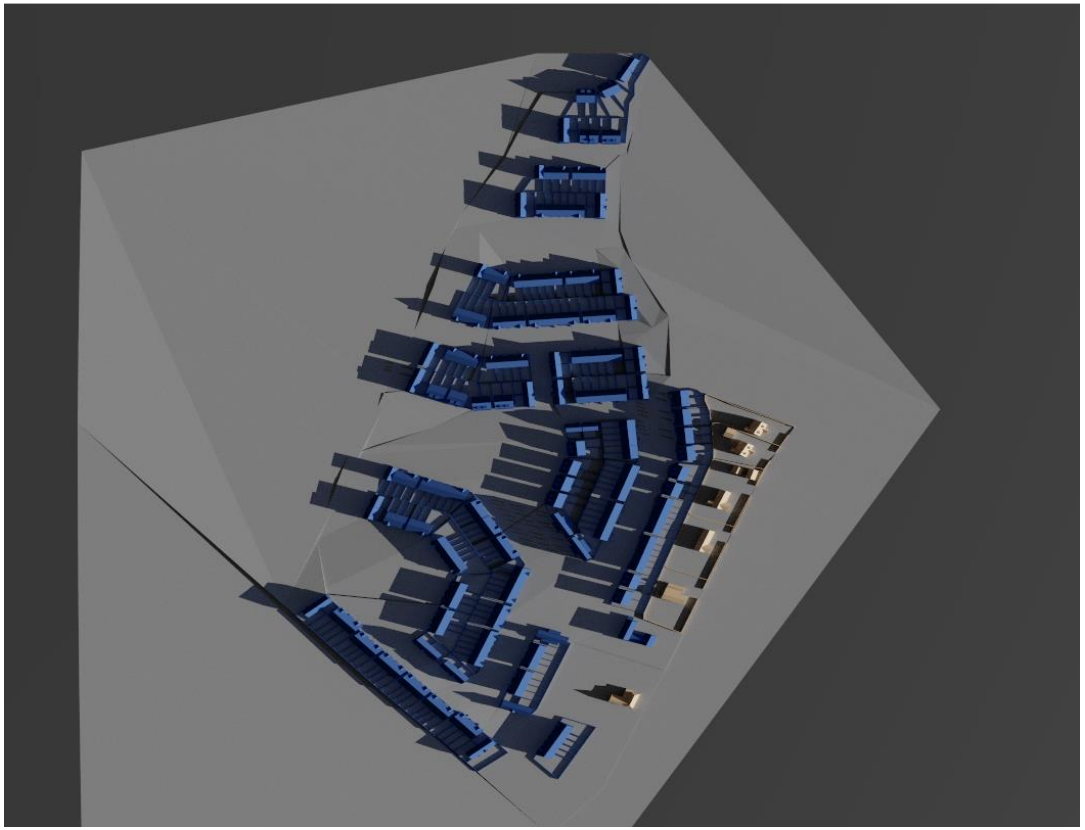
Appendix C Shadow Images

'Before' and 'after' shadow plots are generally used to show the difference that the proposed development makes. However, in this instance, only proposed shadow images have been created as it is a greenfield, so no existing shadows are cast from this area.

Shadow plots were created for March 21st and June 21st. March 21st is the equinox and as such provides the average level of shadowing that can be expected. June 21st is a summertime plot and represents the best case for shadow. (December 21st has not been plotted as at this time of year even low buildings will cast long shadows. In a built up area, it is common for large areas of the ground to be in shadow in December.)

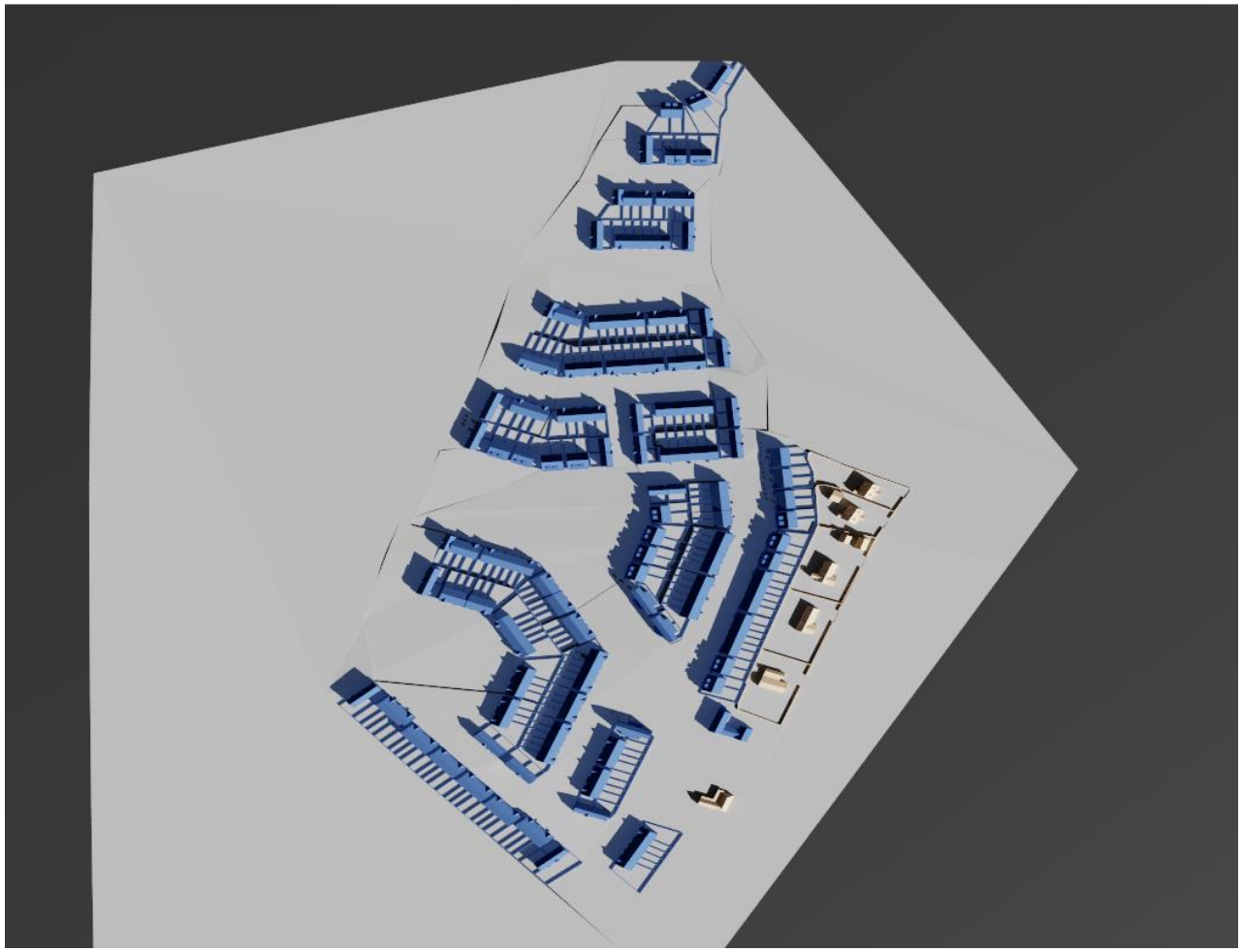
The shadow plots are purely illustrative (as opposed to other quantitative or quantitative metrics used in the analysis).

C.1 March 21st

	Proposed
March 21st - 8:00	20191-ENN-BPC-XX-ZZ-M3-P4-01 21-Mar 08-00 

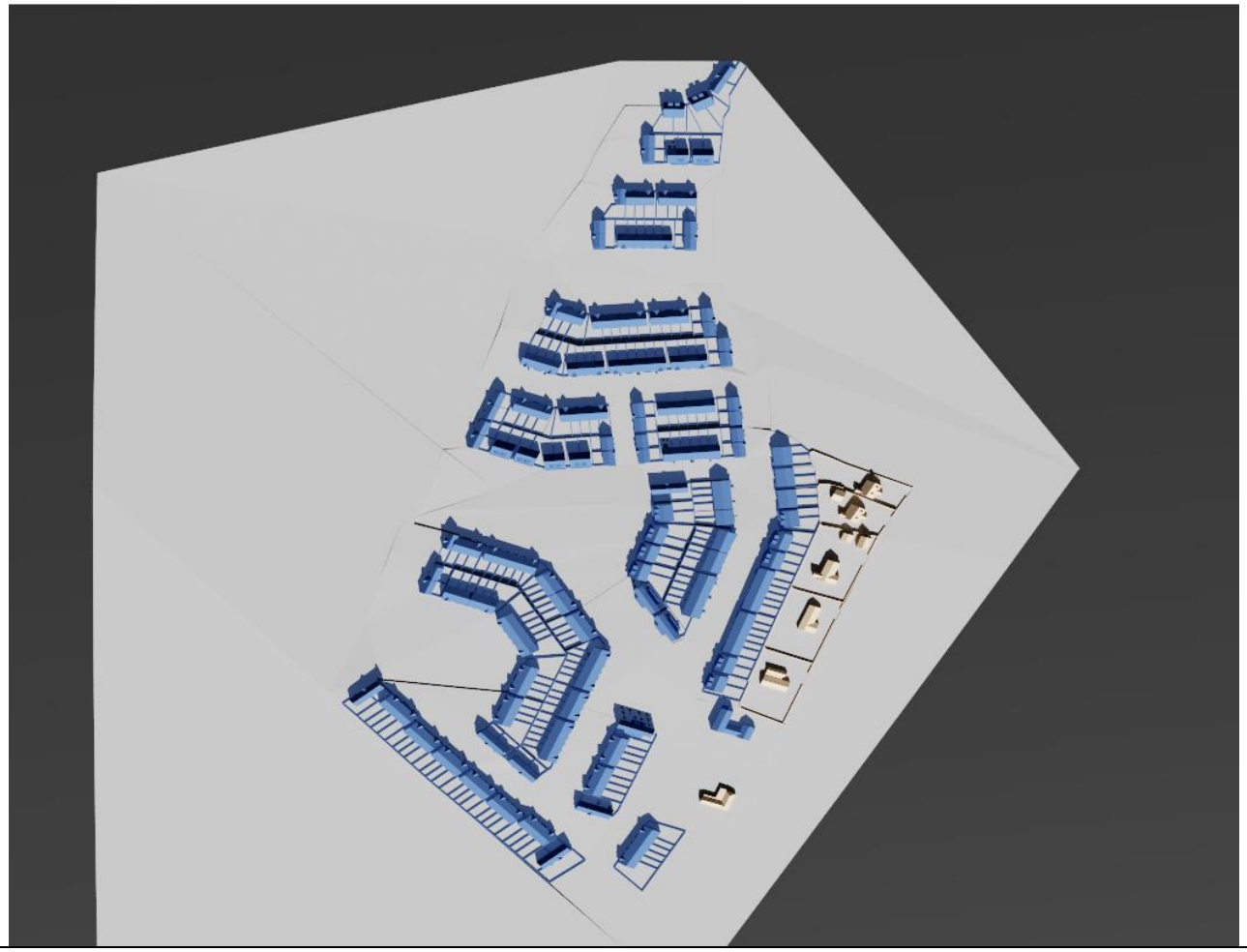
March 21st - 10:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Mar 10-00



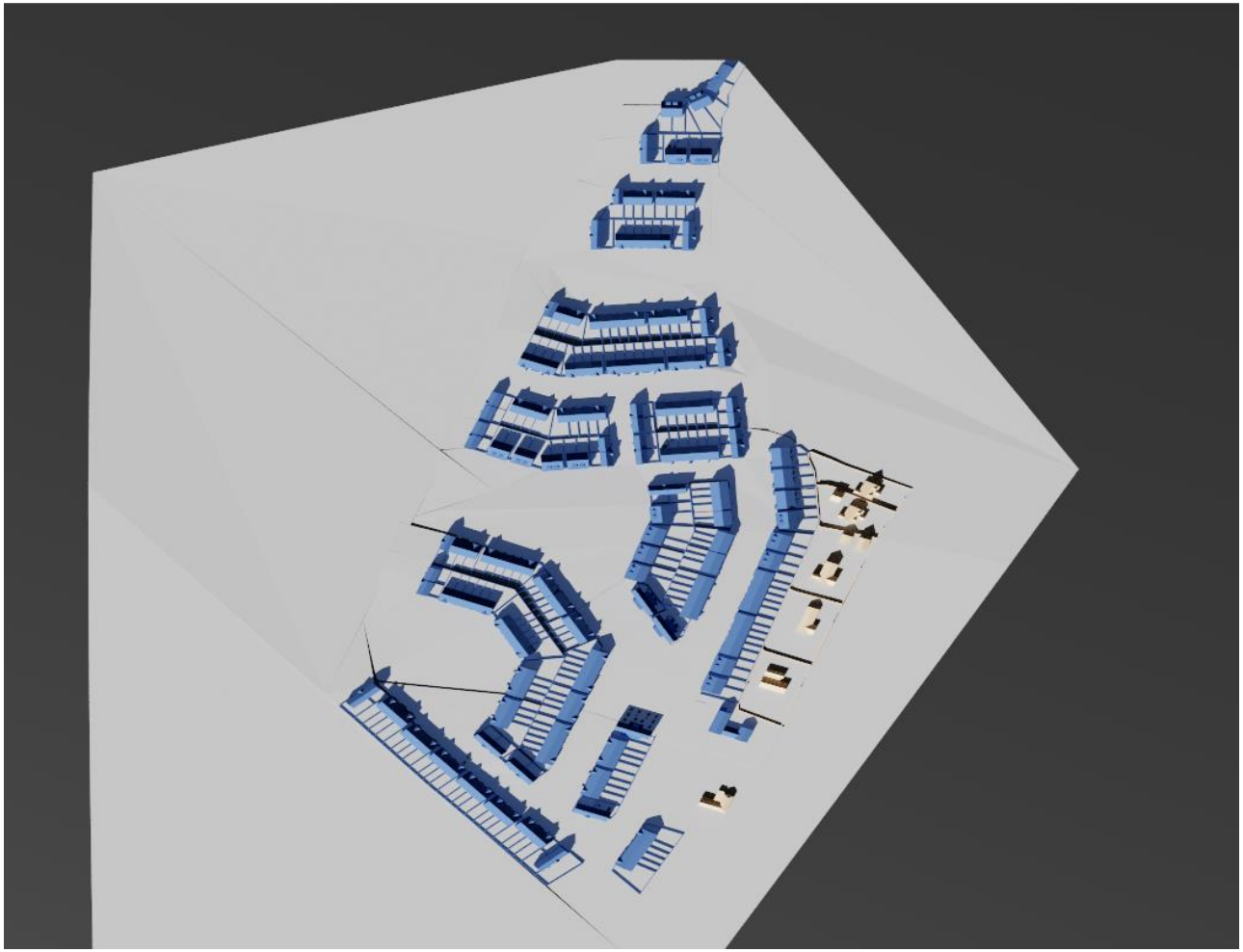
March 21st - 12:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Mar 12-00



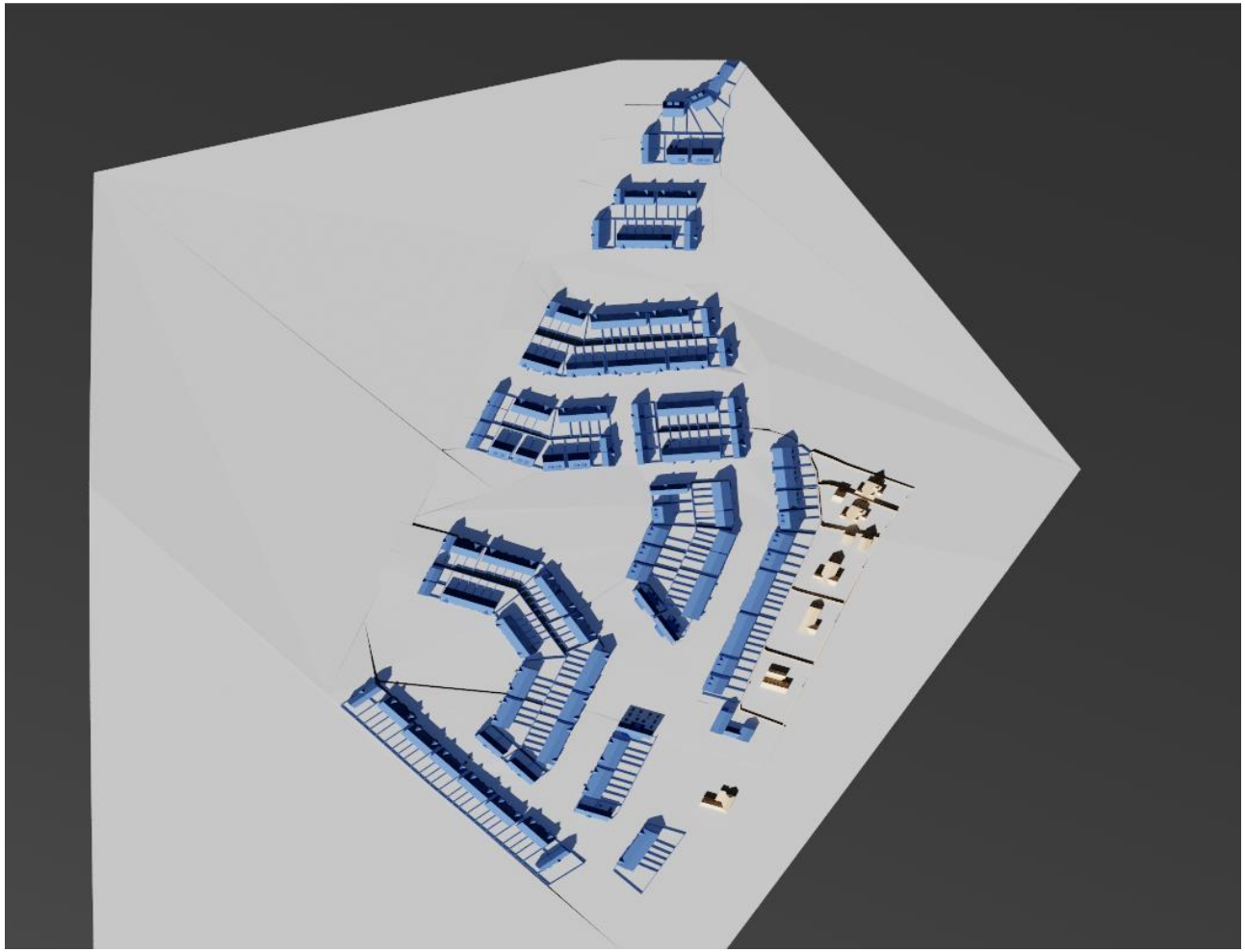
March 21st - 14:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Mar 14-00

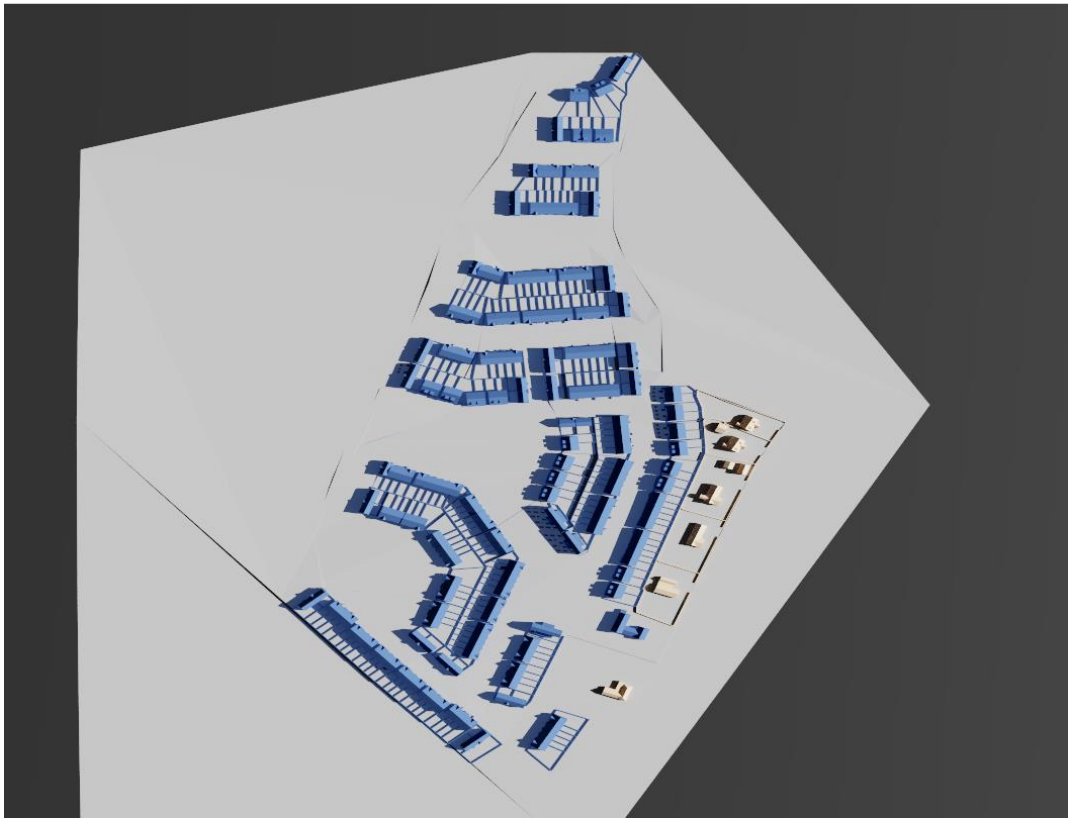


March 21st - 16:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Mar 14-00

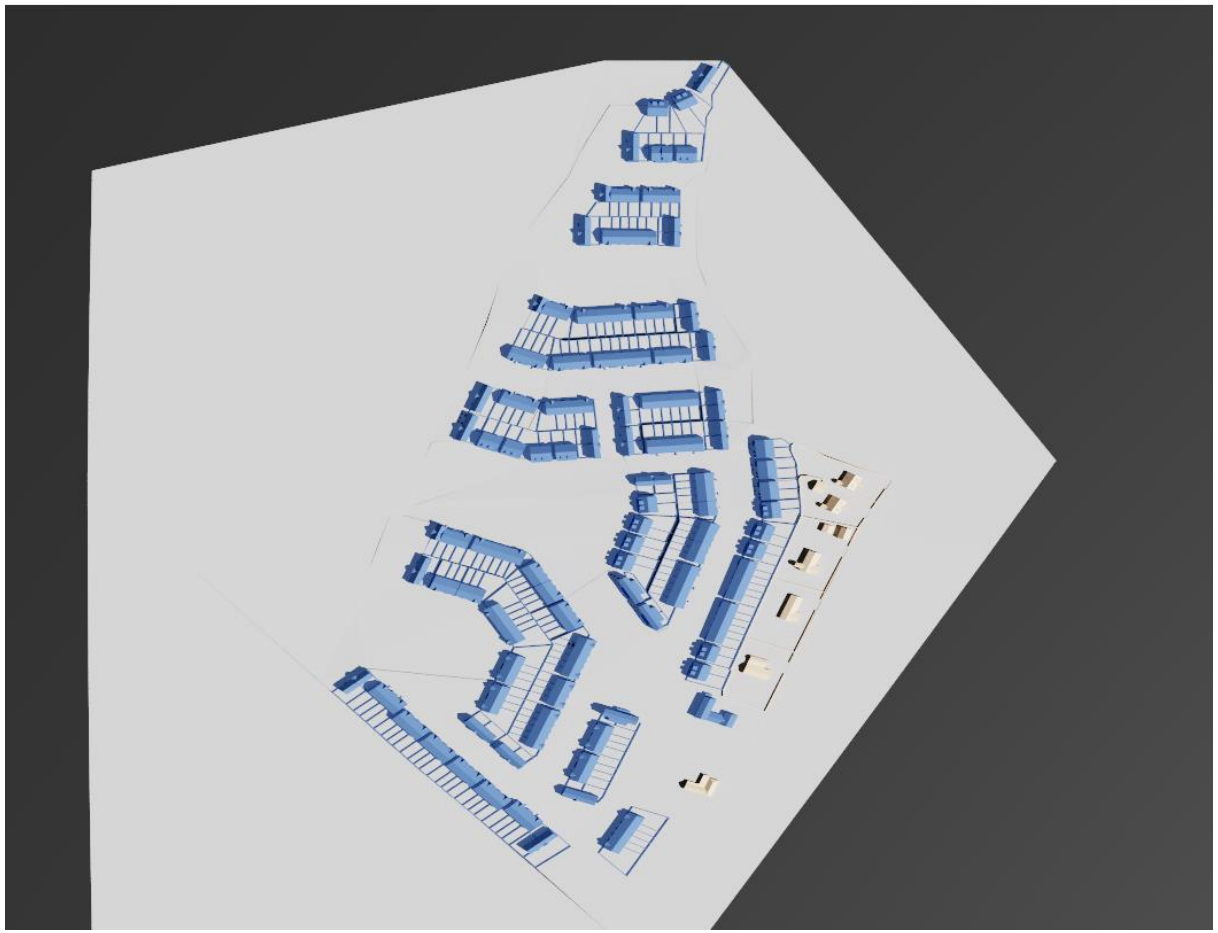


C.2 June 21st

	Proposed
June 21st - 8:00	20191-ENN-BPC-XX-ZZ-M3-P4-01 21-Jun 08-00 

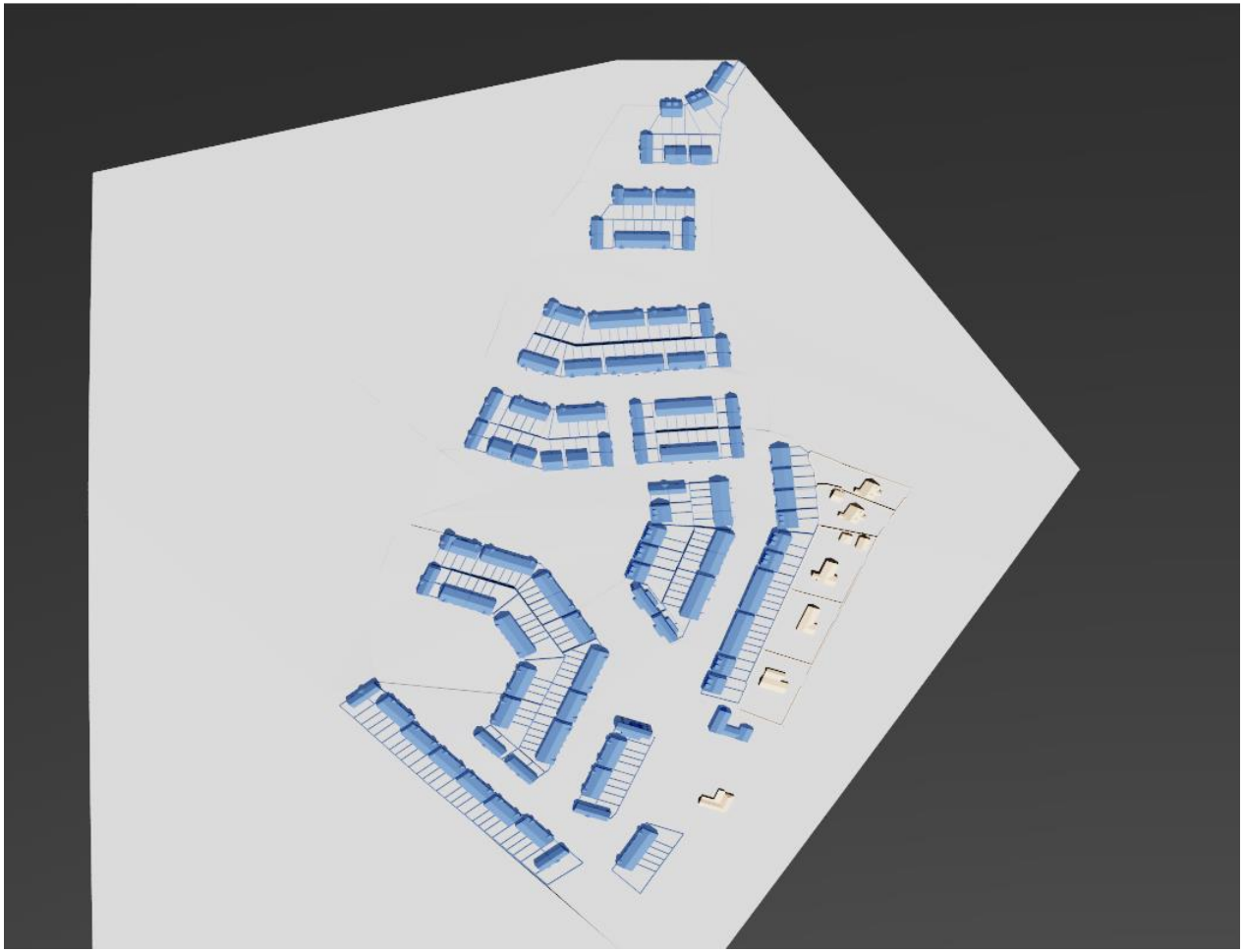
June 21st - 10:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Jun 10-00



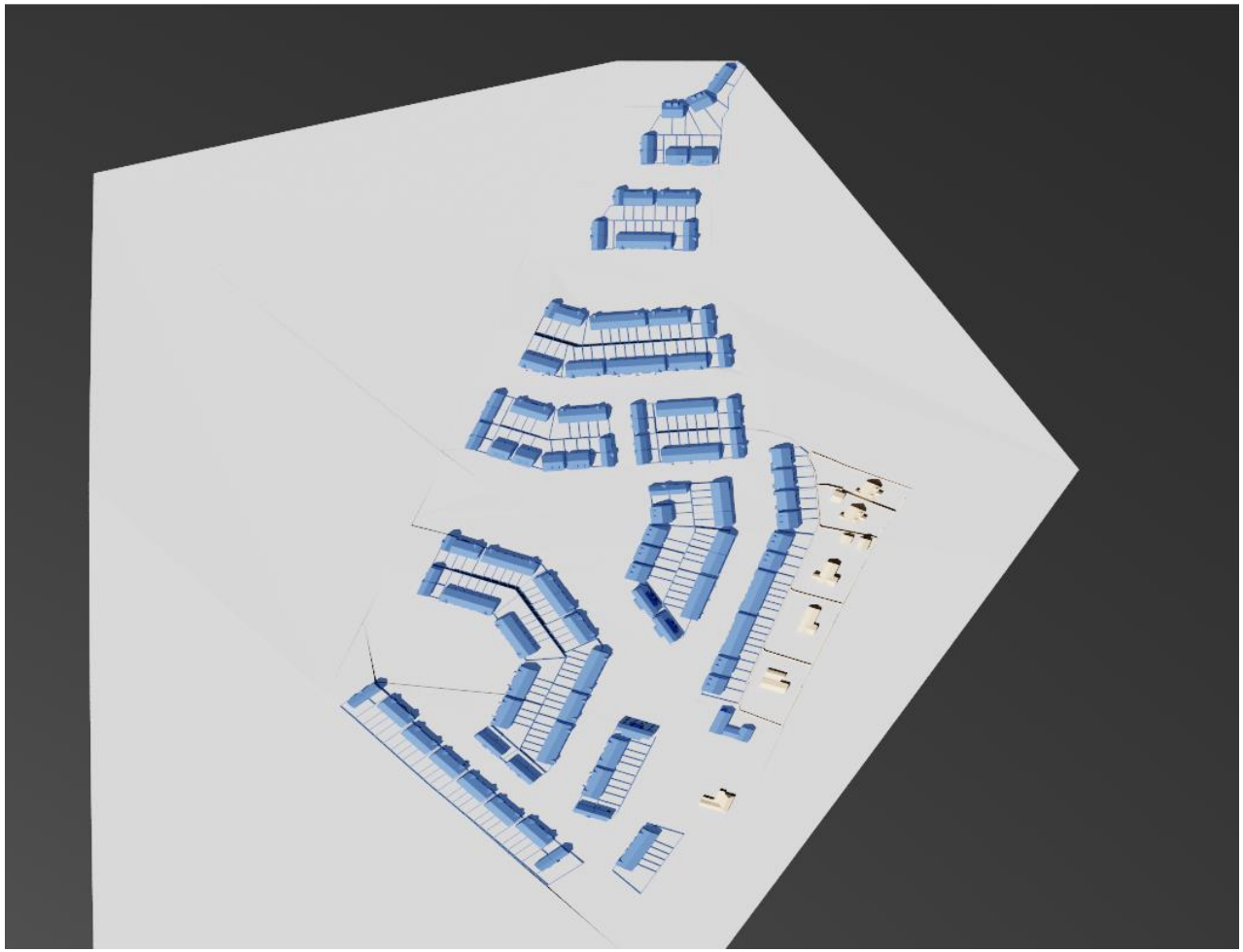
June 21st - 12:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Jun 12-00



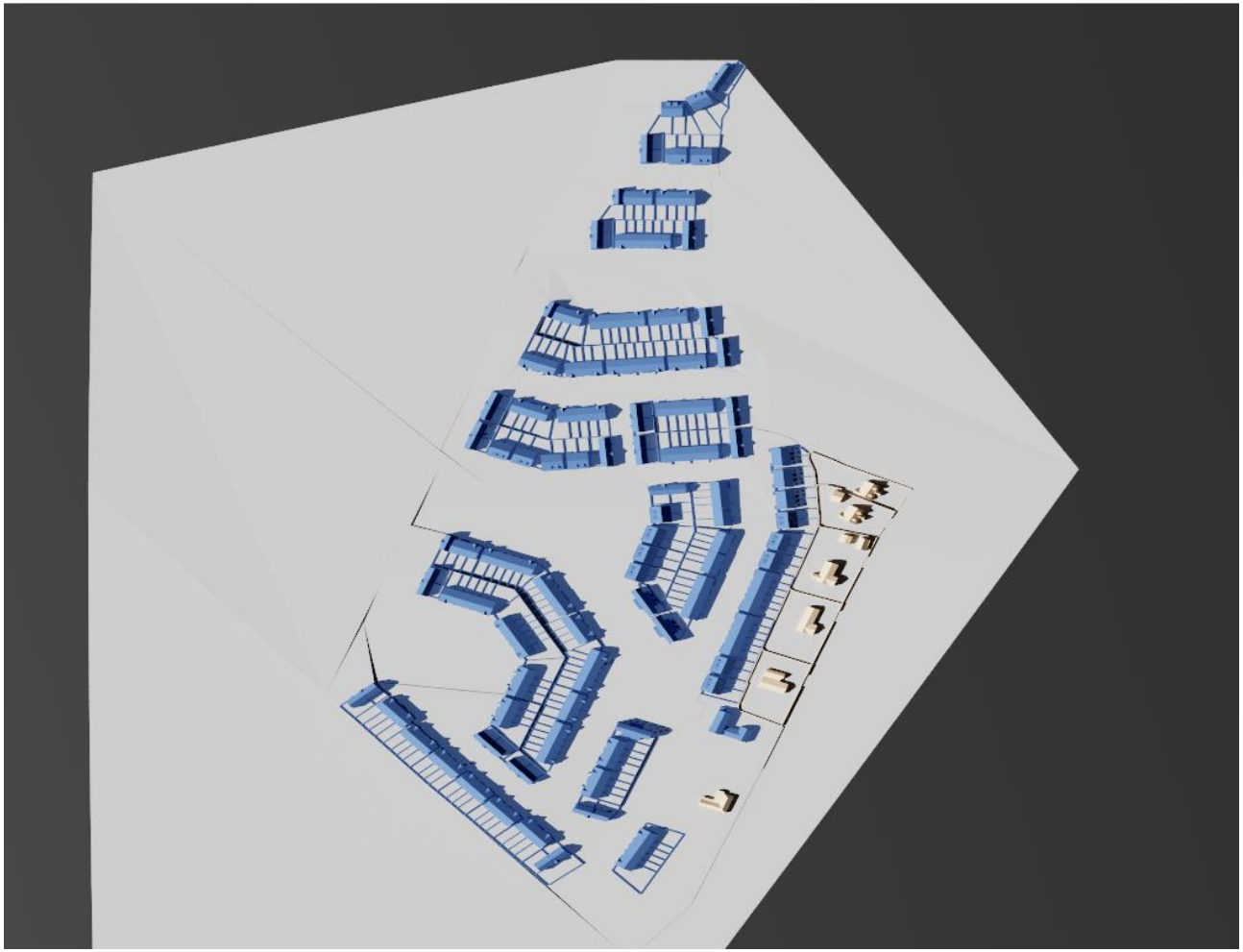
June 21st - 14:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Jun 14-00



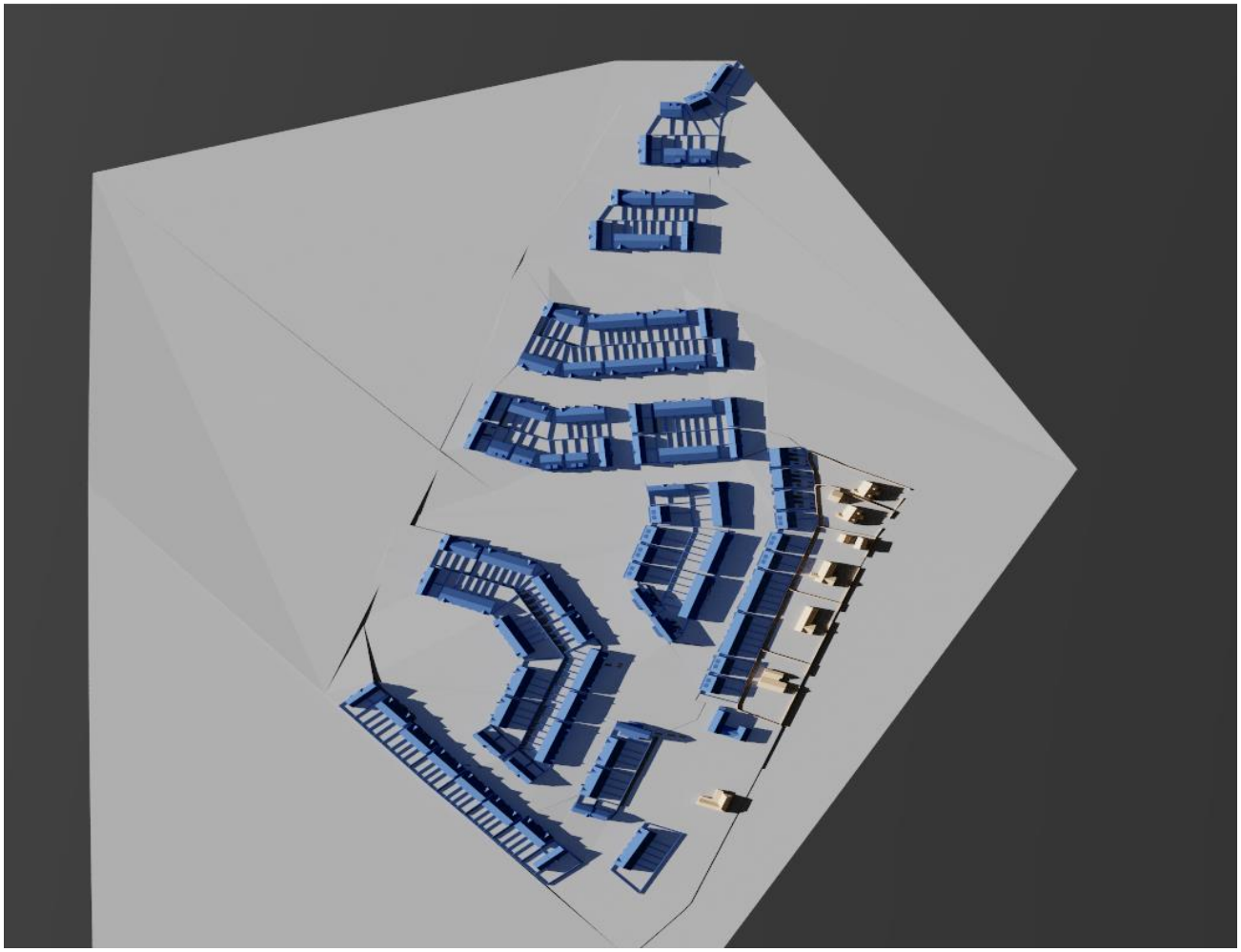
June 21st - 16:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Jun 16-00



June 21st – 18:00

20191-ENN-BPC-XX-ZZ-M3-P4-01
21-Jun 18-00



Appendix D Interior daylighting recommendations & sDA

As discussed in section 4.2, there are a number of ways the interior daylighting results can be presented. BR209 recommends reporting the median illuminance (exceeded over 50% of the reference plane) as this enables comparison with the different recommendations in BS EN 17037. Another method, which may be included as an "optional extra", is to report the % *area* of the reference plane exceeding the target illuminance E_T (for half of the daylight hours.) This is equivalent to Spatial Daylight Autonomy (sDA).

Daylight Autonomy (DA) is a daylight availability metric that corresponds to the percentage of time when a target illuminance at a point in a space is met. *Spatial* Daylight Autonomy (sDA) is "*An annual daylighting metric that quantifies the fraction of the area within a space for which the daylight autonomy exceeds a specified value.*" (Illuminating Engineering Society, 2022). If the defined threshold is set based upon electric lighting criteria, a higher sDA yields greater *autonomy* from electric lighting.

In basic terms, sDA is the percentage of the reference plane meeting a target illuminance for a specified amount of time. It is often presented in a format similar to that shown below:

- $sDA_{300,50\%} \geq 55\%$, means 300lux should be achieved for 50% of the time across at least 55% of the reference plane,
- $sDA_{150,50\%} \geq 60\%$, means 150lux should be achieved for 50% of the time across at least 60% of the reference plane, etc.

So the illuminance targets E_T in BS EN 17037 could also be presented in sDA format. Remembering that the illuminance targets Et are for 50% of the reference plane for 50% of daylight hours, the targets could be presented as follows:

Table 31: Equivalent sDA for Target Illuminance E_T

Room type	Target illuminance E_T (lx)	Target sDA (sDA lux / % time) > % area
Bedroom	100	$sDA_{100,50\%} > 50\%$
Living Room	150	$sDA_{150,50\%} > 50\%$
Kitchen	200	$sDA_{200,50\%} > 50\%$

7 Bibliography

BRE Building Technology Group. (2022). *Site layout planning for daylight and sunlight, A guide to good practice.* London: BRE.

CEN. (2019). *BS EN 17037:2018 Daylight in buildings.* BSI Standards Limited 2019.

CIE. (2020). *CIE S 017:2020 ILV: International Lighting Vocabulary, 2nd edition.* CIE.

Illuminating Engineering Society. (2022). *https://www.ies.org/standards/definitions/*. Retrieved from https://www.ies.org: https://www.ies.org/standards/definitions/

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