Overheating Analysis

(in accordance with CIBSE TM59 and Part O)

Bice Investments Ltd

27 Magdalen Road
Oxford
OX4 1RP
Oxford City Council

Version	Revision	Date	Author	Reviewer	Project Manager
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2	A	07.12.2023	Meeradevi Kathaliyil	Sophie Hopwood	Alaister Coffey

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Executive Summary

Executive Summary

This Overheating Report has been undertaken by SRE for the Proposed Apartments at 27 Magdalen Road, Oxford, (the Proposed Development) on behalf of Bice Investments Ltd (the Client).

This report assesses thermal comfort measures for the Proposed Development, to demonstrate compliance with 2021 Building Regulations Part O1, thus ensuring the summertime thermal condition within the building and the associated rooms meet the standards set out in the Chartered Institute of Building Services Engineers (CIBSE) Technical Memoranda (TM)59 methodology.

To assess the thermal performance of the Proposed Development, a detailed geometry of selected 3 no. sample units (Flats 1,4,6) has been created within the dynamic thermal analysis software Integrated Environmental Solutions Virtual Environment (IES-VE) 2022. All results are based on the simulation output and should be taken as an indication of the expected final situation, but these conditions cannot be guaranteed.

This report describes the dynamic thermal modelling exercise undertaken, lists all the assumptions used, and presents the results obtained.

A range of passive design measures has been incorporated where feasible, to optimise thermal comfort conditions and minimise the overheating risks. This is done through a combination of building fabric specifications, openable windows and skylights, solar control glazing (G-value$_{(glazing)}$ of 0.4) and tilt and turn windows. Active design measures such as Mechanical Ventilation with Heat Recovery (MVHR) is also part of the design.

The results of the simulations indicate that under current climate conditions (Swindon Brize Norton, DSY1 2020s high emissions, 50th percentile), the Proposed Development passes the TM59 assessment criteria with the strategies mentioned above, indicating a good level of thermal comfort during summer periods.

An additional simulation was carried out using a future weather file (Swindon Brize Norton, DSY1 2050s high emissions, 50th percentile) to further test the robustness of the design. The results of the simulation indicate that measures will need to be taken to mitigate the risk of overheating in the Proposed Development. It should be noted that a pass is not mandatory under the future weather file scenario.

In relation to CIBSE TM59 requirements and Building Regulations Part O, Requirement O1, the Proposed Development meets compliance.

Introduction and Methodology

1.0 Introduction

This Overheating Analysis has been undertaken by SRE for the Proposed Development at 27 Magdalen Road, Oxford, (the Proposed Development) on behalf of Bice Investments Ltd (the Client).

Following the guidance of the Chartered Institute of Building Services Engineers (CIBSE) Technical Memoranda (TM)59: 2017 methodology, and Building Regulations 2010, Part O: 2021, this study assesses the Proposed Development's overheating risk. This analysis includes the intensity of heat gains, occupancy patterns, building orientation, dwelling layout, shading strategy and ventilation method in response to the relevant requirements for the Proposed Development.

All results are based on outputs from dynamic thermal simulation software Integrated Environmental Solutions Virtual Environment (IES-VE) 2022, which is fully compliant with CIBSE Applications Manual (AM)11, and should be taken as an indication of the expected final situation. However, these conditions cannot be guaranteed.

It is important to note that with any modelling exercise there are assumptions and approximations that have to be made. As far as possible, details of all assumptions made, and approximations used are supplied as part of the report.

1.1 The Proposed Development

The Proposed Development at 27 Magdalen Road consists of the construction of 6 no. residential flats. The Proposed Development is part of a residential area with detached and semi-detached residences.

Figure 1 shows the site plan of the Proposed Development.

Figure 1 – Site plan of the Proposed Development at 27 Magdalen Road (Re-Format LLP)

Please refer to Appendix A for further architectural details including floor plans, roof plan and elevations.

2.0 Methodology

2.1 CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes

The performance standards set in CIBSE TM59: 2017 have been used to assess the overheating risk within the Proposed Development. Compliance is based on passing both of the following two criteria:

1. For living rooms, kitchens and bedrooms: the number of hours during which the operative temperature exceeds the threshold comfort temperature by 1°C during the period May to September inclusive shall not be more than 3% of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).
2. For bedrooms only: the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26°C for more than 1% of occupied hours. (Note: 1% of occupied hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours will be recorded as a fail.

In addition to living rooms, kitchens and bedrooms, the inclusion of corridors in the overheating analysis is mandatory where community heating pipework runs through them. The overheating test for corridors should be based on the number of annual hours for which an operative temperature of 28 °C is exceeded. Whilst there is no mandatory target to meet, if an operative temperature of 28 °C is exceeded for more than 3% of the total annual hours, then this should be identified as a significant risk within the report.

The overheating risk of the spaces are assessed under the CIBSE design summer year (DSY) weather files for Swindon. A pass is required using the DSY1 2020s, high emissions, 50th percentile weather file. Other files including the more extreme DSY1 2050s weather file, should be used to further test designs of particular concern, but a pass is not mandatory.

2.2 Approved Document Building Regulations Part O

The approved document Building Regulations Part O has been written with the aim to protect the health and welfare of occupants of the building by reducing the occurrence of high indoor temperatures.

Compliance with requirement O1 can be demonstrated by using one of the following methods:

a. The simplified method for limiting solar gains and providing a means of removing excess heat

b. The dynamic thermal modelling method

This report details a dynamic thermal modelling method for demonstrating compliance with requirement O1. It provides a standardised approach to predicting overheating risk for residential buildings using dynamic thermal modelling as an alternative to the simplified method.

CIBSE's TM59 method requires the modeller to make choices. The dynamic thermal modelling method in Part O applies limits to these choices, including:

a. When a room is occupied during the day (8am to 11pm), openings should be modelled to do all of the following:

    i. Start to open when the internal temperature exceeds 22°C.
    ii. Be fully open when the internal temperature exceeds 26°C.
    iii. Start to close when the internal temperature falls below 26°C.
    iv. Be fully closed when the internal temperature falls below 22°C.

b. At night (11pm to 8am), openings should be modelled as fully open if both of the following apply:

    i. The opening is on the first floor or above and not easily accessible.
    ii. The internal temperature exceeds 23°C at 11pm.

c. When a ground floor or easily accessible room is unoccupied, both of the following apply:

    i. In the day, windows, patio doors and balcony doors should be modelled as open, if this can be done securely.
    ii. At night, windows, patio doors and balcony doors should be modelled as closed.

d. An entrance door should be included, which should be shut all the time.

Based on Building Regulations Part O, mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it. The building should be constructed to meet requirement O1 using passive means as far as reasonably practicable. It should be demonstrated to the building control body that all practicable passive means of limiting unwanted solar gains and removing excess heat have been used first before adopting mechanical cooling. Any mechanical cooling (air-conditioning) is expected to be used only where requirement O1 cannot be met using openings.

Dynamic Model

3.0 Dynamic Model

The dynamic thermal modelling has been carried out using IES-VE 2022. IES-VE is a fully dynamic analysis tool which is compliant with CIBSE Applications Manual AM11. The three-dimensional (3D) thermal model of the Proposed Development has been created based on the architectural drawings provided by Re-Format LLP.

Figure 2 and Figure 3 are images taken from the 3D IES-VE model and show the full geometry of the Proposed Development within the thermal model. As with any modelling exercise, some approximations have to be made, but care has been taken to ensure that the scale and dimensions of the model are as close as possible to the design drawings and that glazing areas are accurately represented.

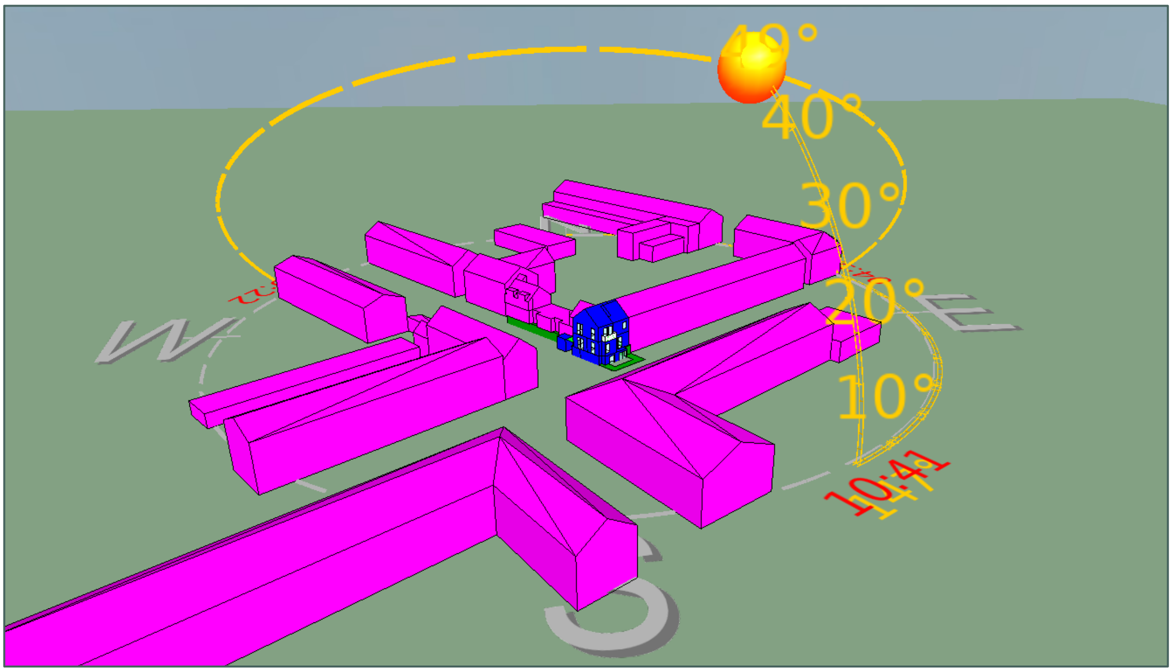


Figure 2 - 3D model of the Proposed Development in the IES-VE 2022 software, view from the south

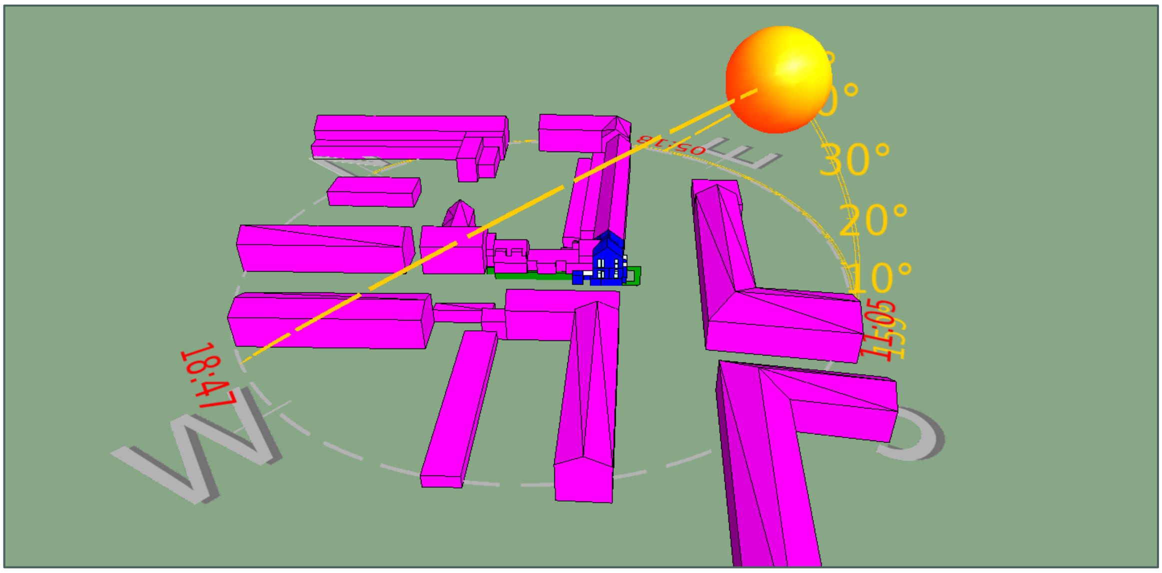


Figure 3 - 3D model of the Proposed Development in the IES-VE 2022 software, view from the southwest

The Proposed Development has been divided into different zones in relation to use. Appropriate profiles and internal gains have been assigned in all different areas, but only the results of the main occupied spaces have been assessed in this study. Secondary spaces occupied only briefly (less than 30 minutes), such as toilets, store and hallways are outside the scope of this study. The assessed occupied spaces in the Proposed Development and their floor areas are listed in Table 1.

Units	Spaces	Floor area (m^2)
Flat 1	Living/Kitchen/Dining	20.16
	Bedroom 1	16.07
Flat 4	Living/Kitchen/Dining	24.28
	Bedroom 1	13.80
Flat 6	Living/Kitchen/Dining	24.87
	Bedroom 1	10.69

Table 1 – List of assessed occupied spaces and their floor area

Figure 4 and Figure 5 indicate the thermal templates applied to each space type.

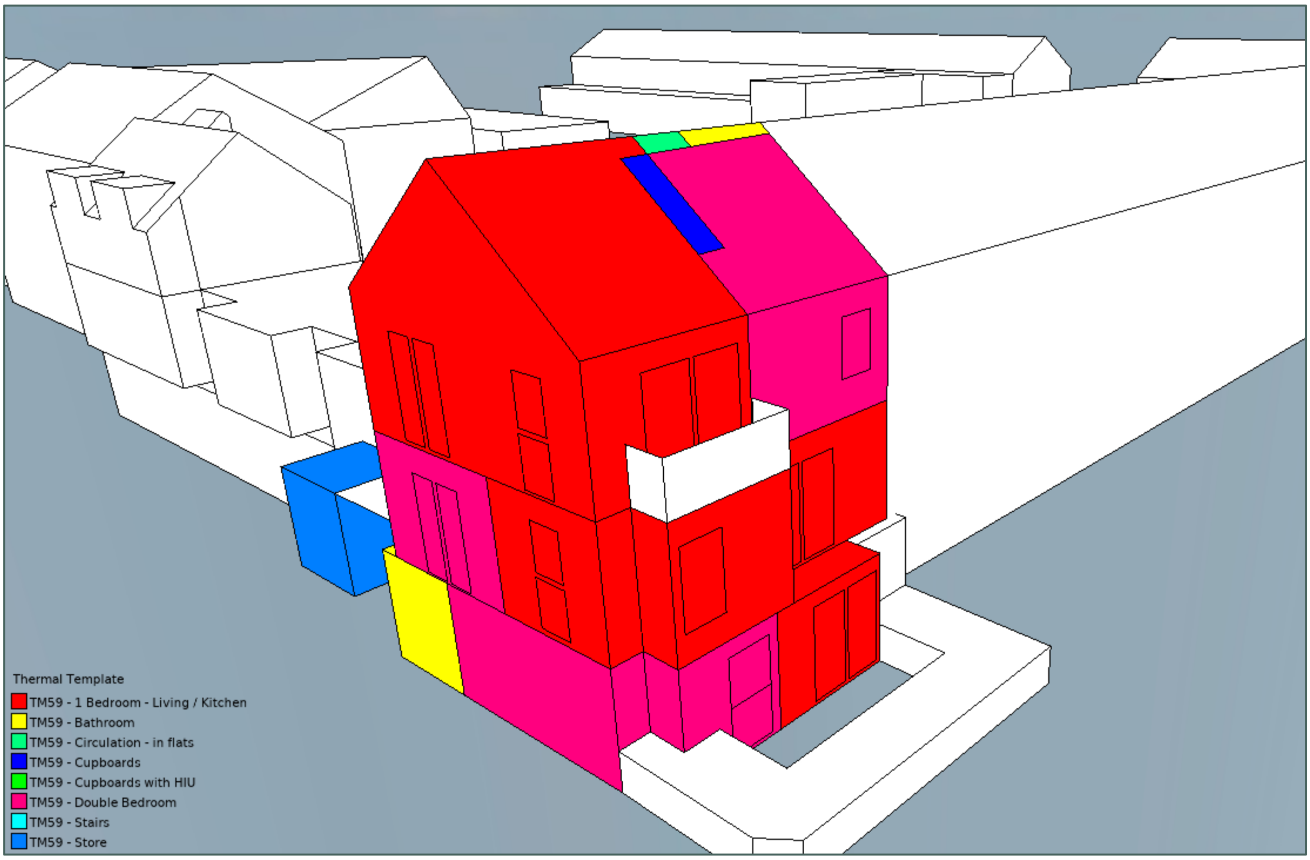


Figure 4 – Thermal zones of assessed spaces, view from south

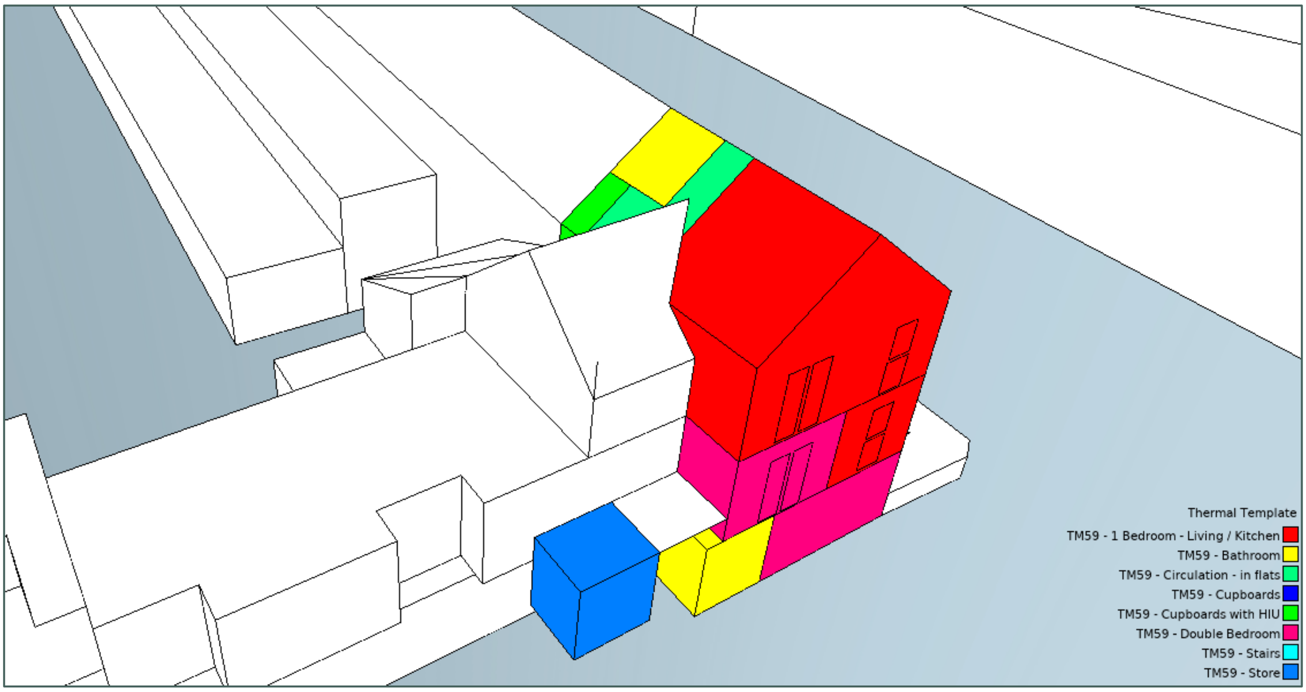


Figure 5 – Thermal zones of assessed spaces, view from west

3.1 Building Fabric

High performance fabric has been specified to reduce heat transfer between the internal conditioned areas and the ambient environment. Table 2 summarises the U-Values of all the fabric elements of the Proposed Development.

Element	Proposed (U-values)
External Wall (Masonry outer)	0.16
External Wall (Concrete outer)	0.16
Sheltered Wall	0.19
Ground Floor	0.13
Pitched Roof	0.10
Windows and Glazed Doors	1.00 (G-value$_{(glazing)}$ – 0.40) – Triple glazed
Doors	1.20
Air Tightness @ 50 N/m^2	3 (m^3/hr/m^2)

Table 2 - Construction details of the Proposed Development

3.2 Occupancy and internal gain profiles

Based on CIBSE Guide A and TM59, a maximum sensible heat gain of 75 W/person and a maximum latent heat gain of 55 W/person are assumed in occupied spaces in the assessment.

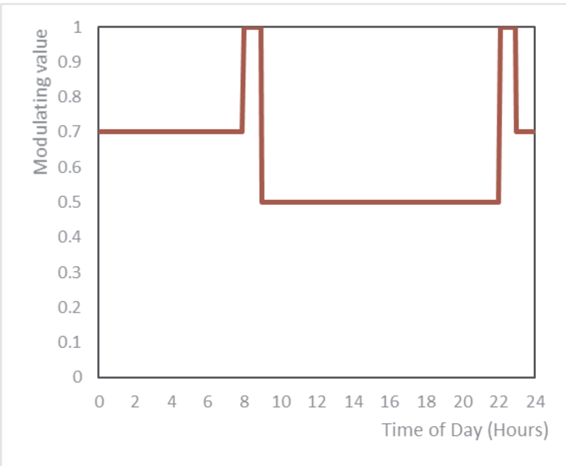
In addition, heat gains from equipment are also included in the assessment, based on the methodology described in CIBSE TM59, which is summarised in Table 3. Lighting load of 2 W/m^2 is applied to all occupied spaces.

Usage	Equipment Peak Load (W)
Double Bedroom	80
Living/Kitchen/Dining	450

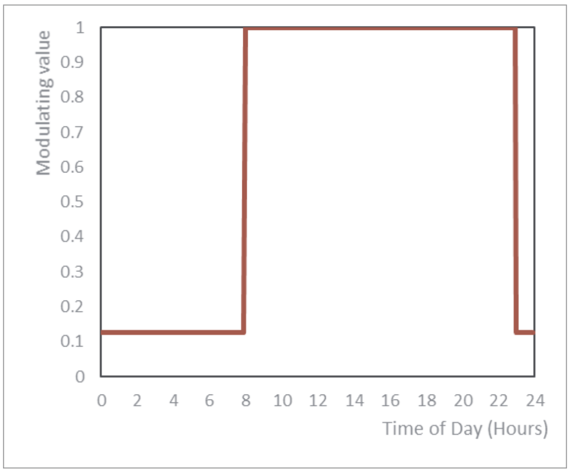
Table 3 - Equipment peak load for different usages

The occupancy and internal gain profiles have been based on the methodology described in CIBSE TM59 standard profiles according to usage, which can be seen in Table 4.

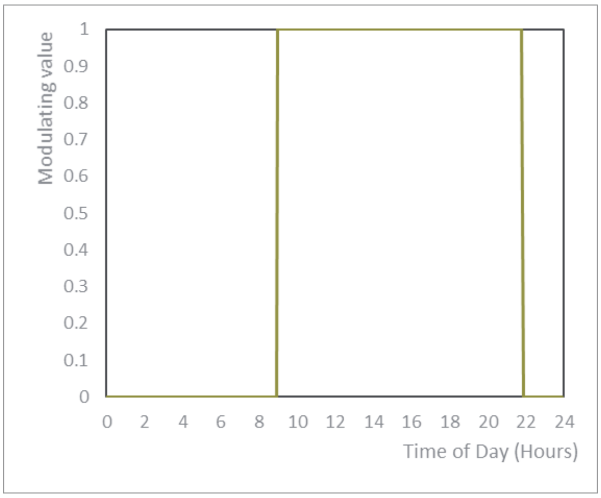
Double Bedroom Occupancy



Double Bedroom Equipment



Living/Kitchen Occupancy



Living/Kitchen Equipment

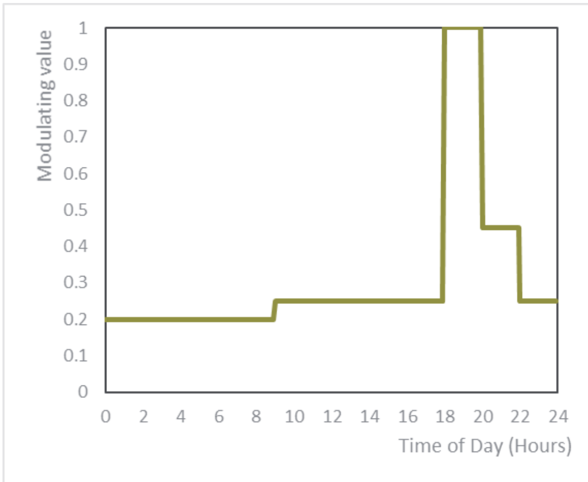


Table 4 - Occupancy and equipment profiles for the occupied space

These profiles represent real life occupancy patterns, ensuring the key aspects of overheating are captured, which include the following characteristics:

- Bedrooms are set with a 24-hour occupancy profile: one person is always considered in each bedroom during the daytime and two people in each double bedroom at night.
- Kitchen and living rooms are unoccupied during the sleeping hours and occupied during the rest of the day.
- No differences between weekdays and weekends are considered and the dwelling is modelled as occupied for 24 hours.

3.3 Air Exchange

Ventilation to the spaces will be provided through a whole house Mechanical Ventilation with Heat Recovery (MVHR) system with summer bypass. The MVHR systems are coupled with natural ventilation through openable windows to provide additional ventilation and reduce the use of active strategies. A constant airflow of 10 l/s is provided for all the spaces.

A design air tightness of 3 $m^3/hr/m^2$ @50 Pa which equates to an infiltration rate of 0.0579 ACH is applied in all areas.

3.4 Window Openings

The specification for the opening areas and angle is summarised in Table 5. Figure 6 show the opening types applied within the thermal comfort model. External doors are modelled as fixed shut. Natural ventilation strategies used to tackle night time overheating are as follows.

- As the building is naturally ventilated, the windows on the upper floors are considered to be fully openable day and night.
- Tilt and turn doors are proposed for bedrooms in the lower ground level. These doors are considered to be 90 degrees open (side hung) during the daytime and 10 degrees open (bottom hung) at night-time.

Openable windows are specified for all occupied rooms in the Proposed Development and are modelled to be open during occupied hours when the internal temperature is above 22°C and when the internal temperature is higher than the external temperature. The equivalent area for natural ventilation and glazing areas are listed in Table 6. Windows and glazed doors have been modelled without their frames to provide an accurate representation of the solar gains within all assessed spaces.

Opening category	Openable area (%)	Max opening angle (o)
Side Hung door	100	90
Tilt & Turn door	100	90 (Side Hung – Daytime) 10 (Bottom Hung – Night time)
Side Hung window	100	90

Table 5 - Glazing specification - openable areas

Unit	Spaces	Glazing Area (m^2)	Equivalent Area [1](m^2)
Flat 1	Living/Kitchen/Dining	3.727	3.847
	Bedroom 1	2.104	2.168
Flat 4	Living/Kitchen/Dining	6.740	5.073
	Bedroom 1	2.648	2.734
Flat 6	Living/Kitchen/Dining	8.262	7.891
	Bedroom 1	1.072	1.124

Table 6 - List of glazing and equivalent opening areas

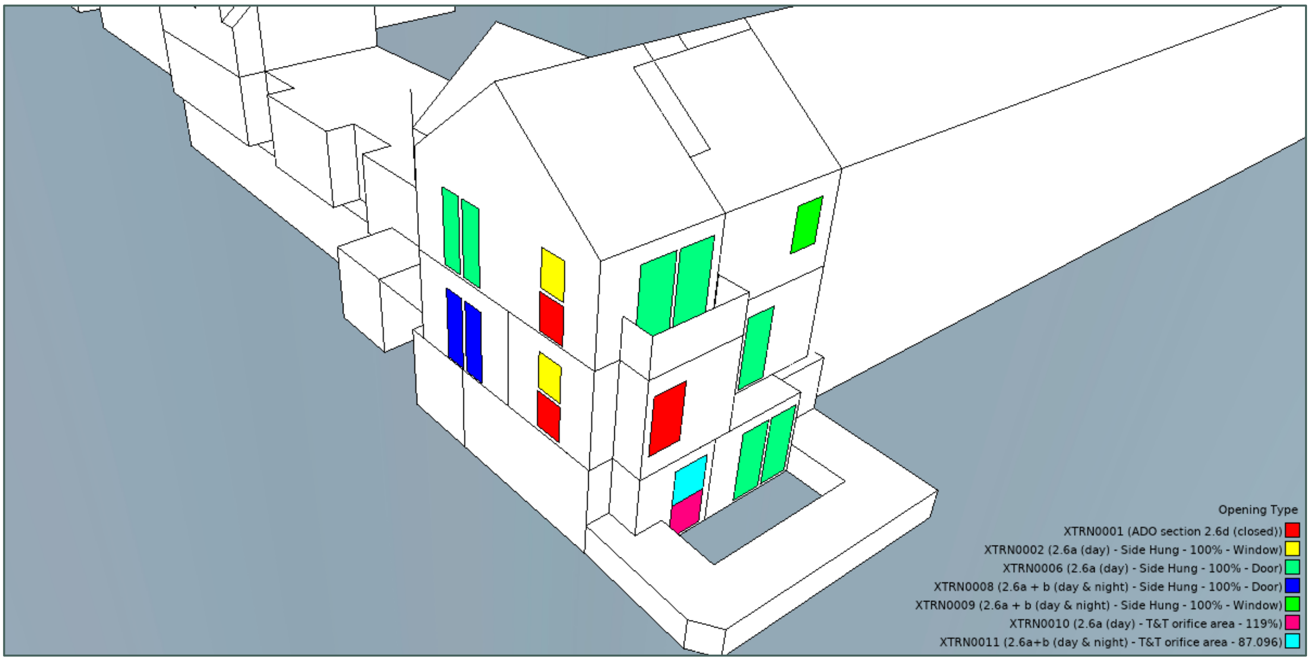


Figure 6 – Opening types – View from south

3.5 Shading devices

External balconies and overhangs have been modelled as per the design. Although internal blinds can be applied to all windows to reduce solar gains during the daytime, this has not been modelled as per Part O1 guidance.

[1] Equivalent area (Aeq) is a measure of the aerodynamic performance of an opening. It is the area of a sharp-edged circular orifice through which air would pass at the same volume flow rate, under an identical applied pressure difference, as through the opening under consideration. This is the effective area divided by the orifice discharge coefficient (Cd0) which assumes a clear sharp-edged orifice would have a coefficient of discharge (Cd) of 0.62. or Aeff / Cd0 = Aeq).

3.6 Weather File

The thermal comfort analysis is conducted under both current and projected future climate conditions in accordance with CIBSE TM59 requirements, based on the weather files below. Figure 7 and Figure 8 show the monthly diurnal averages for the whole year under the current and future climate conditions.

Current condition:

- Swindon Brize Norton DSY1 2020s high emissions 50th percentile

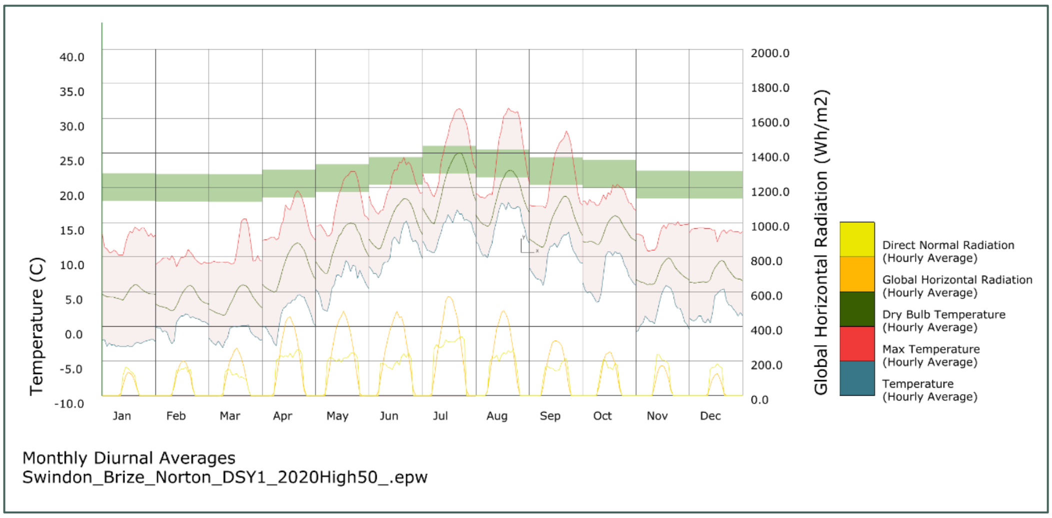


Figure 7 – Monthly diurnal averages, whole year, DSY1 2020, high emissions, 50th percentile weather file

Future condition:

- Swindon Brize Norton DSY1 2050s high emissions 50th percentile

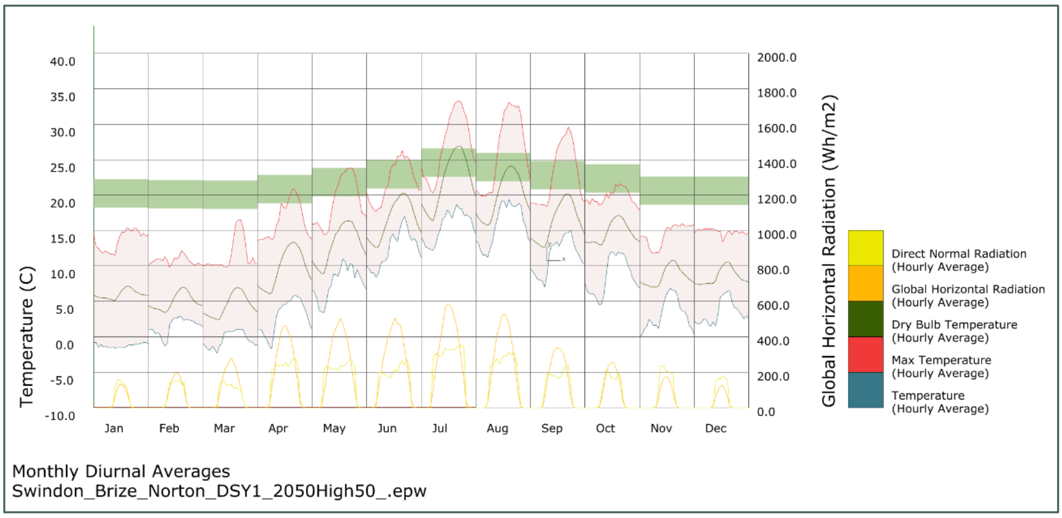


Figure 8 – Monthly diurnal averages, whole year, DSY1 2050, high emissions, 50th percentile weather file

The solar gains are calculated from the IES software based on the weather file, the building's geometry and orientation of its facades, surrounding obstacles, transmission coefficients of the glazing and the solar angles.

Results

4.0 Results

According to CIBSE TM59 and Part O, the overheating assessment has been undertaken for the summer period, from 1st May to 30th September. The air speed is set at 0.1 m/s to generate operative temperature, and the thermal comfort category is assumed to be Category II (new building) in the assessment. Dynamic thermal simulation has been conducted with the settings described in Section 3.0. Results for both the current and future weather conditions are presented in this section.

4.1 Current Weather File – 2020s DSY1

Results for current weather conditions using Swindon Brize Norton DSY1 2020s high emissions 50th percentile are presented in Table 7.

Units	Spaces	Criterion 1 (% hours top-max>=1K)	Criterion 2 (Night time hours operative temp. >26°C)	Pass / Fail
Flat 1	Living/Kitchen/Dining	1	-	Pass
	Bedroom 1	0.2	15	Pass
Flat 4	Living/Kitchen/Dining	1.8	-	Pass
	Bedroom 1	0.8	9	Pass
Flat 6	Living/Kitchen/Dining	1.8	-	Pass
	Bedroom 1	0.6	21	Pass

Table 7 – Simulation results summary for occupied spaces – using the current weather file (DSY1 2020, High 50)

As demonstrated in the table above, all assessed rooms pass the assessment under the current weather file using a combination of passive and active design measures, thus satisfying TM59 requirements and complying with Part O Requirement O1. Summertime overheating is therefore unlikely to arise and building users will generally feel comfortable in summer periods, based on the predicated data from the current weather file. In the current weather scenario, an MVHR flow rate of 10l/s is adequate to bring all spaces under comfort criteria.

4.2 Future Weather File – DSY1 2050

Results for future weather conditions using Swindon Brize Norton DSY1 2050 are presented in Table 8.

Units	Spaces	Criterion 1 (% hours top-max>=1K)	Criterion 2 (Night time hours operative temp. >26°C)	Pass / Fail
Flat 1	Living/Kitchen/Dining	3.1	-	Fail
	Bedroom 1	0.8	48	Fail
Flat 4	Living/Kitchen/Dining	4	-	Fail
	Bedroom 1	1.9	29	Fail
Flat 6	Living/Kitchen/Dining	3.9	-	Fail
	Bedroom 1	1.8	48	Fail

Table 8 – Simulation results summary for occupied spaces – using the future weather file (DSY1 2050, High 50)

As demonstrated in the table above, only certain spaces meet the assessment criteria. This indicates that appropriate mitigation measures should be adapted in these spaces in order to achieve comfortable thermal conditions in the future. MVHR will have to operate at an increased flow rate to bring all spaces under the comfort criteria which will have to be determined. In addition, external shading devices can be incorporated to improve the thermal conditions of the Proposed Development. It should be noted that a pass under the future weather conditions is not compulsory. However, designing for future weather conditions can ensure that the building will be resilient to the future climate changes.

Conclusions

5.0 Conclusions

This Overheating analysis has been undertaken by SRE for the Proposed Development at 27 Magdalen Road, Oxford, in order to assess the risks of overheating and the thermal comfort conditions in the occupied spaces.

The following passive and active design measures to address summertime overheating have been incorporated into the design of all occupied rooms.

- High performance building fabric
- Openable windows and skylights
- Solar control glazing (G-value$_{(glazing)}$ of 0.4)
- Tilt and turn windows
- Mixed mode ventilation via openable windows and MVHR.

The results of the simulations indicate that under current climate conditions (Swindon Brize Norton DSY1 2020s high emissions, 50th percentile), the Proposed Development passes the assessment criteria using passive strategies mentioned above, indicating a good level of thermal comfort during summer periods.

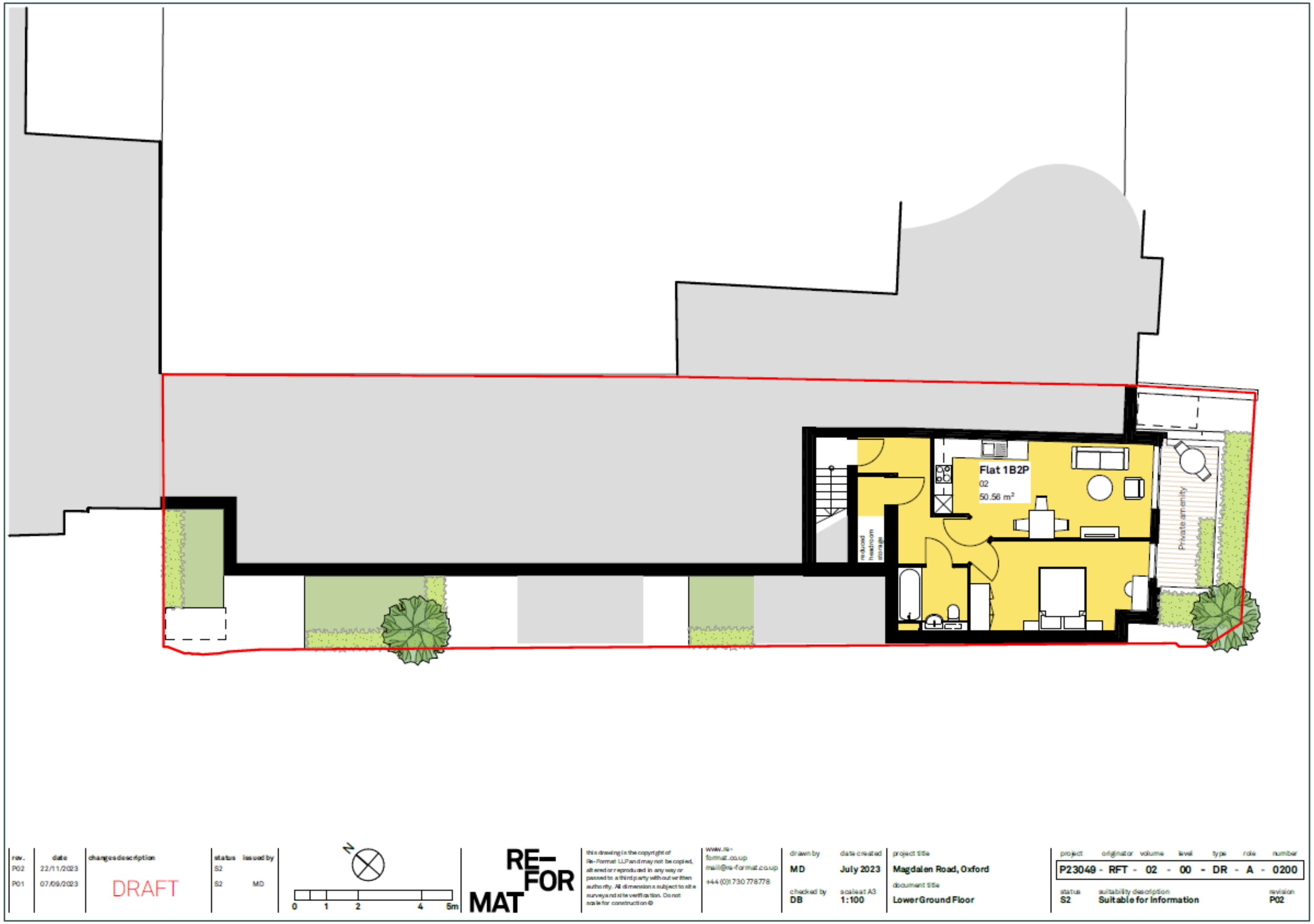
An additional simulation was carried out using a future weather file (Swindon Brize Norton DSY1 2050s high emissions, 50th percentile) to further test the robustness of the design. The results of the simulation indicate that measures will need to be taken to bring all spaces under the comfort criteria. Increased flow rates required for each space will have to be determined. It should be noted that a pass is not mandatory under the future weather scenario but is reported to acknowledge the issues that will arise in the future and take the required measures. All the results are documented in this report.

Results from the simulation indicate that a thermally comfortable environment can be expected within the Proposed Development with the proposed design considerations. In relation to CIBSE TM59 requirements and Building Regulations Part O, Requirement O1, the Proposed Development meets the assessment criteria.

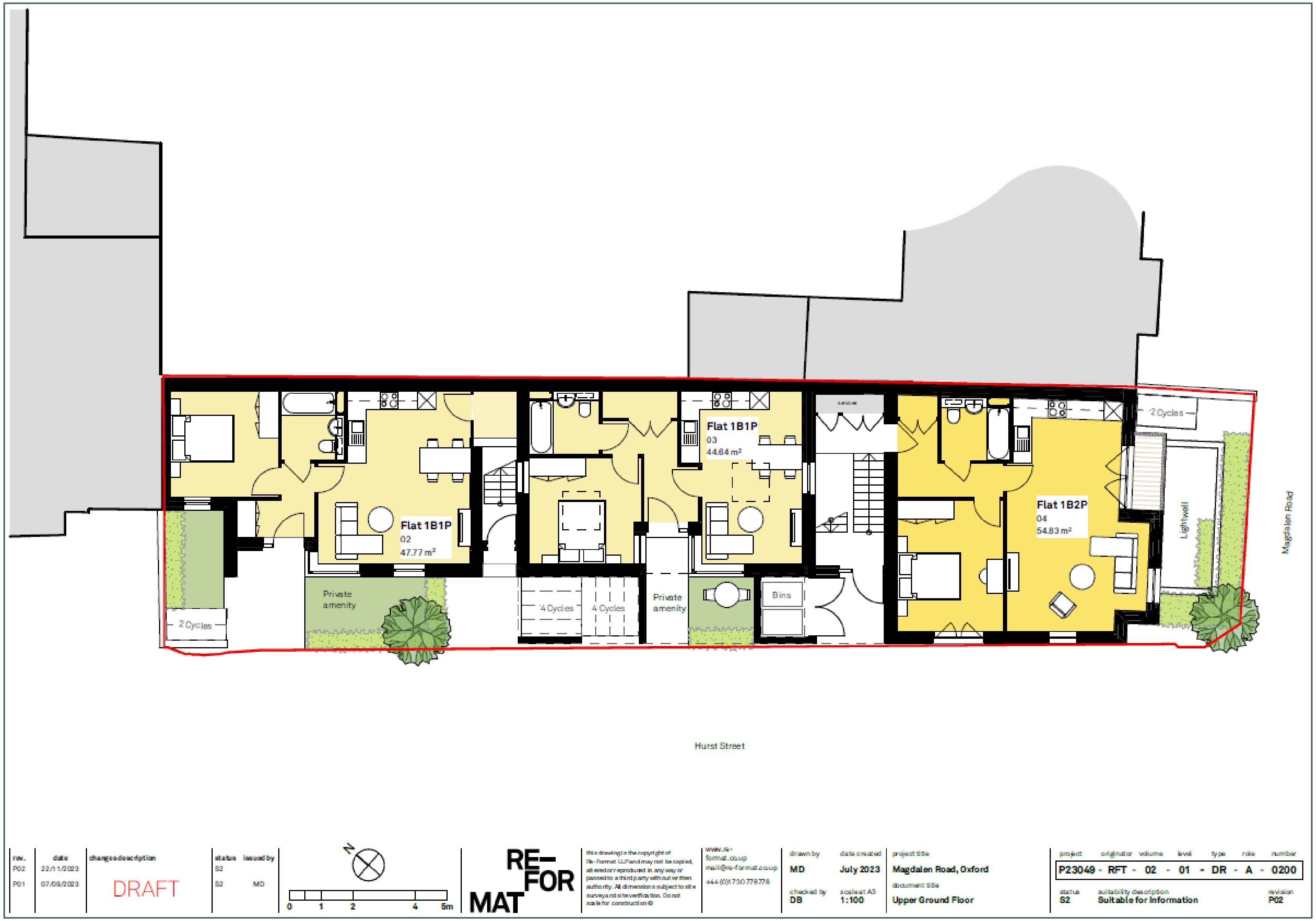
Appendices

Appendix A – Floor Plans, Roof Plan and Elevations

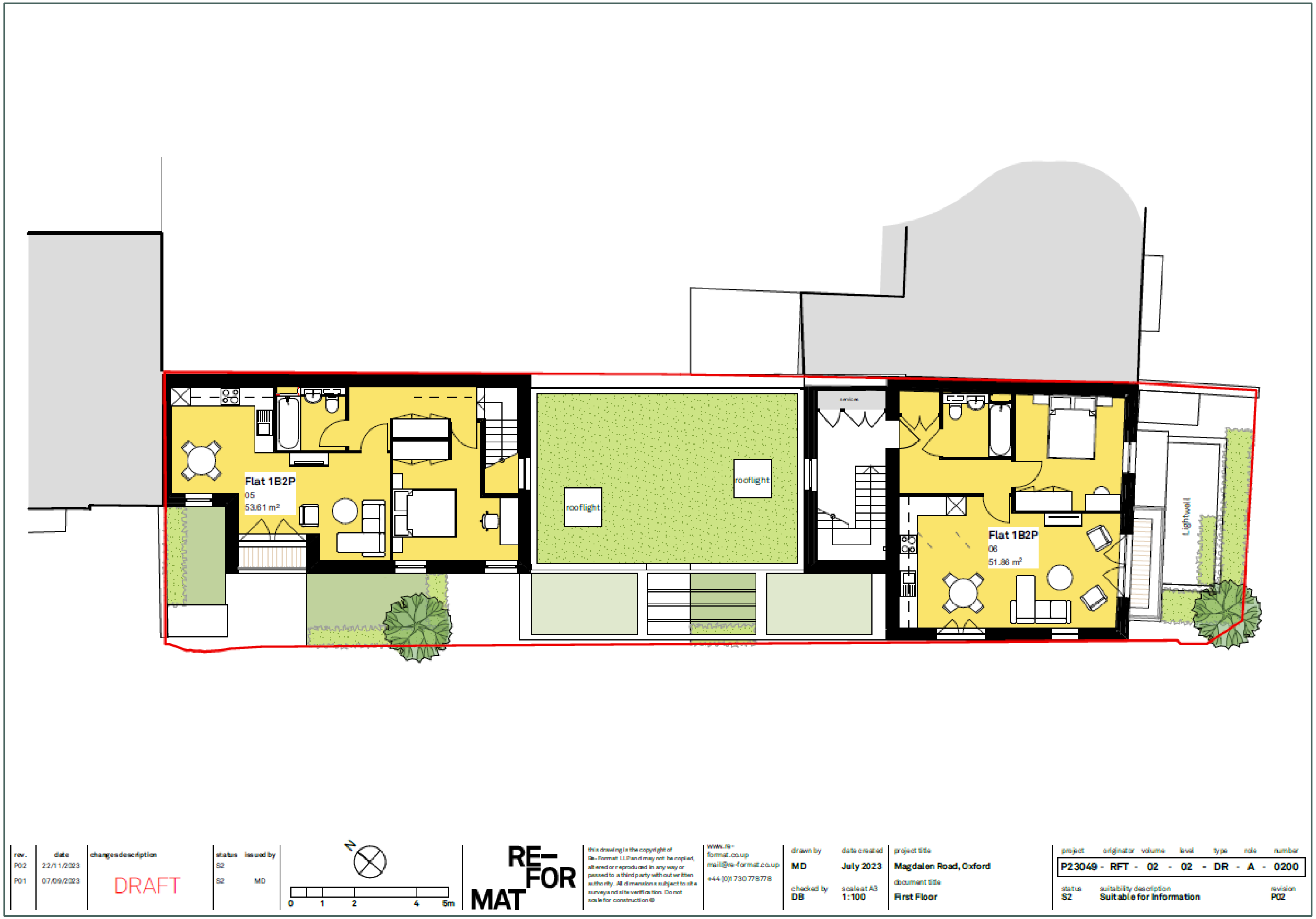
Floor Plans – Lower Ground Level



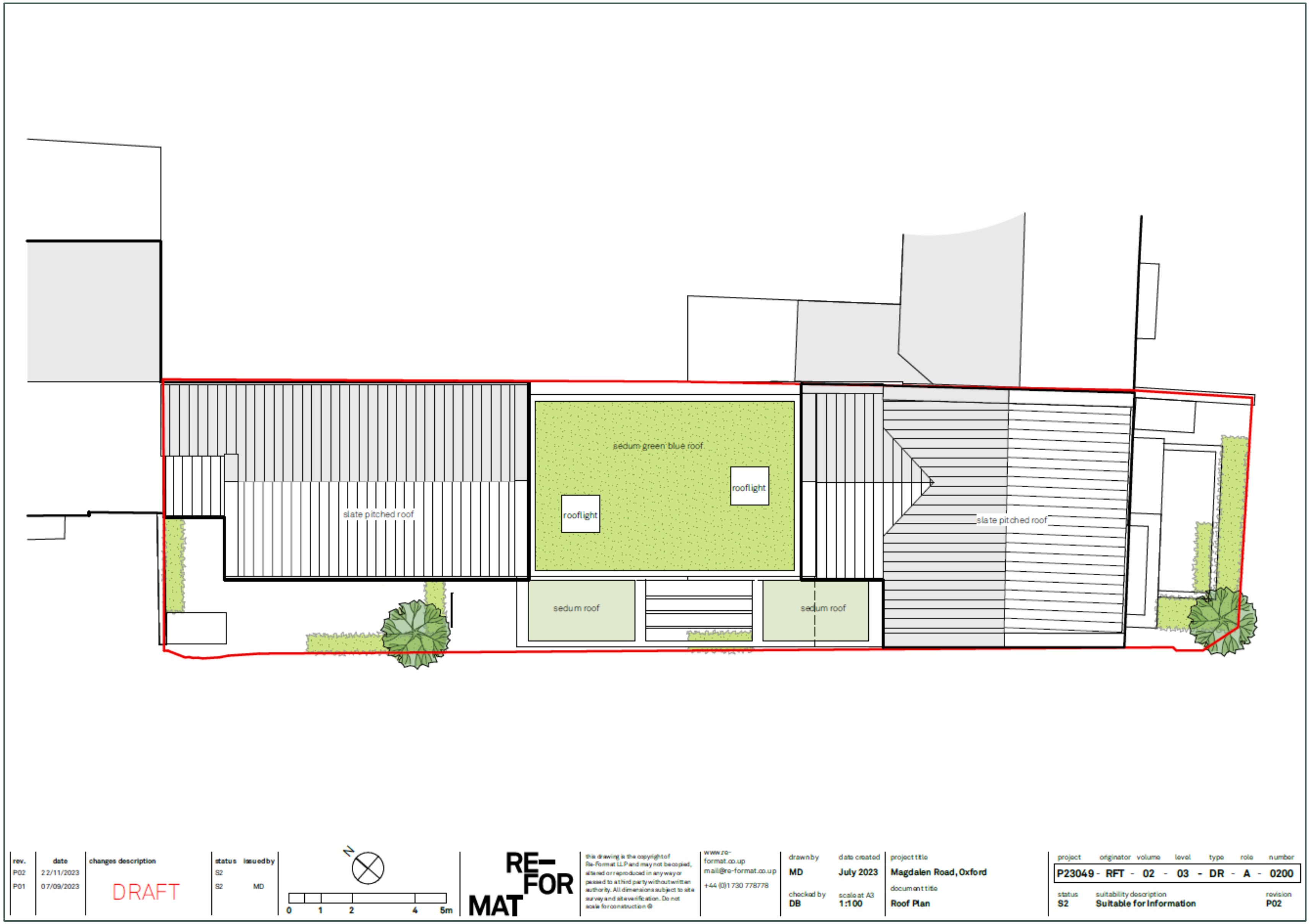
Floor Plans – Ground Floor



Floor Plans – First Floor



Roof Plan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slate pitched roof
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date created
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checked by
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1:100
project title
Magdalen Road, Oxford
document title
Roof Plan
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originator
volume
level
type
role
number
P23049 - RFT - 02 - 03 - DR - A - 0200
status
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suitability description
Suitable for Information
revision
P02

Elevations


outline of existing buildings to be demolished
Key
1 Light Buff Brick
2 Cast stone cills, copings lintels and features
3 Slate tile roof
4 Timber cladding
5 PPC window frames, balustrades, spandrel panels and metal flashings
6 Potential location of integrated PV panels
RE–FOR MAT
drawn by
MD
checked by
DB
date created
August 2023
scale at A1
1:100
project title
Magdalen Road, Oxford
document title
Proposed Elevations
P23049 - RFT - 00 - ZZ - DR - A - 0300
status
S2
Suitable for Information
revision
P02

Sections


outline of the existing structures
outline of previous proposals
RE—FOR MAT
drawn by
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date created
Oct 2023
checked by
DB
scale at A1
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Magdalen Road, Oxford
document title
Sections
project originator volume level type role number
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status
S2
suitability description
Suitable for Information
revision

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