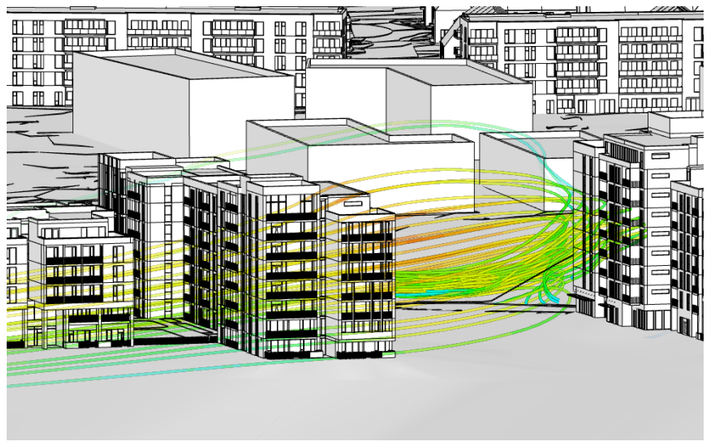
Belcamp SHD,

Lands at Belcamp,
Dublin 17



Gerard Gannon Properties

Microclimatic Wind Analysis and Pedestrian Comfort Report

IN2 Project No. D2205
04/05/2022
REV02

Revision History

Date	Revision	Description
22/04/2022	00	Issue for review
27/04/2022	01	Revised to reflect comments
04/05/2022	02	Updated details of project description

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1.0 Executive Summary

This report compiles the results of Microclimatic Wind Analysis undertaken by IN2 Engineering Design Partnership for the proposed Belcamp SHD, lands at Belcamp Dublin 17, based on 3D modelling information received from Wilson Architects and CCK Architects, comprising of assessments for predicted Wind conditions to the local environment.

The proposed development site straddles the jurisdictions of Dublin City Council (DCC) and Fingal County Council (FCC), with the 67.6 ha. site divided by the Mayne River being also boundary between DCC (17.1ha) and FCC (50.5ha), with the greater Fingal portion containing the protected structure of Belcamp Hall (RPS 463).

The report summarises the analysis undertaken, and conclusions determined from sophisticated Building Simulations performed with regards to Wind/ Pedestrian Comfort, in all cases determining results in accordance with robust Best Practice Guidelines to ensure compliance.

Wind Analysis was assessed utilising Airflow Simulation techniques through Computational Fluid Dynamics (CFD), calculating predicted pressures and velocities throughout the proposed development site and its surroundings.

The CFD model developed includes the 67.6 ha. Belcamp site in its entirety, as well as its receiving environment. Detailed assessment for wind analysis and pedestrian comfort are included in Sections 3.0 and 4.0 – 5.0 respectively. Results are broken out into DCC and FCC lands for presentation purposes, however, the simulations conducted account for the cumulative wind effects and interaction between each site and its surroundings.

The DCC lands to the south of the Mayne River and parallel to the R139 road are generally more exposed to prevailing wind conditions. Winds approaching the proposed development are relatively high, due to the flat, open nature of the neighbouring environment. The spacing and separation distances between building Blocks 1 to 6 reduce the risk of wind funnelling, with no “pinch points” or other adverse wind effects identified across the proposed site at ground level pedestrian zones.

The massing of the proposed apartment buildings provides shelter in their wake from prevailing winds; notably to the adjacent Belcamp Hall, existing Belcamp residential development, and the proposed development on FCC lands (located to the north).

These wind simulations were then compiled and assessed against Lawson Criteria Methodology- an assessment method for Pedestrian Comfort in order to predict activity suitability (sitting/ standing etc.) for persons in the vicinity of the development.

As per the Urban Development and Building Heights Guidelines (2018), the analysis undertaken identified that the proposed development was determined to not unduly impact on the local wind microclimate, with no instances of down-draft effects predicted to be introduced to the receiving environment.

Ground level spaces (communal amenity spaces, green areas, footpaths/ walkways, etc.) across the entirety of the proposed development lands are determined to be predominantly suited to “Outdoor Dining/ Pedestrian Sitting”, in accordance with the Lawson Criteria methodology utilised.

Similarly, all podium level and roof terrace level spaces of buildings in both the DCC and FCC lands are deemed to be suited to “Outdoor Dining/ Pedestrian Sitting”, and therefore appropriate to their intended use as amenity spaces.

All “inset” balconies across the DCC lands were predicted to be suitable for “Outdoor Dining/ Pedestrian Sitting” and therefore well suited to their intended use as amenity spaces.

A number of top floor balconies across Blocks 1 to 5 have been identified in Section 4.5 as less suited to “Pedestrian Sitting”, and more suited to “Pedestrian Standing”. Whilst none were predicted to be “uncomfortable/ unsafe”, wind conditions more suitable for their intended use as private amenity spaces with seating may be achieved by increasing overall balustrade heights to 1.8m surrounding these particular balconies as identified within the report.

All balconies within the proposed FCC lands are predicted to be suitable for “Outdoor Dining/ Pedestrian Sitting”, and therefore suitable to their intended use, without any wind mitigation measures.

Therefore, overall, the proposed development is determined to not negatively impact on neighbouring developments, nor its receiving microclimate.

2.0 Methodology

2.1 Wind Analysis

In order to determine the predicted wind patterns around the proposed development, airflow simulations were undertaken using Computational Fluid Dynamics (CFD) software (Phoenics / Flair). This enabled an assessment of the site wind conditions: highlighting zones of high pressure, negative pressure, and air movement for varying wind conditions.

An initial 3D representational model of the existing buildings and their immediate surroundings was created, and simulations undertaken for 12 cardinal wind directions.

Wind Climate Data was taken from the Global Wind Atlas. This utilises a microscale modelling system, enabling localised wind data to be obtained for high resolution (250m grid) topography, such as hills, ridges, and land use, including urban environments.

Fig 2.1.1 illustrates Global Wind Atlas data for the general Dublin area, indicating average wind speed at 10m height. The relative sheltering of the Urban area can be seen, in contrast to Dublin Airport to the North, and Dublin/ Wicklow mountains to the South, and exposed coastal locations.

Recorded wind speeds for Dublin Airport are relatively high- in what is one of Europe's windier meteorological weather station locations. The particular site location at Belcamp is identified, which is an area relatively unsheltered on a macro level. Wind conditions at the proposed site are similar to those at Dublin Airport (located less than 5km away), with higher wind speeds than those of the built-up Dublin City urban area to the south.

The CFD simulations utilised wind profiles accounting for terrain effects. Allowing for the nature of the site and location, a surface roughness layer profile representative of "Low Crops, Occasional Large Obstacles (z_0=0.1m height)" was utilised, derived from GIS survey analysis[1].

Figures 2.1.2 and 2.1.3 indicates the long-term annual "Wind Rose" obtained from the Global Wind Atlas for the site at Belcamp, Dublin 17. The rose diagrams illustrate the frequency that wind will be from a certain direction and at what speed. It can be seen how the prevailing Westerly South-Westerly winds entirely predominate due to the Atlantic gulf stream, with only lower occurrence from other directions.

[1] European Space Agency's Climate Change Initiative Land Cover (CCI-LC) dataset v2.0.7.

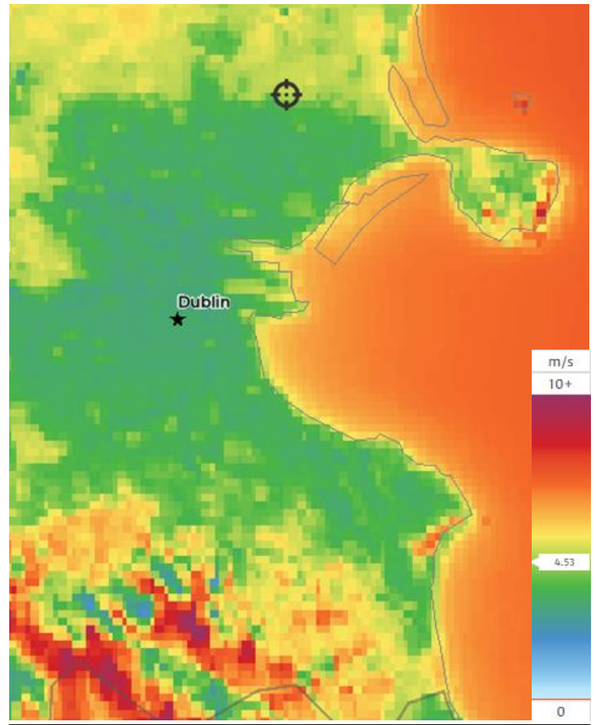

Fig 2.1.1 – Mean Wind Speeds across Dublin – Global Wind Atlas

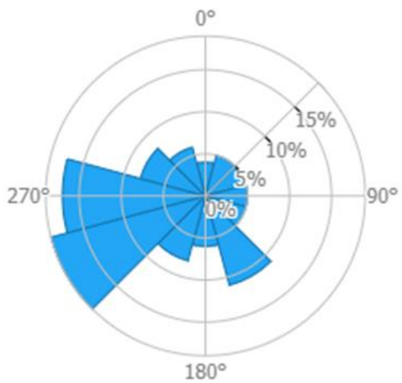

Fig 2.1.2 – Wind Frequency Rose for Belcamp – Global Wind Atlas

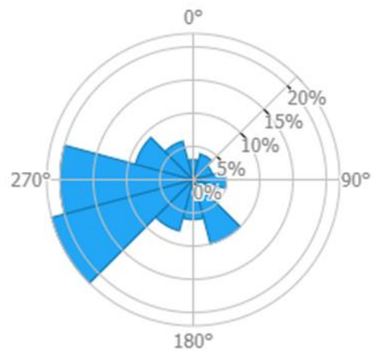

Fig 2.1.3 – Wind Speed Rose for Belcamp – Global Wind Atlas

2.0 Methodology

2.1 Wind Analysis (Cont'd)

As per Fig 2.1.4, 3D representational model of the proposed development and its surroundings was created, and simulations undertaken for 12 cardinal wind directions.

The CFD model developed includes the 67.6 ha Belcamp site in its entirety, and its receiving environment. Results for wind analysis and pedestrian comfort are included in Sections 3.0 and 4.0 – 5.0 respectively. Results are broken out into DCC and FCC lands for presentation purposes, however, the simulations conducted account for the cumulative wind effects and interaction between each site and its surroundings.

The CFD simulations form the basis of the Pedestrian Wind Comfort Analysis undertaken, which is described in Section 2.2 below.

The methodology calculates predicted airflow patterns around buildings for all wind orientations and calculates average velocity applying weighting based on probability of occurrence throughout the year. It should be noted that wind effects around buildings for prevailing SW wind conditions are deemed to have more of a potential impact to pedestrian discomfort, as these will occur on a more regular occurrence.

However, it should be noted that the methodology assesses averaged (hourly) wind conditions for the purposes of general pedestrian comfort and does not intend to predict gusting, abnormal nor potential future climate change conditions.

Nevertheless, the Lawson Criteria methodology basis, as described in detail below, has been proven to be a robust means of analysing Pedestrian Comfort and its basis has been successfully adapted and implemented in both National Standards (Netherlands NEN.8100) and Design Guidelines (City of London – Wind Microclimate Guidelines (2019)).

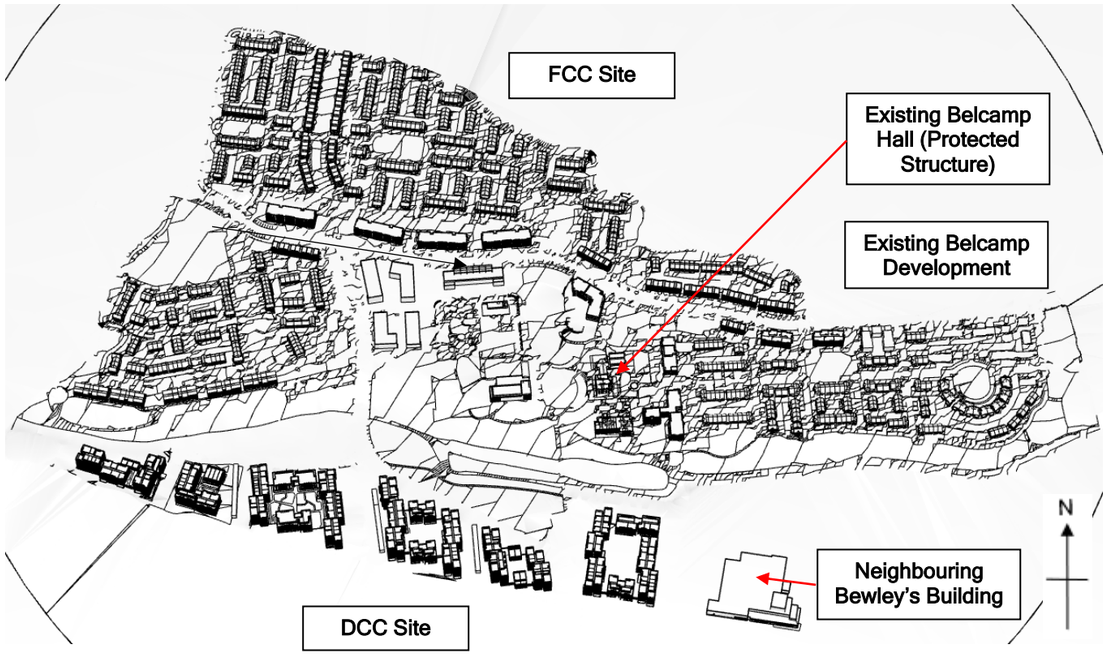

Fig 2.1.4 – 3D Model of Proposed Carlisle Development and Neighbouring buildings

2.0 Methodology

2.2 Pedestrian Comfort

Pedestrian Wind Comfort was assessed utilising the “Lawson Criteria” scale, which has been developed as a means of assessing the long term suitability of urban areas for walking or sitting, accounting for both microclimatic wind effects (i.e. site location and prevailing winds) and microclimatic air movement associated with wind forces influenced by the localised built environment forms and landscaping effects.

The original Lawson Criteria (as described in Building Aerodynamics, Tom Lawson, Imperial College Press, 2001) assesses probability of wind discomfort based on the Beaufort Scale as referenced in Figure 2.2.1.

Figure 2.2.2 illustrates the Lawson Criteria scale, as developed and implemented to the City of London Guidelines as utilised and assessed within the report, which ranges from areas deemed suitable for long term sitting through to regions uncomfortable for pedestrian comfort. “Pedestrian Walking” areas, for example, are defined as areas that would not experience wind velocities in excess of 8m/s for more than 5% of the year, whereas uncomfortable areas would experience averaged wind velocities greater than 10m/s for more than 5% of the year.

The assessment identifies area where potential wind occurrence, based on probability of wind direction and speed, would either be mitigated (Outdoor Dining/ Pedestrian Sitting and Standing) or exacerbated (Business Walking/ Uncomfortable) due to proposed massing from potential developments.

However, it should be noted that in terms of pedestrian comfort, the Lawson Criteria assesses solely for wind/associated air velocity effects. Therefore, other environmental aspects that may influence a space’s microclimate, such as exposure to sunlight and envisaged temperature variation throughout the year are not accounted for within this methodology.

Beaufort Force	Hourly-Average Windspeed m/s	Description of Wind	Noticable Effect of Wind
0	<0.45	Calm	Smoke rises vertically
1	0.45 - 1.55	Light	Direction shown by Smoke drift but not by vanes
2	1.55 - 3.35	Light	Wind felt on faces: leaves rustle: wind vane moves
3	3.35 - 5.60	Light	Leaves and twigs in motion: wind extends a flag
4	5.60 - 8.25	Moderate	Raises dust and loose paper: small branches move
5	8.25 - 10.95	Fresh	Small trees in leaf sway
6	10.95 - 14.10	Strong	Large branches begin to move: telephone wires whistle
7	14.10 - 17.20	Strong	Whole trees in motion

Fig 2.2.1 Beaufort Scale

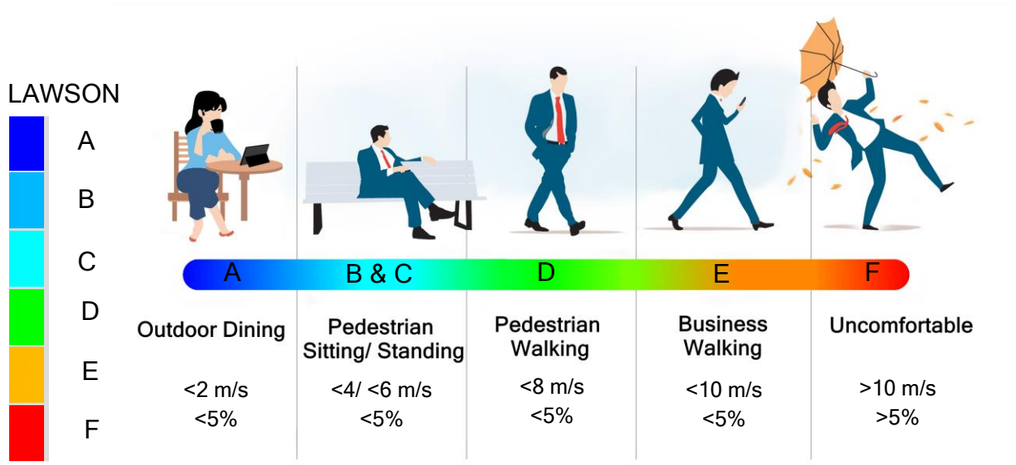

Fig 2.2.2 Lawson Scale

3.0 Wind Analysis

3.1 Wind Analysis Results – DCC Lands

Figure 3.1 illustrates predicted wind velocities across the development under prevailing SW wind conditions, at 10m above ground level.

The proposed development site is located less than 5km from Dublin Airport, which is one of Europe's windier meteorological weather station locations. Additionally, the terrain surrounding the proposed site is quite flat and open, consisting of parks, fields, or low-density suburban housing (2 storey houses/ bungalows). These factors combined result in high wind speeds (indicated by yellow contours in Fig 3.1 below) on the windward side of the proposed development. Some of these higher wind speeds are predicted to flow between the proposed building blocks. However, the spacing and separation distances between the buildings reduce the risk of wind funnelling, with no "pinch points" or other adverse wind effects identified across the proposed site.

The massing of the proposed apartment buildings provides shelter from prevailing winds in their wake; notably to the adjacent Belcamp Hall (protected structure), existing Belcamp residential development, and the proposed development on FCC lands (located to the north). Each of the proposed buildings provide a self-sheltering effect to their respective enclosed courtyard spaces under prevailing wind conditions. The CFD simulations form the basis of the Pedestrian Comfort Analysis undertaken, which is described in detail in Section 4.0, and confirms that these spaces are predicted to be well suited for use as residential amenity spaces from a pedestrian wind comfort perspective.

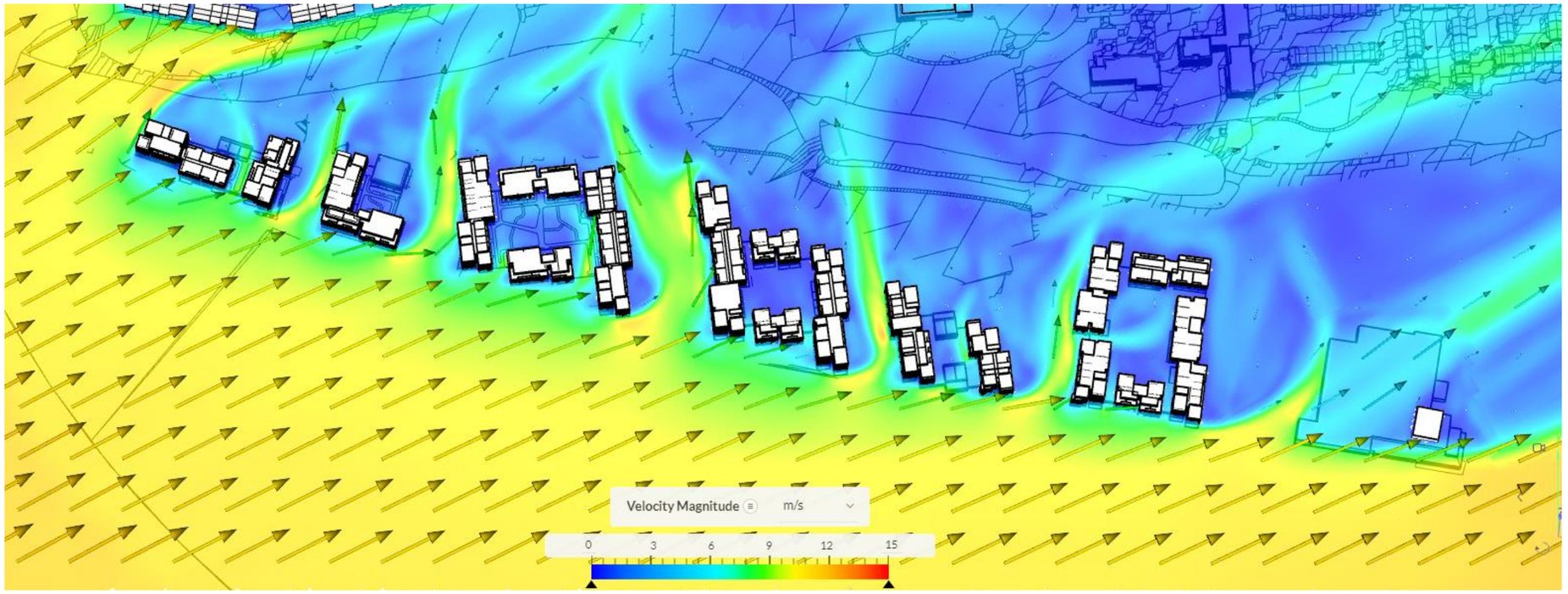

Fig. 3.1 - Wind Velocity at 10m above Ground Level across DCC Lands of Proposed Development

3.0 Wind Analysis

3.2 Wind Analysis Results – FCC Lands

Figure 3.2 illustrates predicted wind velocities across the development under prevailing SW wind conditions, at 5m above ground level.

Wind velocities across the proposed development are predicted to be relatively benign.

The results illustrate that wind velocities are highest at the Western edge of the site. As winds reach the proposed development site, these wind speeds are reduced to relatively benign speeds. The site also benefits from wind sheltering effects provided by the proposed apartment development on DCC lands, located to the south of the FCC site.

Simulation results suggest the proposed building heights are not excessive from a wind microclimate perspective, with no instances of downdraft or other undesirable wind effects predicted across the proposed FCC site.

These CFD simulations form the basis of the Pedestrian Comfort Analysis undertaken, which is described in detail in Section 5.0.

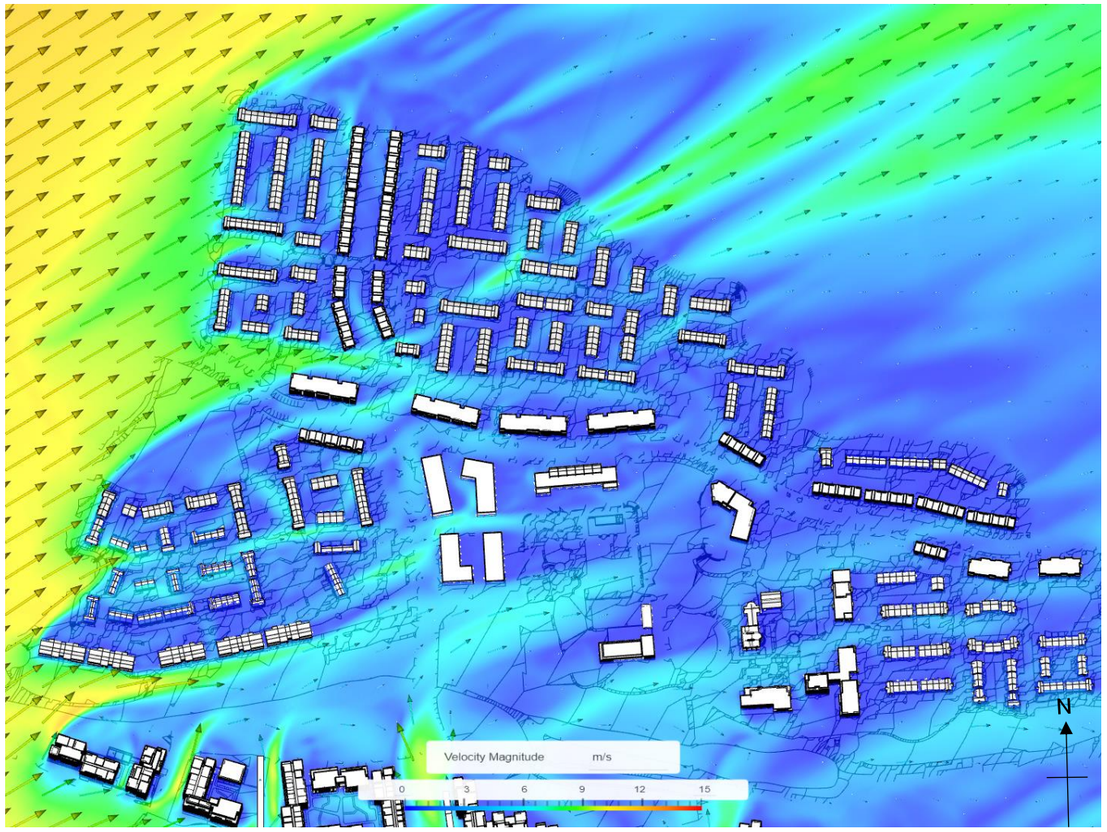

Fig. 3.2 - Wind Velocity at 5m above Ground Level of Proposed Development

4.0 Pedestrian Comfort – DCC Lands

4.1 Ground Level

CFD simulations were undertaken to determine the Lawson Criteria results for the proposed development. Pedestrian comfort at ground level was assessed by predicting Lawson Criteria values at 1.5m above ground level.

The scale in Fig 4.1.1 outlines the Lawson Criteria Scale utilised. Blue contours illustrate the most sheltered regions, areas deemed “Suitable for Outdoor Dining”. Light Blue/ Cyan contours indicate regions “Suitable for Pedestrian Sitting” and “Pedestrian Standing” respectively. Green contours indicate areas “Suitable for Pedestrian Walking”, with orange illustrative of being “Suitable for Business Walking”. Red areas highlight zones as “Uncomfortable”.

As per Fig. 4.1.2, conditions between the proposed buildings at ground level have been determined to be predominantly suitable for “Pedestrian Sitting/ Standing” (light blue/ cyan contours), therefore suitable for their intended use. The immediate surroundings of the buildings have been determined to be suitable for “Outdoor Dining/ Pedestrian Sitting”, as illustrated by blue contours. These more sheltered conditions surrounding the buildings are desirable for ease of entrance and egress from the buildings. Existing hedge rows are proposed to be maintained between buildings – in addition to ecological benefits, this also aids in providing a degree of wind sheltering at ground level.

A	2 m/s	< 5%	Outdoor Dining
B	4 m/s	< 5%	Pedestrian Sitting
C	6 m/s	< 5%	Pedestrian Standing
D	8 m/s	< 5%	Pedestrian Walking
E	10 m/s	< 5%	Business Walking
U	10 m/s	> 5%	Uncomfortable

Fig. 4.1.1 – Lawson Criteria

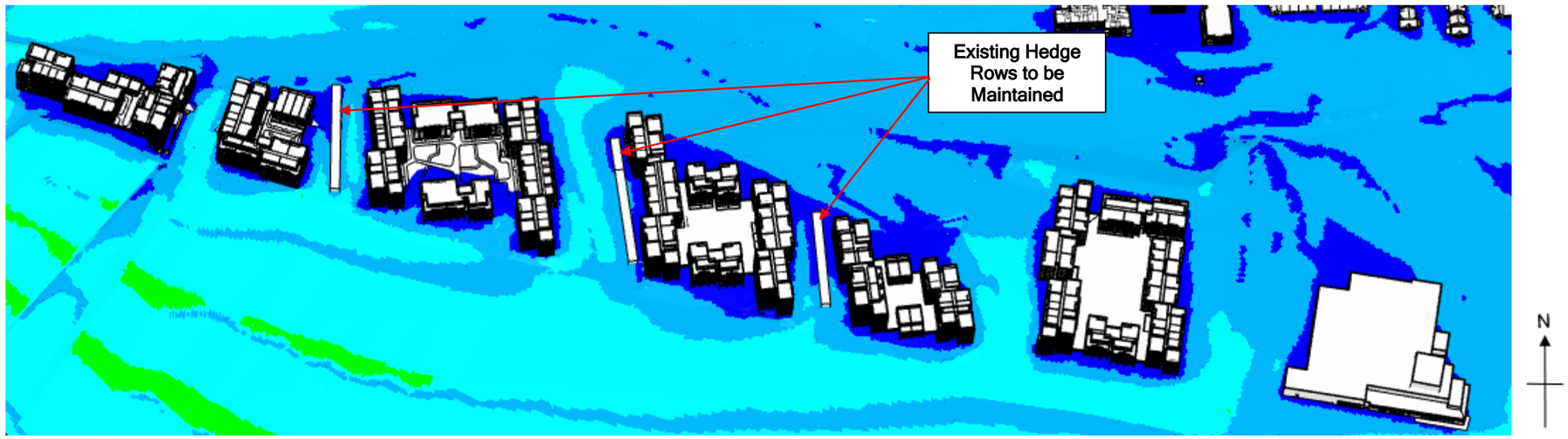

Fig. 4.1.2 – Lawson Criteria Results at 1.5m Above Ground Level Across DCC Lands

4.0 Pedestrian Comfort – DCC Lands

4.2 Podium Level

Each of the podium level amenity spaces of Blocks 1 to 6 within the DCC lands of the proposed development were assessed for pedestrian comfort, in accordance with the Lawson Criteria methodology utilised.

Fig 4.2.1 illustrates results for Blocks 1 to 3, and Fig 4.2.2 the results for Blocks 4 to 6.

All podium level spaces analysed were determined to be suitable for “Outdoor Dining/ Pedestrian Sitting”, and therefore well suited to their intended use as residential amenity spaces.

The massing of the apartment buildings encloses these courtyard amenity spaces, resulting in calm, sheltered wind conditions at pedestrian level. No areas of excessive wind speeds or pedestrian discomfort are predicted in these amenity areas.

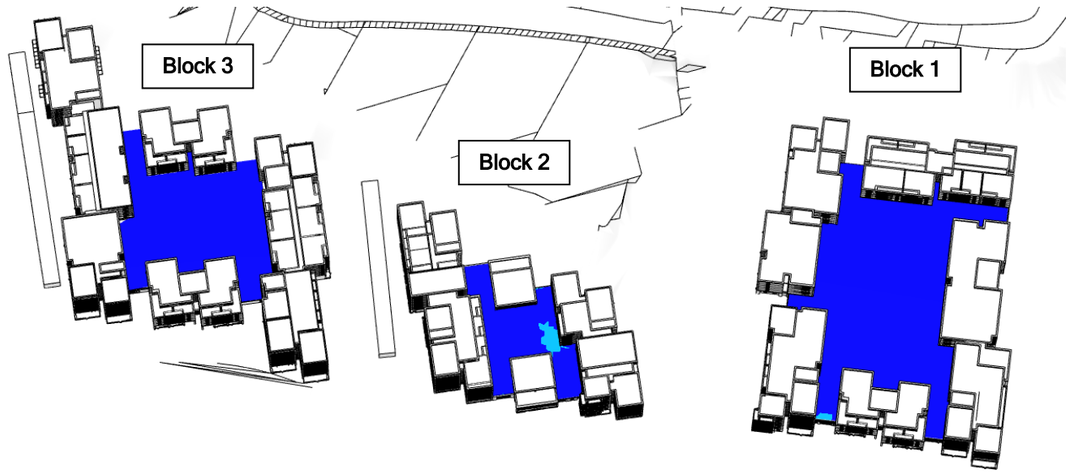

Fig. 4.2.1 – Lawson Criteria Results at Podium Level of Blocks 1 to 3

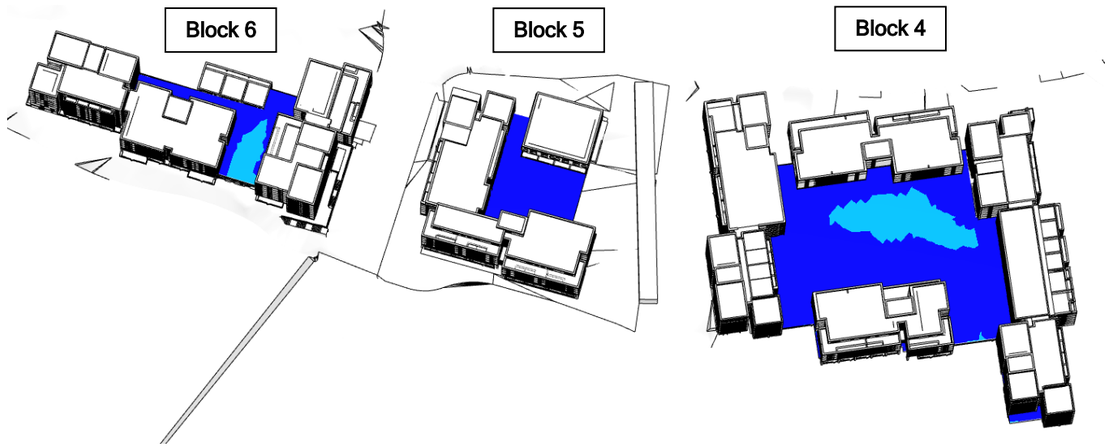

Fig. 4.2.2 – Lawson Criteria Results at Podium Level of Blocks 4 to 6

4.0 Pedestrian Comfort – DCC Lands

4.3 Balconies

All balcony amenity spaces across the proposed development were assessed for pedestrian comfort by predicting Lawson Criteria values at 1.5m above each balcony.

Fig 4.3.1 Lawson Criteria Scale The scale in Fig 4.1.1 outlines the Lawson Criteria Scale utilised. Blue contours illustrate the most sheltered regions, areas deemed “Suitable for Outdoor Dining”. Light Blue/ Cyan contours indicate regions “Suitable for Pedestrian Sitting” and “Pedestrian Standing” respectively.

All “inset” balconies across the proposed development were predicted to be suitable for “Outdoor Dining/ Pedestrian Sitting” and therefore well suited to their intended use as amenity spaces. Fig 4.3.1 illustrates results for balconies across Block 1, and Fig 4.3.2 shows Block 6 results. All other balconies across the proposed development are determined to receive similar or improved pedestrian comfort conditions and well suited to their intended use, with the exception of some of the more open and exposed balconies at top floors of Buildings 1 to 5.

Results for balconies at the top floors of each building are shown in Section 4.4 overleaf. A number of these are determined to more suitable for “Pedestrian Standing” than “Pedestrian Sitting”, which is more desirable for seated amenity use.

Section 4.5 outlines potential mitigation measures (wind screening) for these balconies which are predicted to be non-optimal in terms of wind comfort. Whilst there is scope to improve pedestrian comfort at these top floor balconies, it may be noted that these balconies are not predicted to be “Uncomfortable/ Unsafe”.

A	2 m/s	< 5%	Outdoor Dining
B	4 m/s	< 5%	Pedestrian Sitting
C	6 m/s	< 5%	Pedestrian Standing
D	8 m/s	< 5%	Pedestrian Walking
E	10 m/s	< 5%	Business Walking
U	10 m/s	> 5%	Uncomfortable

Fig. 4.4.1 – Lawson Criteria

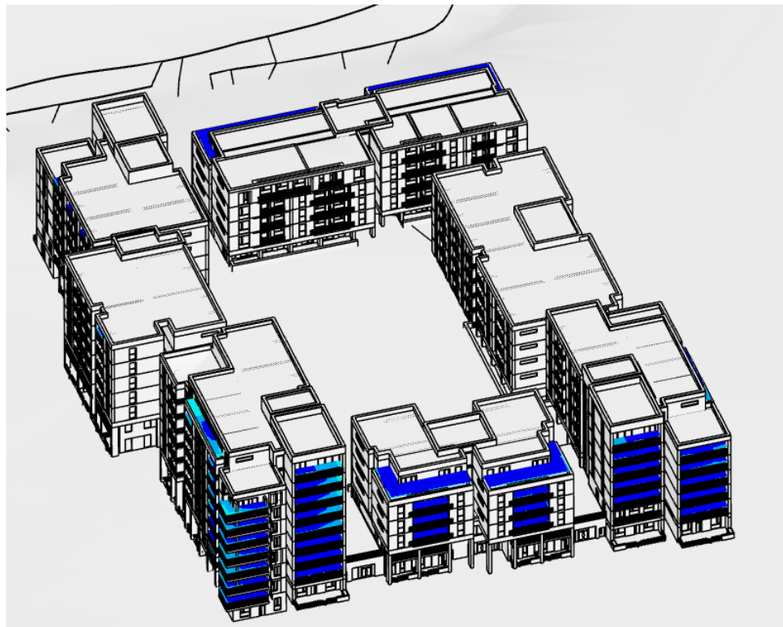

Fig. 4.3.2 – Lawson Criteria Results for Block 1 Balconies

Fig. 4.3.3 – Lawson Criteria Results for Block 6 Balconies

4.0 Pedestrian Comfort – DCC Lands

4.4 Balconies Results

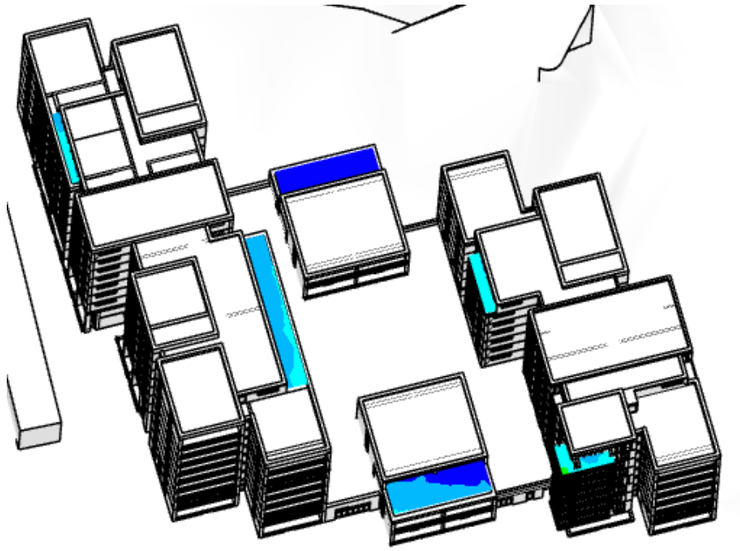

Fig. 4.4.4 – Top Floors of Block 2

A	2 m/s	< 5%	Outdoor Dining
B	4 m/s	< 5%	Pedestrian Sitting
C	6 m/s	< 5%	Pedestrian Standing
D	8 m/s	< 5%	Pedestrian Walking
E	10 m/s	< 5%	Business Walking
U	10 m/s	> 5%	Uncomfortable

Fig. 4.4.3 – Lawson Criteria

Fig. 4.4.5 – Top Floors of Block 3

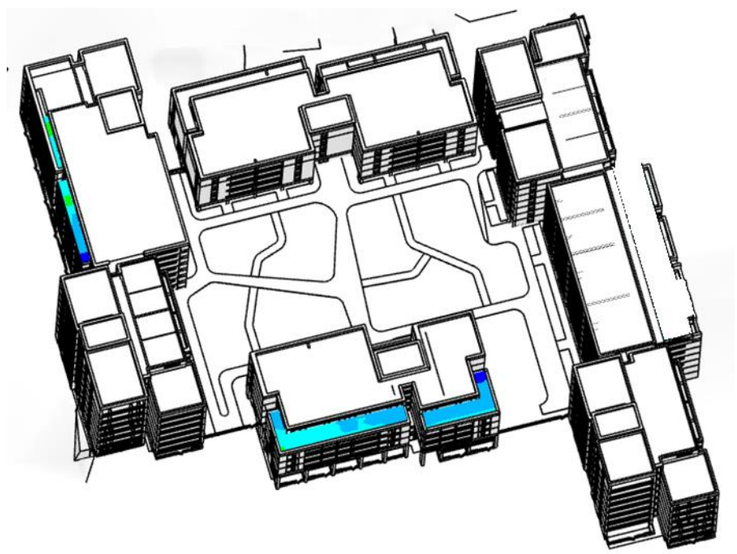

Fig. 4.4.6 – Top Floors of Block 4

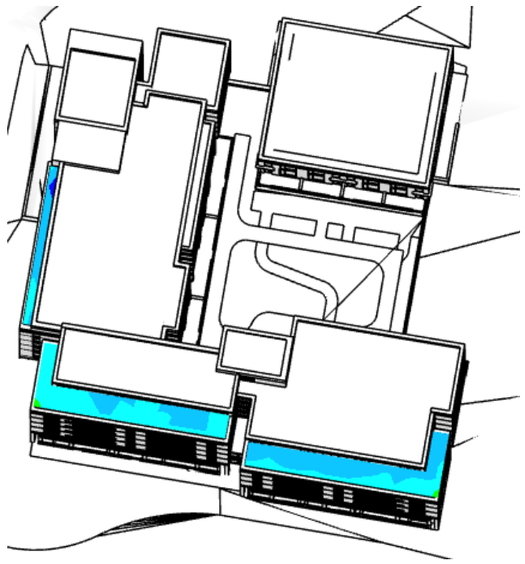

Fig. 4.4.7 – Top Floors of Block 5

4.0 Pedestrian Comfort – DCC Lands

4.5 Upper-Level Balconies - Potential Mitigation Measures

A number of top floor-level balconies across Blocks 1 to 5 are predicted to be unsuitable for “Pedestrian Sitting”, and more suited to “Pedestrian Standing” or “Pedestrian Walking”. Whilst none are predicted to be “uncomfortable/ unsafe”, wind conditions more suited to their intended use as private amenity spaces may be achieved with the use of 1.8m high balustrades.

Increasing the overall height of balcony balustrades to 1.8m, rather than 1.1m, is predicted to deflect wind flow away from the occupied zone. Results for top floor-level balconies with additional wind screening added are shown in Section 4.6 overleaf. The specific balconies at top floor levels are highlighted in orange.

Balconies which are not highlighted were determined to be “Suitable for Sitting” with a 1.1m balustrade, and do not necessarily require additional wind screening.

It may be noted that pedestrian wind comfort is just one of many parameters that can be considered in apartment and amenity space design, and any potential mitigation measures can be balanced against other design considerations. The balconies that were identified to be non-optimal in terms of wind comfort, do have compensatory measures in that they would benefit from larger usable size, wide expansive views (due to their height above ground) and a S/SW aspect, which is beneficial for direct sunlight availability.

Fig. 4.5 – Potential Wind Screening Measures

4.0 Pedestrian Comfort – DCC Lands

4.6 Upper-Level Balconies - Potential Mitigation Measures Results

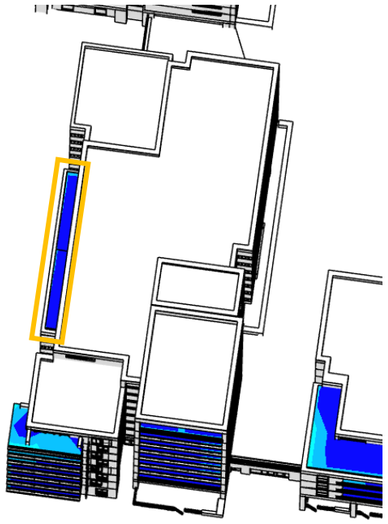

Fig. 4.6.1 – Block 1 Level 8

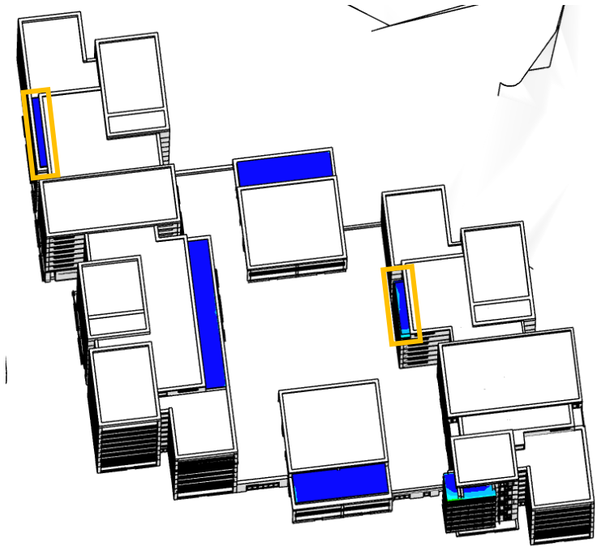

Fig. 4.6.2 – Block 2 Levels 7 and 8

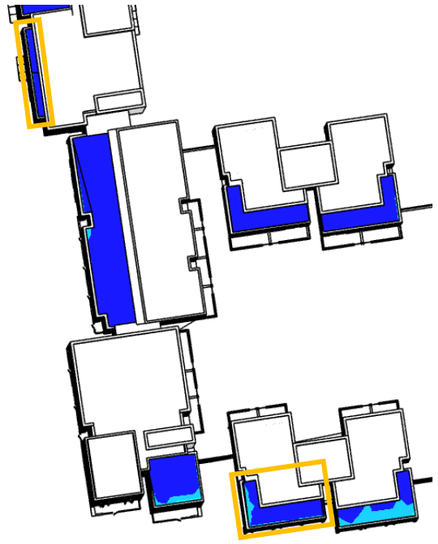

Fig. 4.6.3 – Block 3 Levels 6 and 8

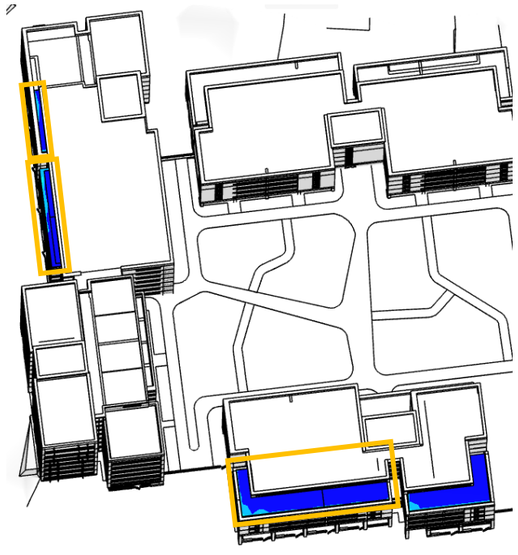

Fig. 4.6.4 – Block 4 Levels 6 and 7

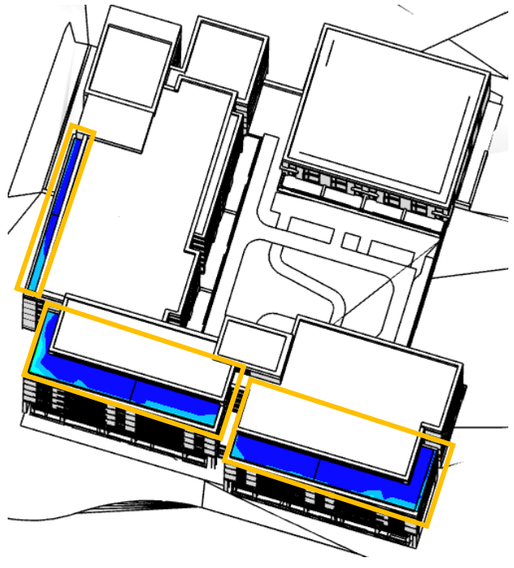

Fig. 4.6.5 – Block 5 Levels 5 and 6

5.0 Pedestrian Comfort – FCC Lands

5.1 Ground Level

CFD simulations were undertaken to determine the Lawson Criteria results for the proposed development.

Pedestrian comfort at ground level was assessed by predicting Lawson Criteria values at 1.5m above ground level.

The scale in Fig 5.1.1 outlines the Lawson Criteria Scale utilised. Blue contours illustrate the most sheltered regions, areas deemed “Suitable for Outdoor Dining”. Light Blue/ Cyan contours indicate regions “Suitable for Pedestrian Sitting” and “Pedestrian Standing” respectively. Green contours indicate areas “Suitable for Pedestrian Walking”, with orange illustrative of being “Suitable for Business Walking”. Red areas highlight zones as “Uncomfortable”.

An approximate site red line has been included to denote the boundary between the proposed development and the existing Belcamp residential development. It should be noted that this has been included for illustration purposes only – please refer to architectural drawings for the complete site red line.

Conditions suitable for “Pedestrian Walking” (green contours) are predicted in the open fields to the West of the proposed development. As winds reach the proposed development site, wind speeds are reduced to relatively benign speeds, resulting in calm wind conditions within the housing clusters. The site also benefits from wind sheltering effects provided by the proposed apartment development on DCC lands, located to the south of the FCC site.

As per Fig. 5.1.2, conditions at ground level within the proposed development have been determined to be predominantly suitable for “Outdoor Dining/ Pedestrian Sitting”, as illustrated by blue/ light blue contours.

All communal amenity spaces and footpaths/ walkways, and private amenity spaces (gardens/ balconies) are determined to be suitable for their intended use from a pedestrian wind comfort perspective.

A	2 m/s	< 5%	Outdoor Dining
B	4 m/s	< 5%	Pedestrian Sitting
C	6 m/s	< 5%	Pedestrian Standing
D	8 m/s	< 5%	Pedestrian Walking
E	10 m/s	< 5%	Business Walking
U	10 m/s	> 5%	Uncomfortable

Fig. 5.1.1 – Lawson Criteria

Fig. 5.1.2 – Lawson Criteria Results at 1.5m Above Ground Level

5.0 Pedestrian Comfort – FCC Lands

5.2 Roof Terrace Level

Pedestrian comfort at roof terrace level was assessed by predicting Lawson Criteria values at 1.5m above roof terrace level.

Communal open space is proposed to be provided at roof level of Block D.

From a wind comfort perspective, this roof terrace benefits from its low height above ground level, and the shelter from prevailing winds provided by the build-up of proposed buildings to the South West.

Therefore, the entirety of this roof space has been determined to be suitable for “Outdoor Dining” as per the Lawson Criteria Scale utilised. Therefore, the space is predicted to be well suited to use as amenity space.

A	2 m/s	< 5%	Outdoor Dining
B	4 m/s	< 5%	Pedestrian Sitting
C	6 m/s	< 5%	Pedestrian Standing
D	8 m/s	< 5%	Pedestrian Walking
E	10 m/s	< 5%	Business Walking
U	10 m/s	> 5%	Uncomfortable

Fig. 5.2.1 – Lawson Criteria

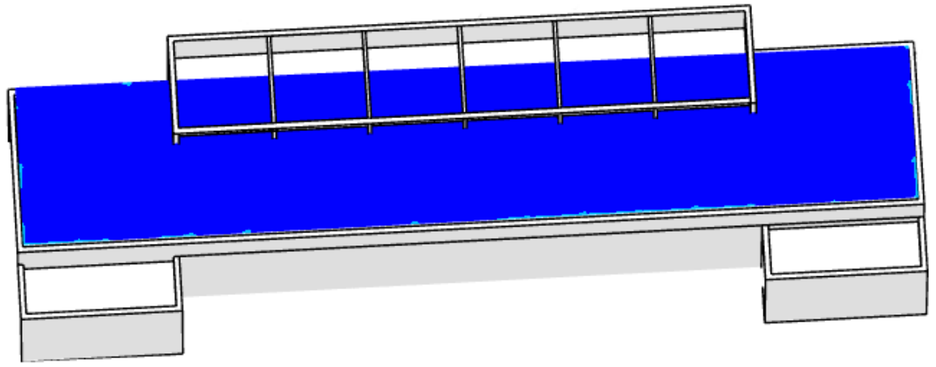

Fig. 5.2.2 – Lawson Criteria at Roof Terrace Level of Block D

IN2 Engineering Design
Unit E&F
Mount Pleasant Business Park
Upper Mount Pleasant Avenue
Dublin 6
(01) 496 0900

info@in2.ie