

REPORT



PROJECT BLUE DRAGON

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 the proposed Project Blue Dragon mixed-use development.

This analysis was conducted following the recommendations outlined in 'BR 209, Site Layout Planning for Daylight and Sunlight – A Guide to Good Practice (2011)' in conjunction with British Standard 'BS 8206-2:2008 – Lighting for buildings – Part 2: Code of practice for daylighting (2008)'.

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 not create a significant impact on daylight and sunlight on the surrounding residential buildings. The reduction in daylight and sunlight access on the nearby windows does not exceed the guidelines provided in BR 209. However, it is important to note that only the windows facing the proposed buildings were considered in the analysis. Windows that do not face the development will still receive the current level of daylight and sunlight access.

All but one of the nearby amenity spaces expected to be impacted by the Proposed Development were predicted to meet the guidelines outlined in BR 209, with more than 50% of their areas predicted to received at least 2 hours of sunlight on 21 March under the Proposed configuration.

However, RWDI notes that the space which did not achieve the 50% threshold is a part of the proposed development.

INTRODUCTION



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

The proposed development is located north of the Cardiff Docks, to the west of the Wales Millennium Centre. It is bounded by Lloyd George Avenue to the east, Bute St to the west, and the A4119 to the south. The surrounding buildings are generally medium-rise. To the southeast of the site are a number of public spaces.

The site is currently occupied by a medium-rise residential building.

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.

INTRODUCTION



- | | |
|-----------------------------------|----------------------|
| 01. 117 Bute St | 30. 107 Bute St |
| 02. 113-116 Bute St | 31. 141 Bute St |
| 03. 110-112 Bute St | 32. 103 Bute St |
| 04. 108-109 Bute St | 33. Cardiff |
| 05. W Bute St | 34. 57 Bute St |
| 06. 122 Bute St | 35. Portland House |
| 07. 125 Bute St | 36. Bute Crescent |
| 08. 19 Bute St | 37. 110 Bute St |
| 09. Meandros House, Docks Lane | 38. Cardiff |
| 10. South Section of Seaway House | 39. 110 Bute St |
| 11. Cardiff Bay | 40. 18 James St |
| 12. 113-116 Bute St | 41. Cardiff |
| 13. Bute St | 42. W Bute St |
| 14. Bute Crescent | 43. Captain's House |
| 15. Cambrian Buildings | 44. Ocean Building |
| 16. Cymric Buildings | 45. 9 Bute Crescent |
| 17. 97-100 Bute St | 46. 10 Bute Crescent |
| 18. 34, 36, 38 Louisa Place | 47. 123 Bute St |
| 19. Cadogan House | 48. 124 Bute St |
| 20. St Clair Court | 49. 4 Bute St |
| 21. 5,7 James St | 50. 54b Bute St |
| 22. 1 James St | 51. 33 Bute St |
| 23. 33 Louisa Place | 52. 2 Bute St |
| 24. 96 Bute St | 53. 54a Bute St |
| 25. 95 Bute St | 54. Imam Ali Centre |
| 26. 14-21 Bute St | |
| 27. Bay Chambers | |
| 28. 105 Bute St | |
| 29. 106 Bute St | |

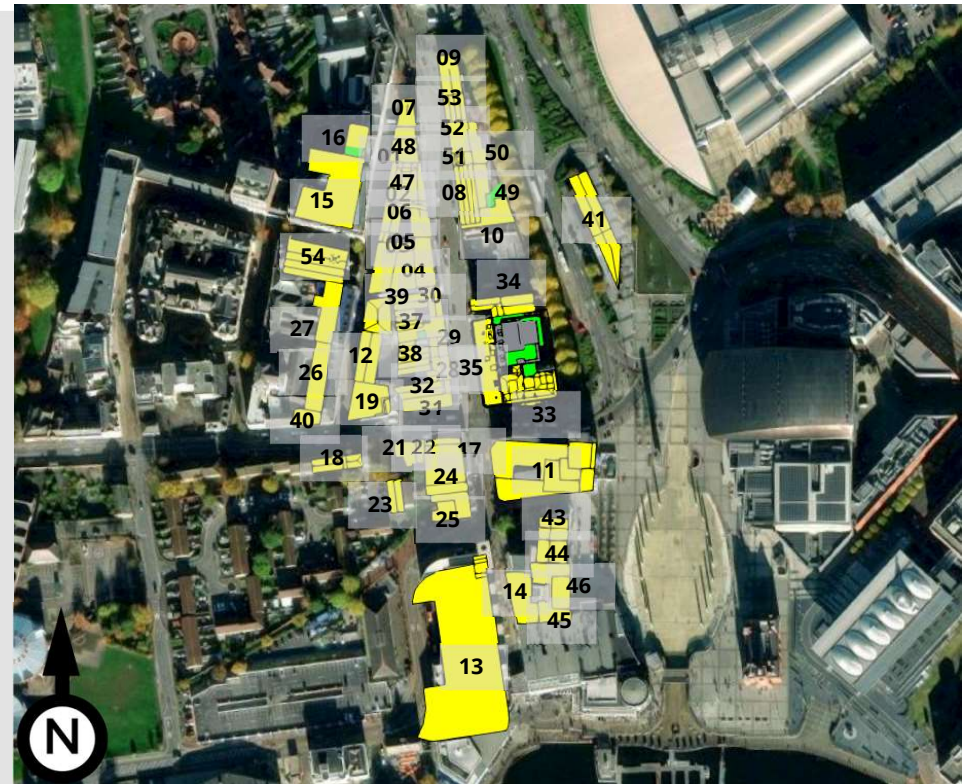


Figure 1 – Aerial View of the Proposed Site (Grey)

ASSESSMENT CRITERIA



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%.

METHODOLOGY



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, existing buildings to be demolished in orange, 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.

Several amenity spaces were noted in the surrounding to the proposed masterplan. These are coloured in green for illustration.

METHODOLOGY

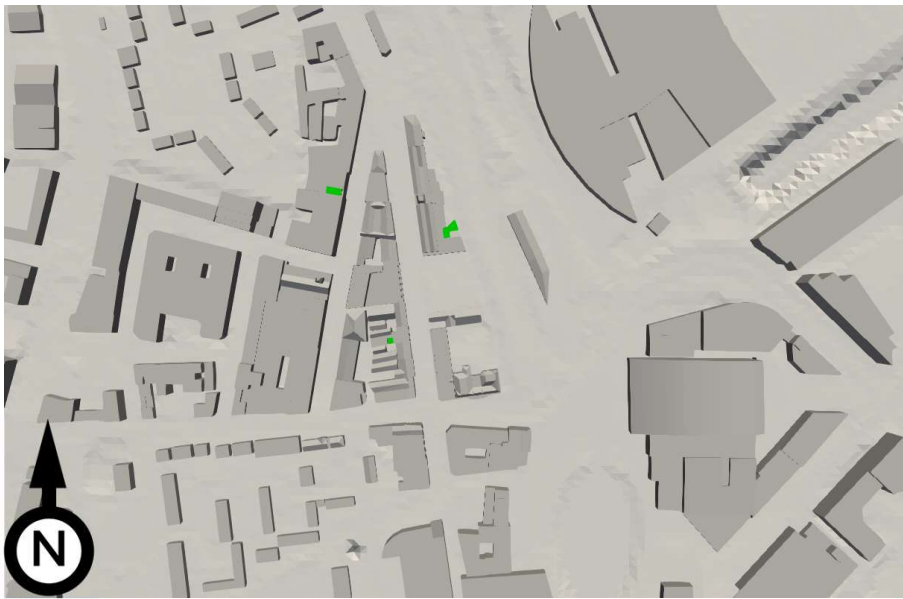


Figure 2 – 3D Models of Existing Condition (left) and Proposed Condition (right). Amenity spaces shown in green. Proposed building shown in grey.

METHODOLOGY



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 0.3 m² 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%). However, there are several buildings where the windows are expected to fall below this threshold currently.

The addition of the proposed building is not expected to significantly change the daylight availability to the windows under VSC criteria.

Tables 1 to 5, summarize the VSC findings for each of the surrounding buildings studied. Figures 3 and 4 on the following pages illustrates 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 | 117 Bute St | 86% | 79% |
| 2 | 113-116 Bute St | 77% | 73% |
| 3 | 110-112 Bute St | 71% | 71% |
| 4 | 108-109 Bute St | 37% | 37% |
| 5 | W Bute St | 75% | 75% |
| 6 | 122 Bute St | 67% | 67% |
| 7 | 125 Bute St | 67% | 67% |
| 8 | 19 Bute St | 100% | 100% |
| 9 | Meandros House, Docks Lane | 89% | 89% |
| 10 | South Section of Seaway House | 100% | 100% |
| 11 | Cardiff Bay | 85% | 80% |

RESULTS



External Daylight Availability - VSC

Table 2 – VSC Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|-----------------------|--|--|
| 12 | 113-116 Bute St | 35% | 35% |
| 13 | Bute St | 0% | 0% |
| 14 | Bute Crescent | 100% | 100% |
| 15 | Cambrian Buildings | 71% | 71% |
| 16 | Cymric Buildings | 83% | 83% |
| 17 | 97-100 Bute St | 61% | 61% |
| 18 | 34,36,38 Louisa Place | 56% | 56% |
| 19 | Resi: Cadogan House | 29% | 29% |
| 20 | St Clair Court | 50% | 44% |
| 21 | 5,7 James St | 70% | 70% |
| 22 | 1 James St | 67% | 67% |

RESULTS



External Daylight Availability - VSC

Table 3 – VSC Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|-----------------|--|--|
| 23 | 33 Louisa Place | 0% | 0% |
| 24 | 96 Bute St | 50% | 50% |
| 25 | 95 Bute St | 42% | 42% |
| 26 | 14-21 Bute St | 33% | 33% |
| 27 | Bay Chambers | 37% | 37% |
| 28 | 105 Bute St | 0% | 0% |
| 29 | 106 Bute St | 0% | 0% |
| 30 | 107 Bute St | 0% | 0% |
| 31 | 141 Bute St | 0% | 0% |
| 32 | 103 Bute St | 0% | 0% |
| 33 | Cardiff | 0% | 0% |

RESULTS



External Daylight Availability - VSC

Table 4 – VSC Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|-----------------|--|--|
| 34 | 57 Bute St | 0% | 0% |
| 35 | Portland House | 0% | 0% |
| 36 | 5 Bute Crescent | 0% | 0% |
| 37 | 110 Bute St | 0% | 0% |
| 38 | Cardiff | 0% | 0% |
| 39 | 110 Bute St | 0% | 0% |
| 40 | 18 James St | 75% | 75% |
| 41 | Cardiff | 0% | 0% |
| 42 | W Bute St | 0% | 0% |
| 43 | Captain's House | 0% | 0% |
| 44 | Ocean Building | 0% | 0% |

RESULTS



External Daylight Availability - VSC

Table 5 – VSC Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|------------------|--|--|
| 45 | 9 Bute Crescent | 67% | 67% |
| 46 | 10 Bute Crescent | 0% | 0% |
| 47 | 123 Bute St | 67% | 67% |
| 48 | 124 Bute St | 33% | 33% |
| 49 | 4 Bute St | 75% | 75% |
| 50 | 54b Bute St | 100% | 100% |
| 51 | 33 Bute St | 100% | 100% |
| 52 | 2 Bute St | 100% | 100% |
| 53 | 54a Bute St | 100% | 100% |
| 54 | Imam Ali Centre | 50% | 50% |

RESULTS



External Daylight Availability - VSC

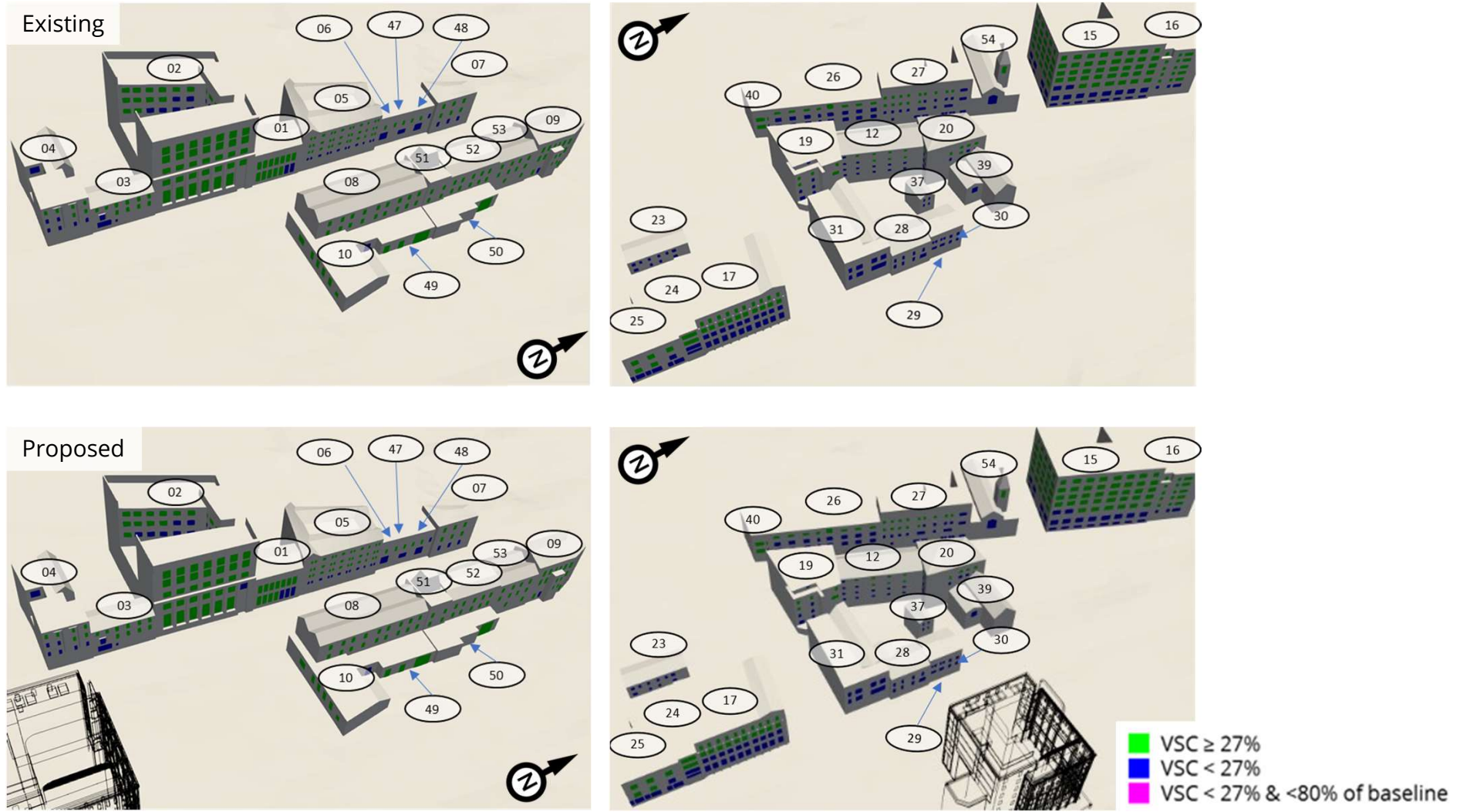


Figure 3 – Graphical VSC Results for Building 1 - 4 and 15

RESULTS



External Daylight Availability - VSC

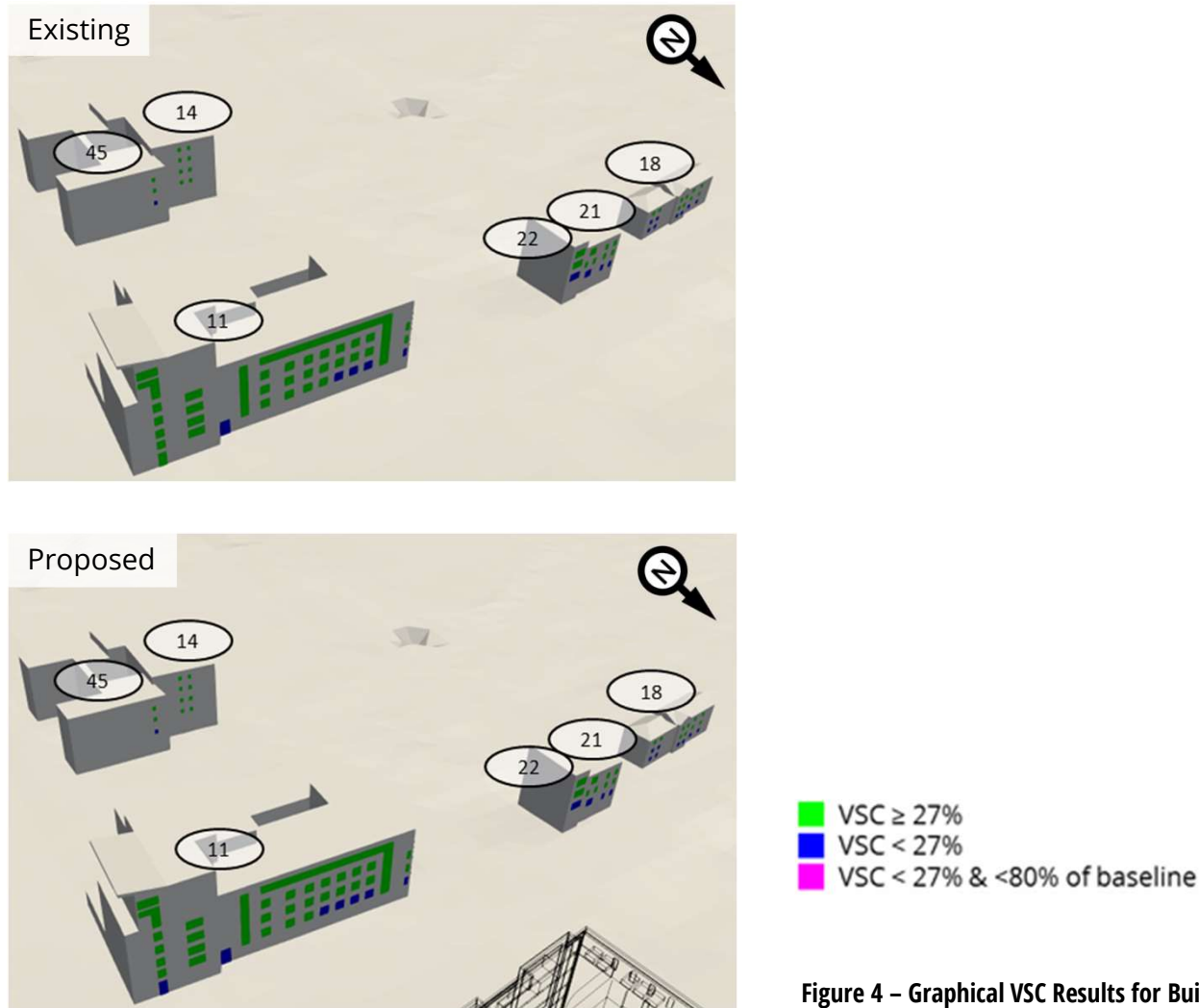


Figure 4 – Graphical VSC Results for Building 1 - 4 and 15

RESULTS



External Sunlight Availability - APSH

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

However, the south facing windows of the buildings to the south of the A4119 will not be affected by the Proposed Development since it lies to the north of these buildings. Thus, as per BR 209, none of these properties were included within the assessment of Annual Probably Sunlit Hours.

Table 6 to the right, summarizes the APSH findings, which are also illustrated graphically on the following pages.

No buildings see any reduction in the percentage of windows meeting the desirable threshold of APSH according to BR 209.

Table 6 – APSH Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|-------------------------------|--|--|
| 2 | 113-116 Bute St | 26% | 26% |
| 4 | 108-109 Bute St | 6% | 6% |
| 10 | South Section of Seaway House | 100% | 100% |
| 12 | 113-116 Bute St | 14% | 14% |
| 15 | Cambrian Buildings | 46% | 46% |
| 16 | Cymric Buildings | 34% | 34% |
| 19 | Resi: Cadogan House | 2% | 2% |
| 20 | St Clair Court | 29% | 29% |
| 26 | 14-21 Bute St | 43% | 43% |
| 27 | Bay Chambers | 46% | 46% |
| 40 | 18 Jasames St | 16% | 16% |
| 54 | Imam Ali Centre | 33% | 33% |

RESULTS



External Sunlight Availability - wPSH

The results for winter Probable Sunlight Hours (wPSH) are similar to the Annual Probable Sunlight Hours presented earlier. The same locations are presented in Table 7 comparing the impact of the Proposed Development.

No buildings see any reduction in the percentage of windows meeting the desirable threshold of APSH according to BR 209.

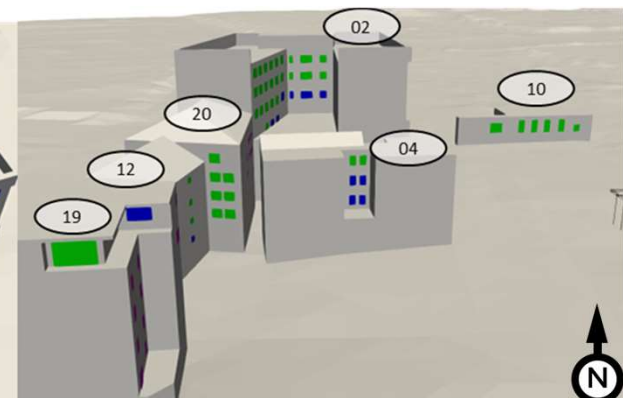
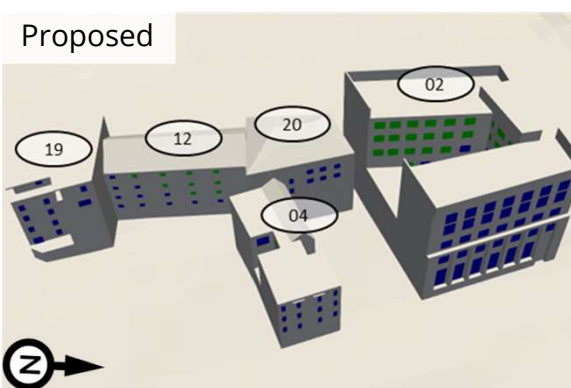
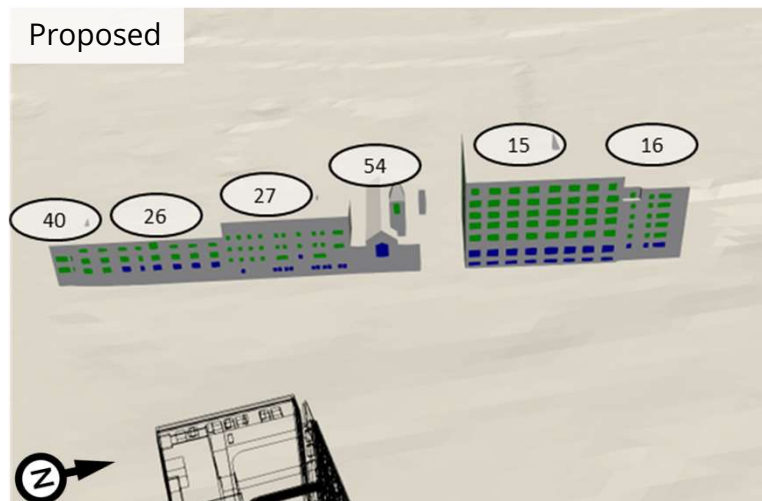
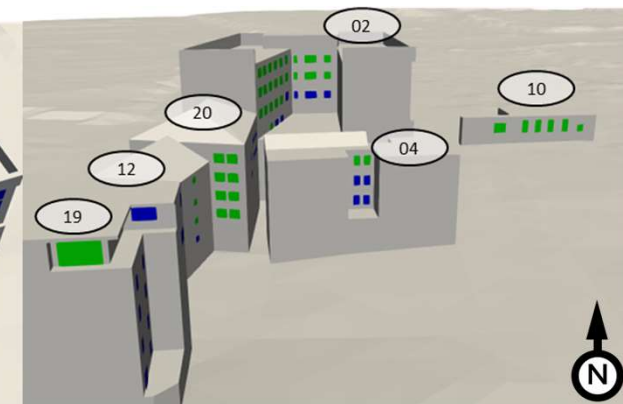
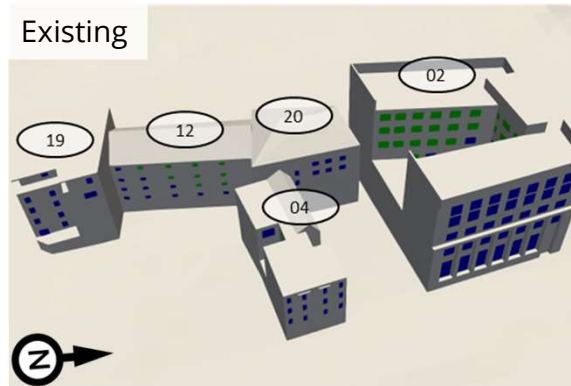
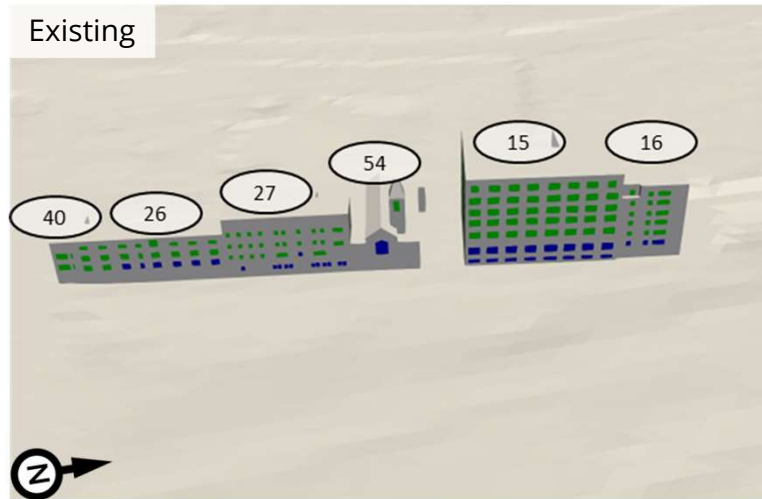
Table 7 – wPSH Results Summary

| Building No. | Building Name | % of Windows Meeting Criteria – Existing Condition | % of Windows Meeting Criteria – Proposed Condition |
|--------------|-------------------------------|--|--|
| 2 | 113-116 Bute St | 32% | 32% |
| 4 | 108-109 Bute St | 19% | 19% |
| 10 | South Section of Seaway House | 100% | 100% |
| 12 | 113-116 Bute St | 14% | 14% |
| 15 | Cambrian Buildings | 48% | 48% |
| 16 | Cymric Buildings | 39% | 39% |
| 19 | Resi: Cadogan House | 3% | 3% |
| 20 | St Clair Court | 29% | 29% |
| 26 | 14-21 Bute St | 57% | 57% |
| 27 | Bay Chambers | 67% | 67% |
| 40 | 18 Jasames St | 16% | 16% |
| 54 | Imam Ali Centre | 67% | 67% |

RESULTS



External Daylight Availability - APSH



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

RESULTS



External Daylight Availability - ASE

Seven 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.

Only one of these amenity spaces (Prop_1 on the proposed building) was predicted to fall below the BRE suggested threshold of 50% of the area having at least 2 hours of sunlight exposure on 21 March. This amenity space is shielded from sunlight in the by the Proposed Development.

The results are presented in tabular form in Table 5 on the right, and graphically in Figure 6 on the following page.

Table 5 – ASE Results Summary

| Amenity No. | Amenity Name | % of Space Meeting Criteria – Existing Condition | % of Space Meeting Criteria – Proposed Condition |
|-------------|--------------------------|--|--|
| 04 | 108-109 Bute St Balcony | 100% | 100% |
| 10 | Seaway House Backyard | 50% | 50% |
| 16 | Cymric Buildings Rooftop | 71% | 71% |
| Prop_1 | Proposed Building | N/A | 0% |
| Prop_2 | Proposed Building | N/A | 95% |
| Prop_3 | Proposed Building | N/A | 73% |
| Prop_4 | Proposed Building | N/A | 93% |

RESULTS



External Daylight Availability - ASE - 21 March

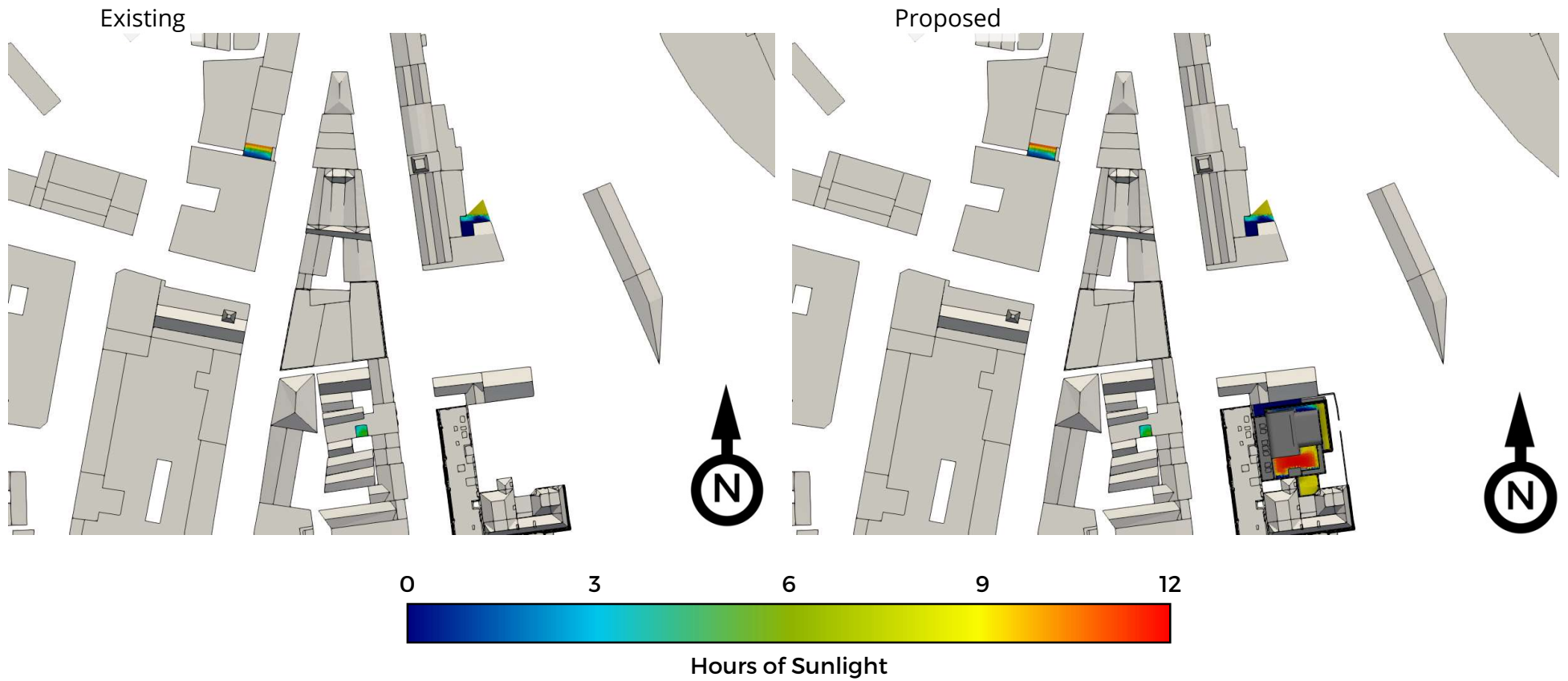


Figure 6 – Graphical ASE Results for Amenity Spaces (21 March)

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, sitting to the west of the Proposed Development were predicted to be impacted by the Proposed Development.
2. This is not unexpected given the existing nature of the site. 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 any of the building windows.
4. Access to direct sunlight was not predicted to be impacted to a significant degree. The properties to the north of the Proposed Development are further away and therefore less affected. The properties to the south are not affected at all. The residential properties to the west are predicted to be impacted to a small extent.
5. Adjacent amenity spaces were predicated to not be significantly impacted by the proposed development. Most amenity spaces are predicted to maintain the BRE recommended level of sunlight exposure under both existing and proposed conditions.
6. The one space which was not predicted to receive sufficient solar access under the proposed condition also falls was on the Proposed Development.

ASSUMPTIONS & LIMITATIONS



Computational solar modelling is highly dependent on the 3D model of the study domain. RWDI has endeavoured to create an accurate model of the study area with multiple sources of data (client provided, publicly available, and previous RWDI models) cross checked against each other for completeness and accuracy.

Should the design of the Proposed Development go through significant design changes, this analysis may require updating. It is the responsibility of others to contact RWDI in this event so that the need for a re-analysis can be determined.