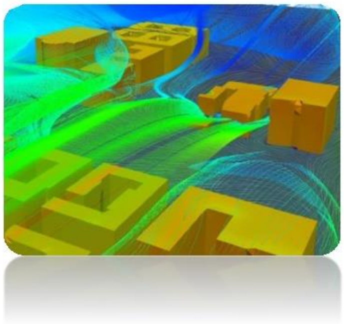 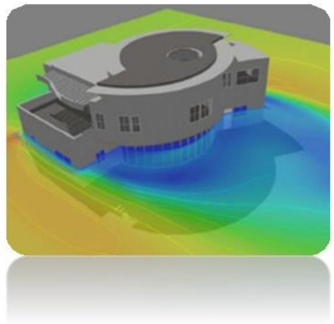 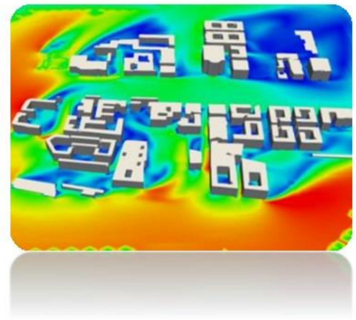

WIND MICROCLIMATE MODELLING

Baldoyle LRD Development

Dublin 13

Prepared by: B-Fluid Ltd.| Buildings Fluid Dynamics Consultants

For: CWPA Planning & Architecture

B-Fluid
Buildings Fluid Dynamics

<table>
<tr><th colspan="3">Document Reference</th></tr>
<tr><td>Project Name</td><td colspan="2">WIND MICROCLIMATE MODELLING
Baldoyle LRD Development</td></tr>
<tr><td>Project Ref.</td><td colspan="2">W_2309484</td></tr>
<tr><td>Site location</td><td colspan="2">Grange Road, Dublin 13</td></tr>
<tr><td>CFD Study by</td><td colspan="2">B-Fluid Ltd.</td></tr>
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Contents

1. EXECUTIVE SUMMARY

B-Fluid Limited has been commissioned by 'CWPA Planning & Architecture' to perform a Wind Microclimate Study for the Baldoyle LRD Development in Grange Road, Dublin 13.

The site is bounded to the north by Myrtle Road and existing residential development, by Grange Road to the south separating the subject site with Baldoyle Industrial Estate, by Longfield Road and Beshoff Motors Car Dealers to the east and an educational facility currently under construction on lands adjoining the west of the subject site.

Figure 1.1 shows a view of the proposed development (colored in orange) in the existing urban context.

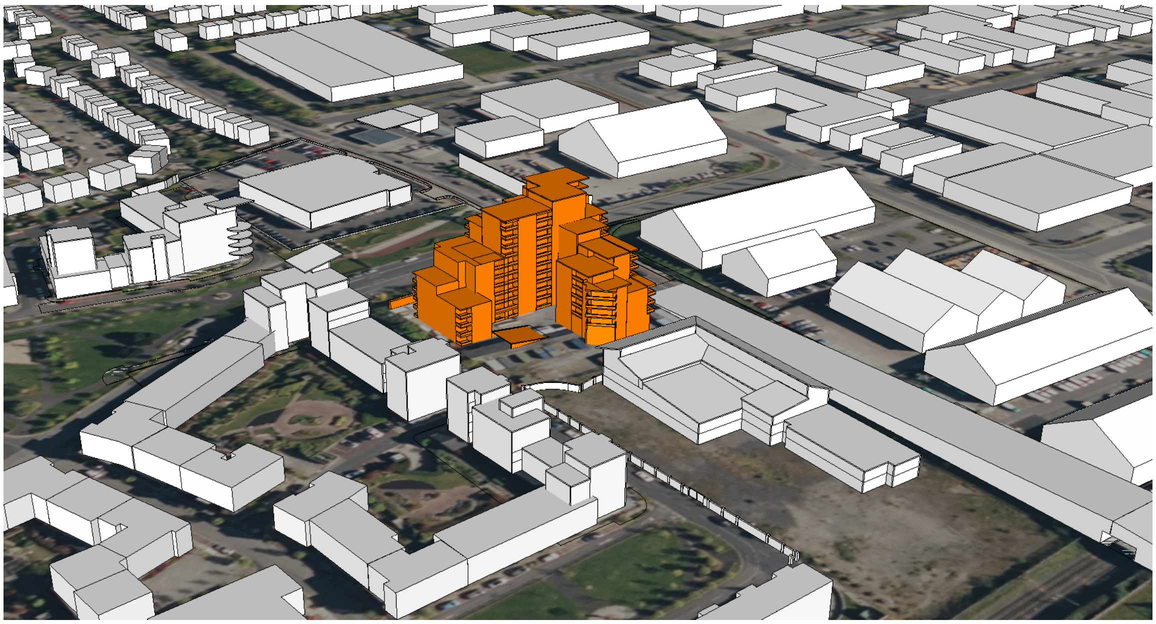


Figure 1.1: Proposed Baldoyle LRD Development

The method for the study of wind microclimate combines the use of Computational Fluid Dynamics (CFD) to predict wind velocities and wind flow patterns, with the use of wind data from suitable meteorological station and the recommended comfort and safety standards (Lawson Criteria).

The effect of the geometry, height and massing of the proposed development and existing surroundings including topography, ground roughness and landscaping of the site, on local wind speed and direction is considered as well as the pedestrian activity to be expected (sitting, standing, strolling and fast walking).

The results of the assessment are presented in the form of contours of the Lawson criteria at pedestrian level.

The assessment has comprised the following scenarios:

- **Baseline Existing Scenario**: this consist of the existing wind microclimate at the site. Figure 1.2 shows a view of the existing surrounding buildings (in white).

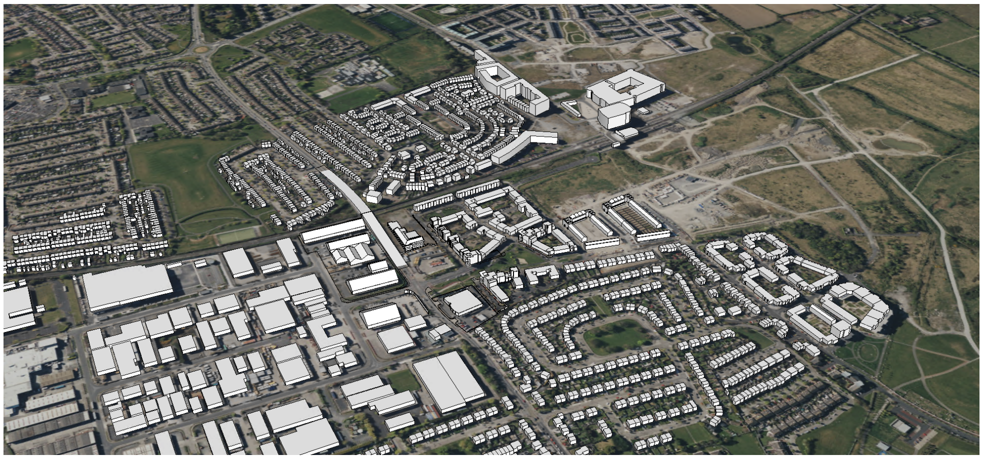


Figure 1.2: Buildings in the Baseline Scenario (Existing buildings in white)

- **Proposed Development Scenario**: this consist of the assessment of the wind microclimate of the site with the proposed development surrounded by existing buildings. Figure 1.3 shows a view of the buildings in the proposed development (colored in orange) and existing surrounding buildings (in white).

Figure 1.3: Buildings in the Proposed Scenario (Baldoyle LRD in orange, existing buildings in white)

- **Cumulative Scenario**: this consist of the assessment of the wind microclimate of the site with the proposed development surrounded by existing and permitted buildings. Figure 1.4 shows buildings within the cumulative scenario which include the buildings in the proposed development, existing surrounding buildings, and the buildings that are not yet built (colored in blue).

Figure 1.4: Buildings in the Cumulative Scenario (Baldoyle LRD in orange, existing buildings in white, cumulative buildings in blue)

Based on the analysis conducted, it can be concluded that:

- The wind profile was built using the annual average of meteorology data collected at Dublin Airport Weather Station purchased from Meteoblue. The local wind speed was determined from CFD simulations with combination of the parameters inside Weibull probability distribution function, which obtained form historical meteorological data recorded 10m above ground level at Dublin Airport.

- A 12-discrete set of wind direction is used in order to evaluate the probability of exceedance at any given threshold speed. It is found that the prevailing wind direction in the west has the largest contribution of the discomfort exceedance probability.

- Microclimate Assessment of Baldoyle LRD Development and it's environment was performed utilizing a CFD (Computational Fluid Dynamics) methodology.

- The assessment of the proposed scenario has shown that the proposed development meets the Lawson Comfort Criteria where no area is unsafe, and no conditions of distress are created by the proposed development. All the ground amenities proposed can be used for their intended scope. The wind microclimate of the proposed development is comfortable and usable for pedestrians.

- Results of wind speeds and Lawson map at 1.5m above the terrace show that these areas are appropriate for the intended use. Most of the terraces are suitable for standing and sitting. Terraces 1 and 3 are suitable for walking. However, wind conditions at all terraces are within tenable conditions. It is important to note that fluctuations in velocity on rooftop terraces can result in door slamming problems. Therefore, the installation of door actuators is strongly recommended to mitigate the potential issue and to ensure smooth operating of the terrace doors.

- As a result of the proposed development construction, the wind on the surrounding urban context remains suitable for the intended use when compared with the baseline situation.

- The proposed development does not impact or give rise to negative or critical wind speed profiles at the nearby adjacent roads, or nearby buildings. Moreover, in terms of distress, no critical conditions were found for “Frail persons or cyclists” and for members of the ”General Public” in the surrounding of the development.

- As a result of the construction of cumulative buildings in the future, the wind conditions on the surrounding urban context remains the same when compared with the proposed development situation. The cumulative buildings will have a negligible effect on the surrounding wind microclimate.

Therefore, the CFD study carried out has shown that under the assumed wind conditions typically occurring within Dublin for the past 15 years:

- **The development is designed to be a high-quality environment for the scope of use intended of each areas/building (i.e. comfortable and pleasant for potential pedestrian), and,**
- **The development does not introduce any critical impact on the surrounding buildings, or nearby adjacent roads.**

2. INTRODUCTION

B-Fluid Limited has been commissioned by 'CWPA Planning & Architecture' to perform a Wind Microclimate Study for the Baldoyle LRD Development in Grange Road, Dublin 13.

Figure 2.1 shows a view of the existing surrounding buildings (in white). Figure 2.2 shows a view of the buildings in the proposed development (colored in orange) and existing surrounding buildings (in white). Figure 2.3 shows buildings within the cumulative scenario which include the buildings in the proposed development, existing surrounding buildings, and the buildings that are not yet built (colored in blue).

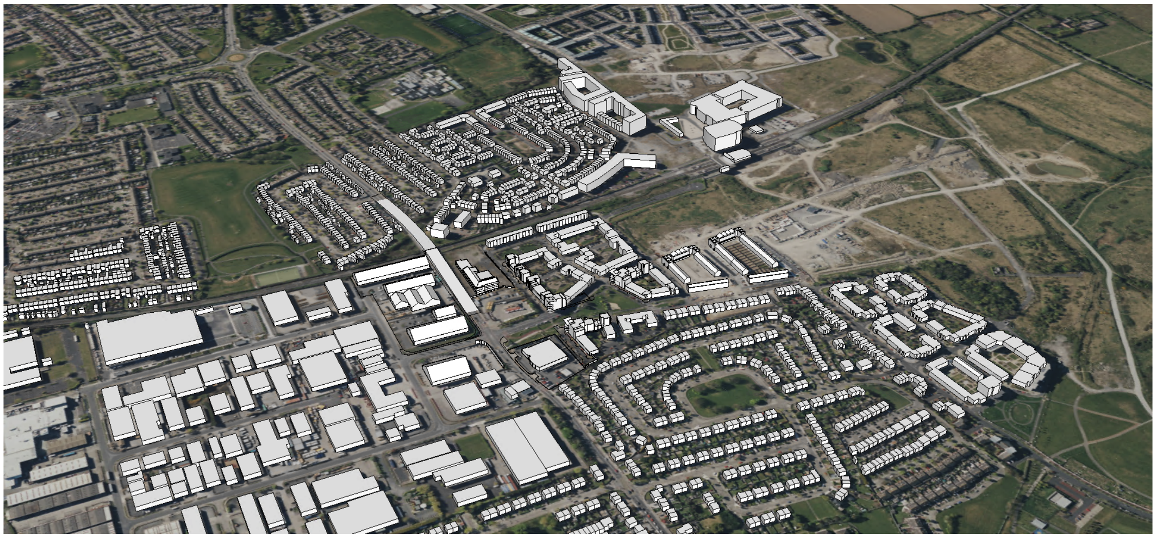


Figure 2.1: Buildings in the Baseline Scenario (Existing buildings in white)

Figure 2.2: Buildings in the Proposed Scenario (Baldoyle LRD in orange, existing buildings in white)

Figure 2.3: Buildings in the Cumulative Scenario (Baldoyle LRD in orange, existing buildings in white, cumulative buildings in blue)

This report is completed by Dr. Cristina Paduano, Dr. Arman Safdari and Dr. Chino Uzoka.

Dr. Cristina Paduano is a Chartered Engineer (CEng) and member of Engineers Ireland who specialises in computational fluid dynamics applications for urban environment and the construction industry with over 18 years experience. She holds a PhD in Mechanical Engineering from Trinity College Dublin, with M.Eng and B.Eng in Aerospace Engineering.

Dr. Arman Safdari is a member of Engineers Ireland and CFD Modelling Engineer who specialises in computational fluid dynamics applications. He is an expert in airflow modeling, heat and mass transfer and multi-phase flow simulations. He holds a PhD in Mechanical Engineering from Pusan National University, a M.Sc. and B.Sc. in Mechanical Engineering.

Dr. Yuxiang Zhang is a member of Engineers Ireland and CFD Engineer who specialises in flow-structure interactions and bridge aerodynamics. He holds a PhD in Civil Engineering from University College Dublin, a M.Sc. in Structural Engineering and a B.Eng in Civil Engineering.

A wind microclimate study considers the possible wind patterns formed under both mean and peak wind conditions typically occurring on the site area, accounting for a scenario where the proposed development is inserted in the existing environment (potential impact) and, for a scenario where the proposed development is analysed together with the existing environment and any permitted development (not constructed yet) that can be influenced by the wind patterns generated by the proposed one (cumulative impact).

The potential receptors include those areas, in the surrounding of the development, which can be exposed to potential risks generated by the elevated wind speed or building massing wind effects. In particular:

- Amenity areas (pedestrian level), areas likely to be utilised for leisure purposes and as such should be comfortable surroundings.
- Pedestrian routes and seating areas – to determine if locations are comfortable for leisure activities.
- Entrance to the buildings – to determine if there is potential for pressure related issues for entrances or lobbies.
- Landscaped areas – where there are sheltered areas.
- Impact to existing or adjoining developments – where the proposed buildings will cause discomfort conditions through proximity related issues.

The acceptance criteria which define the acceptable wind velocities in relation to the perception of comfort level experienced while carrying out a specific pedestrian activity is known as the "Lawson Criteria for Pedestrian Comfort and Distress". A wind microclimate study analyses the wind flow in an urban context (considering the wind conditions typically occurring on the site during a typical year) to develop the so called "Lawson Comfort and Distress Map"; the map identifies where a specific pedestrian activity can be carried out comfortably during most of the time.

The assessment can be performed by physical testing in wind tunnels or by performing "virtual wind tunnel testing" through numerical simulation using Computational Fluid Dynamics (CFD), as done for this project. The scope of the numerical study is to simulate the wind around the development, in order to predict the wind speeds the pedestrians will be exposed to and the level of comfort they will experience when carrying out a specific activity (i.e. walking, strolling, sitting).

The following sections details the methodology, acceptance criteria, CFD wind simulations and the impact of the proposed development on the local wind microclimate against best practice guidelines for pedestrian comfort and safety.

2.1 GUIDANCE and LEGISLATION

According to the 'Urban Development and Building Heights, Guidelines for Planning Authorities (Government of Ireland, December 2020)' document, specific wind impact assessment of the microclimatic effects should be performed for 'buildings taller than prevailing building heights in urban areas'. In the same guidance, standard buildings height is considered 6-8 storeys. Above this height, buildings are considered 'taller' for Dublin standards.

The recommended approach to wind microclimate studies is outlined in the "Wind Microclimate Guidelines for Developments in the City of London '(August 2019) and in the guidelines and recommendations contained in BRE Digest (DG) 520, "Wind Microclimate Around Buildings" (BRE, 2011). The Lawson Criteria of Comfort and Distress is used to benchmark the pedestrian wind microclimate.

The document also indicates how to use Computational fluid dynamics (CFD) to assess wind microclimate conditions and how to generate high quality outputs to provide a good understanding of the fundamental flow features around an urban context.

Usually, the recommended approach to wind microclimate studies is based on the building height, as presented in Figure 2.4.

Building Height	Recommended Approach to Wind Microclimate Studies
Similar or lower than the average height of surrounding buildings **Up to 25m**	Wind studies are not required, unless sensitive pedestrian activities are intended (e.g. around hospitals, transport hubs, etc.) or the project is located on an exposed location
Up to double the average height of surrounding buildings **25m to 50m**	Computational Fluid Dynamics (CFD) Simulations **OR** Wind Tunnel Testing
Up to 4 times the average height of surrounding buildings **50m to 100m**	Computational Fluid Dynamics (CFD) Simulations **AND** Wind Tunnel Testing
High Rise **Above 100m**	Early-Stage Massing Optimization: Wind Tunnel Testing **OR** Computational Fluid Dynamics (CFD) Simulations Detailed Design: Wind Tunnel Testing **AND** Computational Fluid Dynamics (CFD) Simulations

Figure 2.4: Recommended Approach to Wind Microclimate Studies based on Building Height, as prescribed by the Wind Microclimate Guidelines for Developments in the City of London (August 2019)

2.2 URBAN WIND EFFECTS

Buildings and topography affect the speed and direction of wind flows. Wind speed increases with increasing height above the ground, assuming a parabolic profile.

Flow near the ground level encounters obstacles represented by terrain roughness/buildings that reduce the wind speed and introduce random vertical and horizontal velocity components. This turbulence causes vertical mixing between the air moving horizontally at one level, and the air at those levels immediately above and below it. For this reason, the wind velocity profile is given by a fluctuating velocity along a mean velocity value. Figure 2.5 shows the wind velocity profile, as described above.

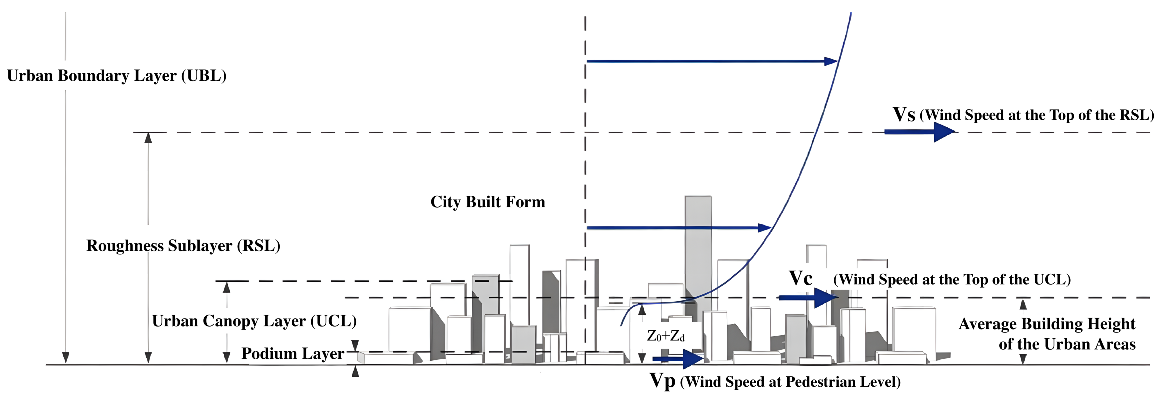


Figure 2.5: Wind Velocity Profile

In an urban context, wind speeds at pedestrian level are generally low compared with upper-level wind speeds, however, the wind can create adverse patterns when flowing in between buildings which can cause local wind accelerations or re-circulations. This wind patterns effect pedestrian safety and comfort. In general, the wind effects to be avoided/mitigated in an urban context include the following:

- **Funnelling Effects**: The wind can accelerate significantly when flowing through a narrow passage between building structures. The highest speeds are experienced at the point where the restriction of the area is the greatest.

- **Downwash Effects**: The air stream when striking a tall building can flow around it, over it and a part can be deflected towards the ground. This downward component is called downwash effect and its intensity depends on the pressure difference driving the wind. The higher the building, the higher this pressure difference can be.

- **Corner Effects**: Wind can accelerate around the corners of the buildings. Pedestrians can experience higher wind speeds as well as more sudden changes in wind speeds. The reason for this is that there are narrow transition zones between the accelerated flows and the adjacent quiescent regions. This effect is linked to the downwash effect as the downward stream component subsequently flows around the corners towards the leeward side of the building.

- **Wake Effect**: Excessive turbulence can occur in the leeward side of the building. This can cause sudden changes in wind velocity and can raise dust or lead to accumulation of debris. This effect is also dependent on the height of the building.

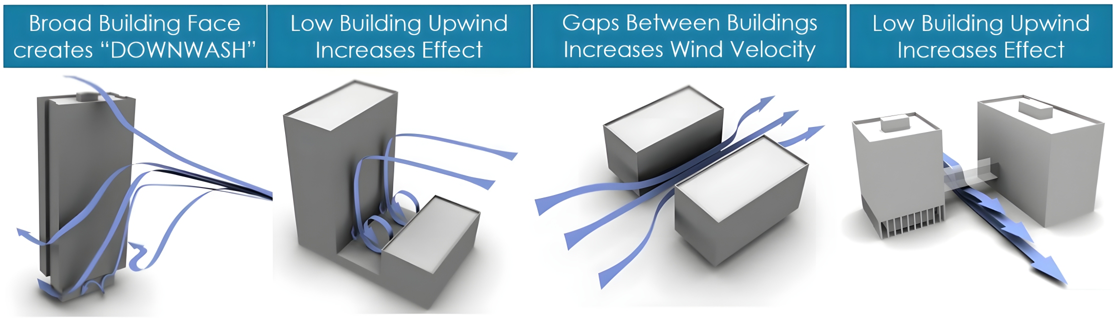


Figure 2.6: Parameters to know for Wind Conditions Assessment

The anticipation of the likely wind conditions resulting from new developments are important considerations in the context of pedestrian comfort and the safe use of the public realm. While it is not always practical to design out all the risks associated with the wind environment, it is possible to provide local mitigation to minimise risk or discomfort where required.

3. ASSESSMENT METHODOLOGY

3.1 METHOD OF ASSESSMENT

The method for the study of wind microclimate combines the use of Computational Fluid Dynamics (CFD) to predict wind velocities and wind flow patterns, with the use of wind data from suitable meteorological station and the recommended comfort and safety standards (Lawson Criteria). The effect of the geometry, height and massing of the proposed development and existing surroundings including topography, ground roughness and landscaping of the site, on local wind speed and direction is considered as well as the pedestrian activity to be expected (sitting, standing, strolling and fast walking). The results of the assessment are presented in the form of contours of the Lawson criteria at pedestrian level.

The assessment has comprised the following scenarios:

- **Baseline Existing Scenario**: this consist of the existing wind microclimate at the site.

- **Proposed Development Scenario**: this consist of the assessment of the wind microclimate of the site with the proposed development surrounded by existing buildings.

- **Cumulative Scenario**: this consist of the assessment of the wind microclimate of the site with the proposed development surrounded by existing and permitted buildings.

In accordance with the guideline cited in section 1.1, the wind microclimate study should consider the effect of the proposed development together with buildings (existing and/or permitted) that are within 800m from the centre of the site, as shown in Figure 3.1. Other taller buildings outside of this zone that could have an influence on wind conditions within the project site should be included for wind directions where they are upwind of the project site.

Figure 3.1: Area of interest to be modelled

In particular, the following has been undertaken:

- Topography of the site with buildings (proposed and adjacent existing/permitted developments massing, depending on the scenario assessed “baseline, proposed or cumulative”) have been modelled using OpenFOAM Software.

- Suitable wind conditions have been determined based on historic wind data. Criteria and selected wind scenarios included means and peaks wind conditions that need to be assessed in relation to the Lawson Criteria.

- Computational Fluid Dynamics (CFD) has been used to simulate the local wind environment for the required scenarios (‘baseline, proposed, cumulative”).

- The impact of the proposed development massing on the local wind environment has been determined (showing the wind flows obtained at pedestrian level).

- Potential receptors (pedestrian areas) have been assessed through review of external amenity/public areas (generating the Lawson Comfort and Distress Map).

- Potential mitigation strategies for any building related discomfort conditions (where necessary) have been explored and their effect introduced in the CFD model produced.

3.2 ACCEPTANCE CRITERIA

Pedestrian Wind Comfort is measured in function of the frequency of wind speed threshold exceeded based on the pedestrian activity. The assessment of pedestrian level wind conditions requires a standard against which measured or expected wind velocities can be compared.

Only gust winds are considered in the safety criterion. These are usually rare events, but deserve special attention in city planning and building design due to their potential impact on pedestrian safety. Gusts cause the majority of cases of annoyance and distress and are assessed in addition to average wind speeds. Gust speeds should be divided by 1.85 and these "gust equivalent mean" (GEM) speeds are compared to the same criteria as for the mean hourly wind speeds. This avoids the need for different criteria for mean and gust wind speeds.

The following criteria are widely accepted by municipal authorities as well as the international building design and city planning community:

- DISCOMFORT CRITERIA: Relates to the activity of the individual.
  Onset of discomfort:
  - Depends on the activity in which the individual is engaged and is defined in terms of a mean hourly wind speed (or GEM) which is exceeded for 5% of the time.

- DISTRESS CRITERIA: Relates to the physical well-being of the individual.
  Onset of distress:
  - 'Frail Person Or Cyclist': equivalent to an hourly mean speed of 15 m/s to be exceeded more than 0.023% per year. This is intended to identify wind conditions which less able individuals or cyclists may find physically difficult. Conditions in excess of this limit may be acceptable for optional routes and routes which less physically able individuals are unlikely to use.
  - 'General Public': A mean speed of 20 m/s or larger speed to be exceeded more than 0.023% per year, when aerodynamic forces approach body weight makes it impossible for anyone to remain standing. If wind speeds exceed these values, pedestrian access should be discouraged.

The above criteria set out six pedestrian activities and reflect the fact that calm activity requires calm wind conditions, which are summarised by the Lawson scale, shown in Figure 3.2. Lawson scale assesses pedestrian wind comfort in absolute terms and defines the reaction of an average person to the wind. Each wind type is associated to a number, corresponding to the Beaufort scale. Beaufort scale is an empirical measure that relates wind speed to observed conditions at sea or on land. A 20% exceedance is used in these criteria to determine the comfort category, which suggests that wind speeds would be comfortable for the corresponding activity at least 80% of the time or four out of five days.

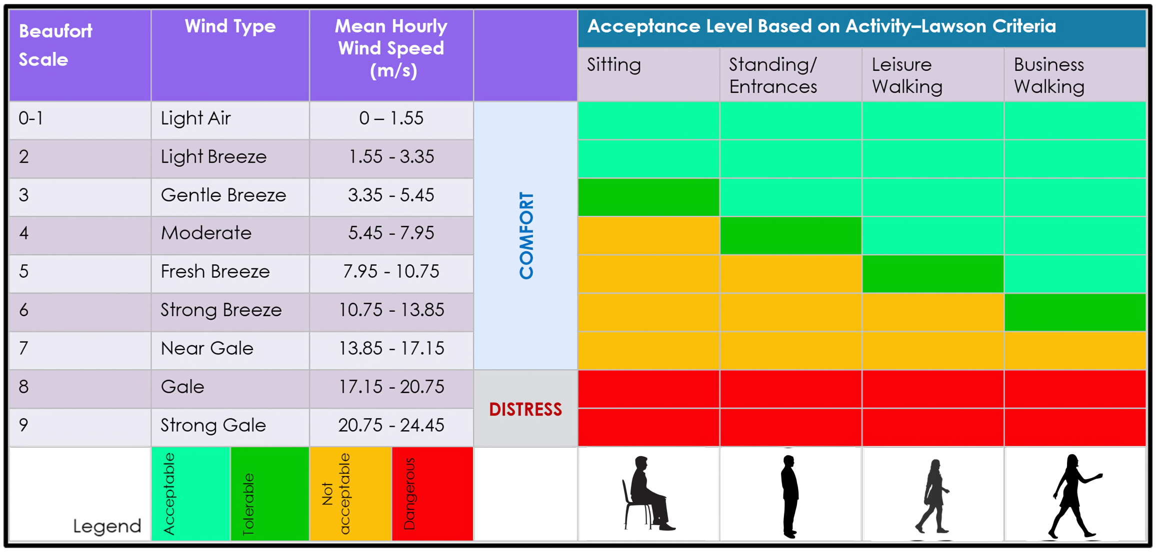


Figure 3.2: Lawson Scale

These criteria for wind forces represent average wind tolerances. They are subjective and variable depending on thermal conditions, age, health, clothing, etc. which can all affect a person's perception of a local microclimate. Moreover, pedestrian activity alters between winter and summer months. The criteria assume that people will be suitably dressed for the time of year and individual activity. It is reasonable to assume, for instance, that areas designated for outdoor seating will not be used on the windiest days of the year. Weather data measured are used to calculate how often a given wind speed will occur each year over a specified area.

Pedestrian comfort criteria are assessed at 1.5m above ground level. Unless in extremely unusual circumstances, velocities at pedestrian level increase as you go higher from ground level.

A breach of the distress criteria requires a consideration of:

- whether the location is on a major route through the complex,
- whether there are suitable alternate routes which are not distressful.

If the predicted wind conditions exceed the threshold, then conditions are unacceptable for the type of pedestrian activity and mitigation measure should be implemented into the design.

Pedestrian Comfort Category (Lawson Scale)	Mean and Gem wind speed not to be exceeded more than 5% of the time	Description
Long-Term Sitting	4m/s	Acceptable for frequent outdoor sitting use, i.e., restaurant /café
Standing	6m/s	Acceptable for occasional outdoor sitting use, i.e., public outdoor spaces
Walking/Strolling	8m/s	Acceptable for entrances/bus stops /covered walkaways
Business Walking	10m/s	Acceptable for external pavements, walkways
Unacceptable/Distress	>10m/s	Start of not comfortable/distress level for pedestrian access

Figure 3.3: Lawson Categories Scale - Comfort

Pedestrian Safety Category (Lawson Scale)	Mean and Gem wind speed not to be exceeded more than 0.0022% of the time	Description
Unsafe for public	>20m/s	Distress/safety concern for pedestrian
Unsafe for cyclists or frail person	>15m/s	Distress/safety concern for cyclist/frail person

Figure 3.4: Lawson Categories Scale - Distress/Safety

If the predicted wind conditions exceed the threshold, then such condition is unacceptable for the type of pedestrian activity required and mitigation measures should be implemented into the design.

3.3 SIGNIFICANCE CRITERIA

The significance of on-site measurement locations are defined by comparing the wind comfort/safety levels with the intended pedestrian activity at each location, using the table provided by the Lawson Comfort and Distress Criteria.

The significance of off-site measurement locations are defined by comparing the wind comfort/safety levels with the intended pedestrian activity at each location, prior and after the introduction of the proposed development.

Significance	Trigger	Mitigation required?
Major Adverse	Conditions are “unsafe”	Yes
Moderate Adverse	Conditions are “unsuitable” (in terms of comfort) for the intended pedestrian use.	Yes
Negligible	Conditions are “suitable” for the intended pedestrian use.	No
Moderate Beneficial	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	No

Figure 3.5: Significance Criteria for On-site Receptors

Significance	Trigger	Mitigation required?
Major Adverse	Conditions that were "safe" in the baseline scenario became "unsafe" as a result of the Proposed Development. *OR* Conditions that were "suitable" in terms of comfort in the baseline scenario became "unsuitable" because of the Proposed Development. *OR* Conditions that were "unsafe" in the baseline scenario are made worse because of the Proposed Development.	Yes
Moderate Adverse	Conditions that were "suitable" in terms of comfort in the baseline scenario are made windier (by at least one comfort category) as a result of the Proposed Development but remain "suitable" for the intended pedestrian activity.	No
Negligible	Conditions remain the same as in the baseline scenario.	No
Major Beneficial	Conditions that were "unsafe" in the baseline scenario became "safe" because of the Proposed Development.	No
Moderate Beneficial Potential Receptors	Conditions that were "unsuitable" in terms of comfort in the baseline scenario became "suitable" because of the Proposed Development. *OR* Conditions that were "unsafe" in the baseline scenario are made better as a result of the Proposed Development (but not so as to make them "safe".	No

Figure 3.6: Significance Criteria for Off-site Receptors

4. CFD MODELLING METHOD

4.1 INTRODUCTION OF CFD TECHNIQUE

Computational Fluid Dynamics (CFD) is a numerical technique to simulate fluid flow, heat and mass transfer, chemical reaction and combustion, multiphase flow, and other phenomena related to fluid flows. CFD modelling includes three main stage: pre-processing, simulation and post-processing as described in Figure 4.1. The Navier-Stokes equations, used within CFD analysis, are based entirely on the application of fundamental laws of physics and therefore produce extremely accurate results providing that the scenario modelled is a good representation of reality.

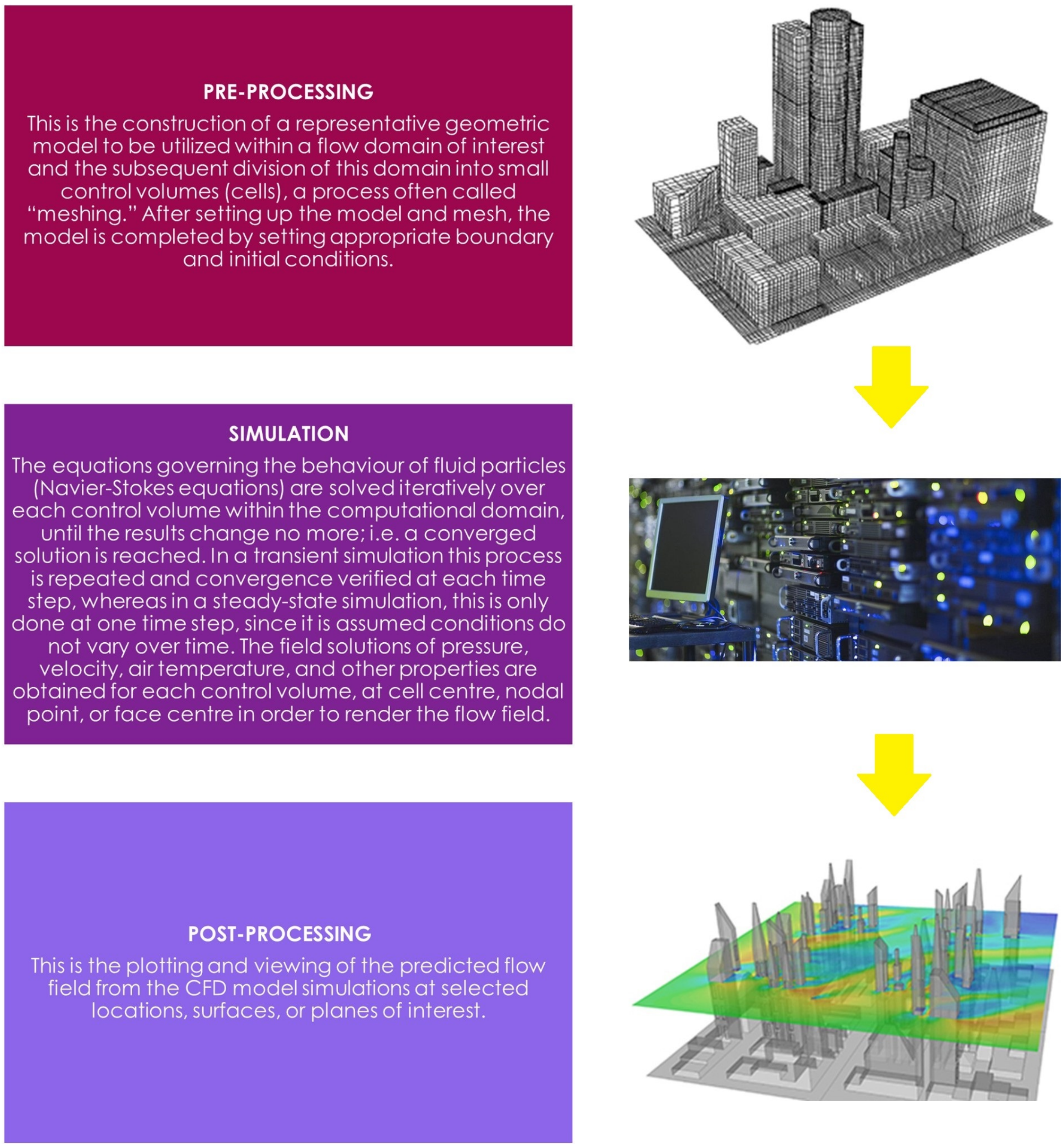


Figure 4.1: CFD Modelling Process Explanation

4.2 CFD SOFTWARE DETAILS

This report employs OpenFOAM Code, based on the concept of Reynolds-Averaged Navier-Stokes (RANS) formulations and the post-processing visualisation tool ParaView. OpenFOAM is a CFD software released and developed primarily by OpenCFD Ltd, since 2004. It has a large user base across most areas of engineering and science, from both commercial and academic organisations. OpenFOAM has an extensive range of features to solve anything from complex fluid flows involving chemical reactions, turbulence and heat transfer, to acoustics, solid mechanics and electromagnetics.

4.3 CFD MODEL DETAILS

PHYSICAL MODEL

In this study, the air flow is assumed to be incompressible, Newtonian, and statistically steady with temperature and gravity effects neglected. The flow is governed by the Reynolds-Averaged Navier–Stokes (RANS) formulation for mass and momentum where the turbulence is modeled using the k-ω SST turbulence model.

MODELED GEOMETRIES

The extent of the built area (e.g. buildings, structures or topography) that is represented in the numerical domain depends on the influence of the features on the region of interest. According to the Best Practice Guideline (COST Action 732), a building with height H (height of the proposed building is 27.5 m) may have a minimal influence if its distance from the region of interest is greater than 6-10H (we considered 500m which larger then 275m).

The modelled layout and dimensions of the surrounding environment are outlined in the table below (Table 4.1).

	MODELLED CFD ENVIRONMENT DIMENSIONS		
	Width	Length	Height
Computational Domain	Approx.1200m	Approx.1200m	Approx.160m

Table 4.1: Modelled Environment Dimensions

A 3D view of the proposed development massing model in the domain is presented in Figure 4.2. Geometries used in this study include two parts:

- The massing model of the proposed Baldoyle LRD (colored in orange), which is generated based on the DWG drawings provided by CWPA Planning & Architecture;
- The massing model of the building blocks within 500 m from the development (colored in grey).

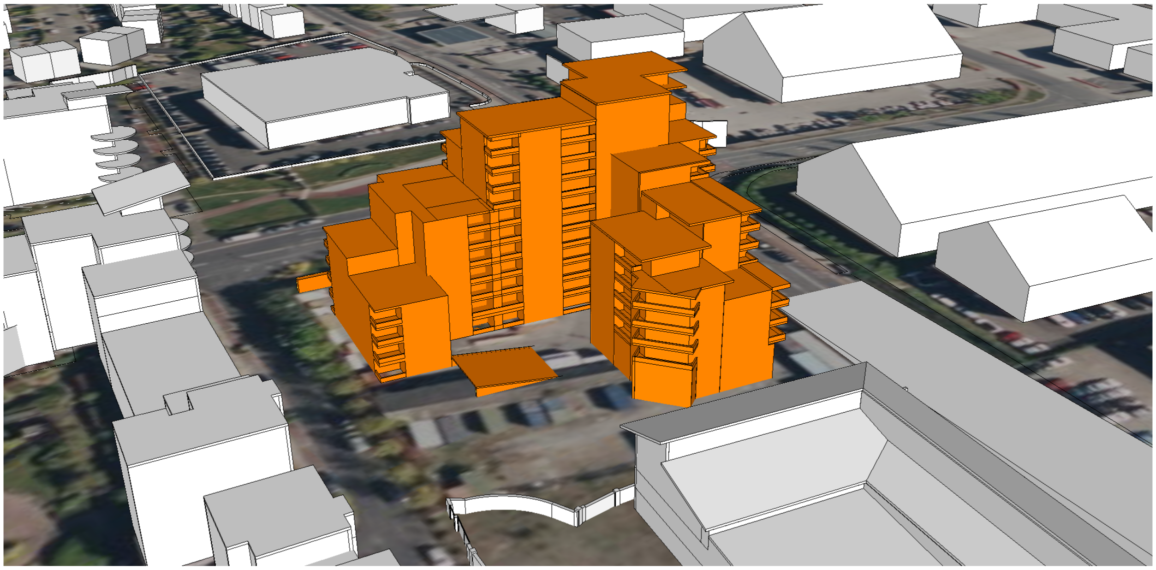


Figure 4.2: 3D View of the Massing Models of the Proposed Baldoyle LRD (colored in orange) and Surrounding Building Blocks (colored in grey)

COMPUTATIONAL MESH

The computational mesh used in this report is created using OpenFOAM utilities blockMesh and snappyHexMesh. It is a hybrid mesh containing a structured background grid and an unstructured hexahedron-dominated mesh in the near-wall region. The largest cell has a depth of 5 m, where the smallest has a depth of 0.15 m. The total cell count is approx. 65 million. An isometric view of the geometry captured by the computational mesh is shown in Figure 4.3.

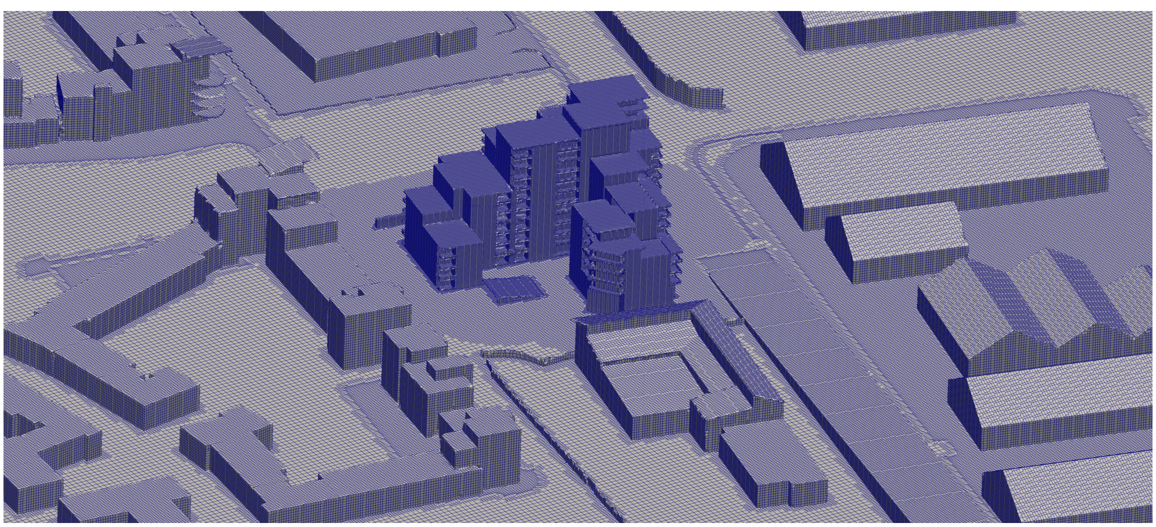


Figure 4.3: Computational Mesh of Baldoyle LRD

BOUNDARY CONDITIONS

For each wind directions, an initial wind velocity was set based on logarithmic wind profile. Surfaces within the model were specified as having 'no slip' condition. This boundary condition, ensures that flow moving parallel to a surface is brought to rest at the point where it meets the surface. All the other domain boundaries are set as "Open Boundaries".

The wind velocity data provided by the historical data collection and by the local data measuring are used in the formula below for the logarithmic wind profile to specify the wind velocity profile (wind velocity at different heights) to be applied within the CFD model:

$$u_{(z)} = \frac{u^{\star}}{K} \cdot ln(\frac{z+z_0}{z_0}) \tag{4.1}$$

where:

- $u_{(z)}$ = wind speed measured at the reference height z
- z = height to measure $u_{(z)}$
- z_0 = roughness length selected according to Eurocode
- $u^{\star}$ = friction velocity
- K = Karman constant

NUMERICAL CONFIGURATIONS

In this study, all simulations employ the SIMPLE algorithm to perform the pressure–velocity coupling (simpleFoam solver in OpenFOAM). All terms in the RANS equations are discretized using the nominally second-order cell-centred finite volume method, where gradient and Laplacian terms are discretized using Gaussian integration with linear interpolation. Convection/advection terms are discretized using a second-order accurate linear-upwind scheme.

Key parameters of the CFD model used in this wind microclimate study are summarised in Table 4.2.

Table 4.2: Key parameters of the CFD model for each wind scenarios

KEY PARAMETERS OF THE CFD MODEL	
Air Density (ρ)	1.2 kg/m^3
Turbulence Model	k-ω SST Model
Cell Size	Approx. 0.15 m at the development Approx. 0.3 m in the surroundings 5 m elsewhere
Background Mesh Ratio	ratio 1:1
Total Mesh Size	Approx. cell count = 65 million

5. LOCAL WIND CLIMATE

5.1 THE EXISTING RECEIVING ENVIRONMENT

In this chapter, wind impact has been assessed on the existing receiving environment considered the existing buildings and the topography of the site prior of the construction of the proposed development. A statistical analysis of 15 years historical weather wind data has been carried out to assess the most critical wind speeds, directions and frequency of occurrence of the same. The aim of this assessment has been to identify the wind microclimate of the area that may cause critical conditions for pedestrians comfort criteria.

Site Location And Surrounding Area

Baldoyle LRD Development will be situated in Grange Road, Dublin 13. The Existing Environment site is shown in Figure 5.1. The area considered for the existing environment and proposed development assessment comprises a 1km^2 area around the Baldoyle LRD Development as represented in Figure 5.2.

Figure 5.1: Baldoyle LRD Development Site Location and Existing Environment

Figure 5.2: Extents of Analysed Existing Environment Around Baldoyle LRD Development

Topography And Built In Environment

Figure 5.3 shows an aerial photograph of the terrain surrounding the construction site at Baldoyle LRD Development. The Baldoyle LRD Site is located in Dublin 13. Therefore, the area surrounding the site can be characterised as urban environment.

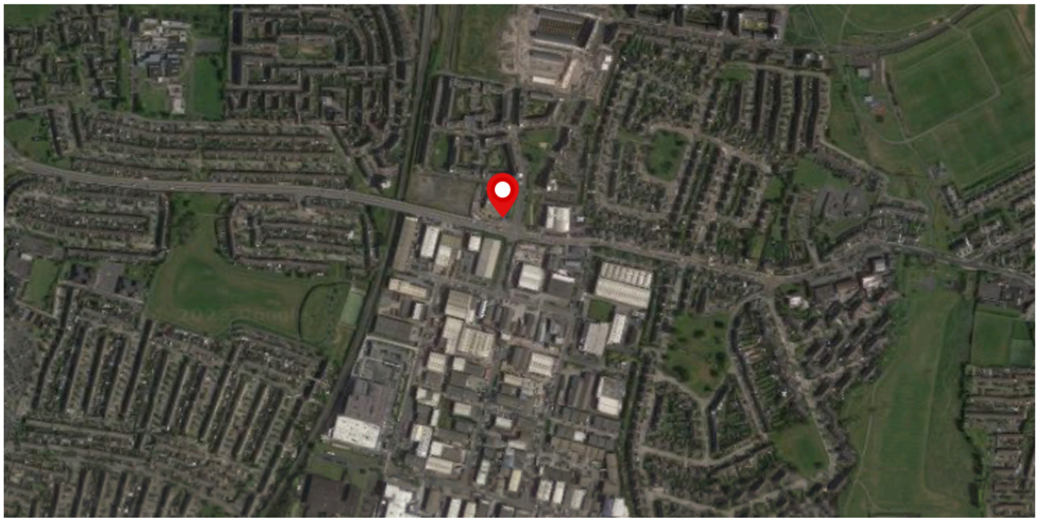


Figure 5.3: Built-in Environment Around Construction Site at Baldoyle LRD Development

5.2 LOCAL WIND CONDITIONS

This analysis considers the whole development being exposed to the typical wind condition of the site. The building is oriented as shown in the previous sections. The wind profile is built using the annual average of meteorology data collected at Dublin Airport Weather Station. Figure 5.4 shows on the map, the position of Baldoyle LRD Development and the position of Dublin Airport.

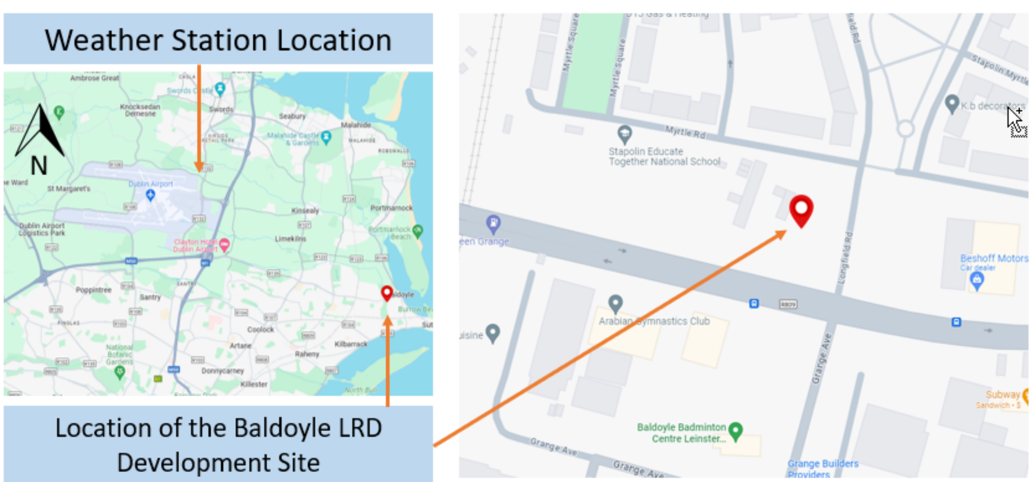


Figure 5.4: Map showing the position of Baldoyle LRD Development and Dublin Airport

Regarding the transferability of the available wind climate data, the following considerations have been made:

- *Terrain*: The meteorological station is located on the flat open terrain of the airport, whereas the development site is in an urban area with dense built-in structures including buildings of more than 10 m height in average and with some buildings even taller.

- *Mean Wind Speeds*: Due to the different terrain environment, the ground-near wind speeds (at pedestrian level) will be lower at the construction site compared to the meteorological station at the airport.

- *Wind Directions*: The landscape around the development site can in principle be characterized as flat terrain. Isolated elevations in the near area of the development should have no influence on the wind speed and wind directions. With respect to the general wind climate no significant influence is expected. Based on the above considerations it can be concluded that the data from the meteorological station at Dublin Airport are applicable for the desktop assessment of the wind comfort at the development site.

The assessment of the wind comfort conditions at the new development will be based on a discrete set of wind data throughout a year (annual wind statistic) provided by Meteoblue for Dublin airport meteological wind station. In this study, a 12-discrete set of wind direction is used in order to evaluate the probability of exceedance at any given threshold speed. A Weibull probability distribution is used to fit the given wind data into a continuous one for each wind direction. From Weibull distribution function, the probability, P, can be obtained for each wind direction by:

$$P = e^{(-\frac{U}{c})^k}$$

Where c is the scale parameter and k is the shape parameter for a wind speed U.

As stated above, the local wind climate is determined from historical meteorological data recorded at Dublin Airport. The data set analyzed for this assessment is based on the meteorological data associated with the maximum daily wind speeds recorded over a 15-year period between 2008 and 2022 at a weather station at the airport, which is located 10m above ground.

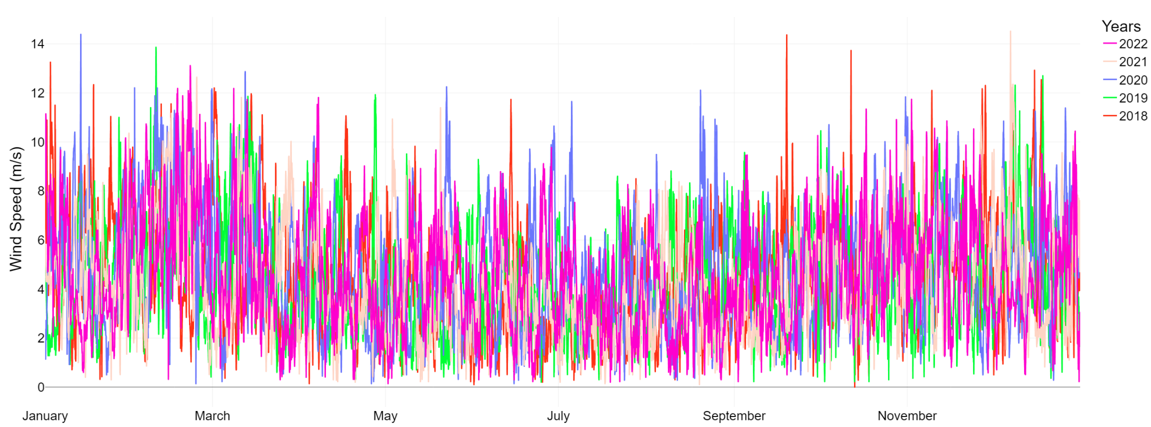


Figure 5.5: Local Wind Conditions - Wind Speed - 2008-2022

Figure 5.6, presenting the wind speed diagram for Dublin, shows the days per month, during which the wind reaches a certain speed. In Figure 5.7, the wind rose for Dublin shows the percentage of wind blows from the indicated direction. As shown in Figure 5.7, west is the prevailing wind direction. This implies that the largest contribution to the discomfort exceedance probability.

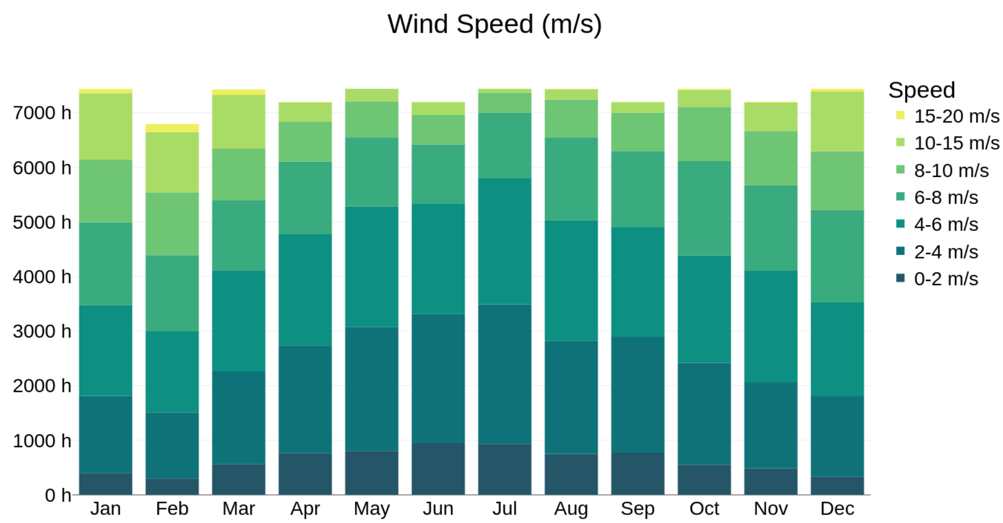


Figure 5.6: Dublin Wind Speed Diagram

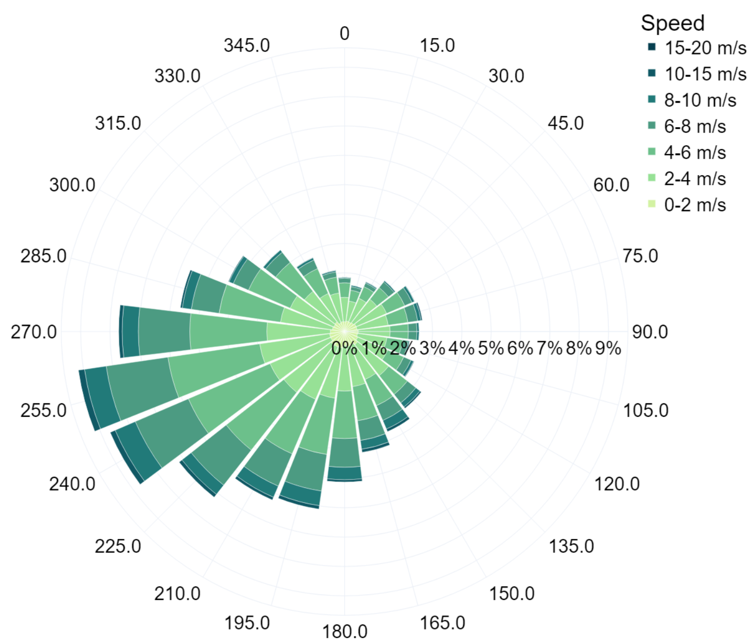


Figure 5.7: Dublin Wind Rose

Statistical analysis of the number of hours and magnitudes of wind is performed in order to indicate the pedestrian comfort and distress analysis as per Lawson Criteria. Each of the wind directions were interpolated to calculate the probability that a velocity threshold will be exceeded.

Based on the criterion of occurrence frequency, if the proposed site is exposed to a wind from a specific direction for more than 5 percent of the time, then the microclimate analysis should consider the impact of this wind (accounting for its direction and most frequent speed) on the local microclimate. In addition, seasonal changes were analysed in order to indicate the prevailing wind directions (Fig 5.8).

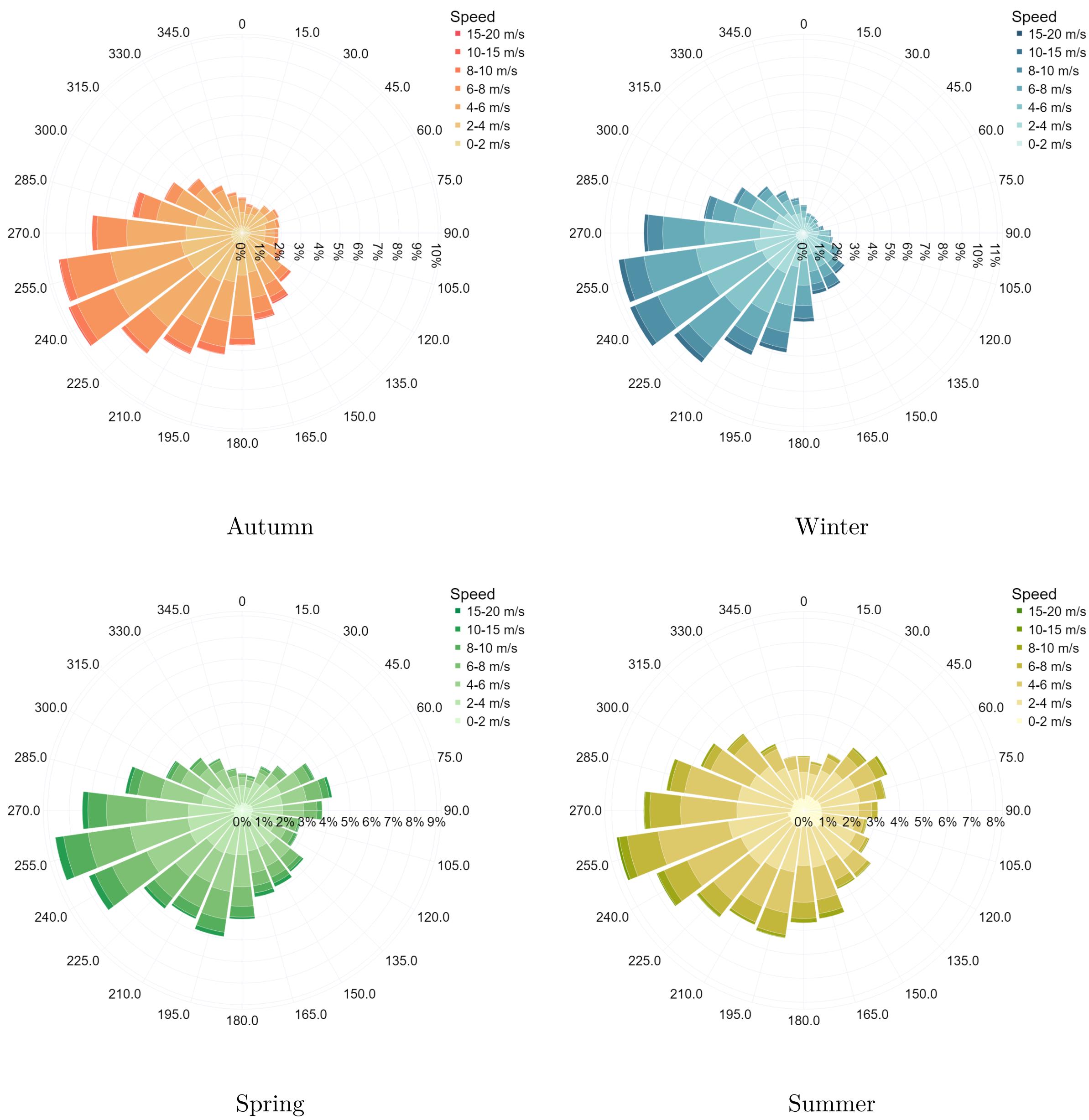


Figure 5.8: Wind speeds and wind directions at different seasons

6. CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

6.1 DESCRIPTION OF PROPOSED DEVELOPMENT

Rondesere Limited intends to apply for a Planning Permission for a Large-Scale Residential Development (LRD) on a site at Grange Road, Baldoyle, Dublin 13.

The site is bounded to the north by Myrtle Road and existing residential development, by Grange Road to the south separating the subject site with Baldoyle Industrial Estate, by Longfield Road and Beshoff Motors Car Dealers to the east and an educational facility currently under construction on lands adjoining the west of the subject site. The proposed Large-scale Residential Development consists of the following;

- Demolition of existing, single storey, storage structures on the subject site (c. 446.5 m2 GFA).
- The construction of a residential development (c. 15, 234.11 m2 GFA) comprising of 120 no. apartment units (15 no. studio units, 18 no. 1 bed units, 78 no. 2 bed units, 7 no. 3 bed units, 2 no. 4 bed penthouse units) within 1 no. block (ranging in height from 4 - 12 storeys over basement level).
- The construction of a basement to be accessed off Myrtle Road with provision of c. 47 no. car parking spaces, including accessible spaces, electric vehicle charging points and residential visitor parking.
- Addition of 2 no. crèche drop off car parking spaces at surface level.
- Provision of 360 no. 'long stay' residential bicycle parking spaces at basement level together with additional 60 no. visitor bicycle parking spaces in secure locations at surface level.
- All apartments are provided with private terraces / balconies.
- Provision of c. 1877 m2 of open space to serve the development including green roof garden terraces between 5th and 10th floor level.
- Provision of a childcare facility at ground floor level (c. 156.6 m2 GFA) with capacity in the order of 35 no. children and associated, secure, open play area (c. 117.1 m2).
- Provision of Café unit (c. 70 m2 GFA) at ground floor level with associated outdoor seating area.
- Provision of associated gymnasium at ground and first floor level (c. 273.12 m2).
- Provision of Multipurpose Room (c. 48 m2 GFA) and Residents Lounge (c. 20 m2) at first floor level.
- Total non-residential use is c. 567.72 m2 (3.73 % of overall development).
- The development will also provide for all associated ancillary site development infrastructure including: ESB sub-station, bike stores, bin stores, plant rooms, public lighting, new watermain connection and foul and surface water drainage; internal roads & footpaths; site landscaping, including boundary treatments; associated scheme signage, and all associated site development and excavation works above and below ground necessary to facilitate the development.

The application contains a statement setting out how the proposal will be consistent with the objectives of the Fingal Development Plan 2023-2029.

The Planning Application may be inspected or purchased at a fee not exceeding the reasonable cost of making a copy at the offices of the Planning Authority (Fingal County Council, Fingal County Hall, Main Street, Swords, Fingal, Co. Dublin) during its public opening hours. The application may also be inspected online at the following website set up by the applicant: www.baldoylelrd.ie

A submission or observation in relation to the application may be made in writing to the planning authority on payment of the prescribed fee (€20.00) within the period of 5 weeks beginning on the date of receipt by the authority of the application, and such submissions or observations will be considered by the planning authority in making a decision on the application. The planning authority may grant permission subject to or without conditions, or may refuse to grant permission.

Figure 6.1 shows a view of the buildings in the proposed development (colored in orange) and existing surrounding buildings (in white). Figure 6.2 shows buildings within the cumulative scenario which include the buildings in the proposed development, existing surrounding buildings, and the buildings that are not yet built (colored in blue).

Figure 6.1: Buildings in the Proposed Scenario

Figure 6.2: Buildings in the Cumulative Scenario

6.2 POTENTIAL RECEPTORS

Potential receptors for the wind assessment include on-site receptors and off-site receptors.

On-site receptors include:

- All pedestrian circulation routes, building entrances and leisure open areas on the ground. The pedestrian level is considered at 1.5m above ground. The on-site pedestrian-level receptor is highlighted in blue as shown in Figure 6.3.
- Roof terraces that are used for sitting/standing are also considered as receptors. These receptors are labeled and highlighted in blue as shown in Figure 6.4.

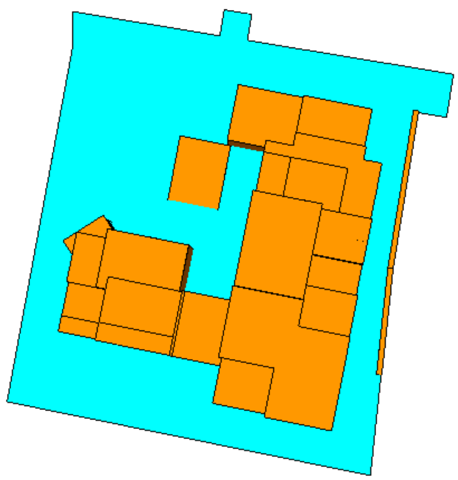


Figure 6.3: Proposed Baldoyle LRD Development - Potential Sensitive Receptors on the Ground Level - Pedestrian Activities Area (blue color)

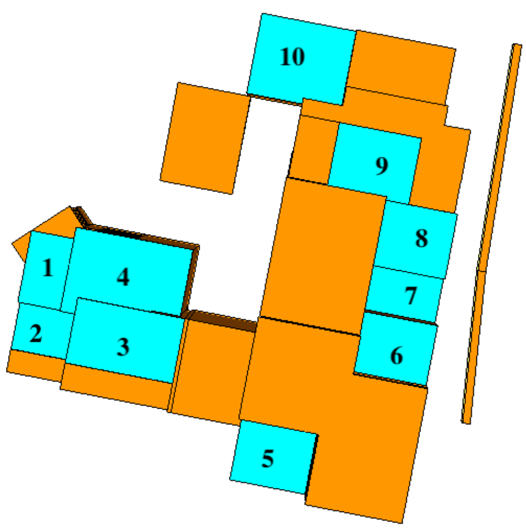


Figure 6.4: Potential Sensitive Receptors on Terraces (blue color)

Off-site receptors are labeled in Figure 6.5.

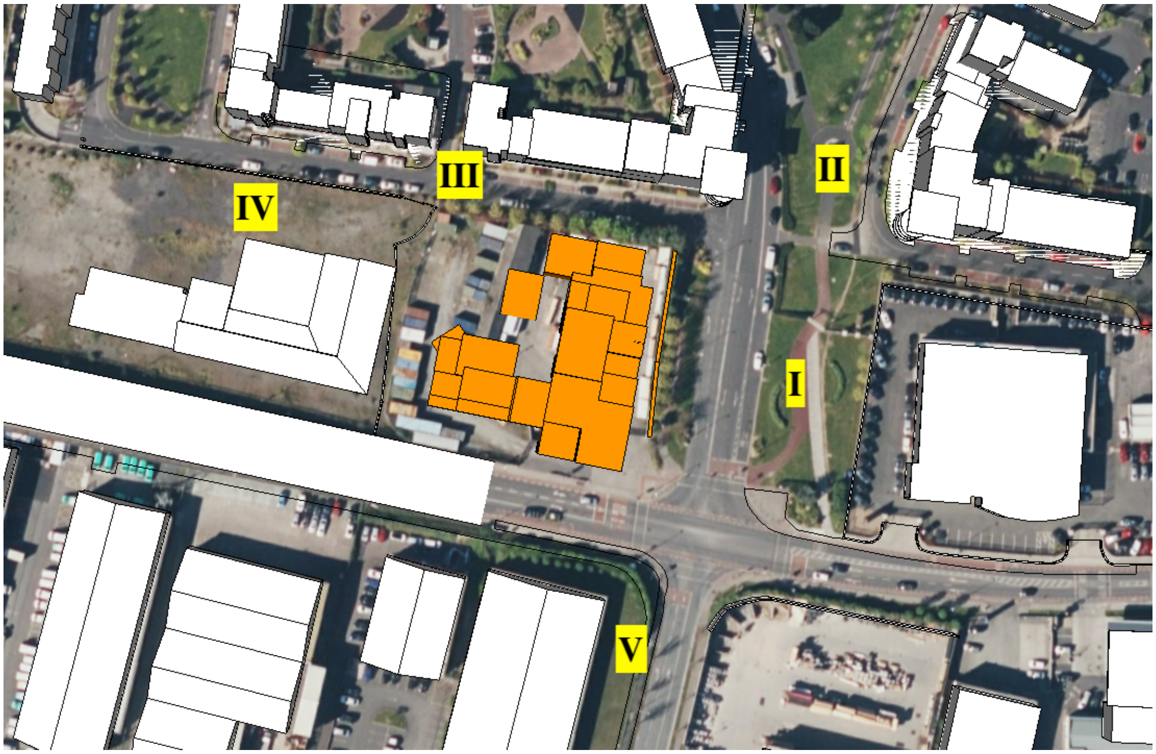


Figure 6.5: Potential Off-Site Receptors on the Ground

7. BASELINE WIND MICROCLIMATE

7.1 BASELINE SCENARIO

The wind microclimate of the baseline scenario is defined by the wind patterns that develop on the site and it's the surroundings (existing buildings and topography) under the local wind conditions relevant for the assessment of the Pedestrian Comfort and Distress.

In this scenario the assessment has considered the impact of wind on the existing area. Results of wind microclimate at pedestrian level (1.5m height - flow speeds) are collected throughout the modelled site. These flow velocities identify if locally, wind speeds at pedestrian-level are accelerated or decelerated in relation to the undisturbed reference wind speed due to the presence of the existing baseline environment.

The impact of these speeds are then combined with their specific frequency of occurrence and presented in the maps that show the area of comfort and distress in accordance with Lawson Criteria, these maps are produced at pedestrian level on the ground and identify the suitability of each areas to its prescribed level of usage and activity.

Figure 7.1: CFD Model of the Baseline Scenario

7.1.1 WIND SPEEDS - Pedestrian Level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the development ground are presented in Figures 7.2 to 7.13 in order to assess wind flows at ground floor level of Baldoyle LRD Development.

Wind flow speeds are shown to be within tenable conditions. Higher velocity and recirculation effects are found in the existing site.

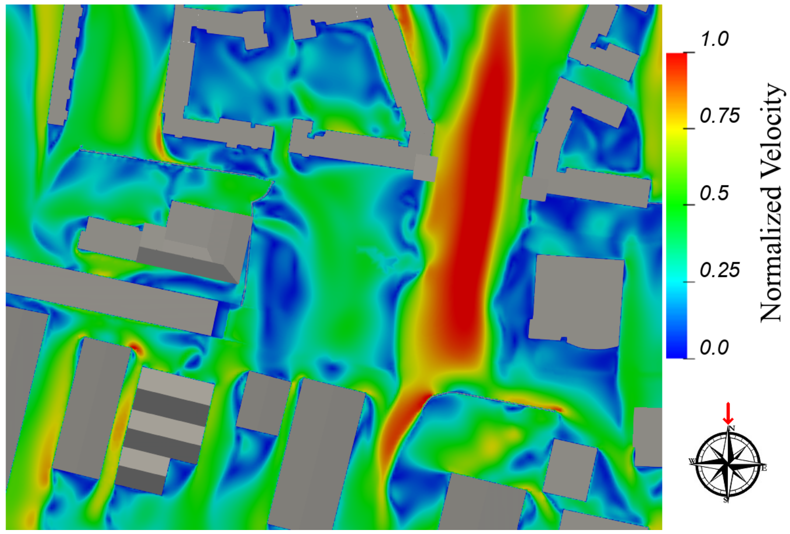


Figure 7.2: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 0°

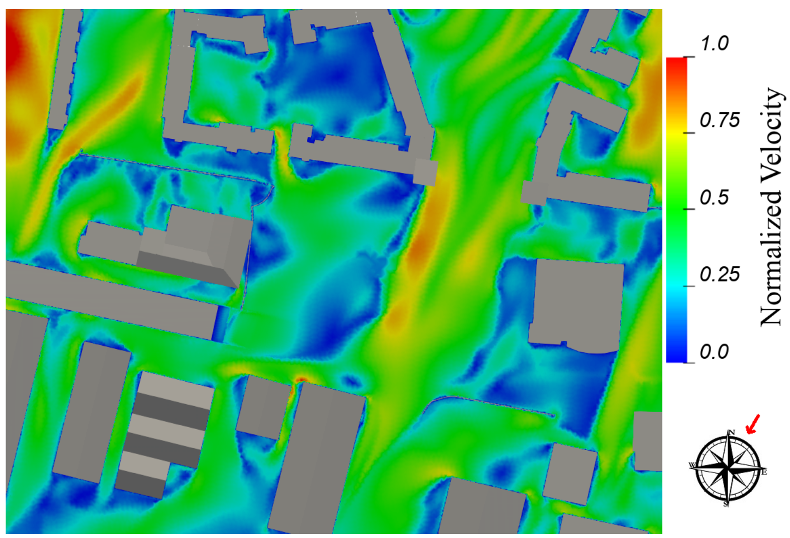


Figure 7.3: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 30°

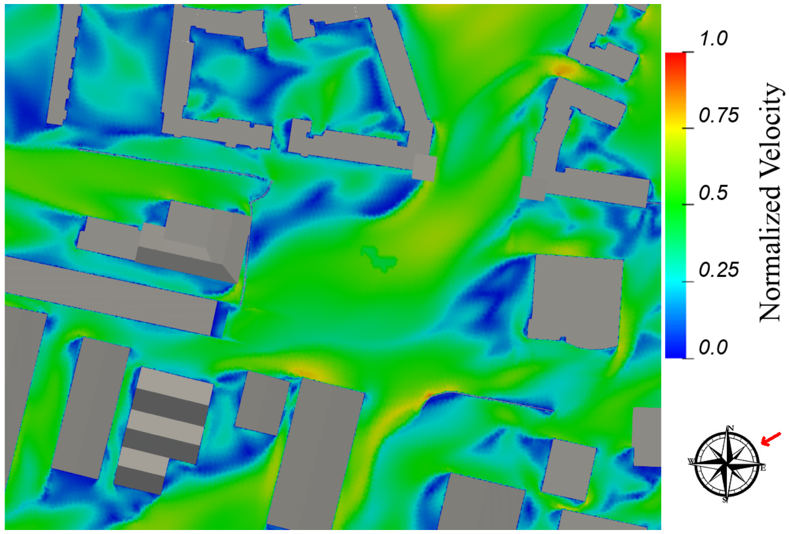


Figure 7.4: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 60°

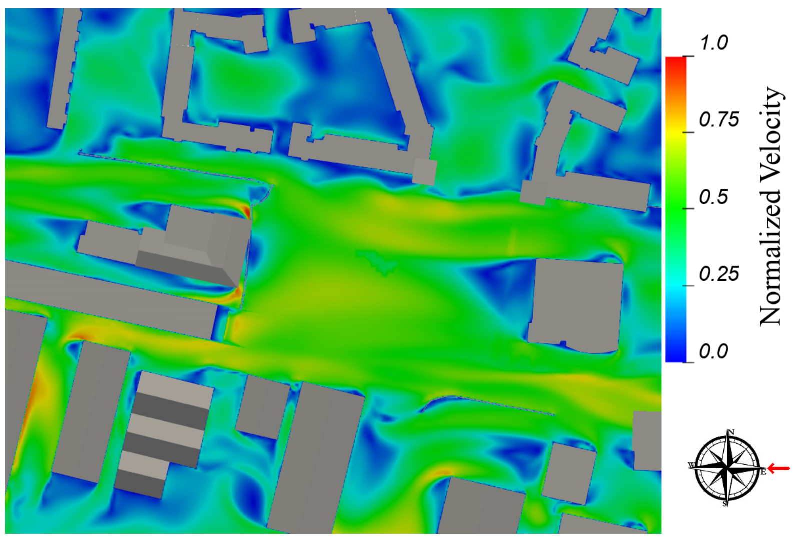


Figure 7.5: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 90°

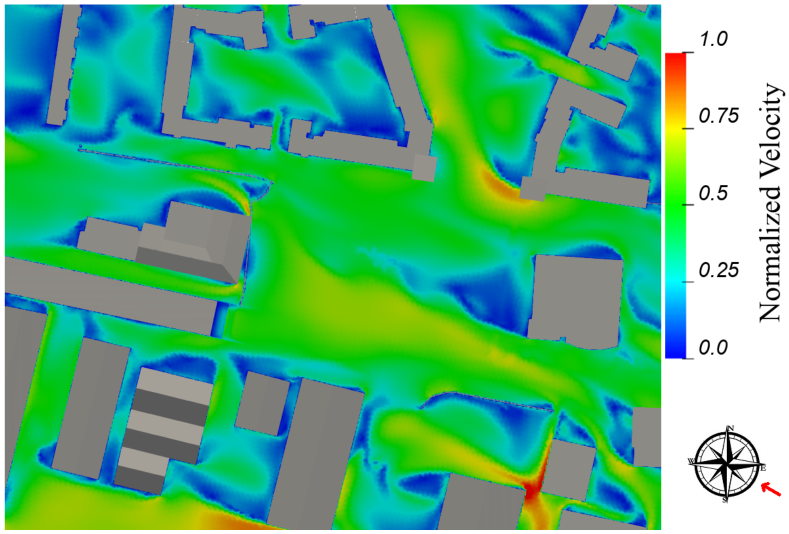


Figure 7.6: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 120°

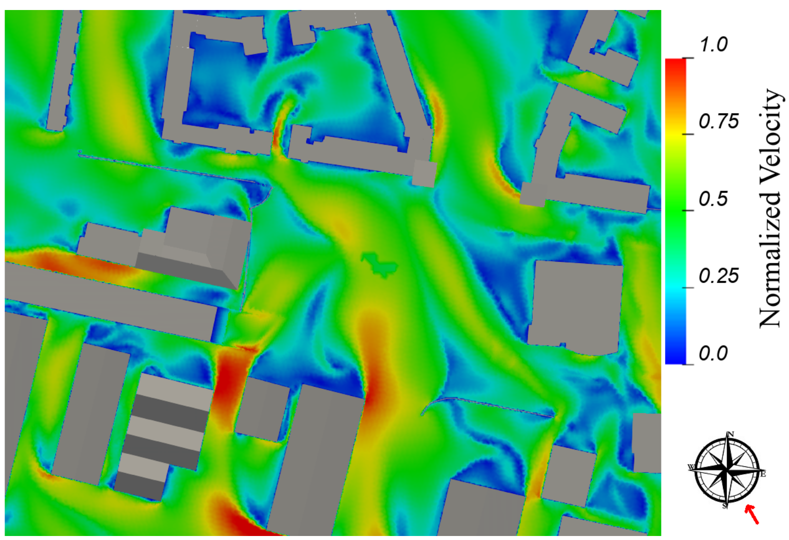


Figure 7.7: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 150°

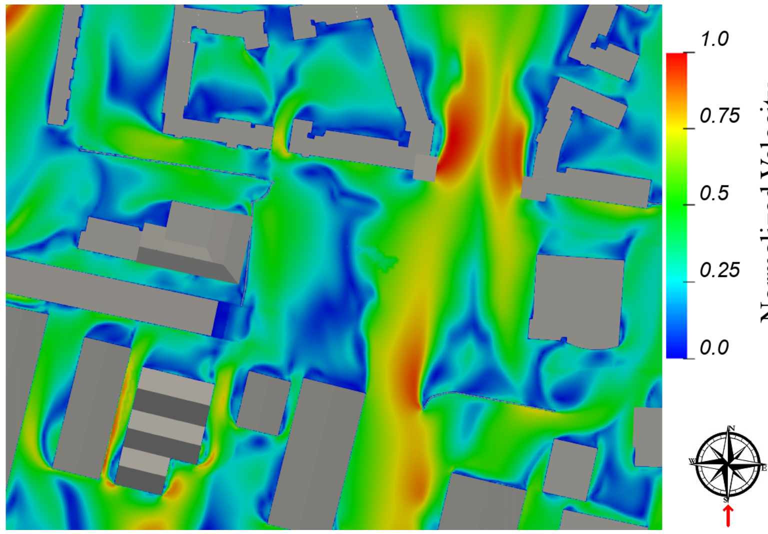


Figure 7.8: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 180°

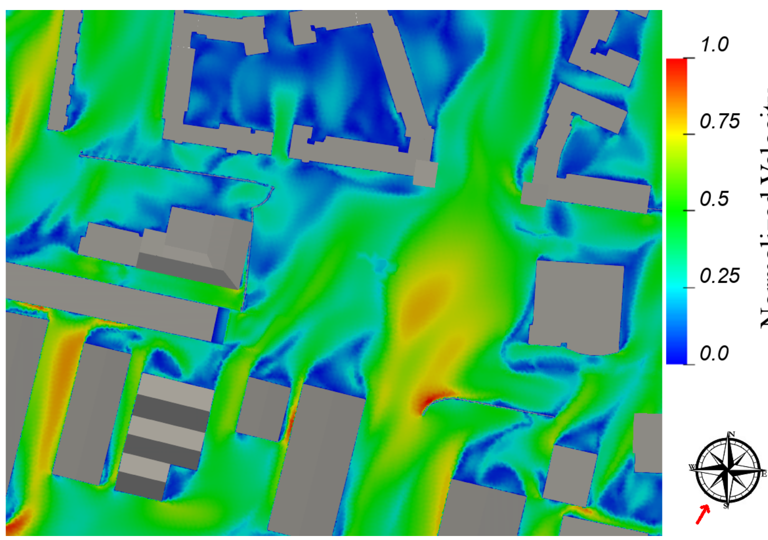


Figure 7.9: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 210°

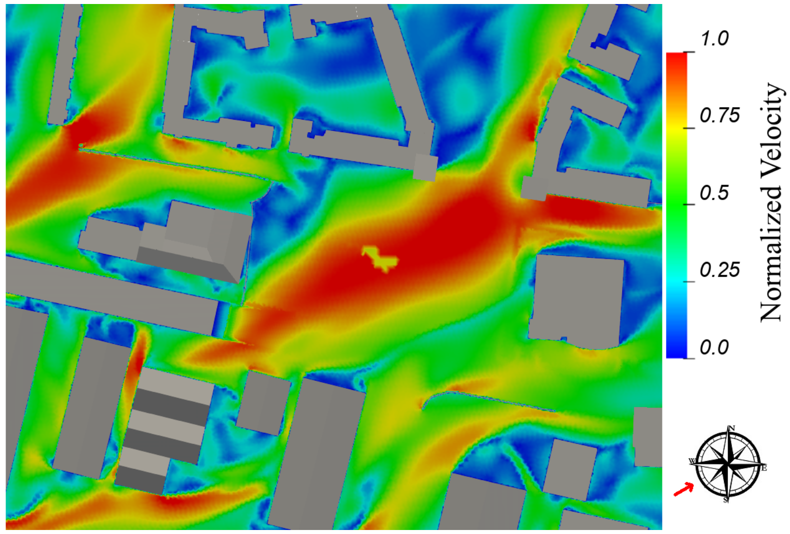


Figure 7.10: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 240°

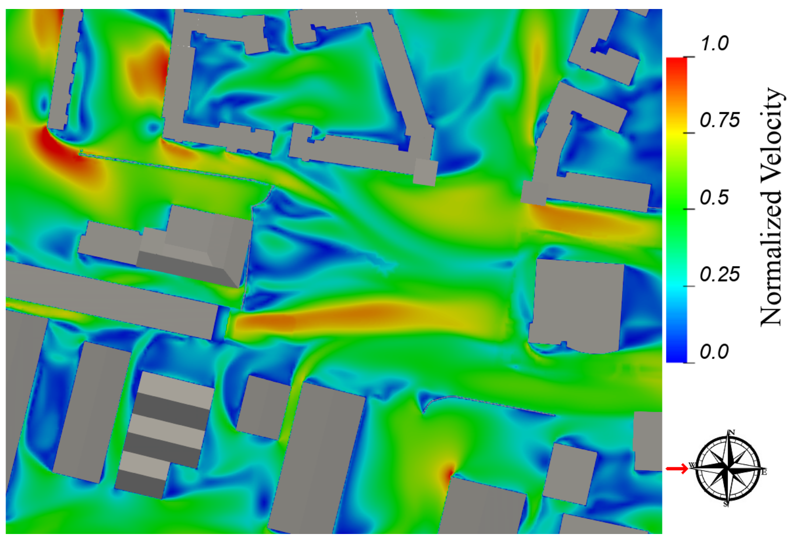


Figure 7.11: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 270°

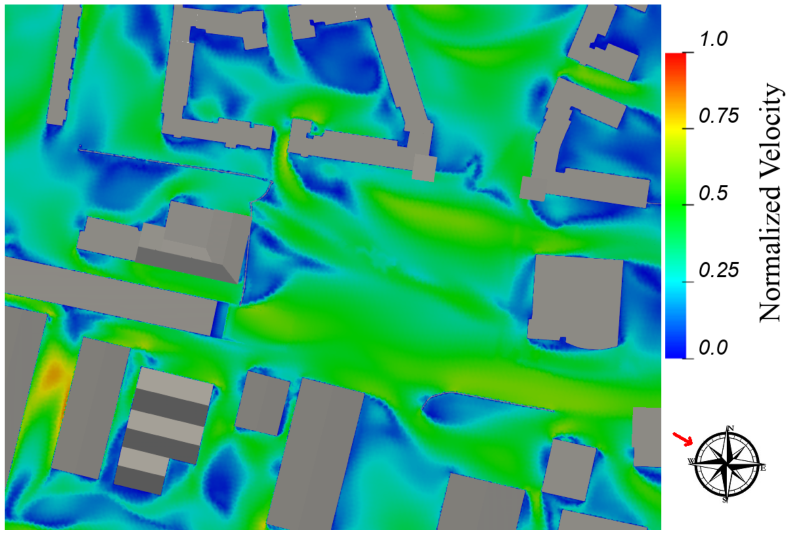


Figure 7.12: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 300°

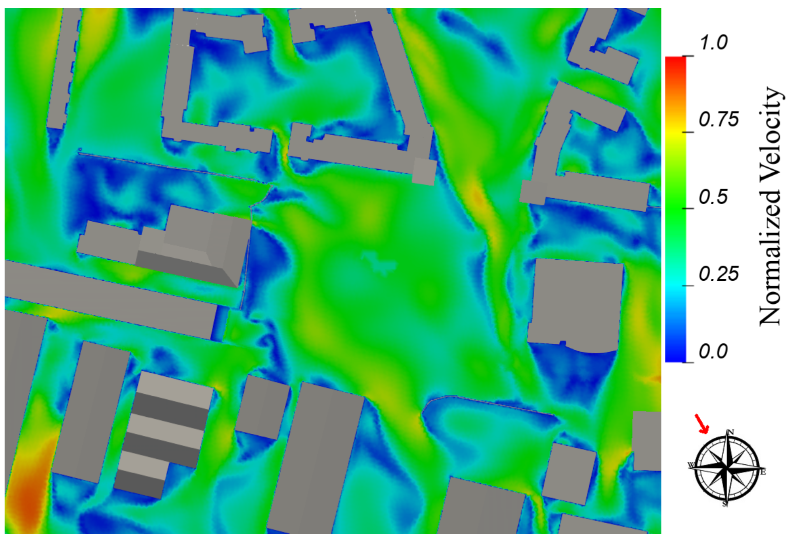


Figure 7.13: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 330°

7.1.2 BASELINE WIND MICROCLIMATE - Lawson Criteria

The wind flow results obtained simulating the different direction and wind speeds, are combined with wind frequencies of occurrence to obtain comfort ratings at pedestrian level in all areas included within the model. The comparison of comfort ratings with intended pedestrian activities is shown in the Lawson Comfort and Distress Map that follows. The comfort/distress conditions are presented using a colour coded diagram formulated in accordance with the Lawson Criteria.

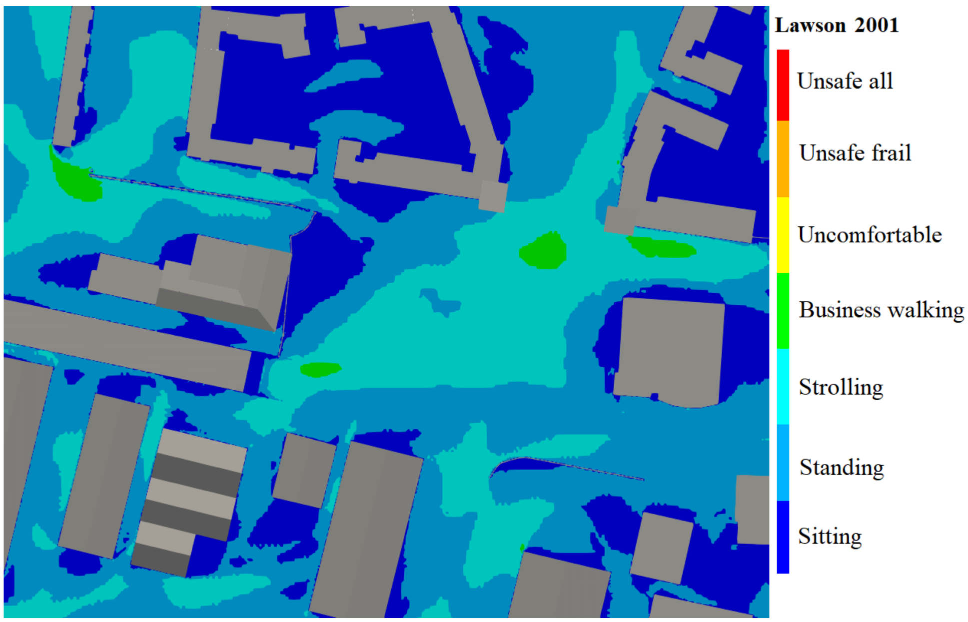


Figure 7.14: Ground Floor - Lawson Discomfort Map - Top View

From the simulation results the following observations are pointed out:

- The assessment of the baseline scenario has shown that no area is unsafe and no conditions of distress are created in the existing environment under the local wind climate.

- The site is usable for walking and standing, the roads in the surrounding are usable for their intended scope.

8. IMPACT OF THE PROPOSED DEVELOPMENT

This section assessed the potential impact of the proposed development on the already existing environment, and the suitability of the proposed development to create and maintain a suitable and comfortable environment for different pedestrian activities.

8.1 CONSTRUCTION PHASE

As the finalization of the development proceeds, the wind setting at the site would progressively conform to those of the completed development. Due to the fact that windier conditions are acceptable within a construction area (not accessible to the public), and the proposed development would not be the reason for critical wind conditions on-Site (and are slightly calmer when the development is in site), the impacts evaluated on-Site are considered to be insignificant. Thus, the predicted impacts during construction phase are identified as not significant or negligible.

In summary, as construction of the Baldoyle LRD Development progresses, the wind conditions at the site would gradually adjust to those of the completed development. During the construction phase, predicted impacts are classified as negligible.

8.2 OPERATIONAL PHASE

This section shows CFD results of wind microclimate assessment carried out considering the ”Operational Phase” of Baldoyle LRD Development. In this case the assessment has considered the impact of wind on the existing area including the proposed Baldoyle LRD Development. Wind simulations have been carried out on all the various directions for which the development could show critical areas in terms of pedestrian comfort and safety.

Results of wind microclimate at pedestrian level (1.5m height - flow speeds) are collected throughout the modelled site and on the roof terraces (potential receptors). These flow velocities identify if locally, wind speeds at pedestrian-level are accelerated or decelerated in relation to the undisturbed reference wind speed due to the presence of the existing baseline environment.

The impact of these speeds are then combined with their specific frequency of occurrence and presented in the maps that show the area of comfort and distress in accordance with Lawson Criteria, these maps are produced at pedestrian level on the ground and on the roof terraces and identify the suitability of each areas to its prescribed level of usage and activity.

Figure 8.1: CFD Model of Proposed Scenario

8.2.1 WIND SPEEDS - Pedestrian Level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the development ground are presented in Figures 8.2 to 8.13 in order to assess wind flows at ground floor level of Baldoyle LRD Development.

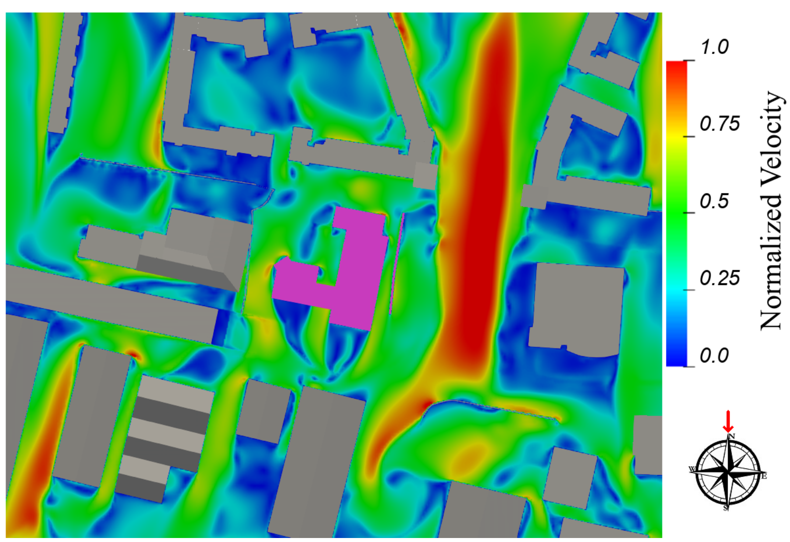


Figure 8.2: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 0°

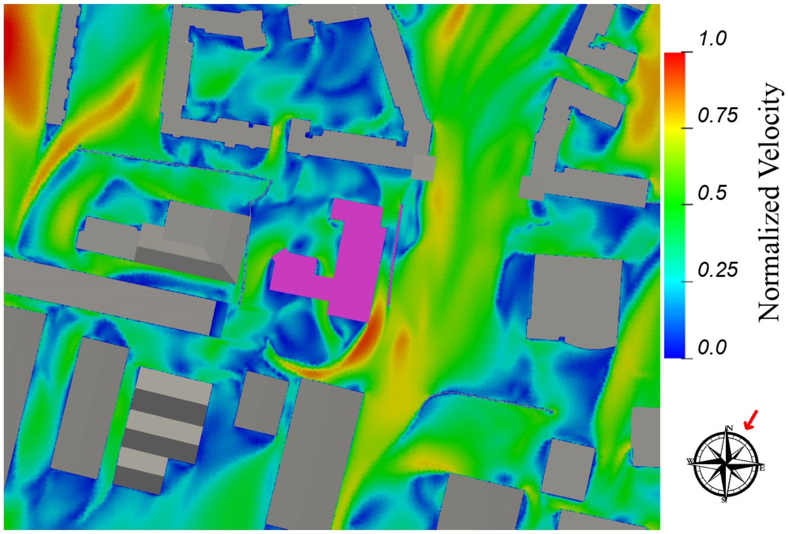


Figure 8.3: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 30°

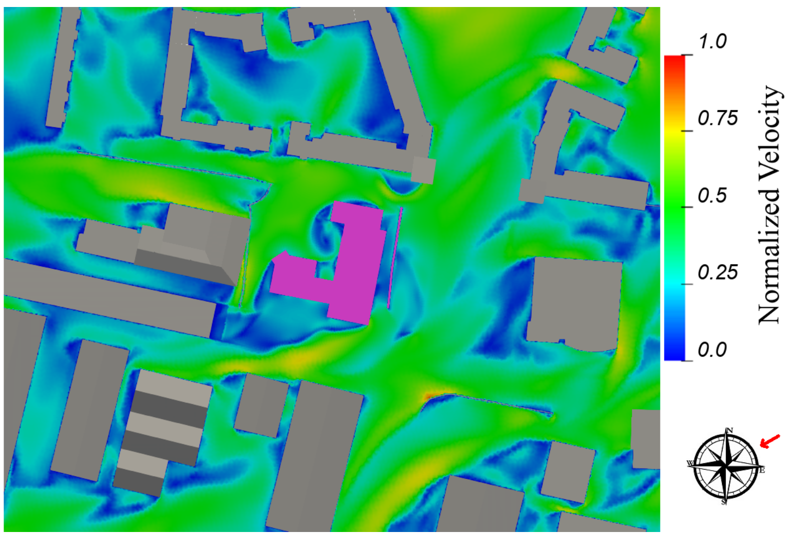


Figure 8.4: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 60°

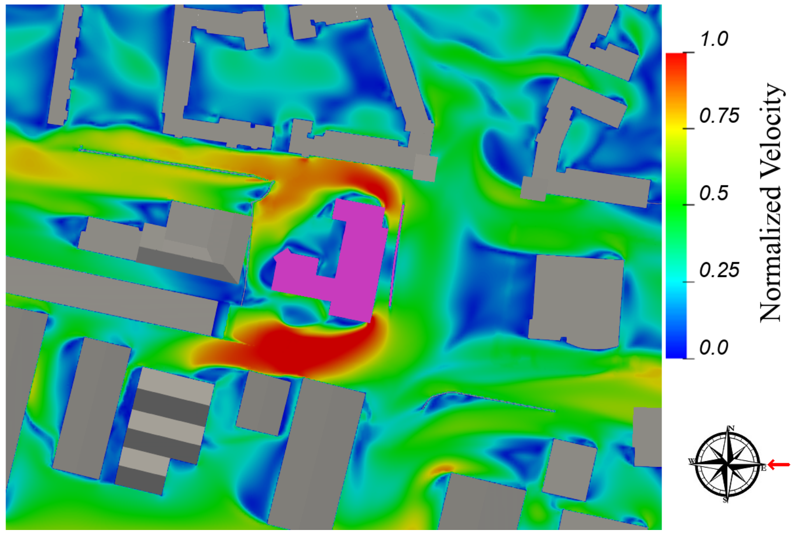


Figure 8.5: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 90°

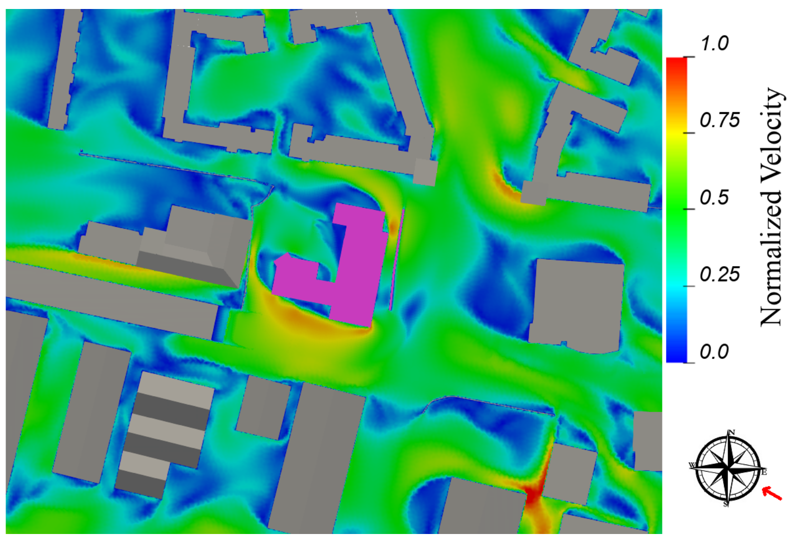


Figure 8.6: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 120°

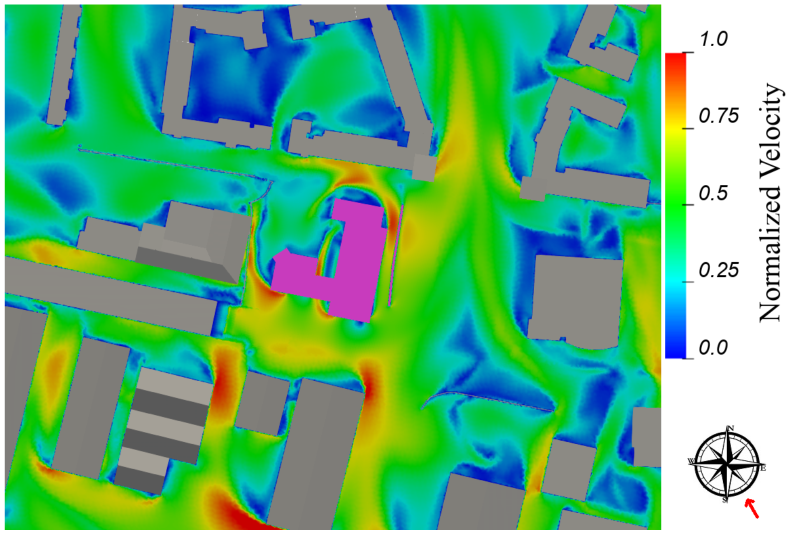


Figure 8.7: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 150°

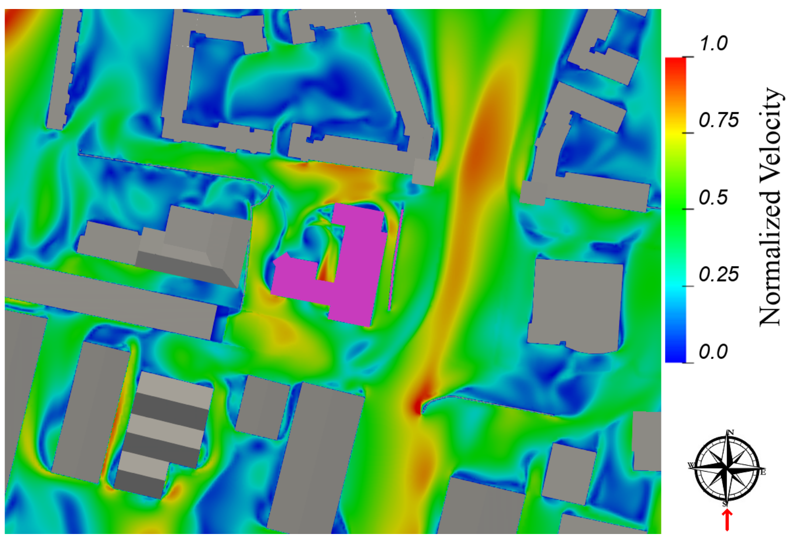


Figure 8.8: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 180°

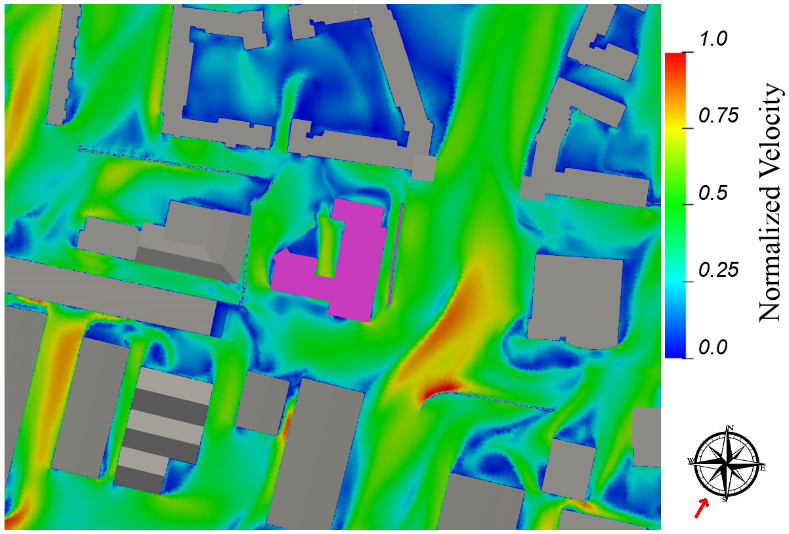


Figure 8.9: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 210°

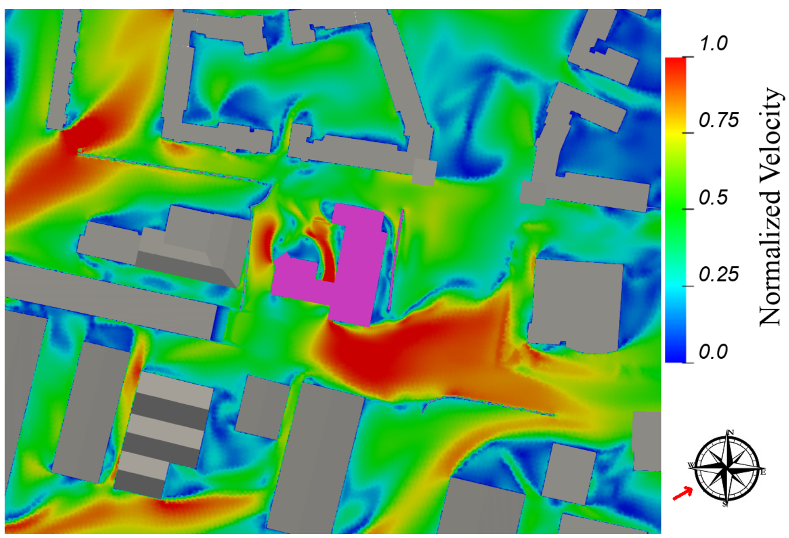


Figure 8.10: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 240°

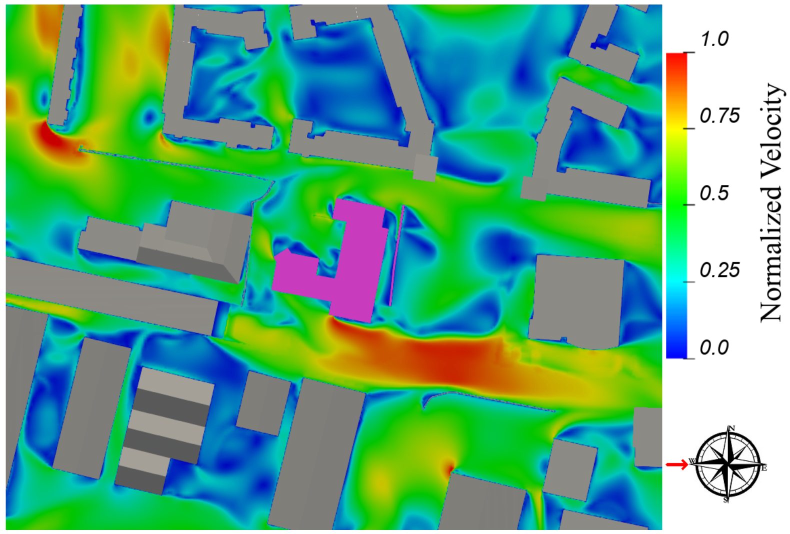


Figure 8.11: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 270°

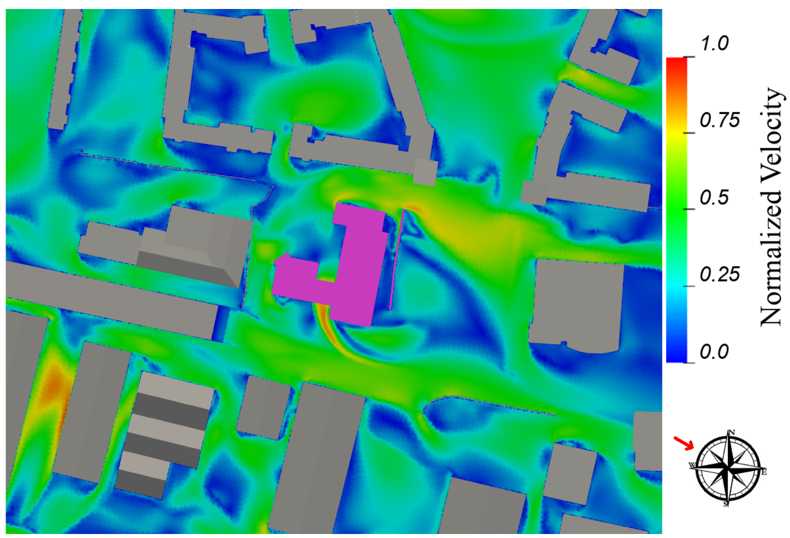


Figure 8.12: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 300°

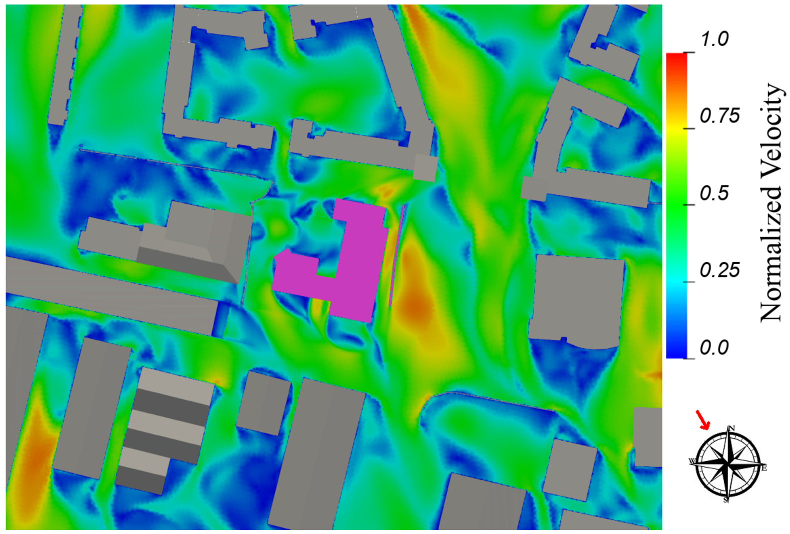


Figure 8.13: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 330°

8.2.2 WIND SPEEDS - Terrace

Results of wind speeds and their circulations at the terrace of Baldoyle LRD Development are presented in Figures 8.14 to 8.25.

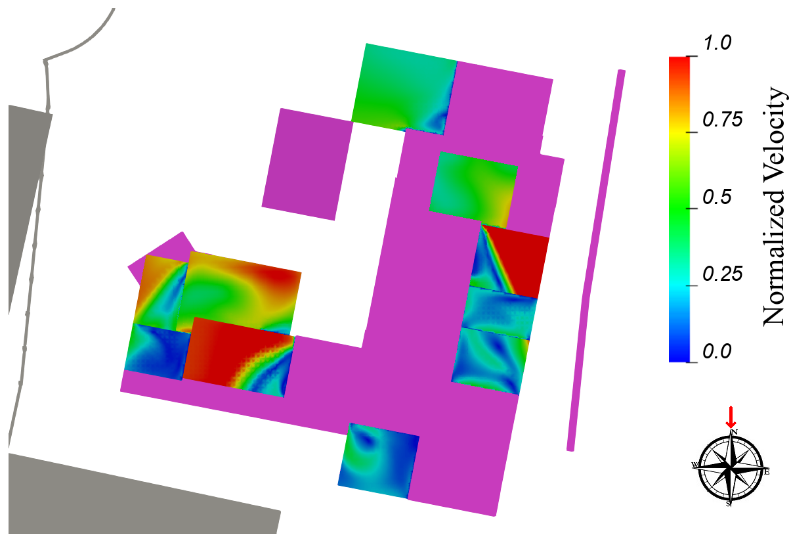


Figure 8.14: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 0°

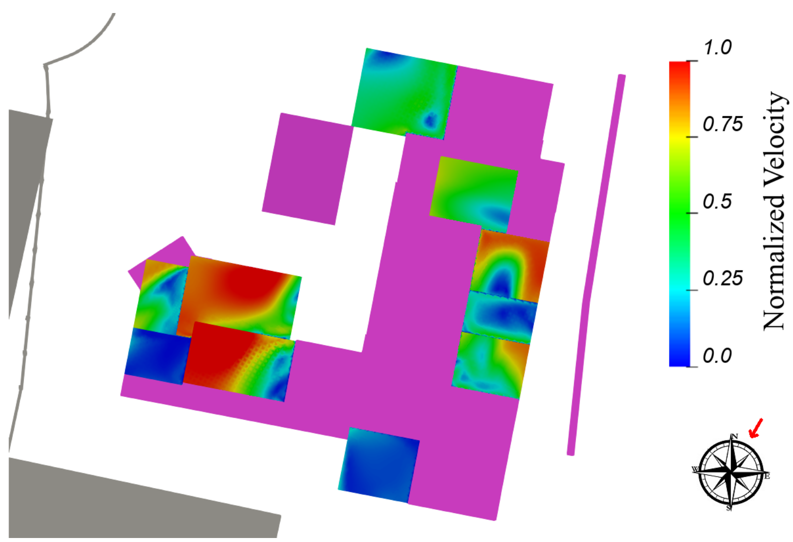


Figure 8.15: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 30°

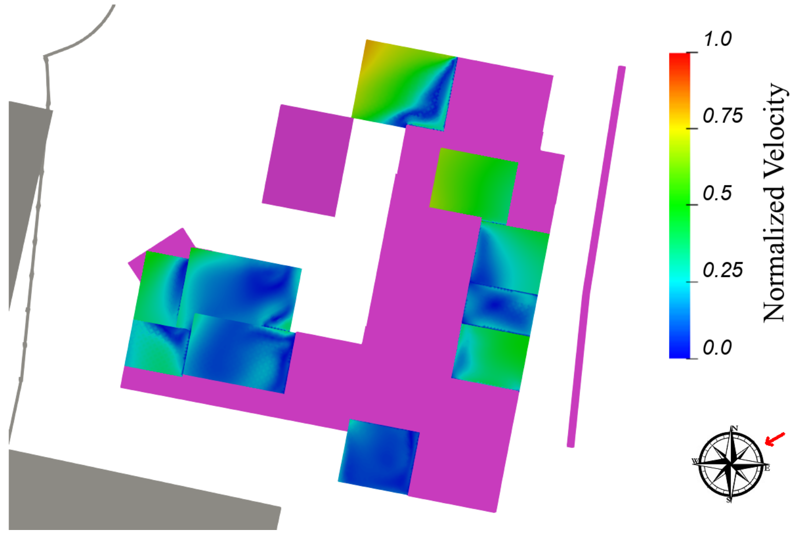


Figure 8.16: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 60°

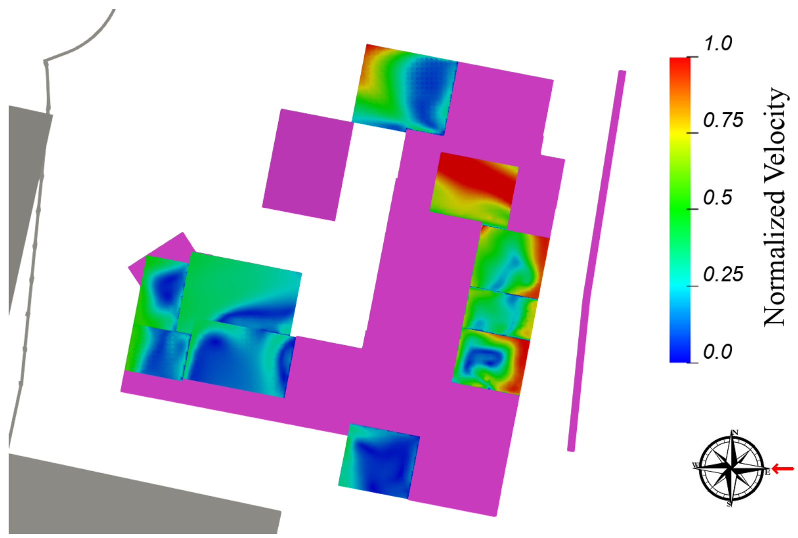


Figure 8.17: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 90°

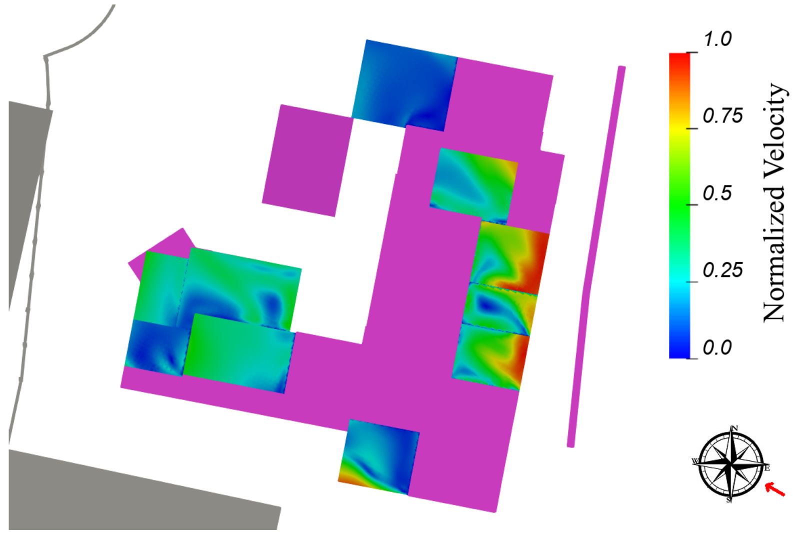


Figure 8.18: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 120°

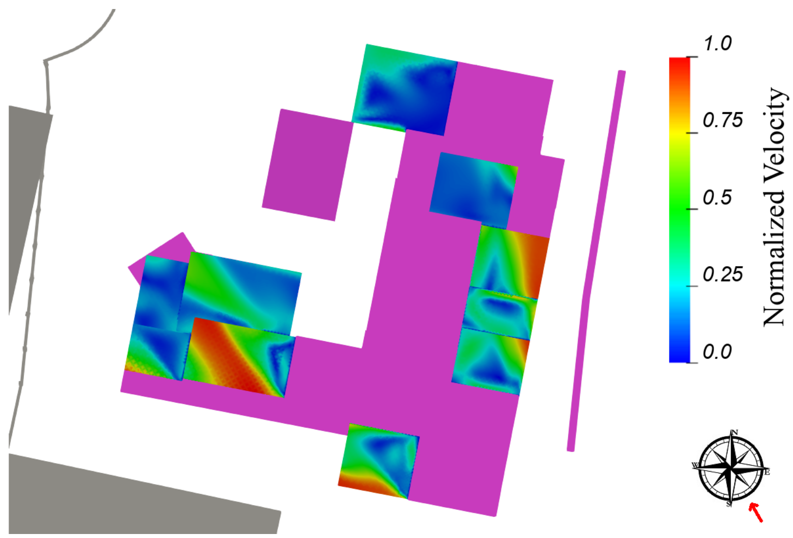


Figure 8.19: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 150°

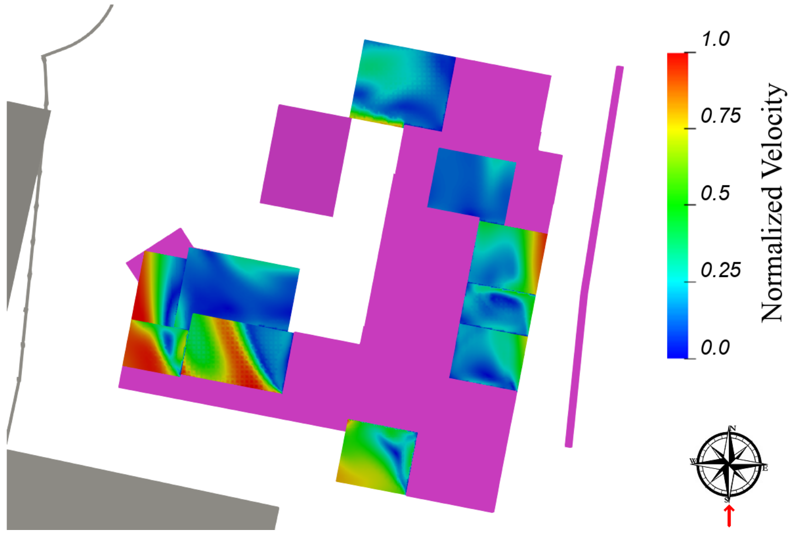


Figure 8.20: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 180°

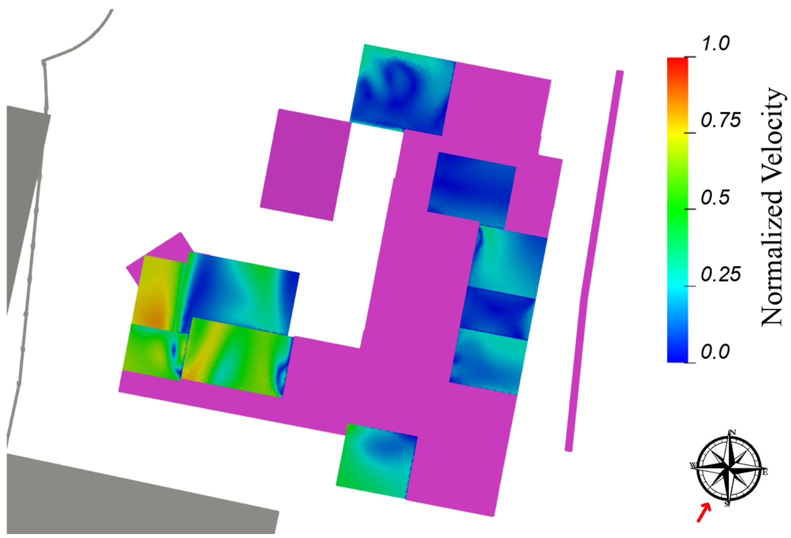


Figure 8.21: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 210°

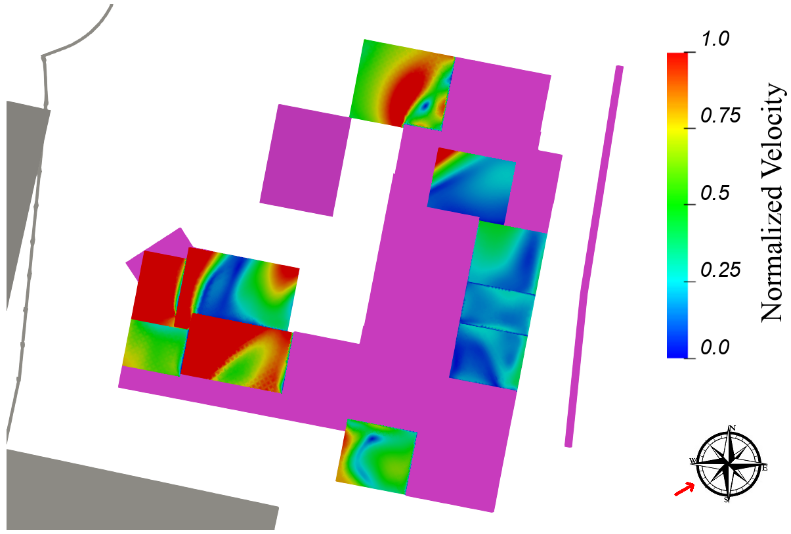


Figure 8.22: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 240°

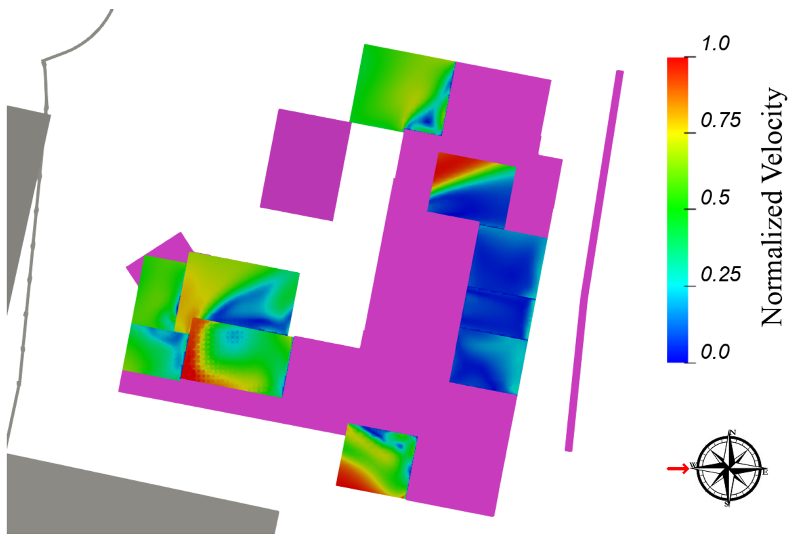


Figure 8.23: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 270°

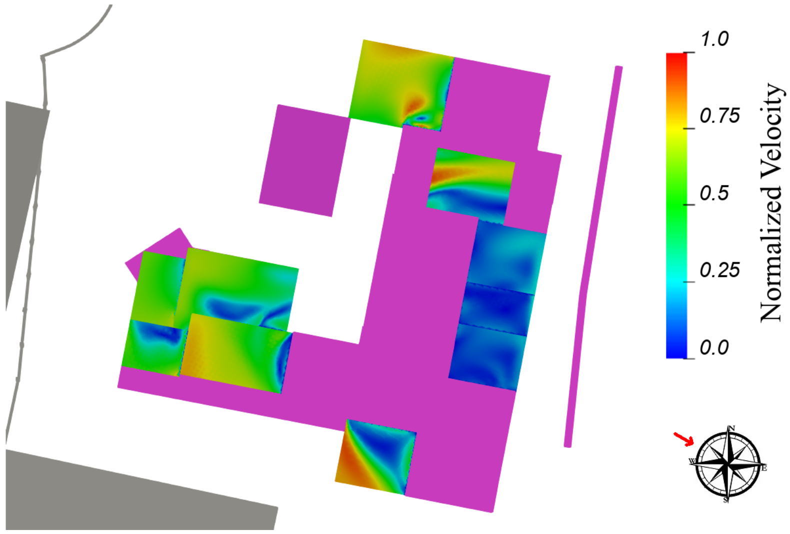


Figure 8.24: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 300°

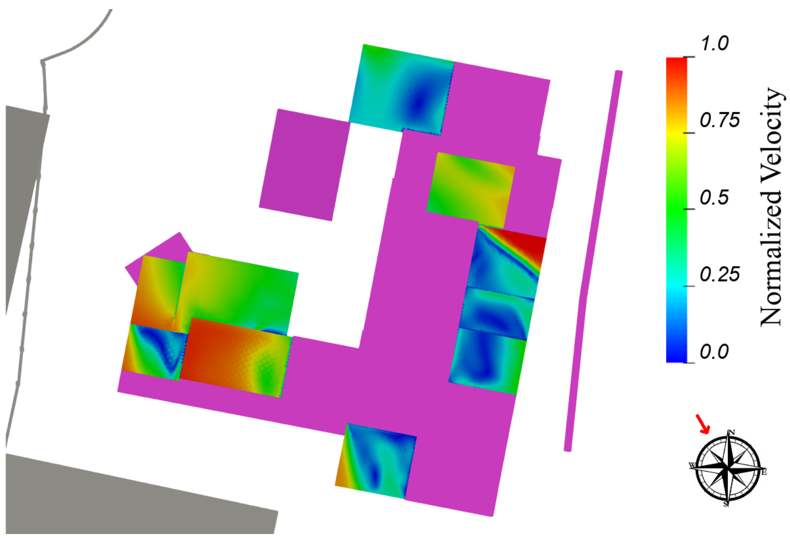


Figure 8.25: Roof Terrace Level - Flow Velocity Results at Z=1.5m above the Terrace- Wind Direction: 330°

8.2.3 PROPOSED DEVELOPMENT WIND MICROCLIMATE - Lawson Criteria

The wind flow results obtained simulating the different direction and wind speeds, are combined with wind frequencies of occurrence to obtain comfort ratings at pedestrian level in all areas included within the model. The comparison of comfort ratings with intended pedestrian activities is shown in the Lawson Comfort and Distress Map that follows.

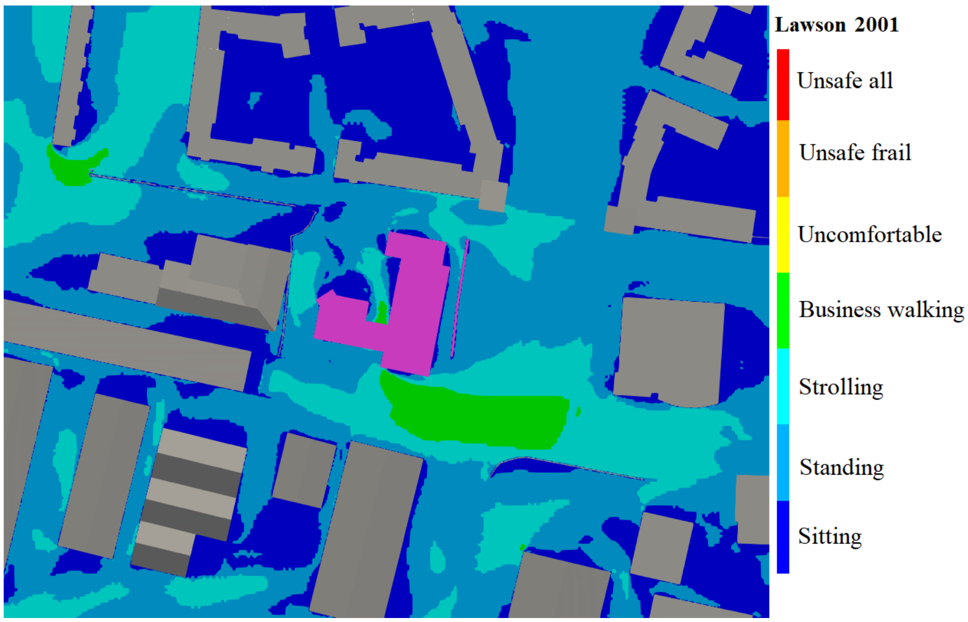


Figure 8.26: Ground Floor - Lawson Discomfort Map - Top View

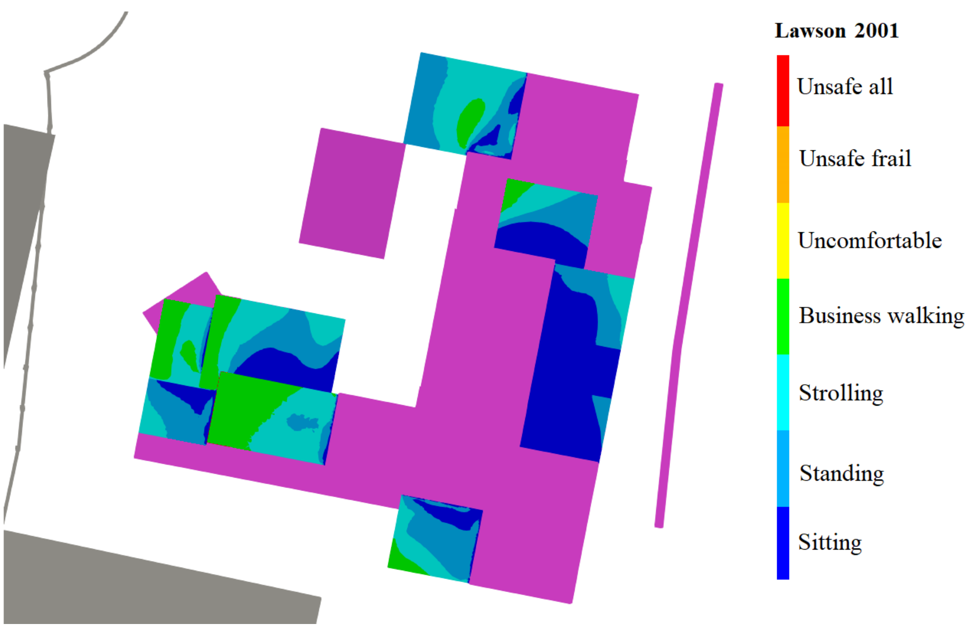


Figure 8.27: Terrace - Lawson Discomfort Map - Top View

In summary, the following conclusions can be made observing the results of the wind microclimate analysis and comparing the results obtained, under the same wind conditions for the baseline scenario versus the proposed development scenario:

- The assessment of the proposed scenario has shown that no area is unsafe, and no conditions of distress are created by the proposed development.

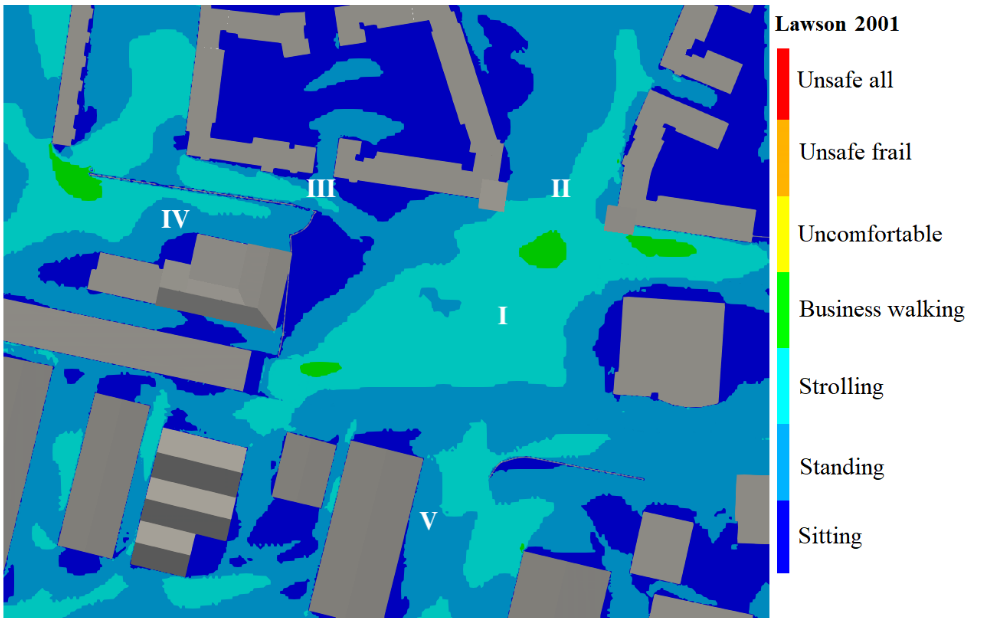
- All the roads proposed can be used for their intended scope.

- The wind microclimate of the proposed development is comfortable and usable for pedestrians.

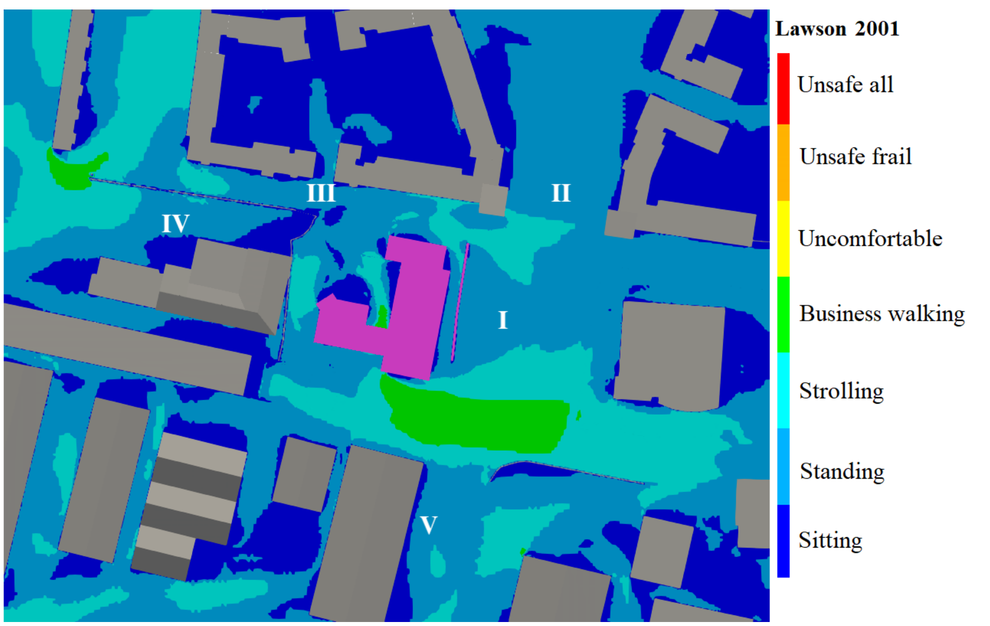
- The assessment of the proposed scenario has shown that the proposed development meets the Lawson Comfort Criteria where no area is unsafe, and no conditions of distress are created by the proposed development. All the ground amenities proposed can be used for their intended scope. The wind microclimate of the proposed development is comfortable and usable for pedestrians.

- Most of the terraces are suitable for standing and sitting. Terraces 1 and 3 are suitable for walking. However, wind conditions at all terraces are within tenable conditions. It is important to note that fluctuations in velocity on rooftop terraces can result in door slamming problems. Therefore, the installation of door actuators is strongly recommended to mitigate the potential issue and to ensure smooth operating of the terrace doors.

As a result of the proposed development construction, the wind on the surrounding urban context remains suitable for the intended use when compared with the baseline situation.



Baseline Scenario



Proposed Development Scenario

Figure 8.28: Comparison Wind Microclimate Conditions (Lawson Comfort/Distress Map)

Tables 8.1 and 8.2 show the intended baseline and proposed wind conditions on-site as well as some potential off-site receptors around the development. Locations of the ground amenity areas listed in these Tables are indicated in Figure 8.29

Table 8.1: Significance Impact of the Proposed Development Versus Baseline Conditions for Comfort - On Site Receptors

On-Site Potential Receptors	**Baseline Conditions**	**Proposed Development Conditions**	**Impact Significance**
Ground Amenities	Suitable for Walking/Standing	Suitable for Walking/Standing (Safe/No distress)	Negligible
Terrace 1	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 2	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 3	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 4	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 5	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 6	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 7	-	Suitable for the intended use (Safe/No distress)	Negligible
Terrace 8	-	Suitable for the intended use - Sitting/Standing (Safe/No distress)	Negligible
Terrace 9	-	Suitable for the intended use - Sitting/Standing (Safe/No distress)	Negligible
Terrace 10	-	Suitable for the intended use - Sitting/Standing (Safe/No distress)	Negligible

Table 8.2: Significance Impact of the Proposed Development Versus Baseline Conditions for Comfort - Off Site Receptros

Off-Site Potential Receptors	Baseline Conditions	Proposed Development Conditions	Impact Significance
Off-site receptor I	Suitable for Standing/Strolling	Condition remains the same as in the baseline condition (Safe/No distress)	Negligible
Off-site receptor II	Suitable for Business walking	Suitable for Standing/Strolling (Safe/No distress)	Beneficial
Off-site receptor III	Suitable for Standing/Strolling	Suitable for Sitting/Standing (Safe/No distress)	Beneficial
Off-site receptor IV	Suitable for Sitting/Standing	Condition remains the same as in the baseline condition (Safe/No distress)	Negligible
Off-site receptor V	Suitable for Sitting/Standing	Condition remains the same as in the baseline condition (Safe/No distress)	Negligible

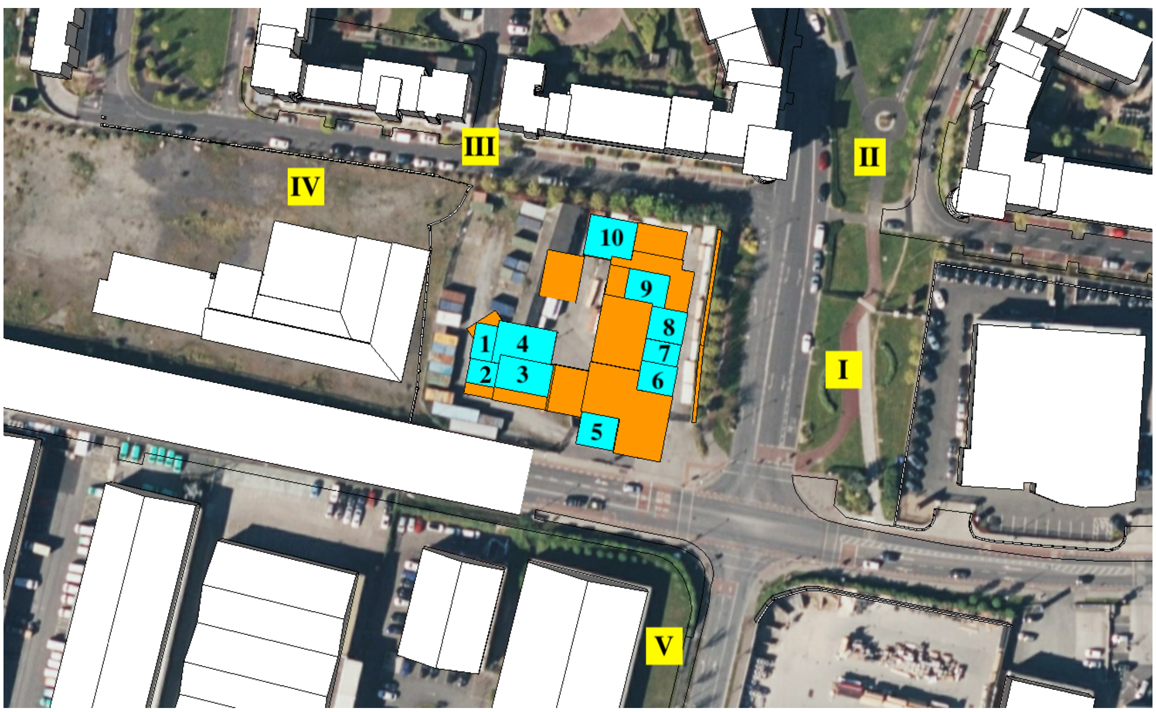


Figure 8.29: Locations of the Terrace (colored in green) and Ground Amenities

9. CUMULATIVE IMPACT

This section assesses the impact of buildings that have been granted planning permission but not yet built on the proposed Baldoyle LRD, as well as the suitability of these cumulative buildings to create and maintain a suitable and comfortable environment for various pedestrian activities.

9.1 OPERATIONAL PHASE

This section shows CFD results of wind microclimate assessment carried out considering the ”Operational Phase” of Baldoyle LRD Development. In this case the assessment has considered the impact of wind on the existing area including the proposed Baldoyle LRD Development and the cumulative buildings which include Shoreline LRD and Shoreline SHD. Wind simulations have been carried out on all the various directions for which the development could show critical areas in terms of pedestrian comfort and safety.

Results of wind microclimate at pedestrian level (1.5m height - flow speeds) are collected throughout the modelled site. These flow velocities identify if locally, wind speeds at pedestrian-level are accelerated or decelerated in relation to the undisturbed reference wind speed due to the presence of the existing baseline environment and permitted buildings (but not built yet).

The impact of these speeds are then combined with their specific frequency of occurrence and presented in the maps that show the area of comfort and distress in accordance with Lawson Criteria, these maps are produced at pedestrian level on the ground and identify the suitability of each areas to its prescribed level of usage and activity.

Figure 9.1: A 3D View of the Proposed Development Buildings (Colored in Orange) and the Cumulative Buildings (Colored in Blue)

9.1.1 WIND SPEEDS - Pedestrian Level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the ground are presented in Figures 9.2 to 9.13 in order to assess wind flows at ground floor level of Baldoyle LRD Development.

Wind flow speeds are shown to be within tenable conditions.

It can be concluded that the wind speeds do not attain critical levels around the development.

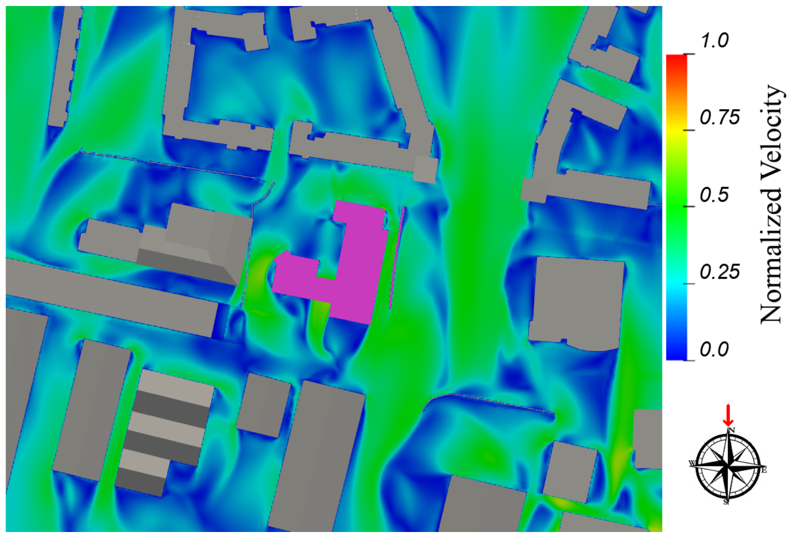


Figure 9.2: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 0°

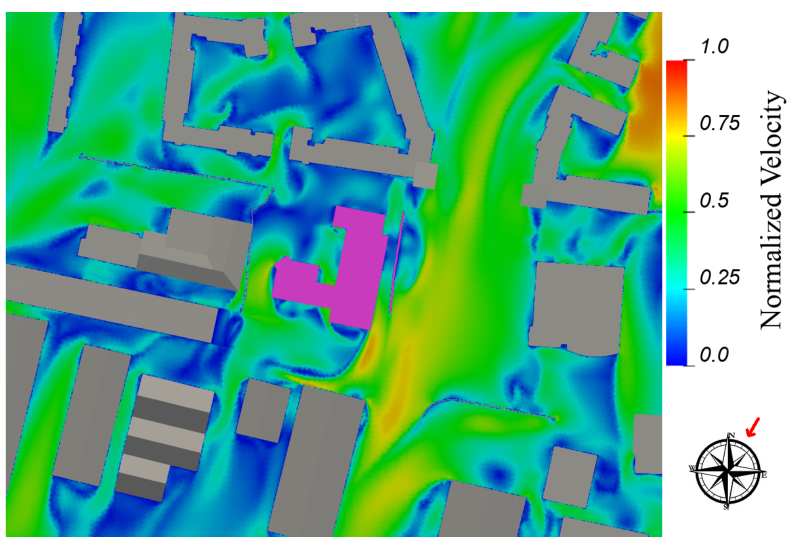


Figure 9.3: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 30°

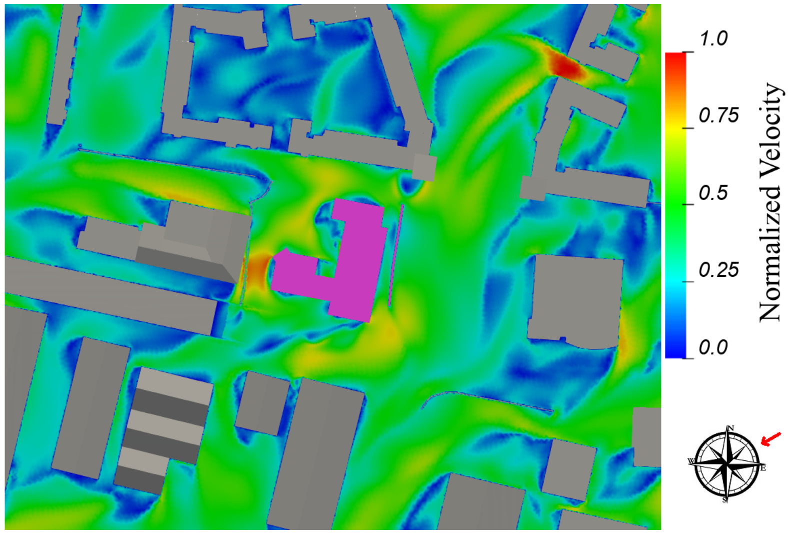


Figure 9.4: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 60°

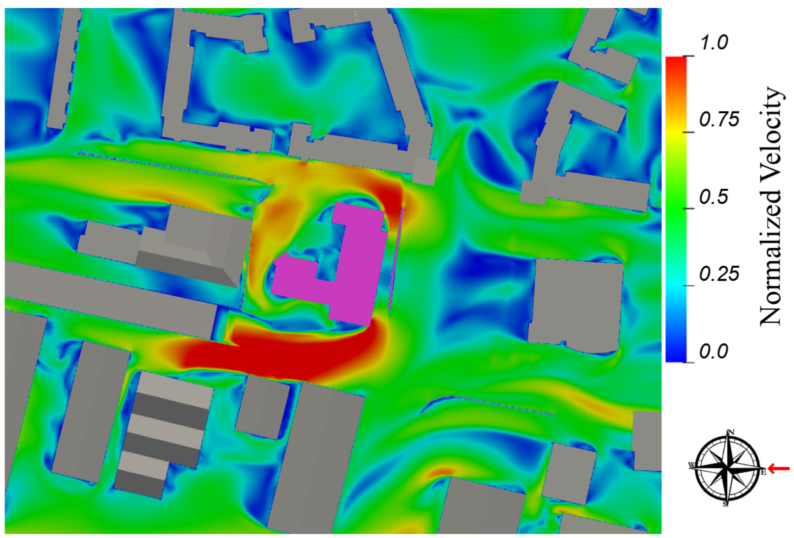


Figure 9.5: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 90°

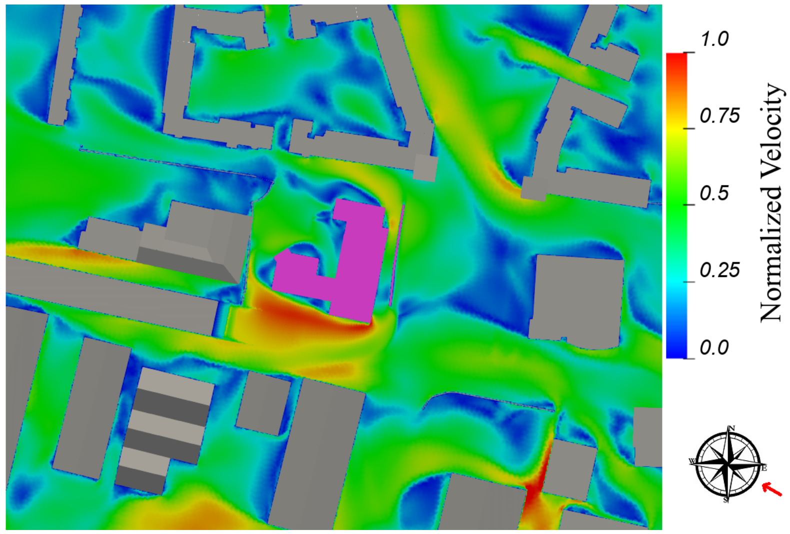


Figure 9.6: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 120°

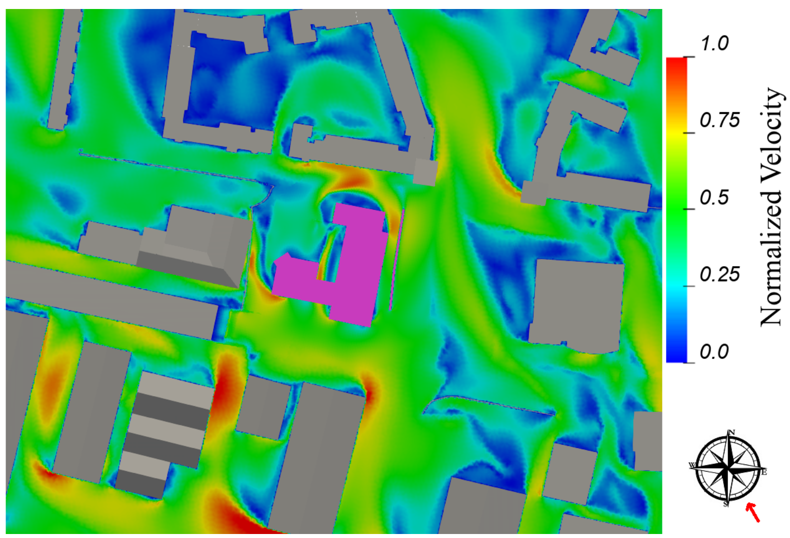


Figure 9.7: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 150°

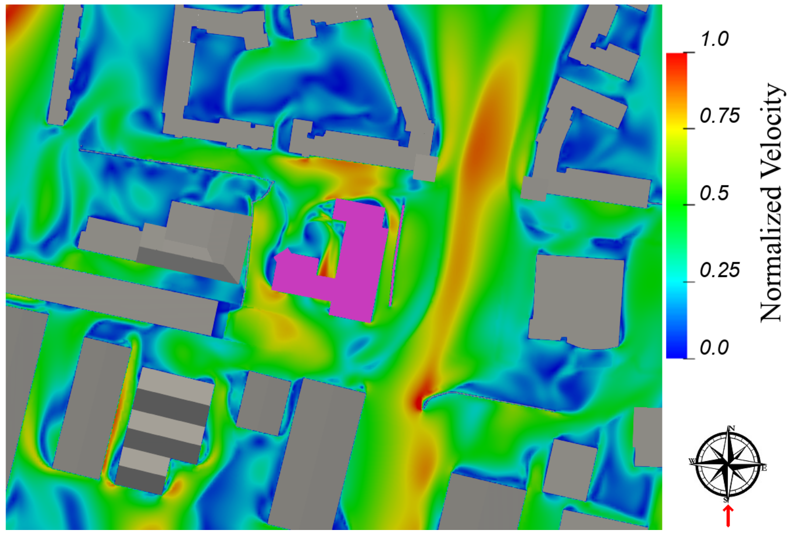


Figure 9.8: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 180°

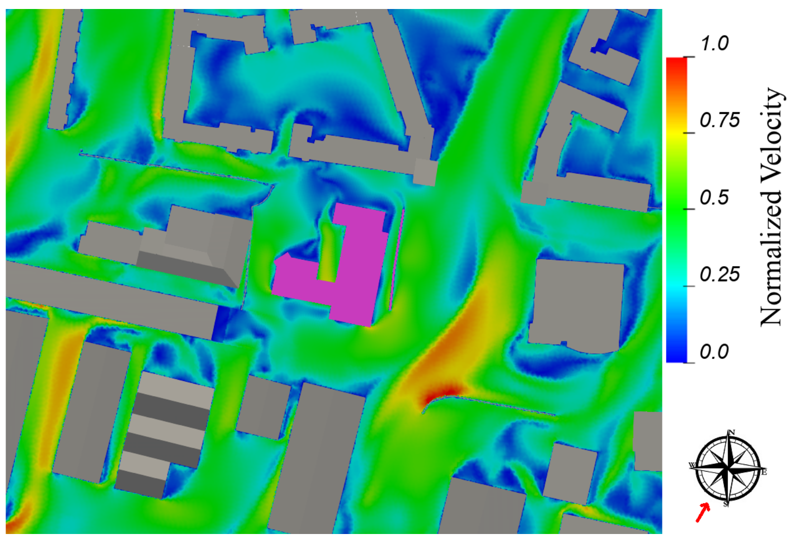


Figure 9.9: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 210°

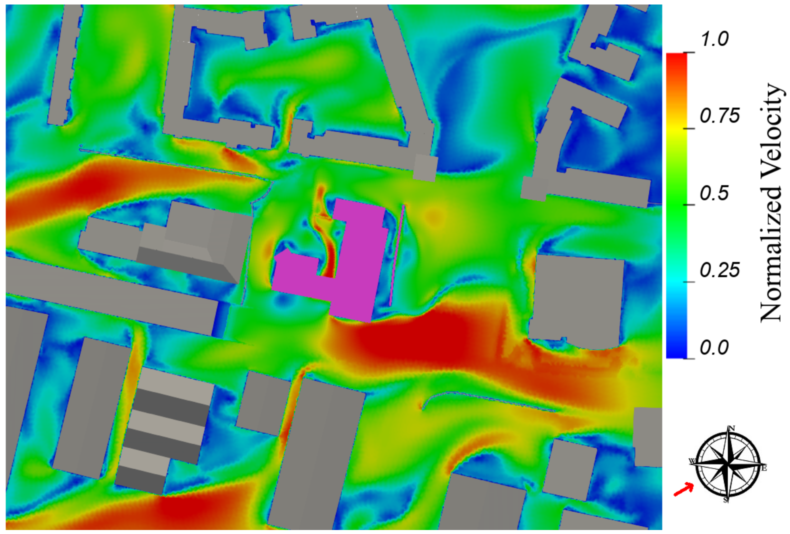


Figure 9.10: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 240°

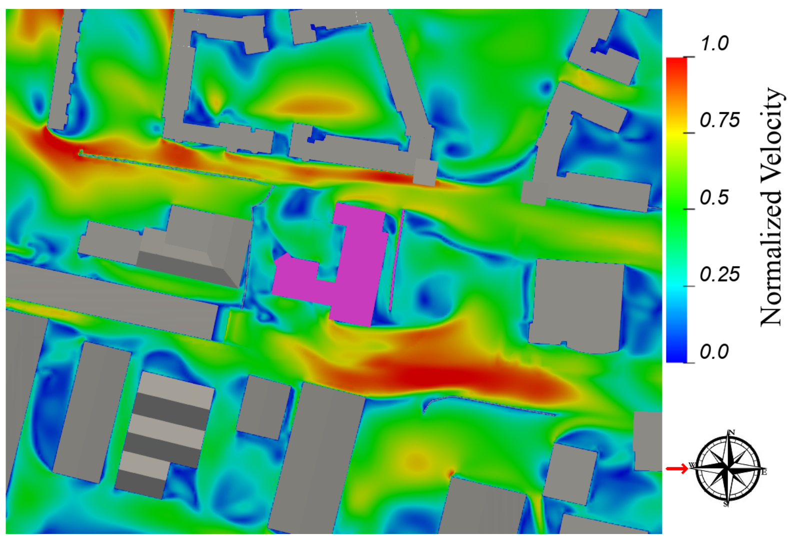


Figure 9.11: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 270°

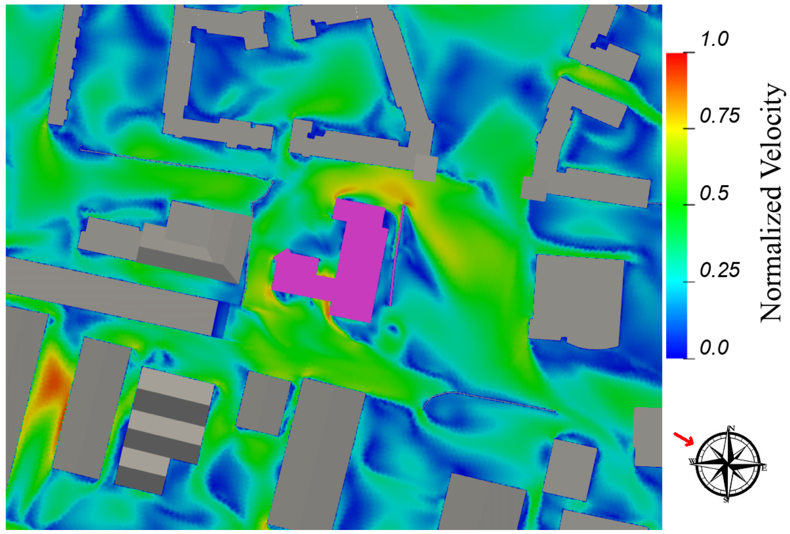


Figure 9.12: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 300°

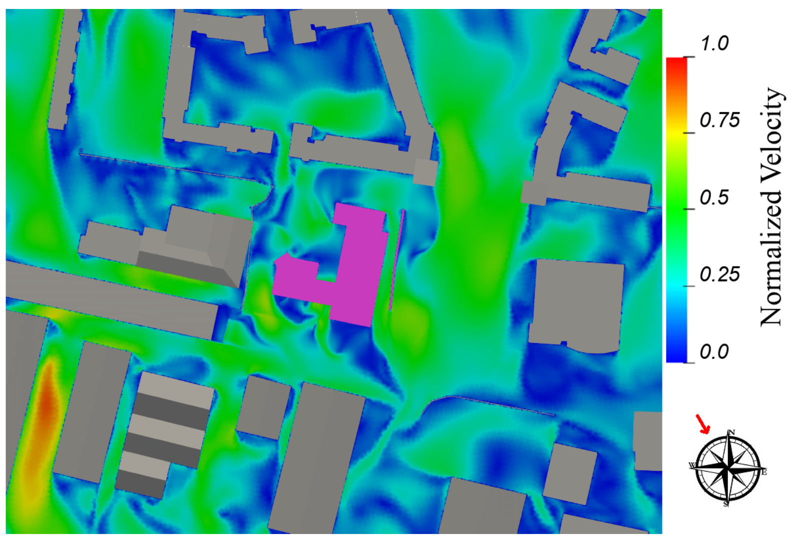
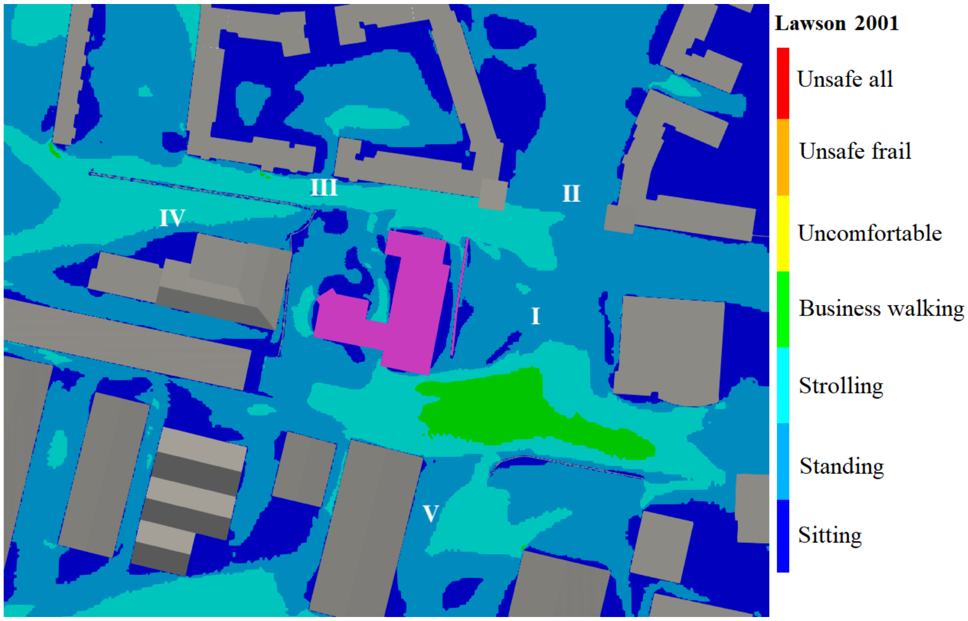


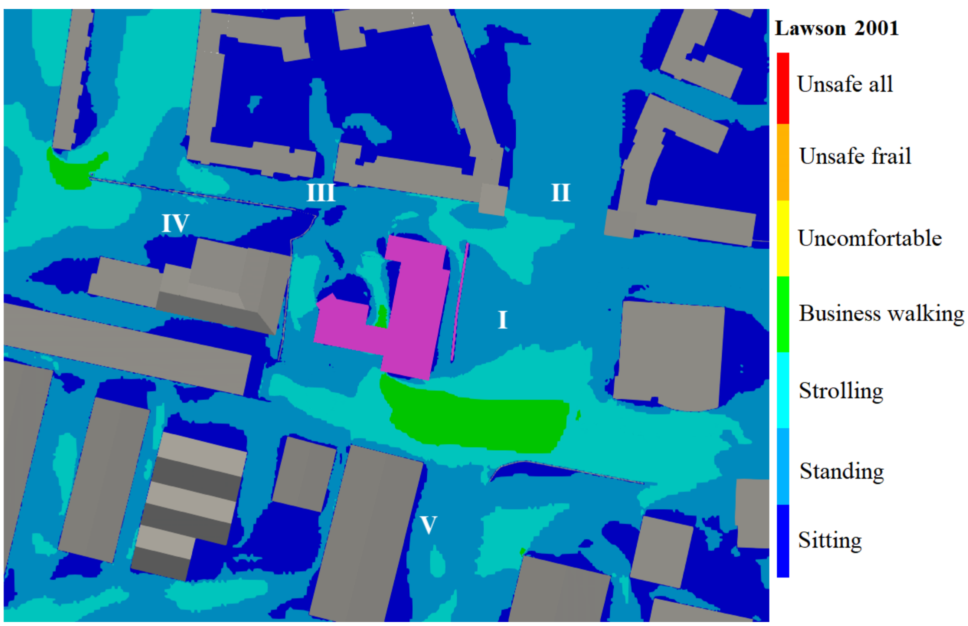
Figure 9.13: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 330°

9.1.2 CUMULATIVE IMPACT - Lawson Criteria

A comparison of Lawson Comfort and Distress Maps for proposed development scenario and the cumulative scenario is presented in Figure 9.14



Cumulative Scenario



Proposed Development Scenario

Figure 9.14: Comparison Wind Microclimate Conditions (Lawson Comfort/Distress Map)

Table 9.1 shows the proposed and cumulative wind conditions at potential receptors around the development. Locations of the off-site receptors listed in this table are indicated in Figure 9.15

Table 9.1: Significance Impact of the Cumulative Scenario Versus Proposed Conditions for Comfort - Potential Receptors

Potential Receptors	Proposed Development Conditions	Cumulative Conditions	Impact Significance
On-site ground amenities	Suitable for Walking/Standing	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible
Off-site receptor I	Suitable for Standing/Strolling	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible
Off-site receptor II	Suitable for Standing/Strolling	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible
Off-site receptor III	Suitable for Sitting/Standing	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible
Off-site receptor IV	Suitable for Sitting/Standing	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible
Off-site receptor V	Suitable for Sitting/Standing	Condition remains the same as in the Proposed development condition (Safe/No distress)	Negligible

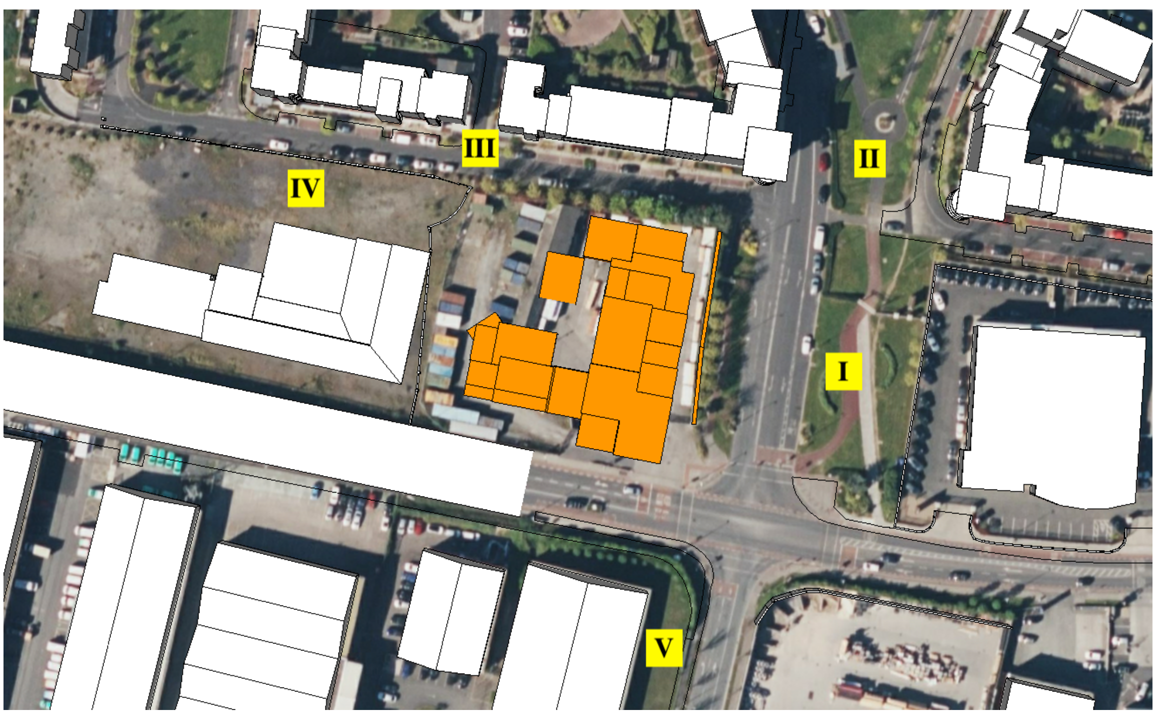


Figure 9.15: Locations of the Off-Site Receptors

As shown in Tables 9.1, there are no distress areas for pedestrians including frail users and cyclist. furthermore, the site and surrounding urban areas are safe for all users.

10. CONCLUSIONS

CONCLUSIONS and COMMENTS ON MICROCLIMATE STUDY

This report presents the CFD modelling assumptions and results of Wind and Microclimate Modelling of Baldoyle LRD Development, Grange Road, Dublin 13.

This study has been carried out to identify the possible wind patterns around the area proposed, under mean and peak wind conditions typically occurring in Dublin, and also to assess impacts of the wind on pedestrian levels of comfort/distress.

The results of this wind microclimate study are utilized by CWPA Planning & Architecture to configure the optimal layout for Baldoyle LRD Development for the aim of achieving a high-quality environment for the scope of use intended of each areas/building (i.e. comfortable and pleasant for potential pedestrian) and not to introduce any critical wind impact on the surrounding areas and on the existing buildings.

- The wind profile was built using the annual average of meteorology data collected at Dublin Airport Weather Station purchased from Meteoblue. The local wind speed was determined from CFD simulations with combination of the parameters inside Weibull probability distribution function, which obtained form historical meteorological data recorded 10m above ground level at Dublin Airport.
- A 12-discrete set of wind direction is used in order to evaluate the probability of exceedance at any given threshold speed. It is found that the prevailing wind direction in the west has the largest contribution of the discomfort exceedance probability.
- Microclimate Assessment of Baldoyle LRD Development and it's environment was performed utilizing a CFD (Computational Fluid Dynamics) methodology.
- The assessment of the proposed scenario has shown that the proposed development meets the Lawson Comfort Criteria where no area is unsafe, and no conditions of distress are created by the proposed development. All the ground amenities proposed can be used for their intended scope. The wind microclimate of the proposed development is comfortable and usable for pedestrians.
- Results of wind speeds and Lawson map at 1.5m above the terrace show that these areas are appropriate for the intended use. Most of the terraces are suitable for standing and sitting. Terraces 1 and 3 are suitable for walking. However, wind conditions at all terraces are within tenable conditions. It is important to note that fluctuations in velocity on rooftop terraces can result in door slamming problems. Therefore, the installation of door actuators is strongly recommended to mitigate the potential issue and to ensure smooth operating of the terrace doors.
- As a result of the proposed development construction, the wind on the surrounding urban context remains suitable for the intended use when compared with the baseline situation.
- The proposed development does not impact or give rise to negative or critical wind speed profiles at the nearby adjacent roads, or nearby buildings. Moreover, in terms of distress, no critical conditions were found for "Frail persons or cyclists" and for members of the "General Public" in the surrounding of the development.
- As a result of the construction of cumulative buildings in the future, the wind conditions

on the surrounding urban context remains the same when compared with the proposed development situation. The cumulative buildings will have a negligible effect on the surrounding wind microclimate.

Therefore, the CFD study carried out has shown that under the assumed wind conditions typically occurring within Dublin for the past 15 years:

- **The development is designed to be a high-quality environment for the scope of use intended of each areas/building (i.e. comfortable and pleasant for potential pedestrian), and,**
- **The development does not introduce any critical impact on the surrounding buildings, or nearby adjacent roads.**

11. REFERENCES

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