

# FINAL REPORT



## PROJECT BLUE DRAGON PHASE 2

### DAYLIGHT, SUNLIGHT AND OVERSHADOWING STUDY

PROJECT # 2205854

#### SUBMITTED TO

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# EXECUTIVE SUMMARY



RWDI was retained to conduct a Daylight, Sunlight and Overshadowing study for Phase 2 of the proposed Project Blue Dragon development.

This analysis was conducted following the recommendations outlined in 'BR 209, Site Layout Planning for Daylight and Sunlight –A Guide to Good Practice (2022)' document in conjunction with British Standard 'BS EN17037 – Daylight in buildings.

This guidance aims to identify areas where the change in daylight levels may be noticeable, in order to inform design. BR 209 also notes that the guidance it provides is advisory in nature, and that it may be difficult to achieve the suggested thresholds in an urban context, thus compliance with these thresholds is not a formal requirement.

RWDI's analysis indicates that the Proposed Development does create an impact on daylight on surrounding residential buildings. The reduction in daylight access on some nearby windows exceeds the 27% guideline promulgated by BR 209. Though for most locations at least 80% of the current VSC values are preserved. The VSC levels fell below 80% of what is currently available for 19 lower-level windows of the Premier Inn adjacent to the proposed building. However, no windows were predicted to have their annual or winter sunlight access reduced to less than BR 209's guidelines under the proposed condition. Further RWDI would note that given the use of the Premier Inn, the occupancy is expected to be more transient than a residential building and therefore a reduction in skylight access can be considered less impactful.

The existing nearby amenity space off-site (pavement near the Red Dragon Centre, west of the proposed development) was predicted to meet the guidelines outlined in BR 209, with 99% of its area predicted to receive at least 2 hours of sunlight on 21 March. This was not expected to change under the proposed configuration.

RWDI notes that the proposed on-site amenity space (located directly north of the proposed development) did not meet the 21 March criteria with only 12% of the area predicted to receive at least 2 hours of direct sunlight. However, the area receiving sunlight is expected to increase for the 21 June test time, with approximately 93% of the space's total area receiving sunlight for at least 2 hours. This indicates that during warmer weather, when the space is more likely to be used good solar access is available.

# INTRODUCTION






RWDI was retained by Expedite to conduct a Daylight, Sunlight and Overshadowing assessment for Phase 2 of the proposed Project Blue Dragon development in Cardiff, Wales. This report presents the background, objectives, results and conclusions from RWDI's assessment.

This phase of the development is located east of the Wales Millennium Centre. It is bounded by Pierhead Street to the south and Bute Place to the west. The surrounding buildings are generally medium-rise. To the southeast of the site are a number of commercial spaces.

This report presents the results of a computational daylight analysis of the impact of the buildings in the masterplan on daylight availability to the existing residential buildings.

## Legend

-  Surrounding Buildings
-  Proposed Building
-  Amenity Space

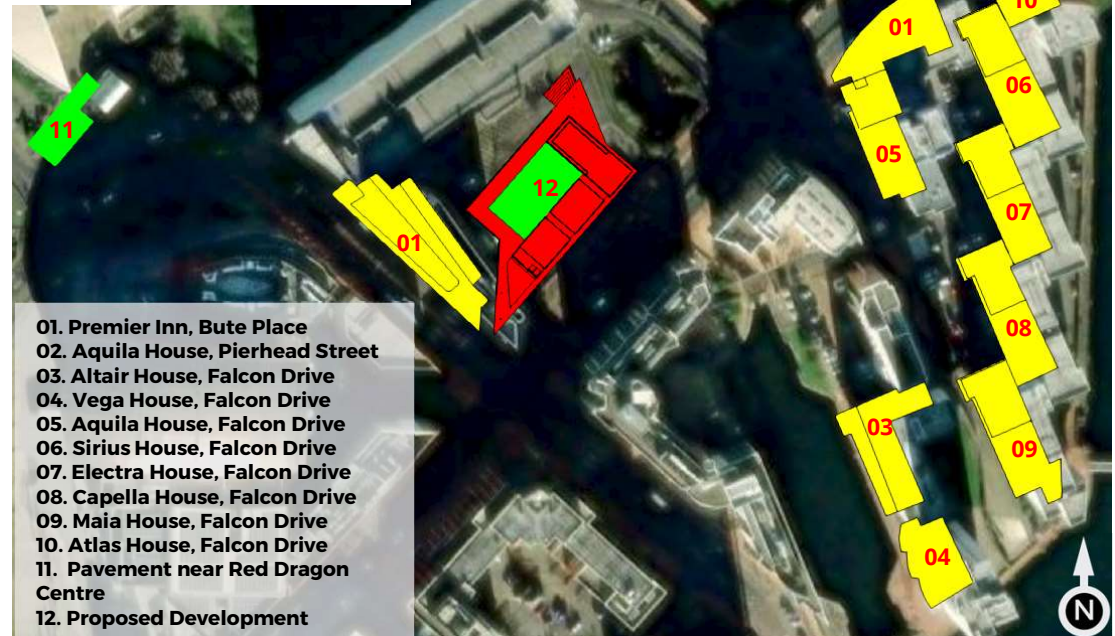


Figure 1 – Aerial View of the Proposed Site (Red)

## Impacts on Surrounding Buildings

Although not mandatory, the industry standard approach to benchmarking how a proposed development impacts sunlight and daylight levels comes from the BRE's 'BR 209, Site Layout Planning for Daylight and Sunlight – A Guide to Good Practice (2022)' document in conjunction with British Standard 'BS EN17037 – Daylight in buildings'.

BR 209 proposes three metrics to use when assessing the impact, a proposed building may have on its surrounds: Vertical Sky Component (VSC), Annual Probable Sunlight Hours (APSH) and Amenity Solar Exposure (ASE).

### Vertical Sky Component (VSC)

The VSC metric is used to assess the availability of daylight at a window. It is defined as the ratio of the illuminance incidence on a given surface and the illuminance on an unobstructed horizontal plane. Per BR 209, the luminance distribution of the sky dome is given by the CIE standard overcast sky. In the context of this assessment, this metric can be interpreted as the fraction of daylight which falls on a window compared to what would fall on open ground. BR 209 guidelines state that daylight may be adversely affected in existing buildings when the VSC of a window is less than 27% and less than 0.8 times its previous value due to the proposed building(s).

### Annual Probable Sunlight Hours (APSH)

APSH is the probable number of sunlit hours per year on a surface, accounting for typical levels of cloud cover. This study uses cloud cover data taken from the closest weather station to the site with this data available (Cardiff Airport EPW file). For every hour in a year, the solar exposure is determined for each of the surfaces of interest (i.e. the windows in the surrounding development which face 90° of due south), with overcast hours excluded. This value is then compared to the total number of APSH. BR 209 suggests that an APSH of 25% or more is desirable, with at least 5% of those hours occurring during the winter months (defined as 21 September through 21 March).

### Amenity Solar Exposure (ASE)

BR 209 also outlines recommended levels of solar exposure for garden and amenity spaces. The metric recommended by the BRE is that at least 50% of an amenity space should be able to receive at least 2 hours of sunlight on 21 March and that new developments should not reduce the existing ASE value by more than 20%.

## Computational Model

A 3D model of the proposed development and the surroundings was created by RWDI based on information provided by Expedite. Where necessary, information was supplemented by publicly available sources. All data was cross-referenced to ensure accuracy.

According to the BRE guidelines, shadowing caused by fences, trees and other vegetation are not required to be analysed. As such they have not been included in the 3D model.

Two scenarios were assessed in this investigation:

- Assess the daylighting levels at the windows of neighbouring residential buildings under the current condition. (The 'Existing' scenario.)
- Assess how the construction of the Proposed Development affects daylighting on the baseline scenario. (The 'Proposed' scenario.)

These two scenarios allow for an understanding of the overall impact of the proposed buildings on their surroundings. The two configurations are illustrated as Figure 2 on the following page.

Existing buildings are coloured in grey, and the proposed building in red.

As per BR 209, the windows and amenity spaces to be tested were selected based on their distance from the proposed masterplan development and the angle which the buildings subtend in the field of view from the window.

An amenity space was also noted in proximity to the proposed masterplan. These are coloured in green for illustration.



**Figure 2 – 3D Models of Existing Condition (left) and Proposed Condition (right). Amenity spaces (numbered) shown in green. Proposed building shown in red.**



## Daylight/Sunlight Modelling

Depending on the metric being computed, different models for the light emanating from the sky and sun were required:

- Daylight Factors and Vertical Sky Components were computed using the standard overcast sky model promulgated by the Commission internationale de l'éclairage (CIE) as per BR 209.
- Annual Probable Sunlight Hours were determined based on an analysis of the closest Energy Plus Weather (EPW) file to the site. (Cardiff Airport at 51.40°N, 3.34°W). This data set represents a long term "typical" year of meteorology data including cloud cover. Any hours where opaque clouds covered more than 50% of the sky were deemed overcast, and thus excluded from the analysis.
- Amenity Solar Exposure and APSH exposure was computed based on a clear sky assumption (i.e. exposure is a function of solar position only) for 21 March and all non-overcast hours respectively.
- The solar position was based on a site latitude and longitude of 51.46°N, 3.16°W.

The external realm metrics were computed using *Eclipse*, RWDI's proprietary solar modelling engine. This is a tool explicitly designed to rapidly and accurately compute solar conditions in the external realm. Its predictions have shown good agreement with both Radiance and measured data and computes results significantly faster than Radiance. VSC and APSH values were computed for every window.

The surfaces which make up the amenity spaces were subdivided into sub-surfaces approximately 0.4 m<sup>2</sup> in area. Each sub-surface was tested for ASE at 15 min increments. This allows for the computation of both an area averaged ASE as well as the BR 209 required percentage of the space which received more than 2 hours of sunlight.

# RESULTS



## External Daylight Availability - VSC

Under the existing condition, a majority of the study windows are expected to experience VSC levels at or above the BRE recommended value (27%). There are several buildings where the windows are expected to fall below this threshold in the existing conditions.

The VSC levels fall below 80% of what is currently available, for 19 lower-level windows of the Premier Inn, located adjacent to the proposed building.

Apart from this, the addition of the proposed building is not expected to change the VSC level to below 80% of the current VSC level for any other buildings.

Table 1 summarizes the VSC findings for each of the surrounding buildings studied. Figures 3 and 4 on the following pages illustrate the results graphically.

Table 1 – VSC Results Summary

Building No.	Building Name	% of Windows Meeting Criteria – Existing Condition	% of Windows Meeting Criteria – Proposed Condition
1	Premier Inn, Bute Place	100%	90%
2	Aquila House, Pierhead Street	100%	100%
3	Altair House, Falcon Drive	97%	96%
4	Vega House, Falcon Drive	96%	96%
5	Aquila House, Falcon Drive	94%	92%
6	Sirius House, Falcon Drive	64%	64%
7	Electra House, Falcon Drive	77%	77%
8	Capella House, Falcon Drive	82%	81%
9	Maia House, Falcon Drive	75%	75%
10	Atlas House, Falcon Drive	95%	95%

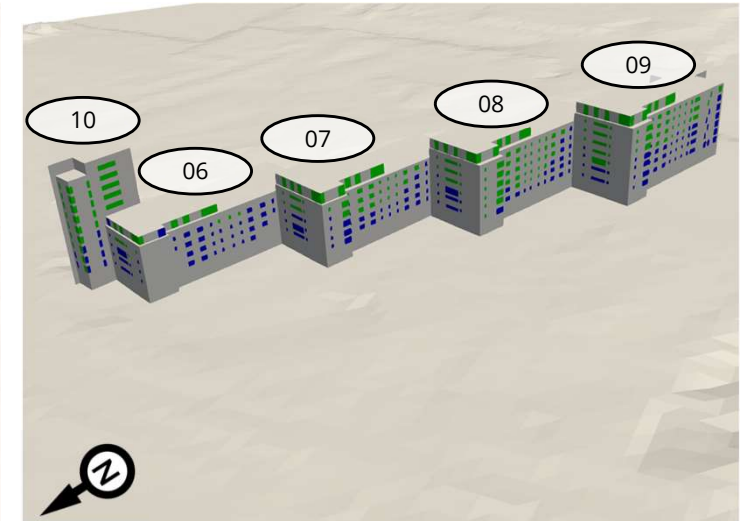
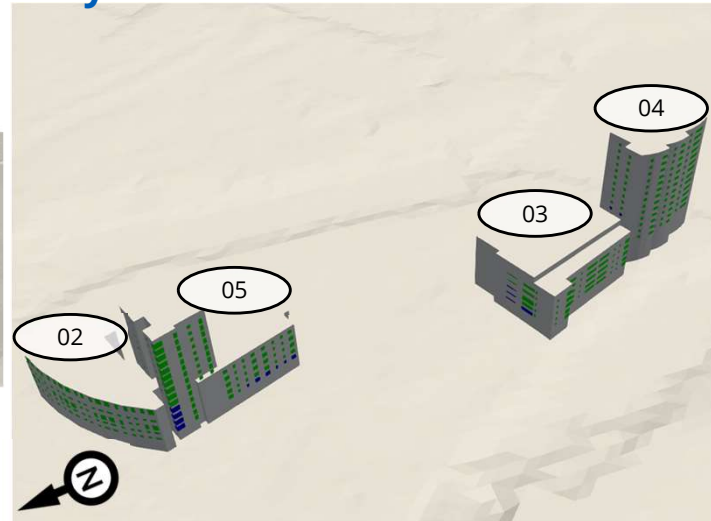
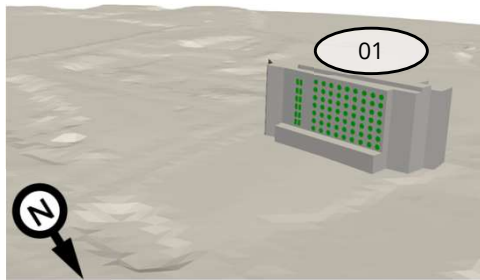


# RESULTS

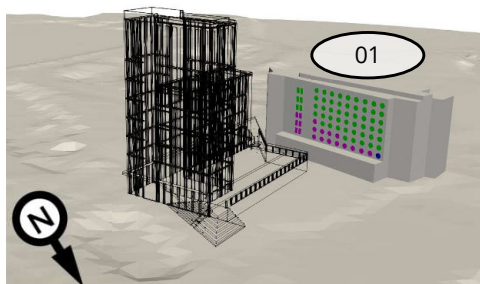


## External Daylight Availability - VSC

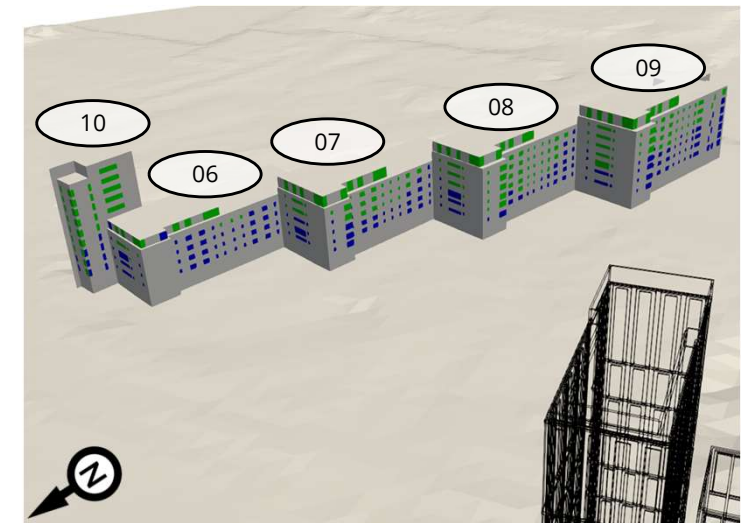
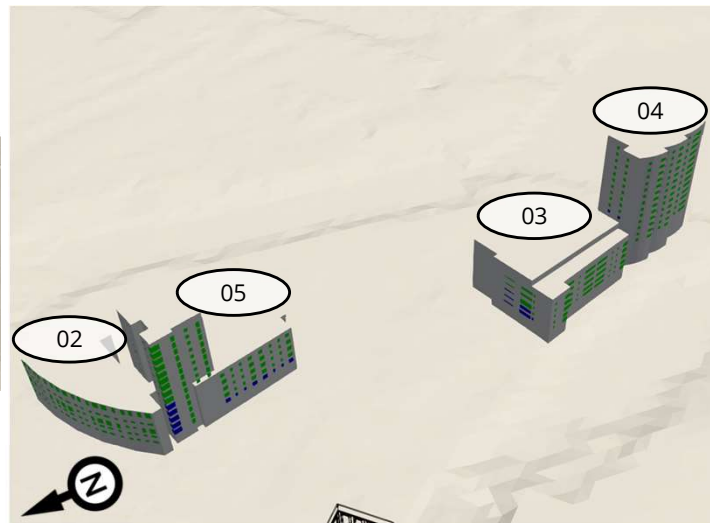
Existing



Proposed



- VSC  $\geq 27\%$
- VSC  $< 27\%$
- VSC  $< 27\%$  &  $< 80\%$  of baseline



# RESULTS



## External Daylight Availability – VSC Reduction

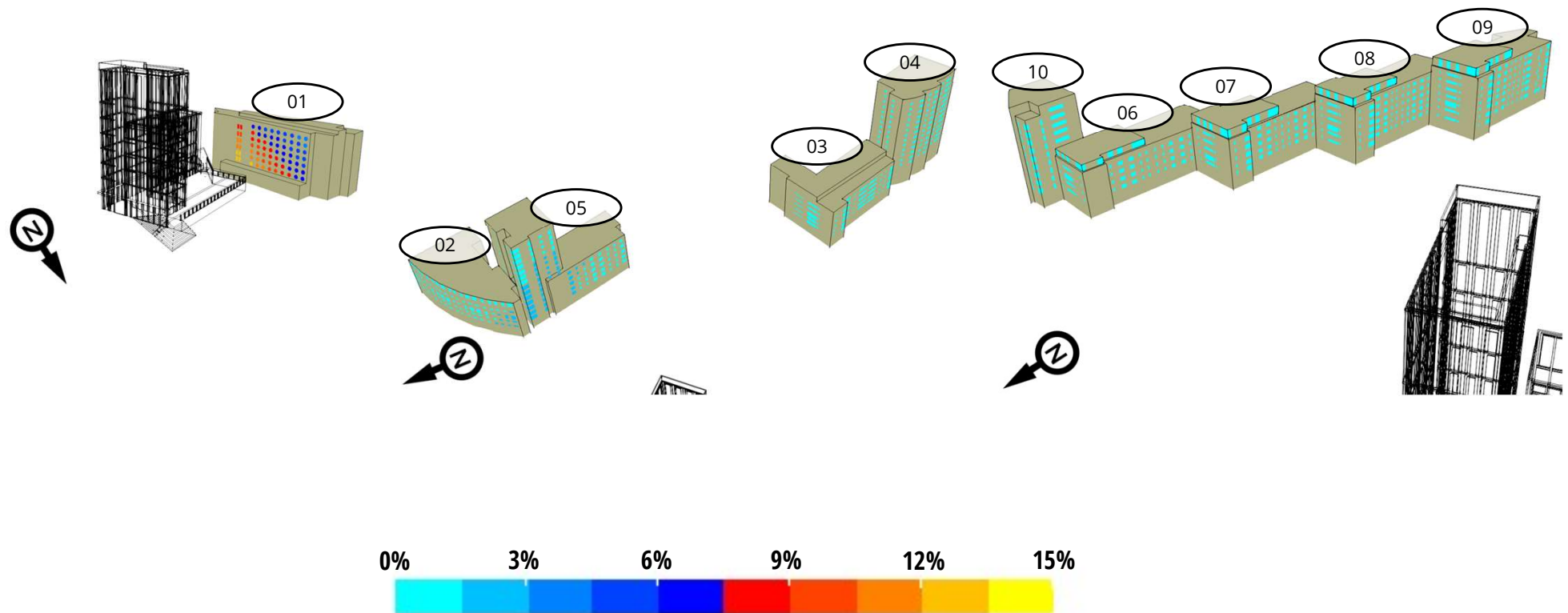


Figure 4 – Graphical VSC Reduction Results for Surrounding Buildings

# RESULTS



## External Sunlight Availability - APSH

BR 209 indicates that only windows which face 90° of south should be tested for APSH.

However, some of the properties did not have any south facing windows that could be impacted by the proposed development. As such, these properties have been excluded from the analysis.

Table 2 at right, summarizes the APSH findings, which are also illustrated graphically on the following pages.

No buildings were predicted to see any reduction in the percentage of windows meeting the target APSH outlined in BR 209.

**Table 2 – APSH Results Summary**

Building No.	Building Name	% of Windows Meeting Criteria – Existing Condition	% of Windows Meeting Criteria – Proposed Condition
3	Altair House, Falcon Drive	100%	100%
4	Vega House, Falcon Drive	100%	100%
5	Aquila House, Falcon Drive	100%	100%
6	Sirius House, Falcon Drive	61%	61%
7	Electra House, Falcon Drive	86%	86%
8	Capella House, Falcon Drive	87%	84%
9	Maia House, Falcon Drive	98%	98%
10	Atlas House, Falcon Drive	83%	83%

# RESULTS



## External Sunlight Availability - wAPSH

The results for Winter Annual Probable Sunlight Hours (wAPSH) are similar to the Annual Probable Sunlight Hours presented earlier. The same locations are presented in Table 3 comparing the impact of the Proposed Development.

No buildings were predicted to see any reduction in the percentage of windows meeting the target wAPSH outlined in BR 209.

**Table 3 – wAPSH Results Summary**

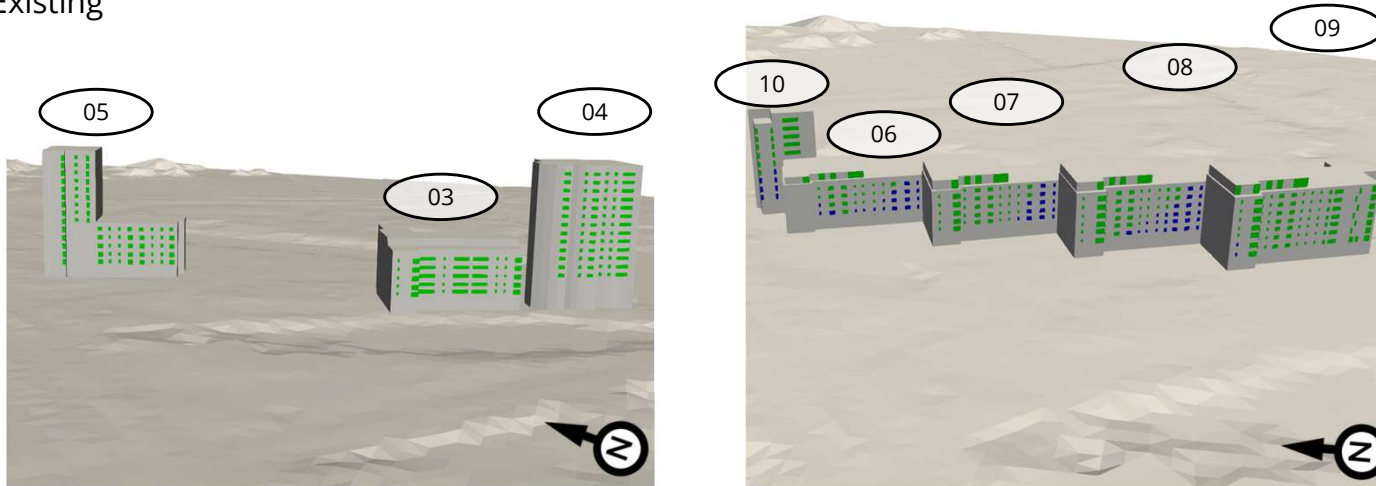
Building No.	Building Name	% of Windows Meeting Criteria – Existing Condition	% of Windows Meeting Criteria – Proposed Condition
3	Altair House, Falcon Drive	100%	100%
4	Vega House, Falcon Drive	100%	100%
5	Aquila House, Falcon Drive	100%	100%
6	Sirius House, Falcon Drive	66%	66%
7	Electra House, Falcon Drive	76%	76%
8	Capella House, Falcon Drive	66%	66%
9	Maia House, Falcon Drive	100%	100%
10	Atlas House, Falcon Drive	70%	70%

# RESULTS

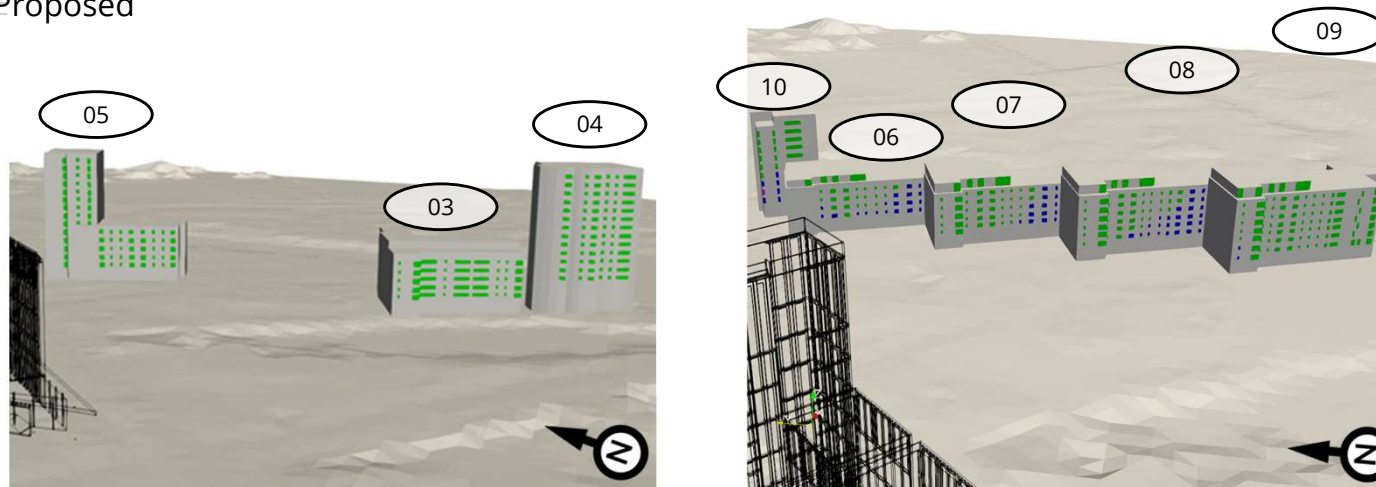


## External Daylight Availability – APSH

Existing



Proposed



- APSH  $\geq 25\%$
- APSH  $< 25\%$  or wAPSH  $< 5\%$
- APSH  $< 25\%$  & APSH  $< 80\%$  of baseline or wAPSH  $< 5\%$  & wAPSH  $< 80\%$  of baseline

Figure 5 – Graphical APSH/wAPSH Results for Surrounding Buildings

# RESULTS



## External Daylight Availability - ASE

Two existing amenity spaces were noted during the initial review of the surroundings as being close enough to potentially be affected by the proposed development of the master plan.

The ASE criteria for Amenity Space 11 remains unchanged under the proposed condition.

Amenity Space 12 is highly sheltered from sunlight by the Proposed Development with only 12% of the area predicted to receive at least 2 hours of direct sunlight on March 21<sup>st</sup>. That said, on the 21 June test time, the area expected to receive sunlight for at least 2 hours increases to 93% of the total area.

The results are presented in tabular form in Table 4 on the right, and graphically in Figure 6 on the following page.

**Table 4 – ASE Results Summary**

Amenity No.	Amenity Name	% of Space Meeting Criteria – Existing Condition	% of Space Meeting Criteria – Proposed Condition
11	Pavement near Red Dragon Centre	99%	99%
12	Proposed Building	N/A	12%

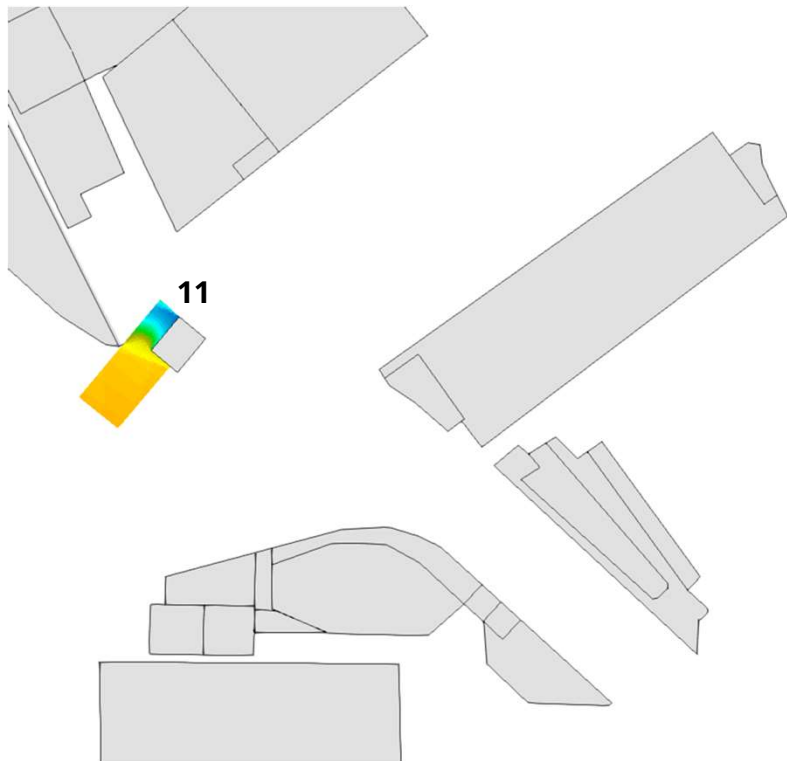


# RESULTS



## External Daylight Availability – ASE – 21 March

Existing



Proposed

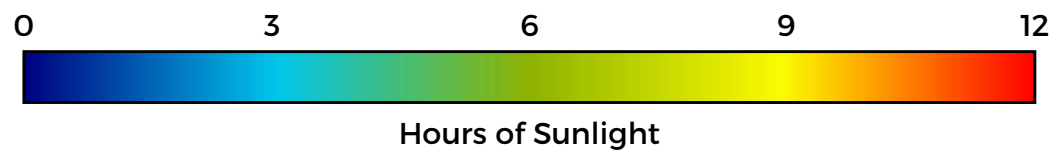
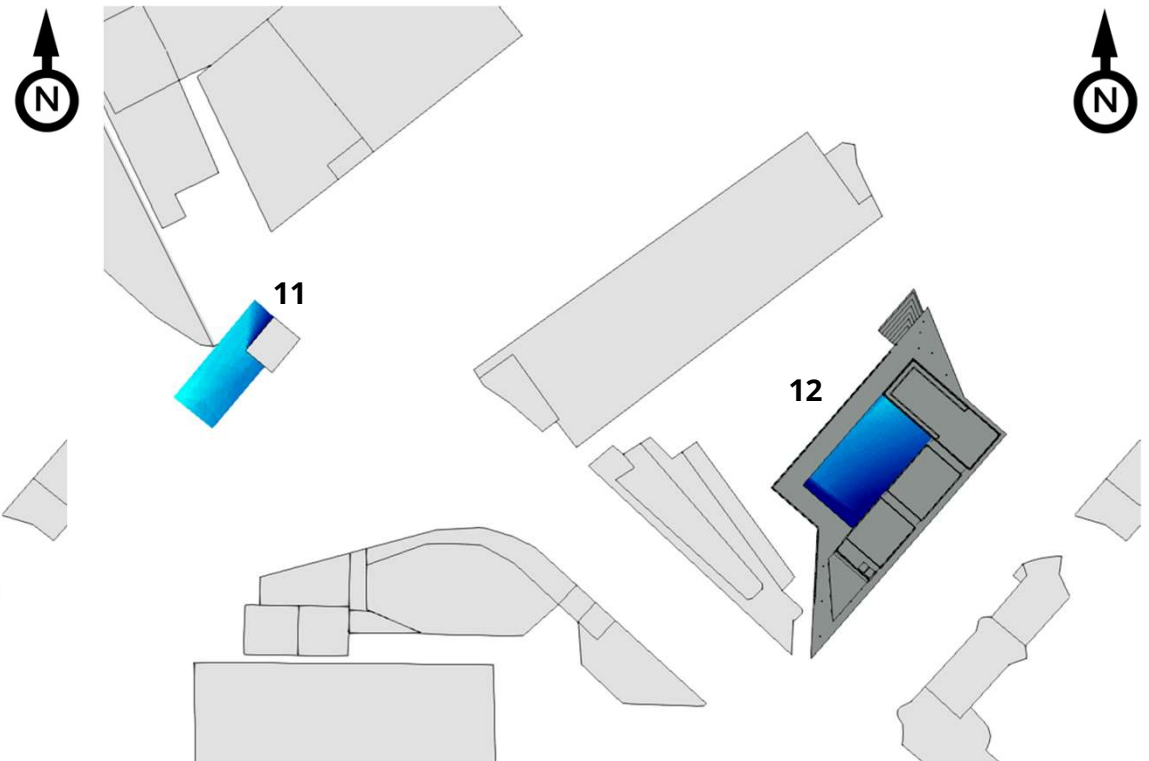


Figure 6 – Graphical ASE Results for Amenity Spaces (21 March)



# CONCLUSIONS & RECOMMENDATIONS



The impact on daylight of the Proposed Development was conducted based on direction from BR 209. This guidance aims to identify areas where the change in daylight levels may be noticeable, in order to inform design. BR 209 also notes that the guidance it provides is advisory in nature, and that it may be difficult to achieve the suggested thresholds in an urban context, thus compliance with these thresholds is not a formal requirement. With the above in mind, the following conclusions can be drawn:

1. The residential buildings immediately adjacent to the site, and to the south of the Proposed Development were predicted to be impacted by the Proposed Development.
2. This is not unexpected given the existing nature of the Proposed Development. Any significant uplift would naturally result in some loss of daylight.
3. Access to daylight (i.e., the VSC metric) was not predicted to reduce noticeably (i.e., more than the BRE suggested 20%) for most of the building windows. The Premier Inn, located immediately to the west was predicted to be impacted to a small extent. The VSC level for its lower windows, was predicted to be below 80% of what is currently available.
4. However, RWDI would note that given the use of this building, the occupancy is expected to be more transient than a residential building and therefore a reduction in skylight access can be considered less impactful.
4. Access to direct sunlight at neighbouring windows was predicted to be minimally affected by the Proposed Development. Properties to the north of the Proposed Development are far enough away to avoid major impacts and properties to the south were not predicted to be affected at all.
5. The off-site amenity space (Number 11), was predicted to not be significantly impacted by the proposed development. It was predicted to maintain the BRE recommended level of sunlight exposure under the proposed condition.
6. The on-site amenity space (Number 12), located north of the proposed development was not predicted to receive the BRE suggested amount of daylight on 21 March. However, it was predicted to have at least some direct solar access during the warmer months, with the area under exposure increasing to 93% of its total area on 21 June. This indicates that during warmer weather, when the space is more likely to be used good solar access is available.
7. Aside from the advisory nature of the ASE guidelines, RWDI would also note that having shade could be seen as an advantage from a thermal comfort standpoint during warmer times of year. Also, while the sheltered nature of this amenity space causes increased shadowing, it may also protect it from winter winds potentially enhancing thermal comfort.

# GENERAL STATEMENT OF LIMITATIONS



This report entitled “Project Blue Dragon Phase 2 DSO Study”, dated 5 December 2022 was prepared by RWDI Anemos Limited (“RWDI”) for Expedite (“Client”). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein (“Project”). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared.

Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.