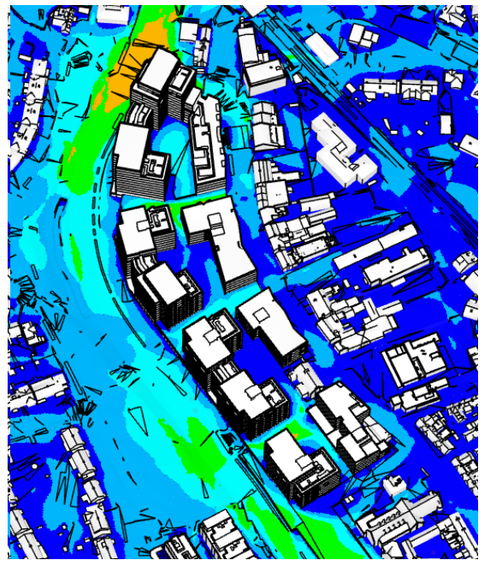
Dundrum Village Strategic Housing Development,

Dundrum,
Dublin 14

Dundrum Retail GP DAC
(Acting for and on behalf of Dundrum Retail Limited Partnership)



Microclimatic Wind Analysis and Pedestrian Comfort Report

IN2 Project No. D2141
14/03/2022

Revision History

Date	Revision	Description
09/02/2022	00	Stage 3 issue for review
10/03/2022	01	Revised to reflect comments
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14/03/2022	03	Revised to reflect comments

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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 Strategic Housing Development at Dundrum, Dublin 14, based on 3D modelling information received from GRID Architects, comprising of assessments for predicted Wind conditions to the local environment.

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

Detailed assessment of predicted Wind conditions and associated Pedestrian Comfort were undertaken in Sections 3.0 and 4.0, respectively.

Wind Analysis was assessed utilising Airflow Simulation techniques, calculating predicted pressures and velocities throughout the proposed development site and its surroundings.

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 detailed in Section 2.3 of this report, the results as presented for predicted microclimatic wind conditions and associated pedestrian comfort provide a conservative assessment accounting for future climate change conditions.

Ground level communal amenity spaces within the proposed development are determined to be very well sheltered, predominantly suited to “Outdoor Dining/ Pedestrian Sitting”, in accordance with the Lawson Criteria methodology utilised. All pedestrian links through the site are deemed to be suited to “Pedestrian Walking”, and therefore suited to their intended use.

All roof terrace spaces have a considerable portion of their area deemed to be suitable for “Outdoor Dining/ Sitting” (blue contours). The landscaping design includes wind mitigation measures in the form of wind screening and wind tolerant planting, which minimises potential excess wind speeds at roof terraces. Therefore, the roof terrace levels analysed are predicted to be suitable for their intended use as amenity spaces.

All balconies within the proposed development are predicted by the Lawson Criteria methodology utilised to be suited to “Outdoor Dining” or Pedestrian Sitting/ Standing”, and therefore suited to their intended use as private amenity spaces.

Wind conditions more suited to “Business Walking” are predicted to occur to the north of Zone 1. However, these wind conditions are predicted to occur along the R117 Dundrum Bypass Road, and therefore away from any pedestrianised areas.

The proposed development is determined to not adversely impact on its receiving environment or neighbouring developments in terms of wind microclimate and pedestrian comfort, with no areas deemed to be “Uncomfortable” or “Unsafe”.

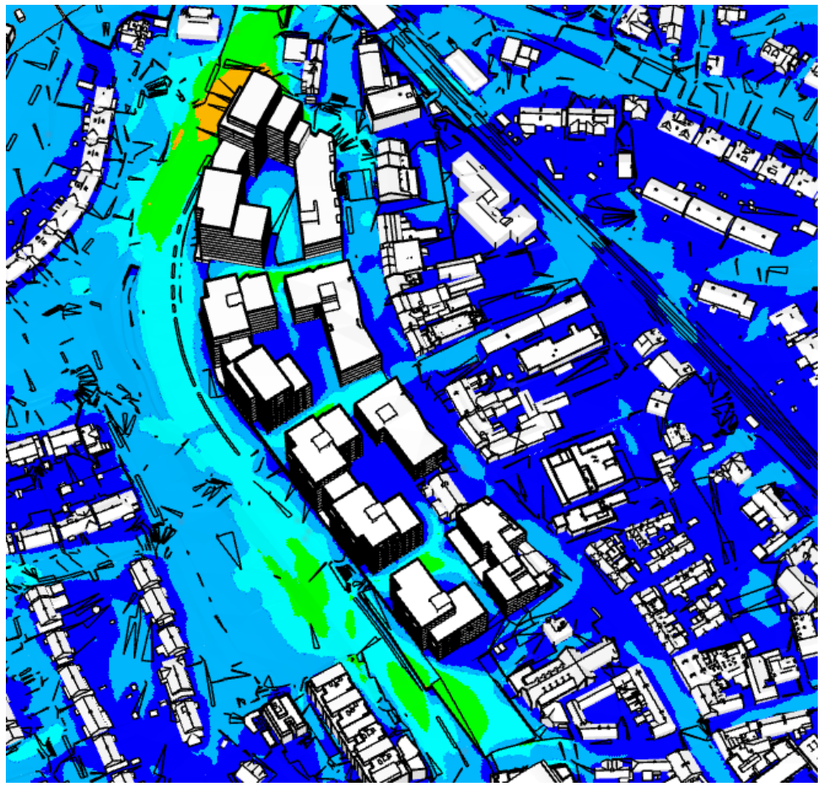

Fig 1.1 – Lawson Criteria Results across Proposed Development

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, however, the particular site location at Dundrum is identified, which is an area relatively sheltered on a macro level, on the outskirts of the Dublin City area.

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 "Urban Terrain (z_0=0.4m 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 Dundrum, Dublin 14. 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.

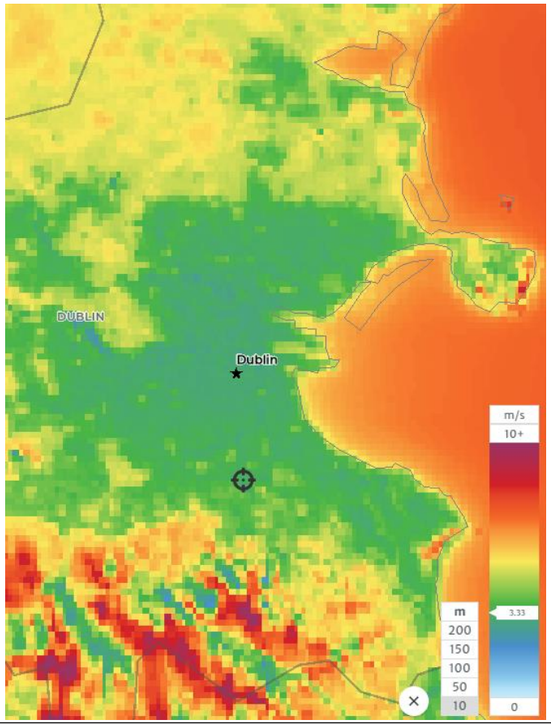

Fig 2.1.1 – Mean Wind Speeds across Dublin – Global Wind Atlas

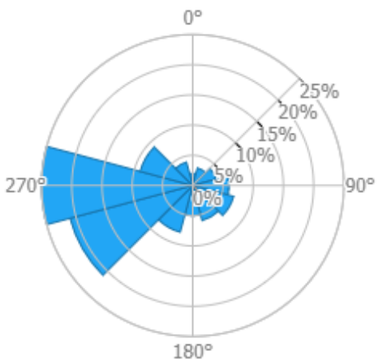

Fig 2.1.2 – Wind Frequency Rose for Dundrum – Global Wind Atlas

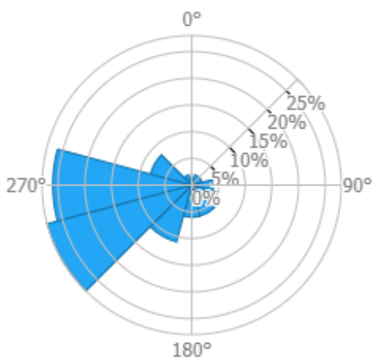

Fig 2.1.3 – Wind Speed Rose for Dundrum – Global Wind Atlas

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 simulations form the basis of the Pedestrian Wind Comfort Analysis undertaken, which is described in detail 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 W/ 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)).

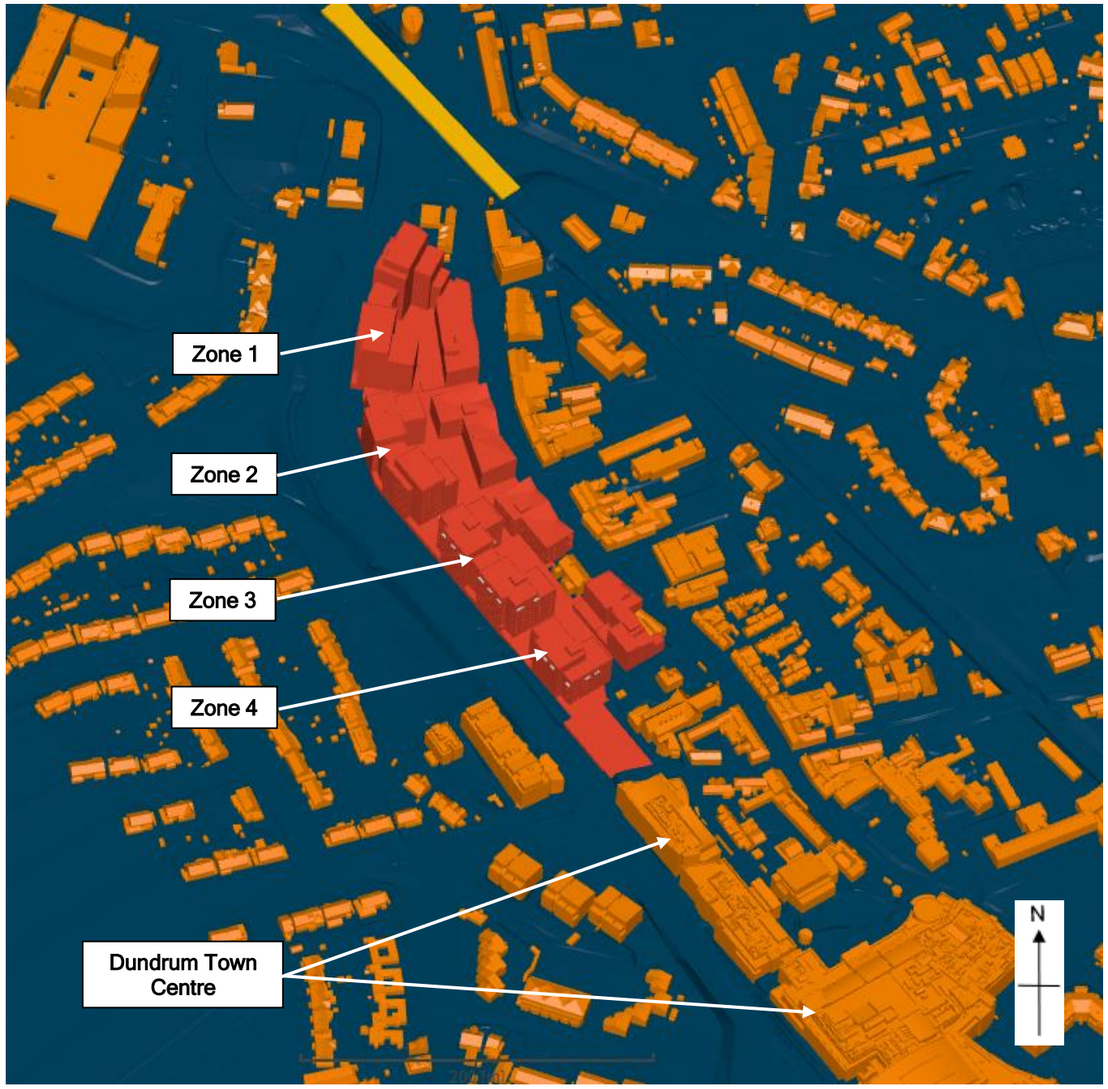

Fig 2.1.4 – 3D Model of Proposed Dundrum Development and Neighbouring buildings

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

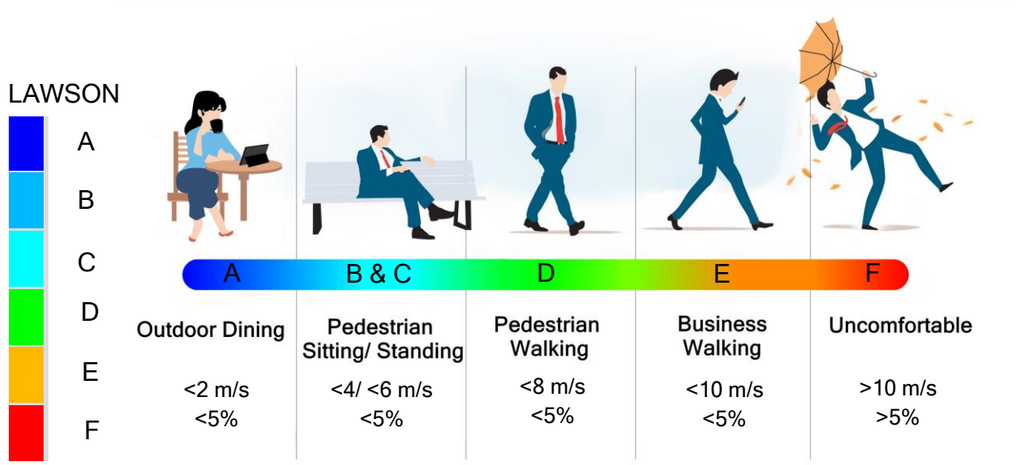

Fig 2.2.2 Lawson Scale

2.0 Methodology

2.3 Climate Change

Whilst extreme weather events including storms/ infrequent high wind conditions are envisaged to become more commonplace, the Lawson Methodology assesses average wind conditions throughout the whole year and these are projected to decrease in spring/ summer and autumn, whilst remaining the same in winter.

Fig 2.3.1 provides further discussion of this from Met Éireann - Climate Change.

Therefore, the results as presented for predicted microclimatic wind conditions and associated pedestrian comfort provide a conservative assessment accounting for future climate change conditions.

Wind Energy and Storm Tracks:

Studies have shown significant projected decreases in the energy content of the wind for the spring, summer and autumn seasons, with the projected decreases largest for summer and no significant trend in winter. The overall number of North Atlantic cyclones is projected to decrease by approximately 10 %. Results also indicate that the paths of extreme storms will extend further south, bringing an increase in extreme storm activity over Ireland, although the number of individual storms is projected to be quite small [2]. As extreme storm events are rare, the storm-tracking research needs to be extended. Future work will focus on analysing a larger ensemble, thus allowing a robust statistical analysis of extreme storm track projections.

Fig 2.3.1 Met Éireann –Climate Change

3.0 Wind Analysis

3.1 Wind Analysis Results

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

Wind velocities within the enclosed courtyards of the proposed development are predicted to be relatively benign, due to the sheltering provided by the building massing.

The results illustrate some acceleration of winds around the corners of the proposed development, as well as between the buildings of Zones 2 and 3. However, this is not determined to be excessive.

No adverse wind conditions such as excessive wind acceleration or wind tunnelling were predicted to occur as a result of the proposed building massing or site layout. The proposed buildings in Zones 1+2, 2+3 and 3+4 have been spaced a distance enough apart so as to avoid adverse wind effects such as wind tunnelling.

These CFD simulations form the basis of the Pedestrian Comfort Analysis undertaken for the occupied pedestrian zones at Ground Level, roof terraces, and balconies, which is described in detail in Section 4.0 below.

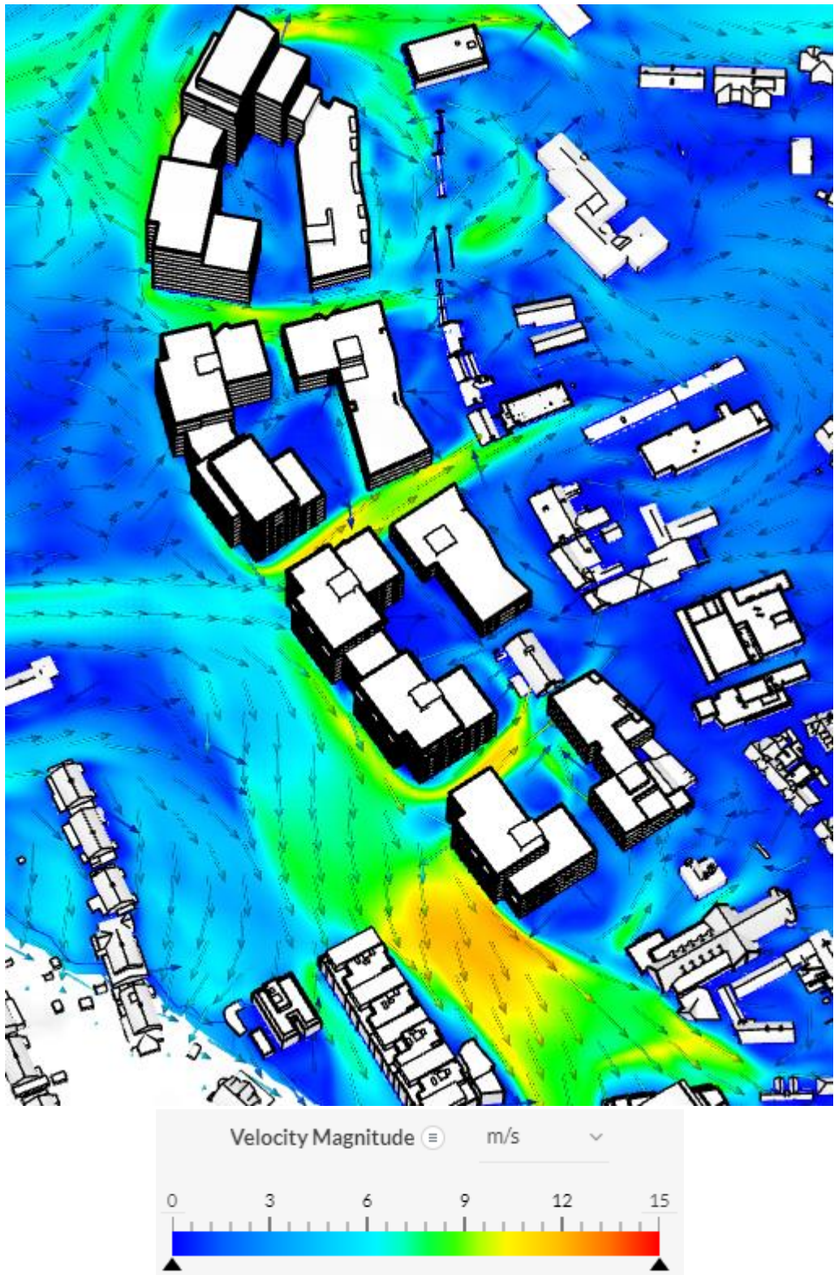

Fig. 3.1 - Wind Velocity at 10m above Ground Level

4.0 Pedestrian Comfort

4.1 Ground Level Results

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 relative height above ground level.

Figure 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 at ground level vary throughout the site.

The communal courtyard amenity spaces within Zones 2 and 3 were determined to be particularly pleasant from a wind and pedestrian comfort perspective, suitable for “Outdoor Dining” in accordance with the Lawson Criteria methodology utilised. These spaces would be well suited to café/restaurant seating areas or similar long term seated amenity use.

Zones 1 and 4 have been deemed to be predominantly suitable for “Pedestrian Sitting/ Standing”, as illustrated by light blue/ cyan contours.

The proposed pedestrian links between Zones 1 and 2 and Zones 3 and 4 were determined by the methodology to be suitable for “Pedestrian Walking”, and therefore well to their intended use.

To the North of Zone 1, the surrounding streets were predicted to experience somewhat accelerated wind conditions, more suited to “Business Walking”. This region is described in more detail in Section 4.2.

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. 4.1.1 – Lawson Criteria

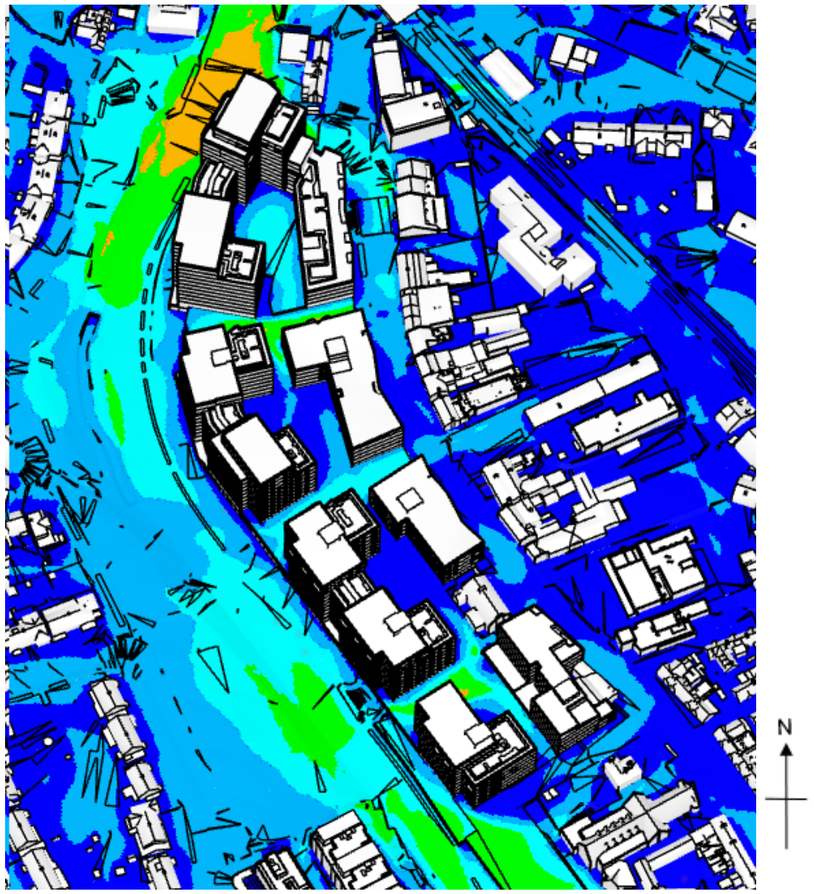

Fig. 4.1.2 – Lawson Criteria Results at 1.5m Above Ground Level

4.0 Pedestrian Comfort

4.2 Zone 1 Results

Figure 4.2.2 illustrates results of pedestrian comfort results at ground level within the vicinity of Zone 1 of the proposed development.

Simulations and subsequent analysis have identified Zone 1 as an area where winds have potential to be accelerated around corner and down the face of the West-facing facades of the buildings. This would result in regions suitable for “Business Walking” in accordance with the Lawson Criteria methodology utilised. It may be noted that these wind conditions are not determined to be uncomfortable or unsafe.

However, these potentially accelerated wind speeds are predicted to occur along the R117 Dundrum Bypass Road, therefore not impacting a pedestrianised area.

All existing pedestrian footpaths and public transit stations (Dublin Bus and LUAS) are located outside of this zone of orange contours.

Building entrances have been located away from this zone of orange contours to ensure comfortable entrance and egress from the building by pedestrians.

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. 4.2.1 – Lawson Criteria

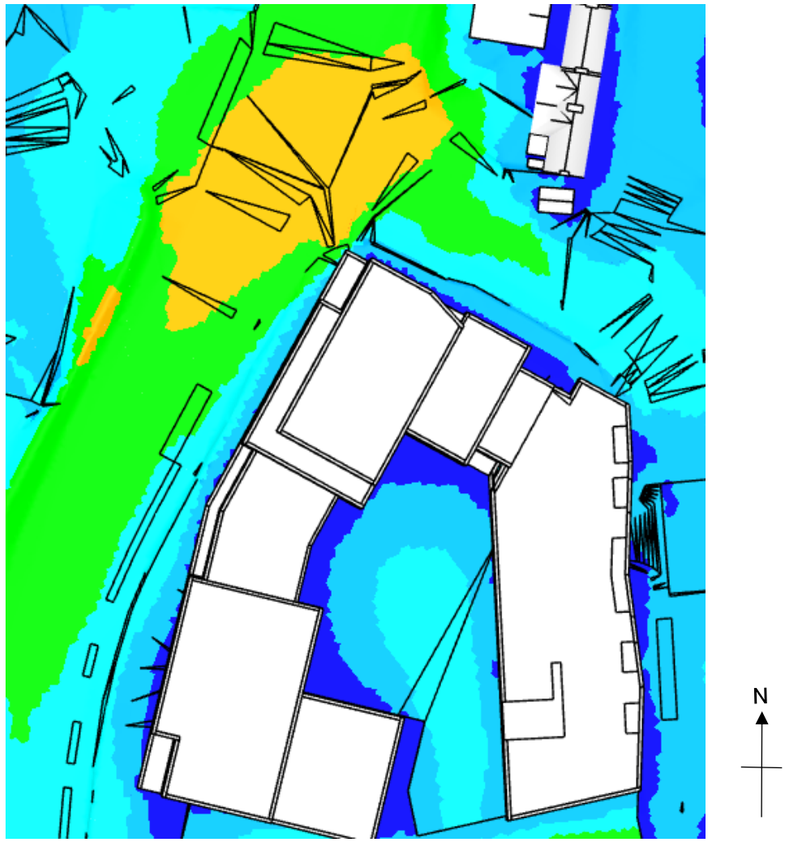

Fig. 4.2.2 – Lawson Criteria Results at Zone 1 of Proposed Dundrum Development

4.0 Pedestrian Comfort

4.3 Roof Terrace Level Results

Figure 4.3.2 illustrates results of pedestrian comfort results at roof terrace levels across the development. All roof terrace levels intended to be accessible to occupants have been analysed.

Roof terraces across the development are predominantly determined by the Lawson methodology utilised to be suitable for “Pedestrian Sitting/Standing” (light blue/ cyan contours).

Mitigation measures were required at roof terrace levels within Zone 1, to improve wind conditions in these areas. The proposed landscaping design by NMP Landscape Architecture includes wind mitigation measures in the form of wind screening and wind tolerant planting, which minimises potential excess wind speeds at roof terraces.

All roof terrace spaces have a considerable portion of their area deemed to be suitable for “Outdoor Dining/ Sitting” (blue contours). Therefore, the roof terrace levels analysed are predicted to be suitable for their intended use as amenity spaces.

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. 4.2.1 – Lawson Criteria

Fig. 4.2.2 – Lawson Criteria Results at Roof Terrace Levels

4.0 Pedestrian Comfort

4.4 Balcony Level Results

All balconies throughout the development were assessed for pedestrian comfort utilising the Lawson Criteria, at 1.5m above the height of each balcony. This height is representative of standing height in accordance with best practice guidelines.

Fig 4.4.2 illustrates Lawson results for balconies at the upper floor levels of Building 1A. This building is 16 storeys tall and is the tallest building within the proposed development, therefore these balconies are representative of the "worst-case scenario" for balconies within the proposed development.

The analysis determined these balconies, and all others across the proposed development, to be suitable for "Outdoor Dining" (dark blue contours" or "Pedestrian Sitting/ Standing" (light blue/ cyan contours) as defined within the methodology, and therefore well suited to their intended use as private amenity spaces.

No incidences of unsuitable wind conditions were predicted for balconies across Zones 1, 2, 3, or 4. All balconies across the proposed development were predicted by the Lawson Criteria methodology to be subject to similar or improved pedestrian comfort conditions as those illustrated in Fig 4.4.2 and 4.4.3.

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

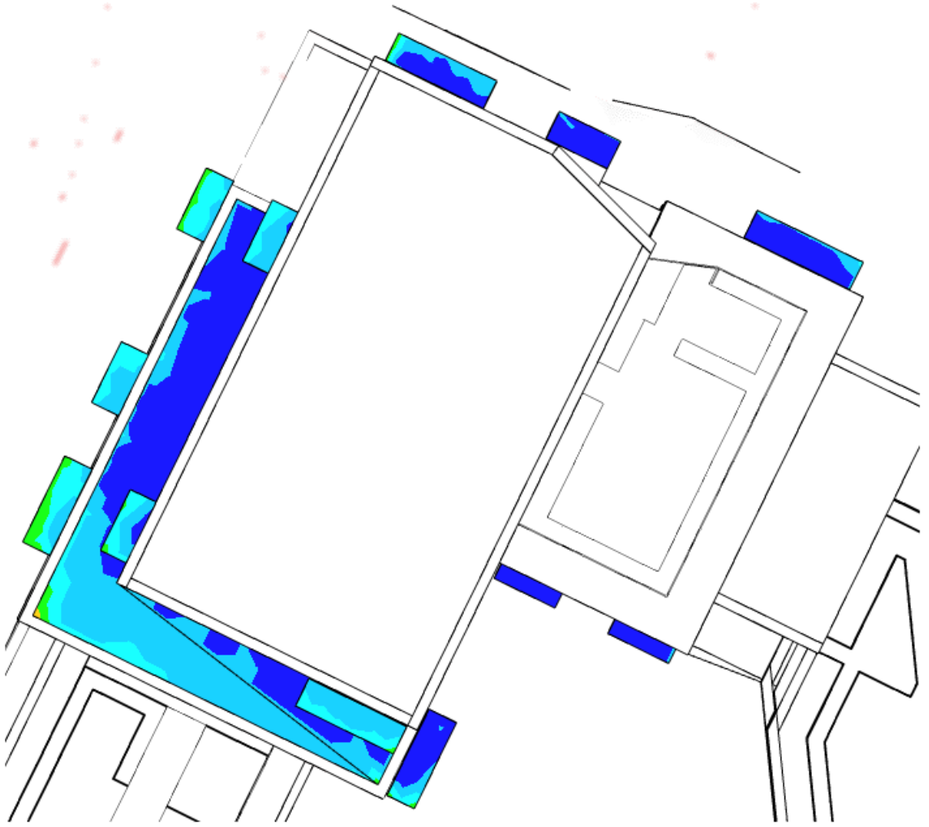

Fig. 4.4.2 – Plan View of Lawson Criteria Results at Upper Level Balconies of Building 1A

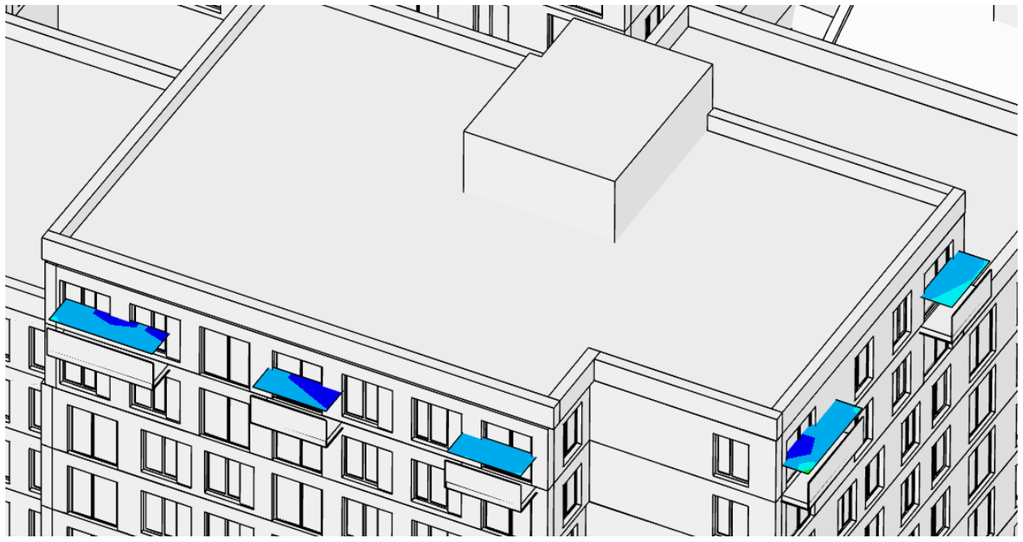

Fig. 4.4.3 – Lawson Criteria Results at 10th Floor Balconies of Building 3B

4.0 Pedestrian Comfort (Cont'd)

4.4 Balcony Level Results (Cont'd)

Further to the above results, it may be noted that balconies at the corner of the West façade of Building 1A are determined to have some of their area more suitable for "Pedestrian Walking" (green contours). The above assessment results shown in Fig 4.4.2 are at a height of 1.5m, which is standing height.

Fig 4.4.3 illustrates assessment results at 1m above each balcony, which is representative of sitting height.

When assessed at this height, all balconies were determined to have all their area suitable for "Outdoor Dining" (dark blue contours) or "Pedestrian Sitting" (light blue contours). These balconies are therefore suitable for long term seated amenity use at sitting height. Balconies are more sheltered at 1m height, due to the sheltering effect of the 1100mm balustrade surrounding each balcony.

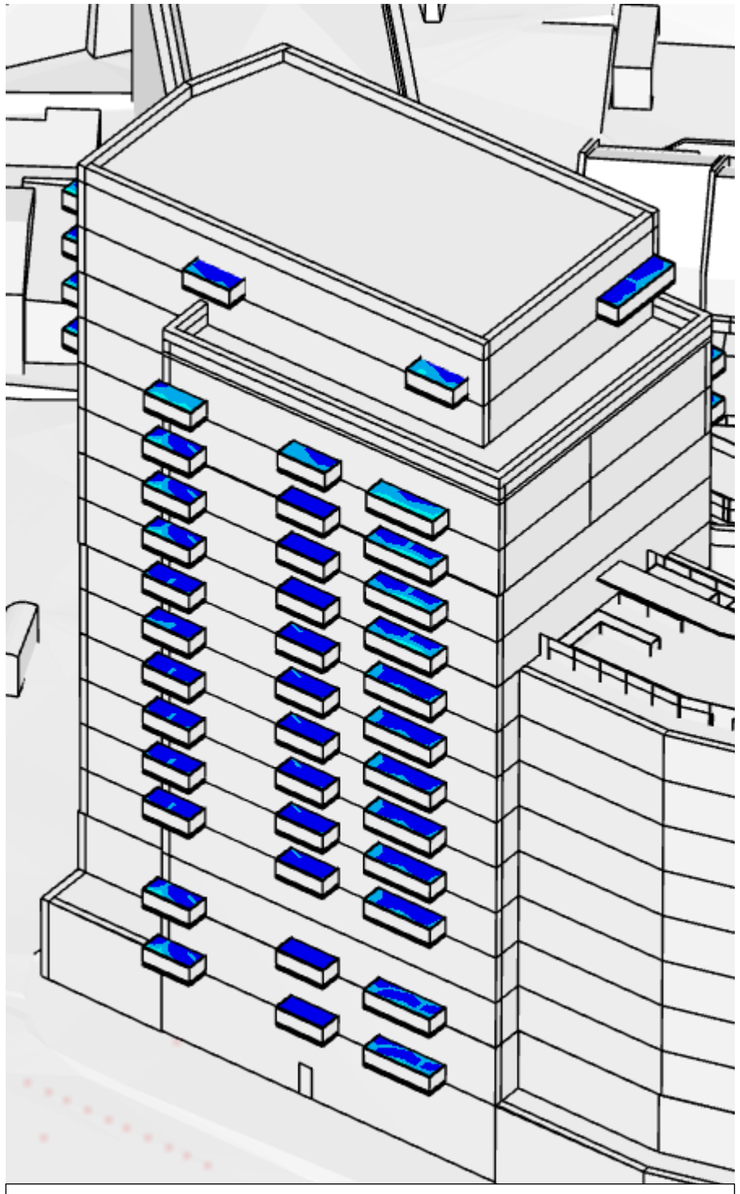

Fig. 4.4.3 – Plan View of Lawson Criteria Results at Balconies on West Façade of Building 1A

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