

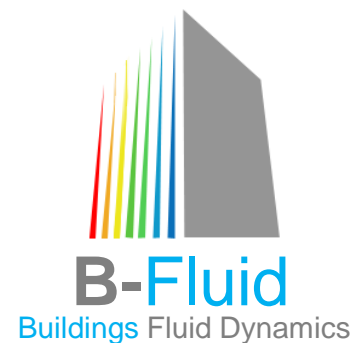
# WIND MICROCLIMATE MODELLING

Chadwicks Development

Santry, Dublin 9

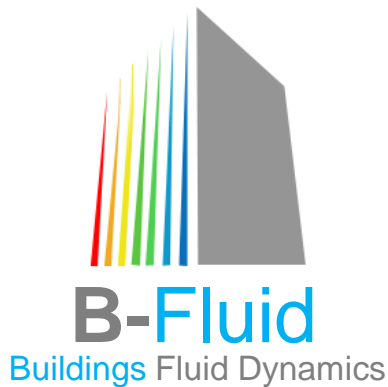
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For: Armstrong Fenton Associates



Document Reference	
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CFD Study by	B-Fluid Ltd.
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# 1. INTRODUCTION

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B-Fluid Limited has been commissioned by 'Armstrong Fenton Associates' to perform a Wind Microclimate Study for the Chadwicks Development in at the junction of Santry Avenue and Swords Road, Santry, Dublin 9.

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



Figure 1.1: Proposed Chadwicks Development

This report is completed by Dr. Cristina Paduano, Dr. Patrick Okolo and Dr. Arman Safdari.

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 10 years experience. She holds a PhD in Mechanical Engineering from Trinity College Dublin, with M.Eng and B.Eng in Aerospace Engineering.

Dr. Patrick Okolo is a Chartered Engineer (CEng) and member of Engineers Ireland who specialises in computational fluid dynamics applications for the urban environment and in wind tunnel measurements for the aerospace industry. He holds a PhD in Aeroacoustics from Trinity College Dublin, a M.Sc. and B.Sc. in Mechanical Engineering.

Dr. Arman Safdari is a 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.

A Wind Microclimate Study identifies the possible wind patterns that form when wind moves through a built environment and evaluates how a new development is going to modify

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those patterns. Wind Microclimate is defined as the wind flow experienced by people and the subsequent influence it has on their activities. Wind can accelerate or re-circulate through buildings in such a way to compromise the comfort/safety of pedestrians and the capacity of using the public realm/ external places in accordance with their designated intended use.

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 this to predicting under which wind speeds pedestrians will be exposed and what level of comfort pedestrian 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.

## 1.1 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 2020) 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 1.2.

Building Height	Recommended Approach to Wind Microclimate Studies
Similar or lower than the average height of surrounding buildings <b>Up to 25m</b>	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 <b>25m to 50m</b>	Computational (CFD) Simulations <b>OR</b> Wind Tunnel Testing
Up to 4 times the average height of surrounding buildings <b>50m to 100m</b>	Computational (CFD) Simulations <b>AND</b> Wind Tunnel Testing
High Rise <b>Above 100m</b>	<b>Early Stage Massing Optimization:</b> Wind Tunnel Testing <b>OR</b> Computational (CFD) Simulations  <b>Detailed Design:</b> Wind Tunnel Testing <b>AND</b> Computational (CFD) Simulations to demonstrate the performance of the final building design

Figure 1.2: 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 2020)



## 1.2 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 16.3 shows the wind velocity profile, as described above.

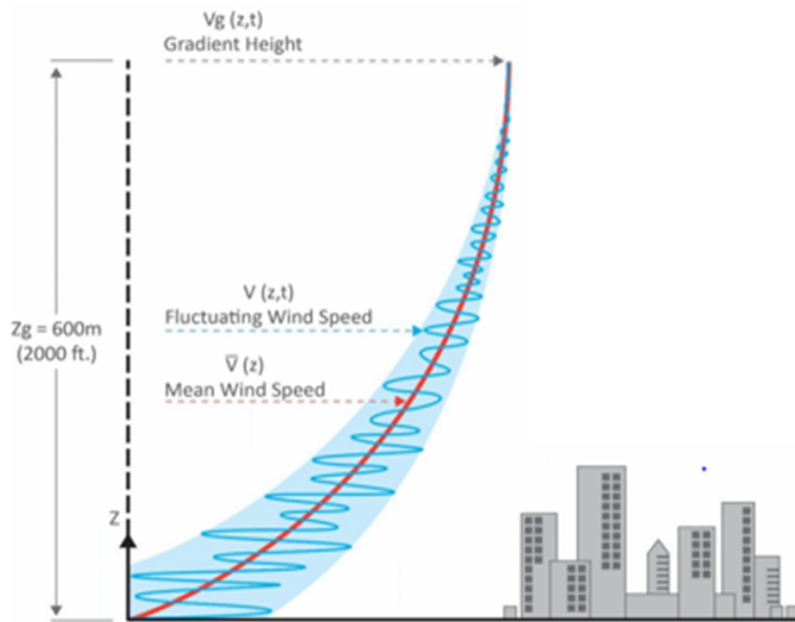


Figure 1.3: Wind Velocity Profile

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 (see Figure 16.4). This patterns effects 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 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.

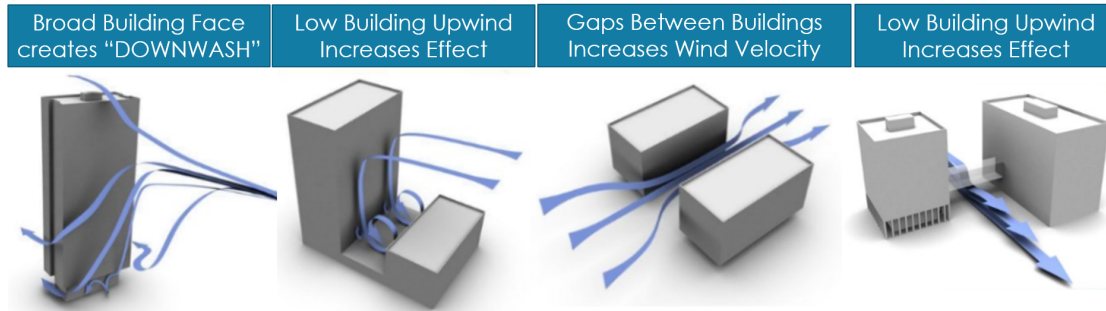


Figure 1.4: Parameters to know for Wind Conditions Assessment

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.

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## 2. ASSESSMENT METHODOLOGY

## 2.1 ASSESSMENT METHODOLOGY

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 in the Existing 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 400m from the centre of the site. 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 2.1: Area of interest to be modelled

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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 CFD 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.

### 2.1.1 ACCEPTANCE CRITERIA for PEDESTRIAN COMFORT and DISTRESS

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 and a

gust speed of 28 m/s (62 mph) to be exceeded less often than once a 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 and a gust speed of 37 m/s (83 mph) to be exceeded less often than once a year. Beyond this gust speed, aerodynamic forces approach body weight and it rapidly becomes impossible for anyone to remain standing. Where 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 2.6. 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.


Beaufort Scale	Wind Type	Mean Hourly Wind Speed (m/s)		Acceptance Level Based on Activity–Lawson Criteria				
				Sitting	Standing/ Entrances	Leisure Walking	Business Walking	
0-1	Light Air	0 – 1.55	COMFORT	Acceptable	Tolerable	Not acceptable	Dangerous	
2	Light Breeze	1.55 - 3.35		Acceptable	Tolerable	Not acceptable	Dangerous	
3	Gentle Breeze	3.35 - 5.45		Acceptable	Tolerable	Not acceptable	Dangerous	
4	Moderate	5.45 - 7.95		Acceptable	Tolerable	Not acceptable	Dangerous	
5	Fresh Breeze	7.95 - 10.75		Acceptable	Tolerable	Not acceptable	Dangerous	
6	Strong Breeze	10.75 - 13.85		Acceptable	Tolerable	Not acceptable	Dangerous	
7	Near Gale	13.85 - 17.15		Acceptable	Tolerable	Not acceptable	Dangerous	
8	Gale	17.15 - 20.75	DISTRESS	Dangerous	Dangerous	Dangerous	Dangerous	
9	Strong Gale	20.75 - 24.45		Dangerous	Dangerous	Dangerous	Dangerous	
Legend				Acceptable	Tolerable	Not acceptable	Dangerous	

Figure 2.2: 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.

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

Figure 2.3: Lawson Categories Scale - Comfort

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

Figure 2.4: Lawson Categories Scale - Distress/Safety

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

### 2.1.2 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 2.5: Significance Criteria for On-site Receptors



Significance	Trigger	Mitigation required?
Major Adverse	<p>Conditions that were “safe” in the baseline scenario became “unsafe” as a result of the Proposed Development.</p> <p><i>OR</i></p> <p>Conditions that were “suitable” in terms of comfort in the baseline scenario became “unsuitable” as a result of the Proposed Development.</p> <p><i>OR</i></p> <p>Conditions that were “unsafe” in the baseline scenario are made worse as a result of the Proposed Development.</p>	Yes
Moderate Adverse	<p>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.</p>	No
Negligible	<p>Conditions remain the same as in the baseline scenario.</p>	No
Major Beneficial	<p>Conditions that were “unsafe” in the baseline scenario became “safe” as a result of the Proposed Development.</p>	No
Moderate BeneficialPotential REceptors	<p>Conditions that were “unsuitable” in terms of comfort in the baseline scenario became “suitable” as a result of the Proposed Development.</p> <p><i>OR</i></p> <p>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”).</p>	No

Figure 2.6: Significance Criteria for Off-site Receptors

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## 3. CFD MODELLING METHOD

### 3.1 CFD MODELLING METHOD

The wind microclimate study is conducted through Computational Fluid Dynamics (CFD). This 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. Wind flow is described by Navier-Stokes equations which are solved within the CFD analysis using a finite volume algorithm based on the volumetric mesh/grid in which the geometry is divided. CFD modelling includes three main stages: pre-processing, simulation, and post-processing as described in the image that follows.

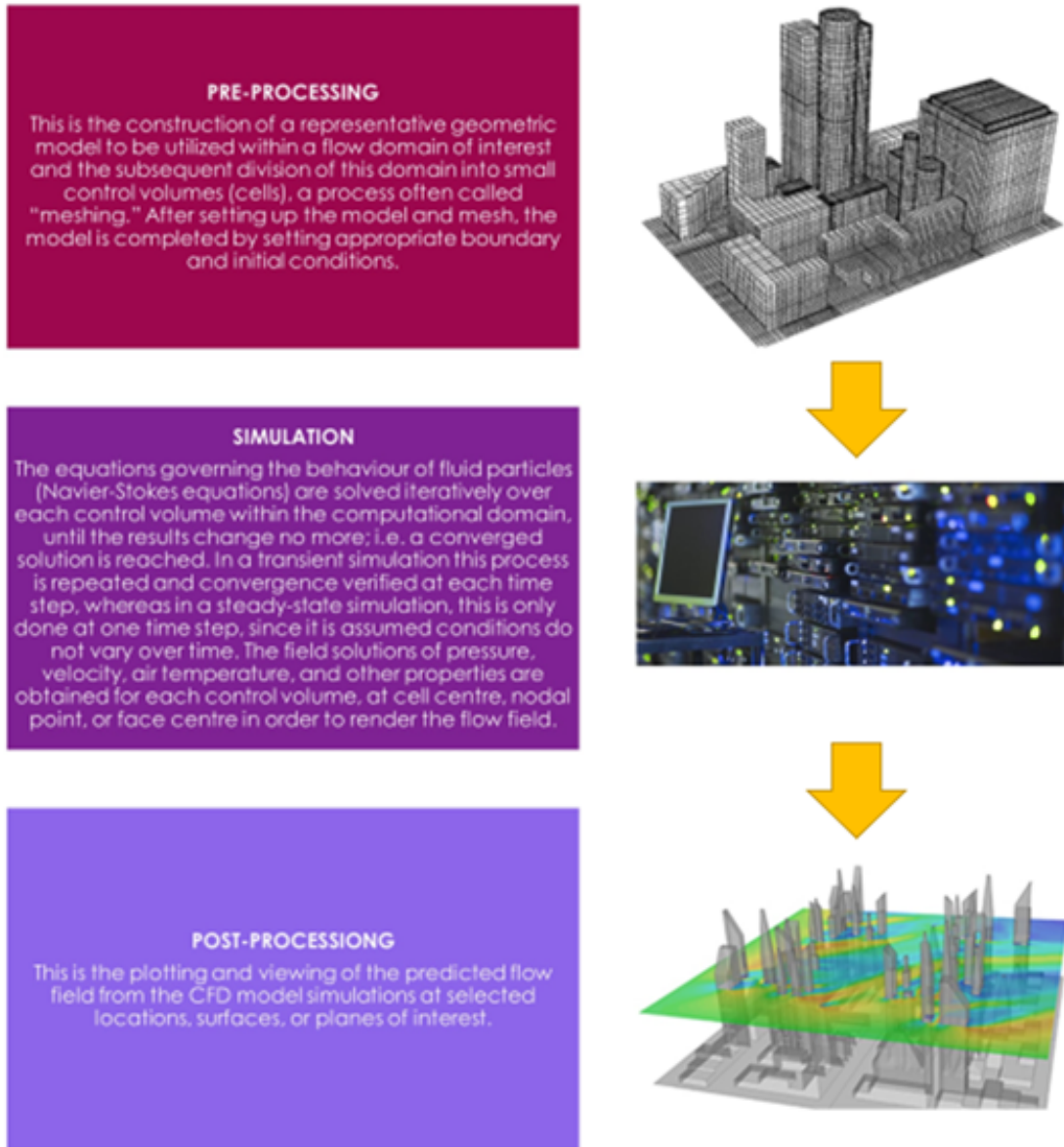


Figure 3.1: CFD Modelling Procedure Concept

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## 3.2 CFD SOFTWARE DETAILS

The analysis of this chapter employs OpenFoam Code, which is based on a volume averaging method of discretization and uses the post-processing visualisation toolkit Paraview version 5.5. OpenFoam is a CFD software code 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 CFD code has capabilities of utilizing a Reynolds Averaged Navier-Stokes (RANS) approach, Unsteady Reynolds Averaged Navier-Stokes (URANS) approach, Detached Eddy Simulation (DES) approach, Large Eddy Simulation (LES) approach or the Direct Numerical Simulation (DNS) approach, which are all used to solve anything from complex fluid flows involving chemical reactions, turbulence and heat transfer, to acoustics, solid mechanics and electromagnetics.

Quality assurance is based on rigorous testing. The process of code evaluation, verification and validation includes several hundred daily unit tests, a medium-sized test battery run on a weekly basis, and large industry-based test battery run prior to new version releases. Tests are designed to assess regression behaviour, memory usage, code performance and scalability.

The OpenFOAM solver algorithm directly solves the mass and momentum equations for the large eddies that comprise most of the fluid's energy. By solving the large eddies directly no error is introduced into the calculation.

To reduce computational time and associated costs the small eddies within the flow have been solved using the widely used and recognised Smagorinsky Sub-Grid Scale (SGS) model. The small eddies only comprise a small proportion of the fluids energy therefore the errors introduced through the modelling of this component are minimal. The error introduced by modelling the small eddies can be considered of an acceptable level. Computational time will be reduced by modelling the small eddies (compared to directly solving).

## 3.3 CFD MODEL DETAILS

This section describes all features included in the geometrical and physical representation of Chadwicks Development CFD model. Any object which may have significant impact on wind movement and circulation are represented within the model. To be accurate, the structural layout of the building being modelled should include only the obstacles, blockages, openings and closures which can impact the wind around the building. It is important to remember that a CFD simulation approximates reality, so providing more details of the geometry within the model will not necessarily increase the understanding of the bulk flows in the real environment.

### Modelled Geometry

A 3D view of the proposed development massing model in the domain is presented in Figures 3.2 and 3.3.

The modelled layout and dimensions of the surrounding environment are outlined in the

table below (Table 3.1).

In order to represent reality and consider the actual wind impacting on the site, the modelled area for the wind modelling study comprises a wider urban area of 400m radius around the Chadwicks Development, as shown.

	MODELLED CFD ENVIRONMENT DIMENSIONS		
	Width	Length	Height
CFD Mesh Domain	1500m approx	1500m approx	60m approx

Table 3.1: Modelled Environment Dimensions

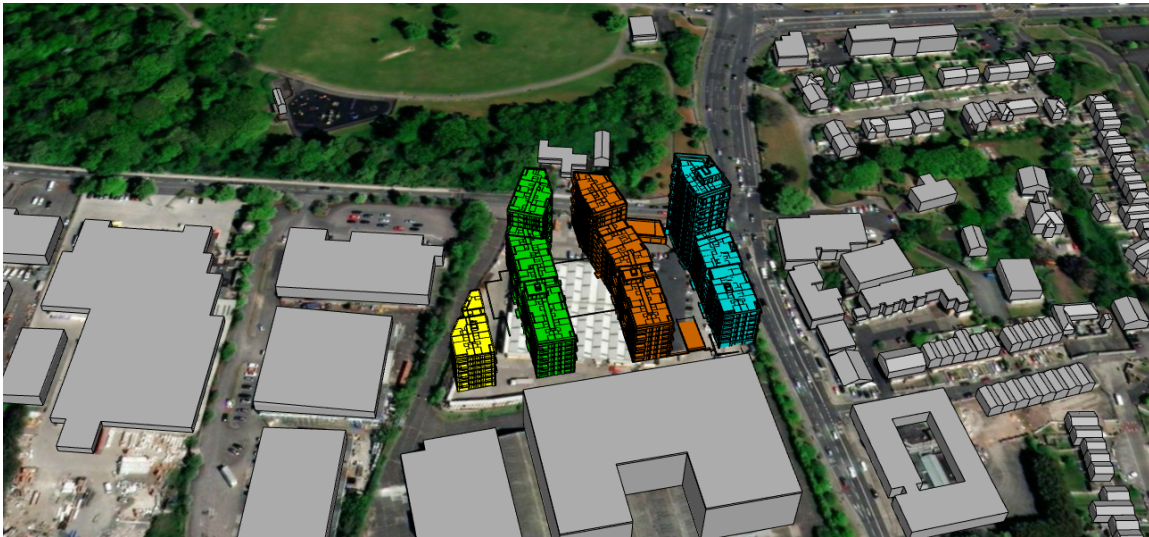


Figure 3.2: 3D View of the Proposed Chadwicks Development and Adjacent Buildings - South Side View



Figure 3.3: 3D View of the Proposed Chadwicks Development and Adjacent Buildings - North Side View

### Boundary Conditions

A rectangular computational domain was used for the analysis. The wind directions were altered without changing the computational mesh. For each simulation scenario, an initial wind velocity was set according to the statistical weather data collected in order to consider the worst case scenario. Building surfaces within the model are specified as ‘no slip’ boundary conditions. This condition ensures that flow moving parallel to a surface is brought to rest at the point where it meets the surface. Air flow inlet boundaries possess the ‘Inlet’ wind profile velocity patch boundary condition with its appropriate inflow turbulence intensity and dissipation rates. Air exits the domain at the ‘pressure outlet’ boundary condition.

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:

$$v_2 = v_1 \cdot \frac{\ln \frac{h_2}{z_0}}{\ln \frac{h_1}{z_0}} \quad (3.1)$$

where:

- $v_1$  = wind speed measured at the reference height  $h_1$
- $h_1$  = reference height to measure  $v_1$
- $h_2$  = height of the wind speed  $v_2$  calculated for the wind profile
- $z_0 = 0.4$  [m] roughness length selected

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## Computational Mesh

The level of accuracy of the CFD results are determined by the level of refinement of the computational mesh. Details of parameters used to calculate the computational mesh are presented in Table 3.2. Figure 3.4 shows the mesh utilised in the simulations.

The grid follows the principles of the ‘Finite Volume Method’, which implies that the solution of the model equations is calculated at discrete points (nodes) on a three-dimensional grid, which includes all the flow volume of interest. The mathematical solution for the flow is calculated at the center of each of these cells and then an interpolation function is used by the software to provide the results in the entire domain.

PARAMETERS TO CALCULATE COMPUTATIONAL MESH	
Air Density $\rho$	$1.2\text{kg}/\text{m}^3$
Ambient Temperature (T)	$288\text{K}(\text{approx.}15\text{C}^\circ)$
Gravity Acceleration (g)	$9.8\text{m}/\text{s}^2$
$dx$	0.5 m at the building 1m in the surroundings 2m elsewhere
Background Mesh cells ratio	1:1
Total mesh size	Approx. cells number = 10 million

Table 3.2: Parameters To Calculate Computational Mesh

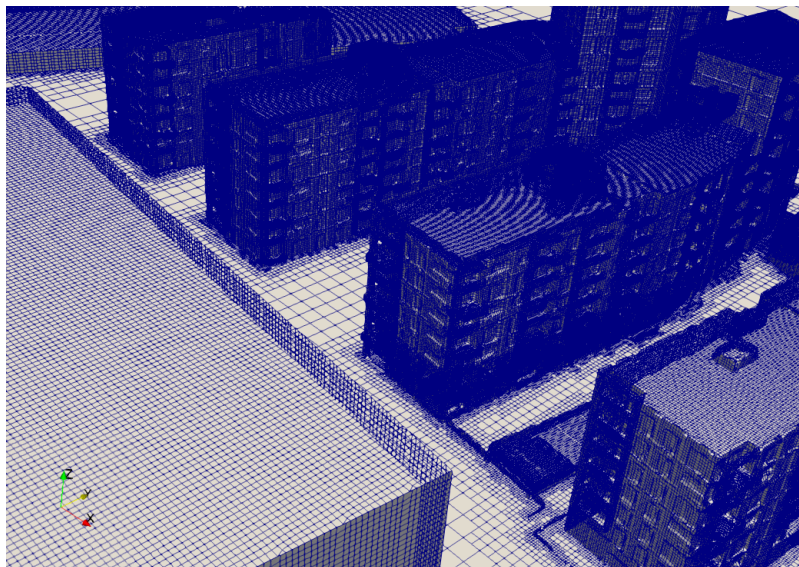


Figure 3.4: Chadwicks Domain Computational Mesh Utilized

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## 4. LOCAL WIND CLIMATE



## 4.1 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 30 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.



Figure 4.1: Existing Receiving Environment (Baseline Situation)

### Site Location And Surrounding Area

Chadwicks Development will be situated in at the junction of Santry Avenue and Swords Road, Santry, Dublin 9. The Existing Environment site is shown in Figure 4.2. The area considered for the existing environment and proposed development assessment comprises a 3km<sup>2</sup> area around the Chadwicks Development as represented in Figure 4.3.

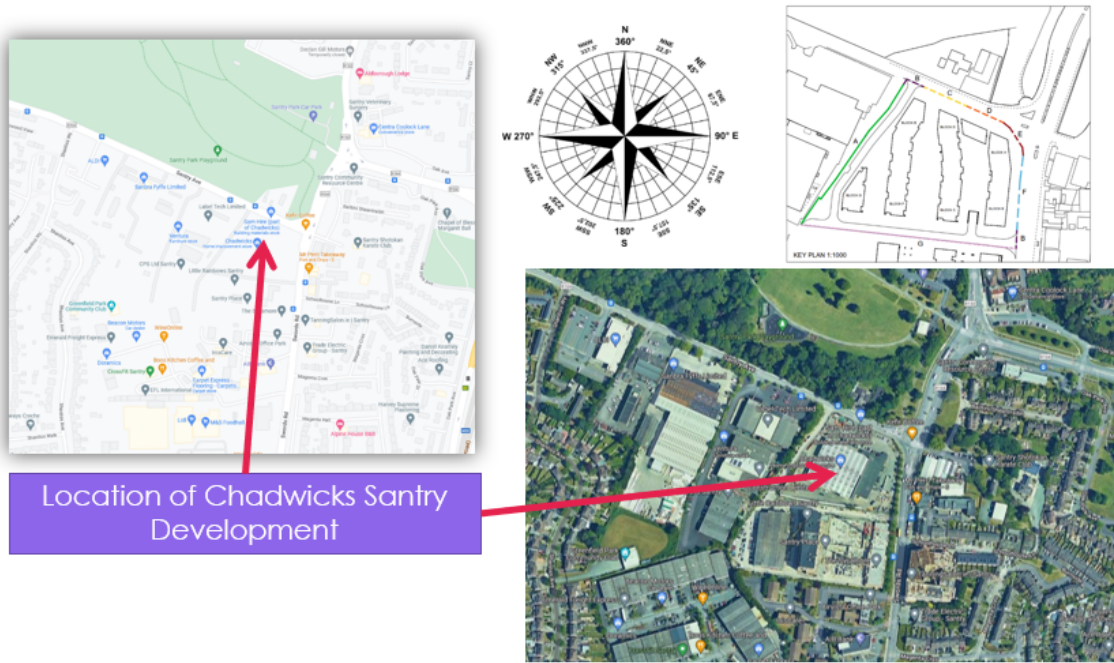


Figure 4.2: Chadwicks Development Site Location and Existing Environment



Figure 4.3: Extents of Analysed Existing Environment Around Chadwicks Development

### Topography And Built In Environment

Figure 4.4 shows an aerial photograph of the terrain surrounding the construction site at Chadwicks Development.

The Chadwicks Site is located in Santry, Dublin 9. The site is located at the junction of Santry Avenue to the north and Swords Road to the east. To the south it borders the the permitted Santry Place development (granted under Dublin City Council Reg. Ref.:

2713/17 and 2737/19), and to the west by the Santry Avenue Industrial Estate. The area surrounding the site can be characterised as urban environment.



Figure 4.4: Built-in Environment Around Construction Site at Chadwicks Development

### 4.1.1 LOCAL WIND CONDITIONS

This analysis consider 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 4.5 shows on the map the position of Chadwicks Development and the position of Dublin Airport.

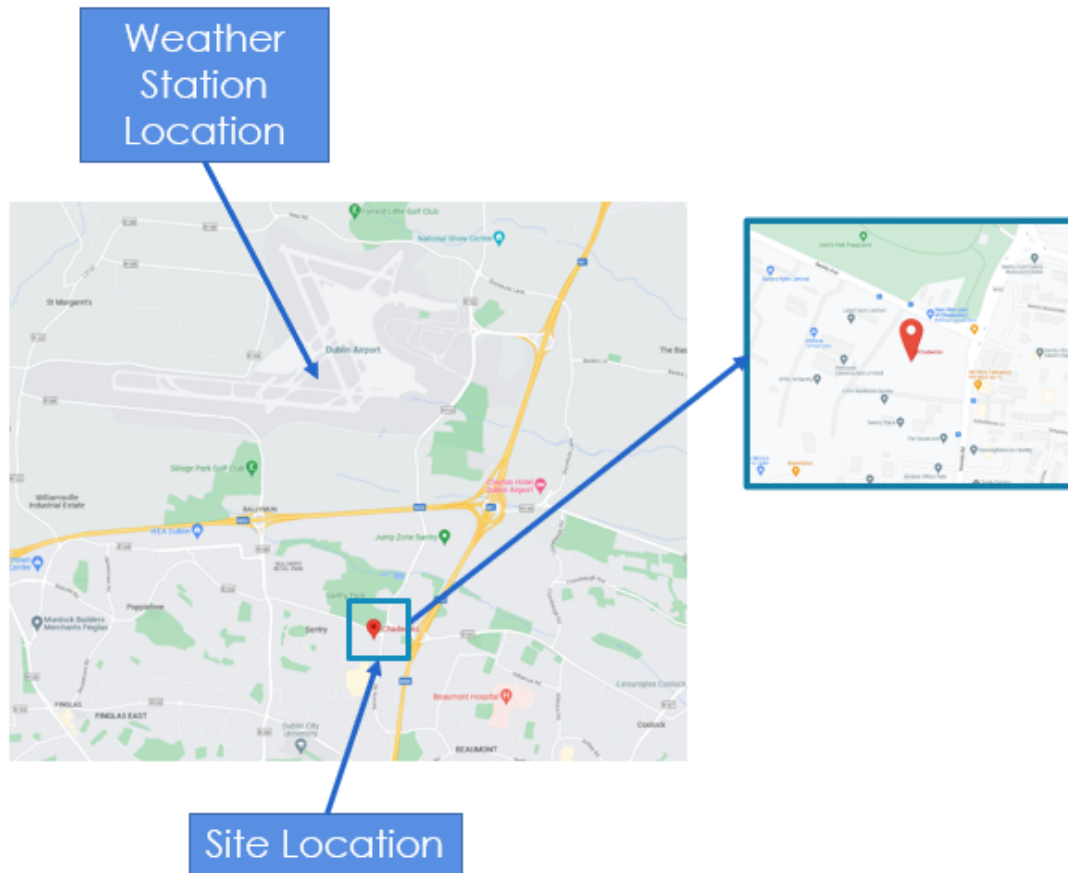


Figure 4.5: Map showing the position of Chadwicks Development and Dublin Airport

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

- *Terrain:* The meteorological station is located in the flat open terrain of the airport, whereas the development site is located in urban area with built-in structure with buildings of at least 10m height in average.
- *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

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the dominating wind directions throughout a year (annual wind statistic).

As stated above, the local wind climate is determined from historical meteorological data recorded at Dublin Airport. Two different data sets are analyzed for this assessment as follows:

- The meteorological data associated with the maximum daily wind speeds recorded over a 30 year period between 1990 and 2020 and,
- The mean hourly wind speeds recorded over a 10 year period between 1990 and 2020. The data is recorded at a weather station at the airport, which is located 10m above ground or 71mOD.

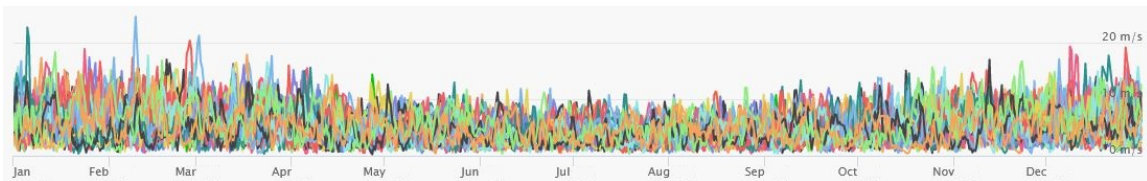


Figure 4.6: Local Wind Conditions - Wind Speed - 1990-2020

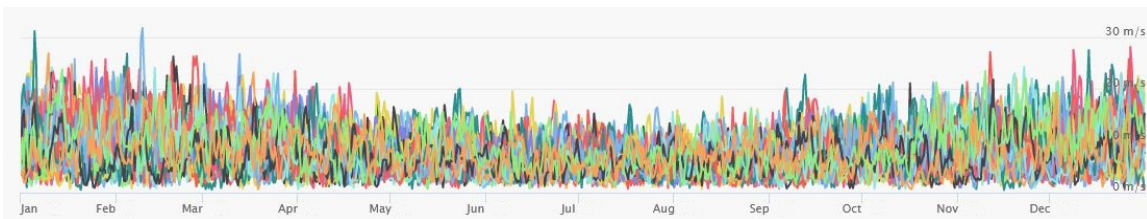


Figure 4.7: Local Wind Conditions - Wind Gust - 1990-2020

Figure 4.8, presenting the wind speed diagram for Dublin, shows the days per month, during which the wind reaches a certain speed. In Figure 4.9, the wind rose for Dublin shows how many hours per year the wind blows from the indicated direction, confirming how the predominant directions are WSW, W, and SW.

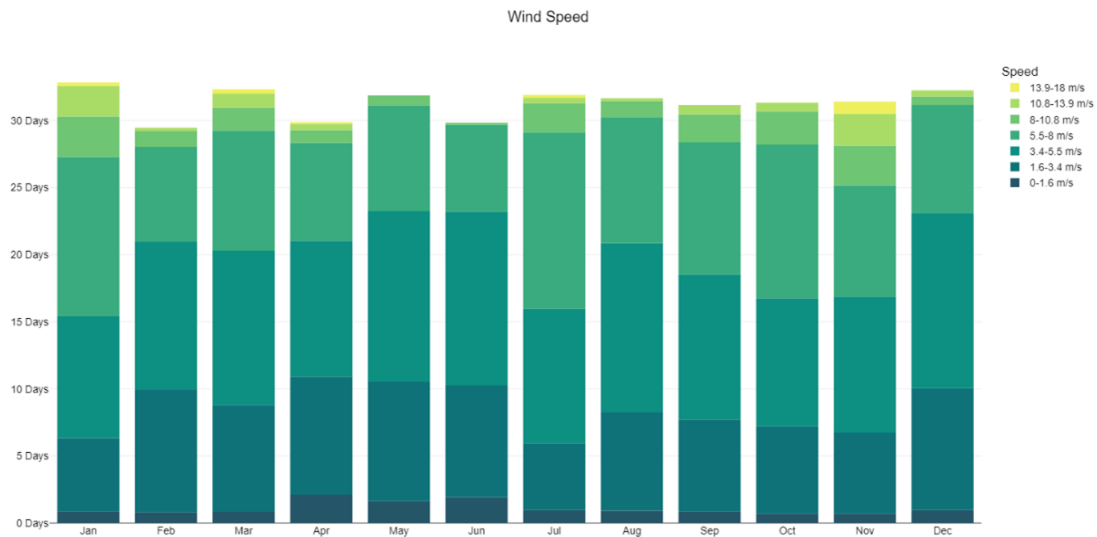


Figure 4.8: Dublin Wind Speed Diagram

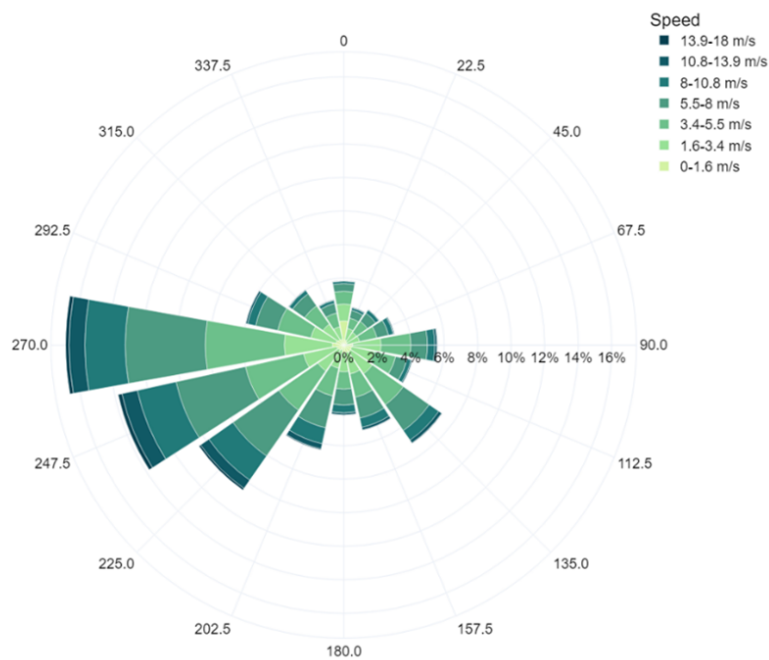


Figure 4.9: Dublin Wind Rose

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.

The table that follows reports all the wind directions and their correspondent velocity,

displayed in order of frequency of occurrence with those most frequent on the top. As it can be noted, the wind at the site is mostly blowing (higher frequency of occurrence) from the South-West (225deg) direction with a wind velocity of approximately 5m/s. A similar wind speed is blowing also from the South-South-West direction (213deg), however the frequency of occurrence of this wind is less than 5 percent(only 3.288 percent of the times, as indicated in the table) therefore, this wind is not relevant for the scope of performing the pedestrian comfort and distress analysis as per Lawson Criteria.

BASELINE WIND SPEEDS, DIRECTIONS and FREQUENCY OF OCCURENCE		
Velocity (m/s)	Direction (deg)	Frequency(%)
5.601	225	11.233 (> 5%)
4.626	135	6.849 (> 5%)
5.847	236.25	6.792 (> 5%)
6.049	258.75	6.747 (> 5%)
6.034	247.5	6.689 (> 5%)
5.888	270	5.662 (> 5%)
4.994	315	4.338
5.503	281.25	3.904
4.974	292.5	3.436
5.357	213.75	3.288
4.736	123.75	3.105
4.406	146.25	2.751
5.101	303.75	2.648
5.246	112.5	2.500
4.121	157.5	2.386
4.581	101.25	2.340
4.169	45	2.180
3.558	90	2.135

Figure 4.10: Main Wind Directions Occurrence Frequency

For assessing the wind microclimate for the proposed development, the study has considered the site exposed to all the wind directions which exceed the 5 percent of frequency, as required for the Lawson Criteria and some additional high-speed winds, which are occurring less often (below 5 percent of the times) but that can cause distress conditions because of their speed. On this basis, the wind scenarios to be considered for the wind microclimate assessment are presented Figure 4.11

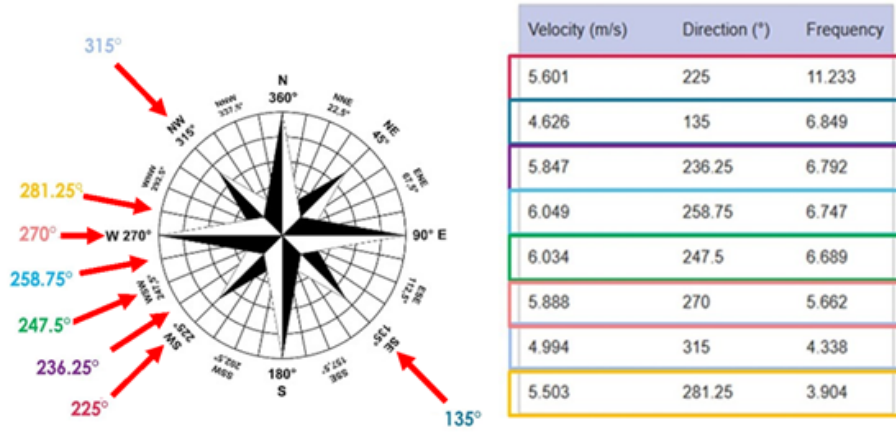


Figure 4.11: Main Wind Directions Occurrence Frequency



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## **5. CHARACTERISTICS OF THE PROPOSED DEVELOPMENT**

## 5.1 DESCRIPTION OF PROPOSED DEVELOPMENT

The subject site is approximately 1.5 hectares in size. It is located at the junction of Santry Avenue to the north and Swords Road to the east. To the south it borders the the permitted Santry Place development (granted under Dublin City Council Reg-Ref 2713/17 and 2737/19), and to the west by the Santry Avenue Industrial Estate. The lands subject to this planning application, are currently occupied by Chadwick's (former Heiton Buckley) builder's providers. Figure 5.2 shows a view of the proposed development.

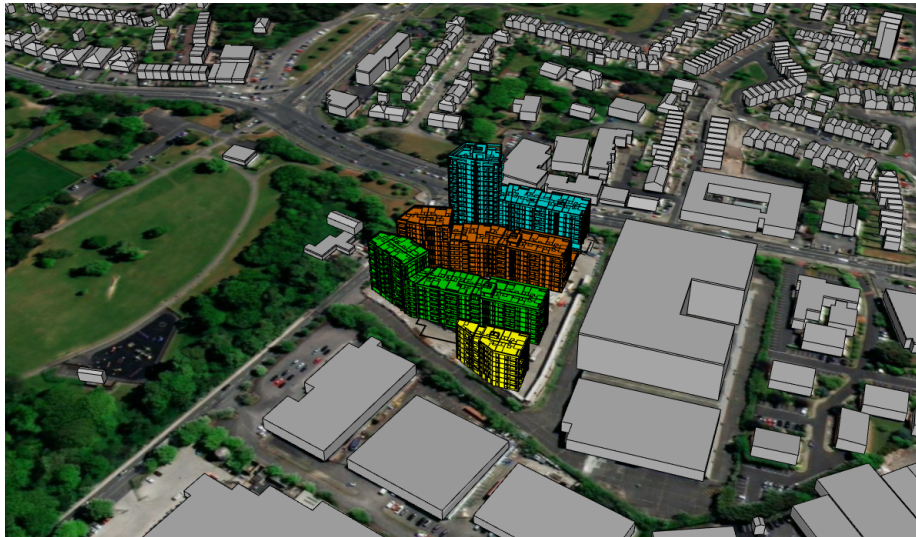


Figure 5.1: Proposed Chadwick's Development



Figure 5.2: Proposed Chadwick's Development (Blocks)

### 5.1.1 POTENTIAL RECEPTORS

Potential receptors for the wind assessment are all pedestrian circulation routes, building entrances and leisure open areas within the site and in neighboring adjacent areas. The pedestrian level is considered at 1.5m above ground.

In addition to the roads and entrances, some sensitive receptors for this assessment are discussed below, these areas are designed for public use activities such as for long term sittings and need to be particularly comfortable/safe.

The public open space is designed as a sequence of spaces: a large central lawn area accommodates active and passive recreation while smaller sub-spaces enclosed by vegetation and tree planting result in a garden-like environment.

A strong sense of enclosure permeates throughout, creating a comfortable, secure setting for residents and visitors. The main circulation meanders through the various landscape typologies creating an attractive car-free alternative to the footpath along Swords Road. A small plaza space with a café and outdoor seating area is located to the north, acting as a fulcrum for intersecting pedestrian circulation coming from Santry Park and the wider area.

Pedestrian routes and open spaces have been deliberately divorced from vehicular traffic, in order to maximise human interaction with open space rather than road-scape.

Figure 5.4 shows the Main Public Open Space and the Public Realm which are considered sensitive potential receptors for the wind microclimate.

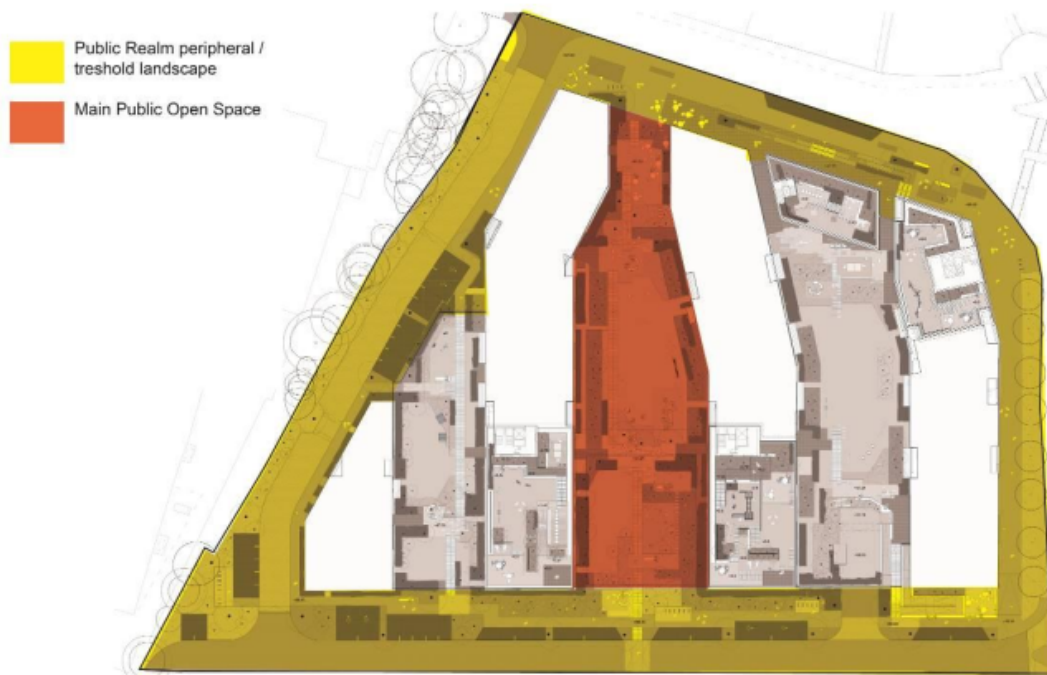


Figure 5.3: Proposed Chadwicks Development -Potential Receptors - Public Area and Public Open Space

Furthermore, Communal Open Space for the proposed apartments is located between the building blocks (Ground Level) and on the roof terraces (Roof Level). The proposed development caters for resident's amenity at roof level, delivering a complementary experience framed by long distance views. Tall hedges, screens and dense tree planting in key areas provide a sense of enclosure and serve as wind breaks without interrupting the spatial flow of the terraces and creating favorable microclimate suitable for long-term and short-term recreation.

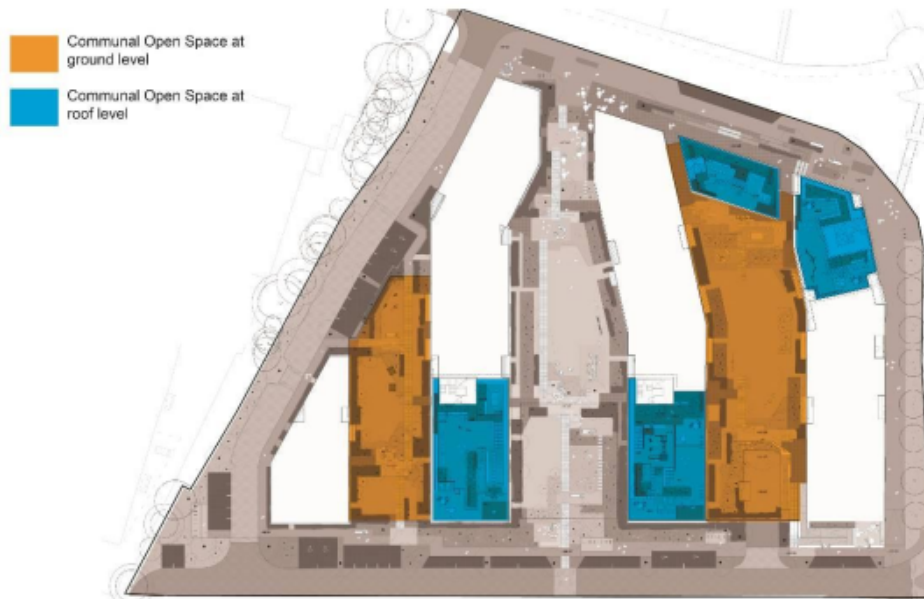


Figure 5.4: Proposed Chadwicks Development - Potential Receptors - Communal Open Space at Ground and at Roof Level

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## 6. BASELINE WIND MICROCLIMATE

## 6.1 BASELINE SCENARIO

The wind microclimate of the baseline scenario is defined by the wind patterns that develop on the site and its 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 area to its prescribed level of usage and activity.



Figure 6.1: CFD Model of the Baseline Scenario

### 6.1.1 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 6.2 to 6.17 in order to assess wind flows at ground floor level of Chadwicks Development.

Wind flow speeds are shown to be within tenable conditions. Some higher velocity indicating minor existing funnelling effects are found near the South-West side.

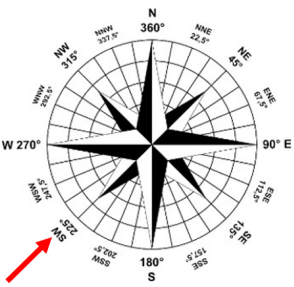
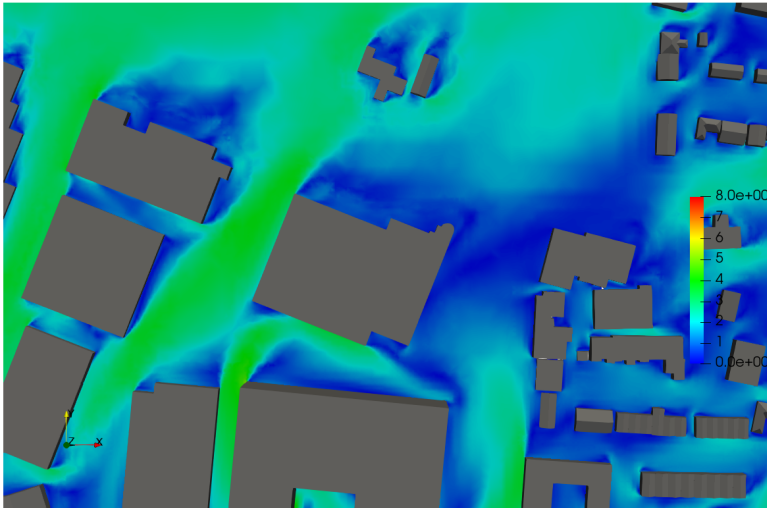


Figure 6.2: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 225°

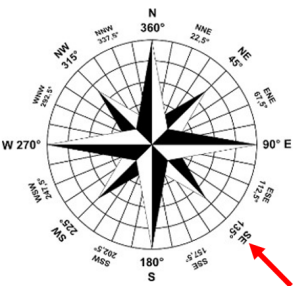
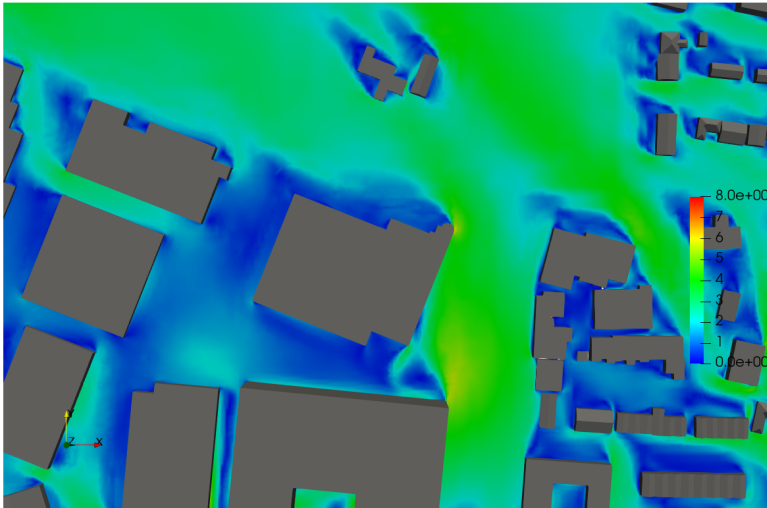


Figure 6.3: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 135°

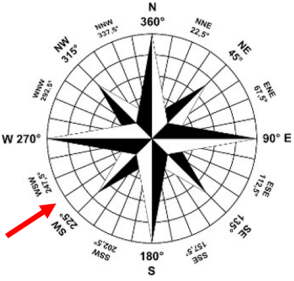
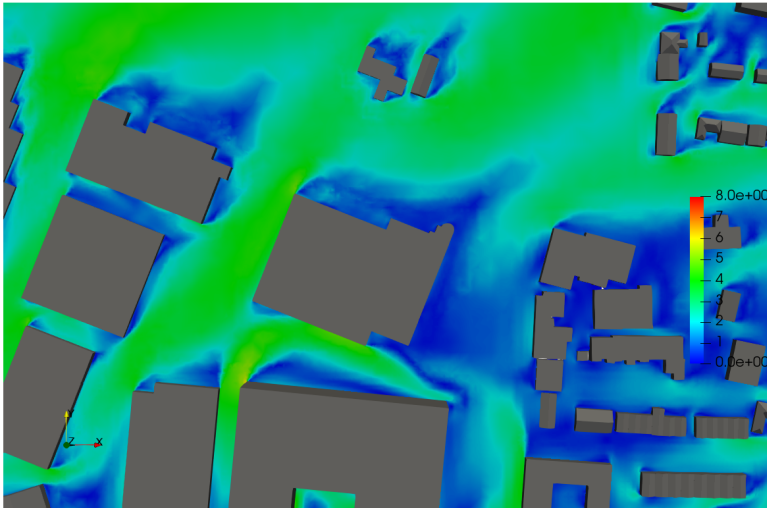


Figure 6.4: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 236°

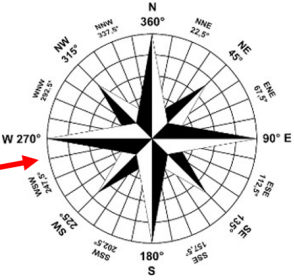
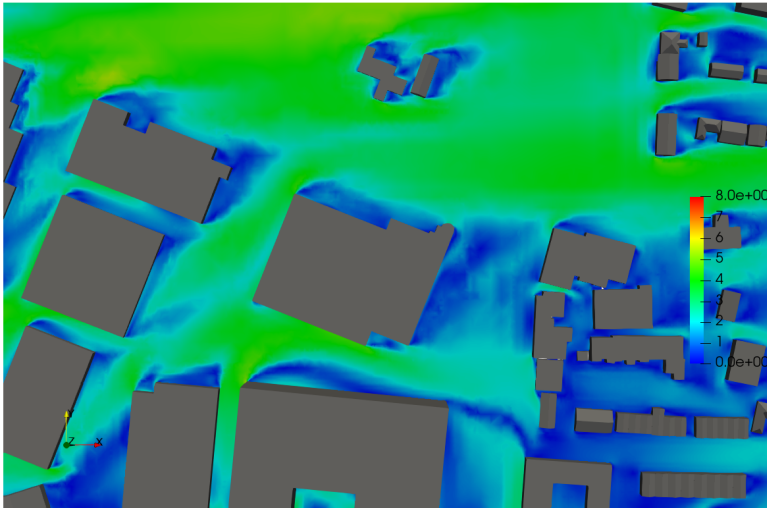


Figure 6.5: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 258°



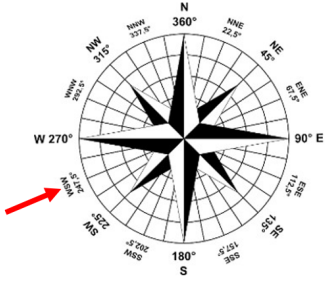
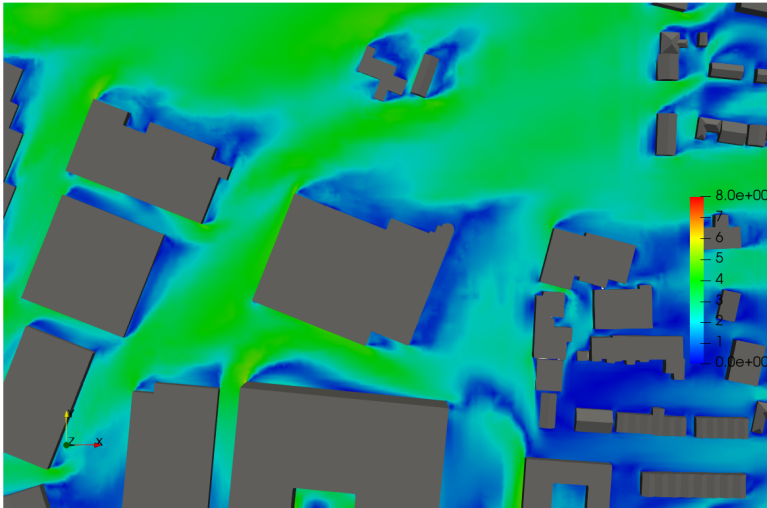


Figure 6.6: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 247°

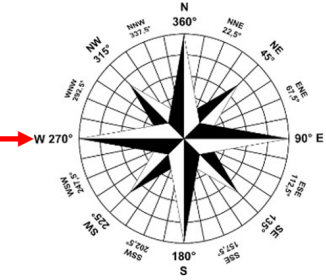
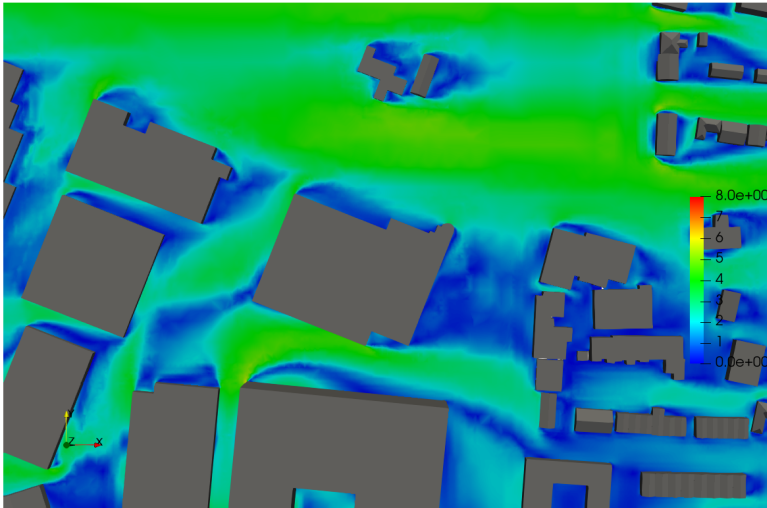


Figure 6.7: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 270°

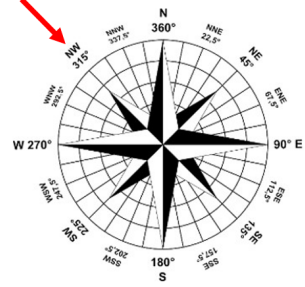
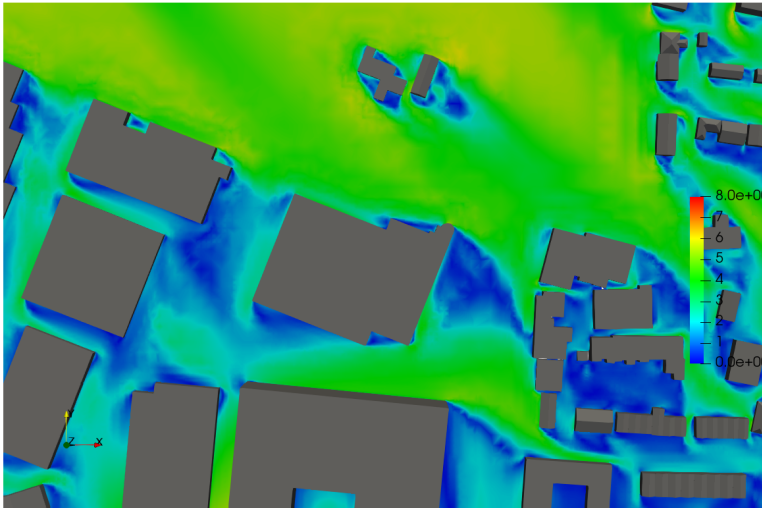


Figure 6.8: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 315°

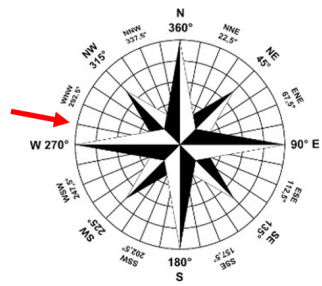
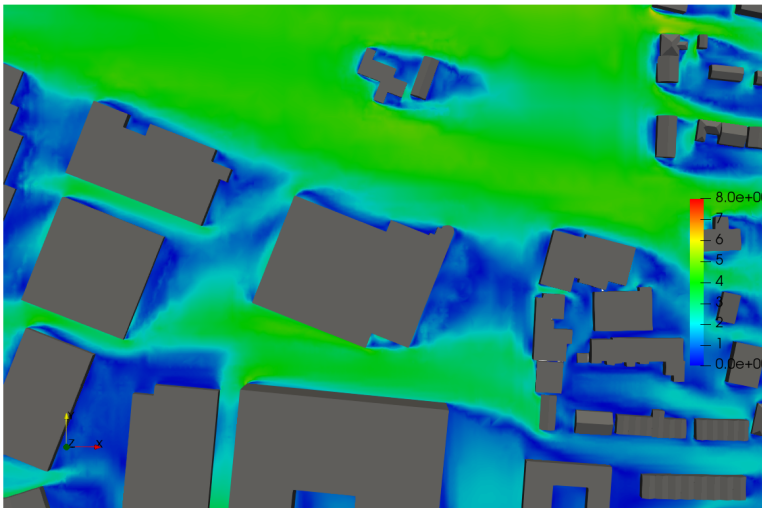


Figure 6.9: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 281°

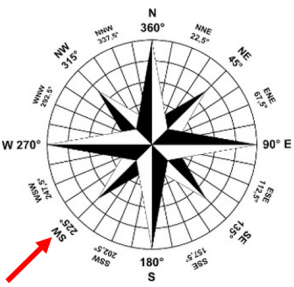
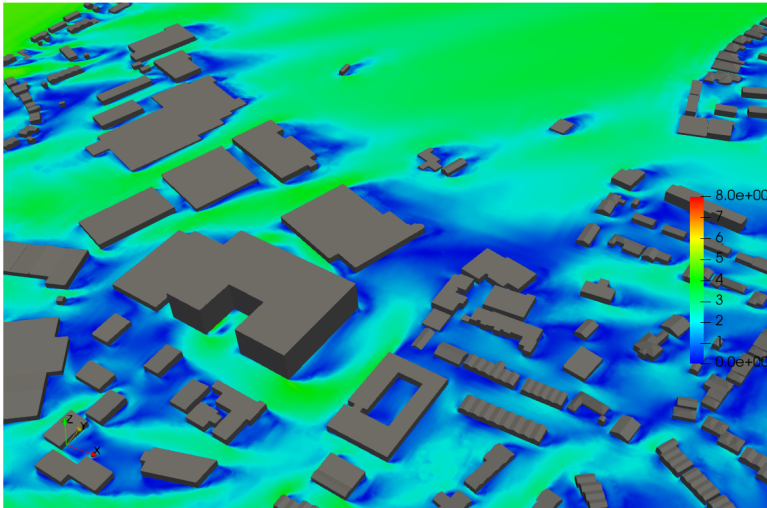


Figure 6.10: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 225°

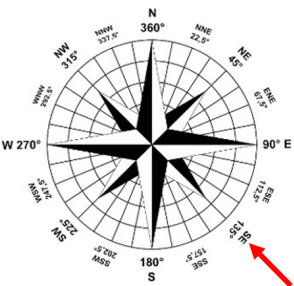
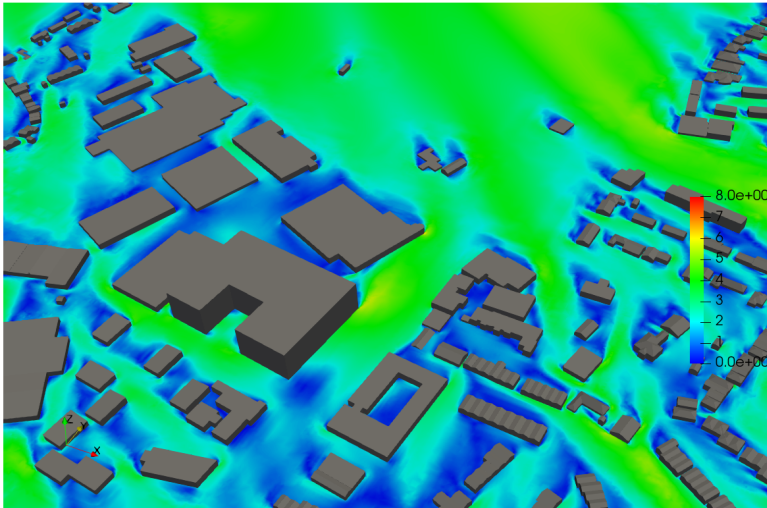


Figure 6.11: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 135°

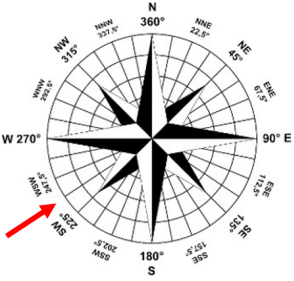
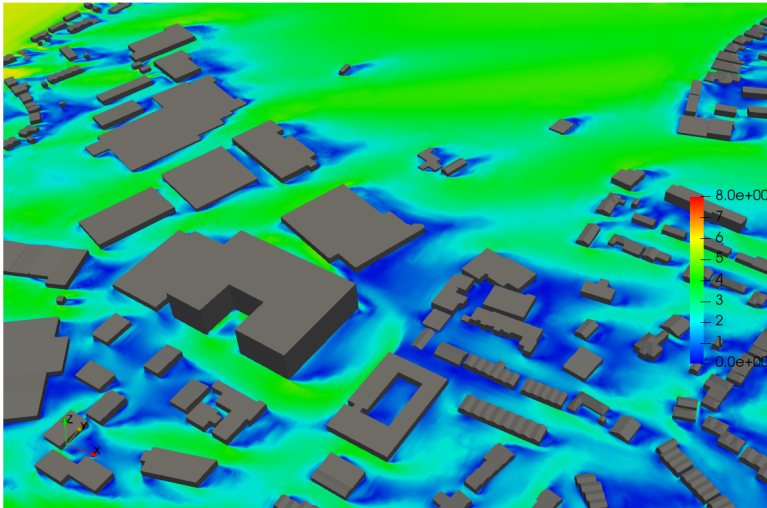


Figure 6.12: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 236°

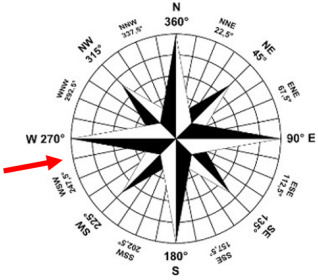
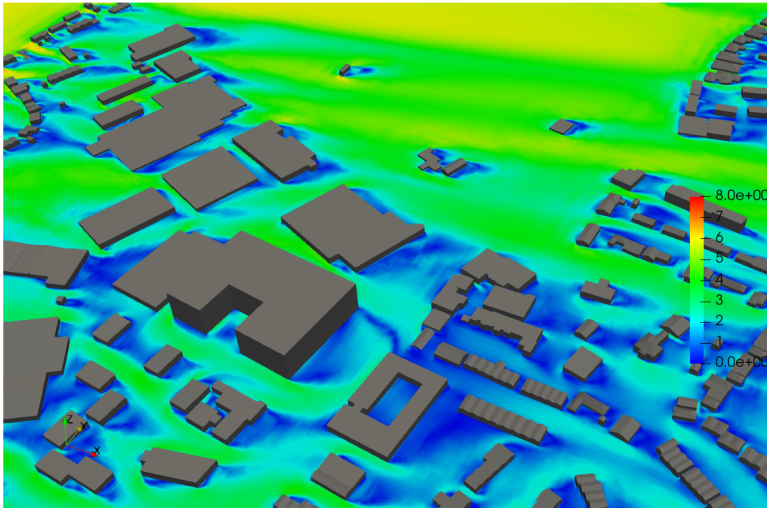


Figure 6.13: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 258°

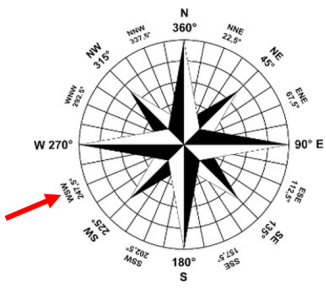
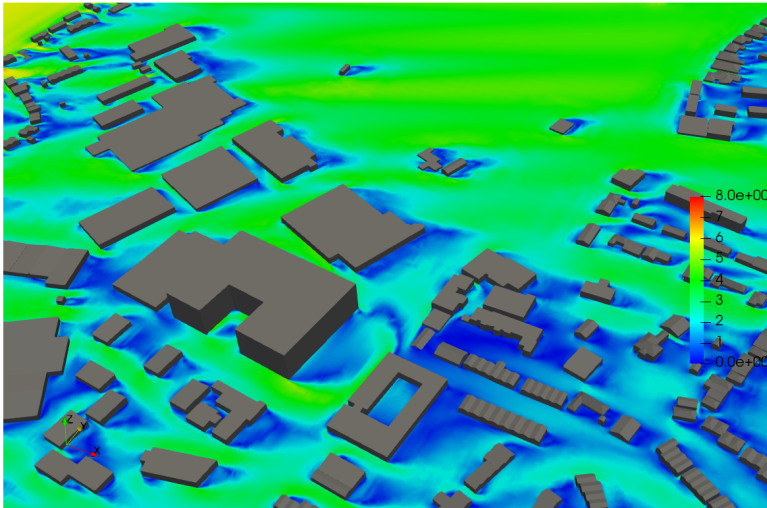


Figure 6.14: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 247°

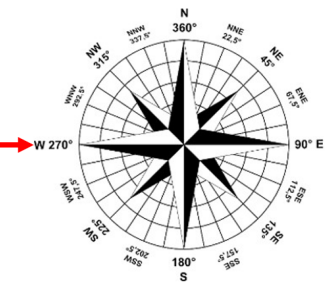
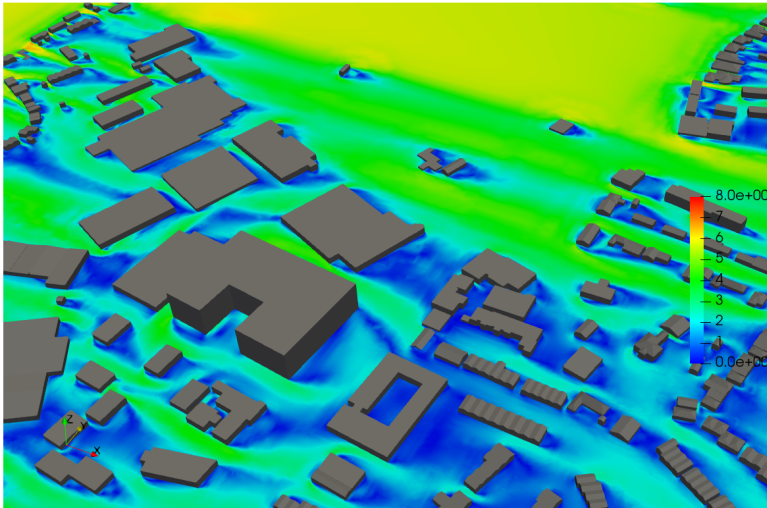


Figure 6.15: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 270°

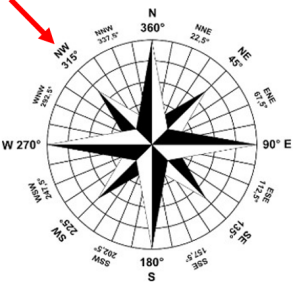
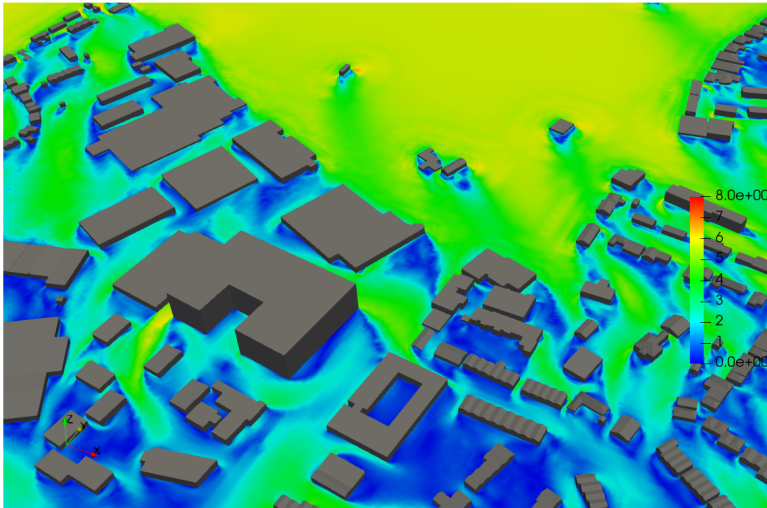


Figure 6.16: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 315°

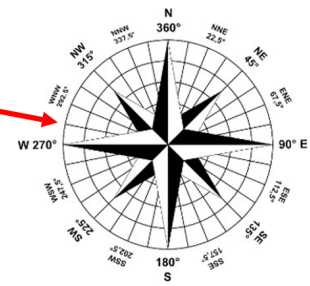
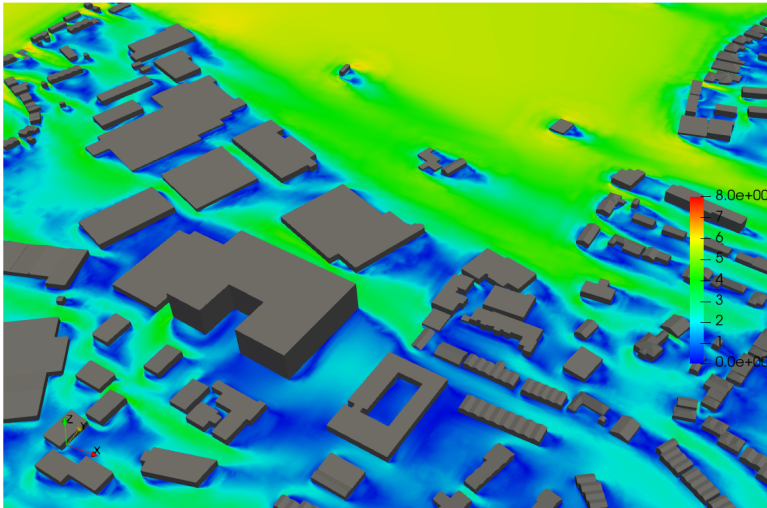


Figure 6.17: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 281°

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### 6.1.2 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 below formulated in accordance with the Lawson Criteria.

#### Plot Colour:

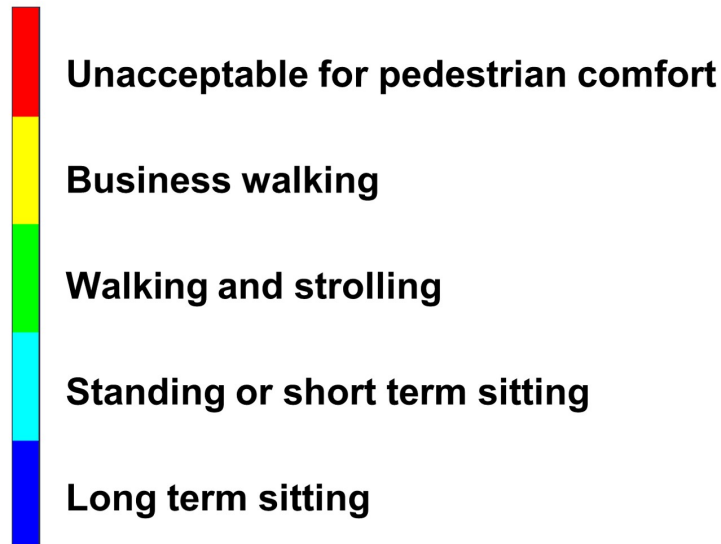


Figure 6.18: Lawson Comfort Categories

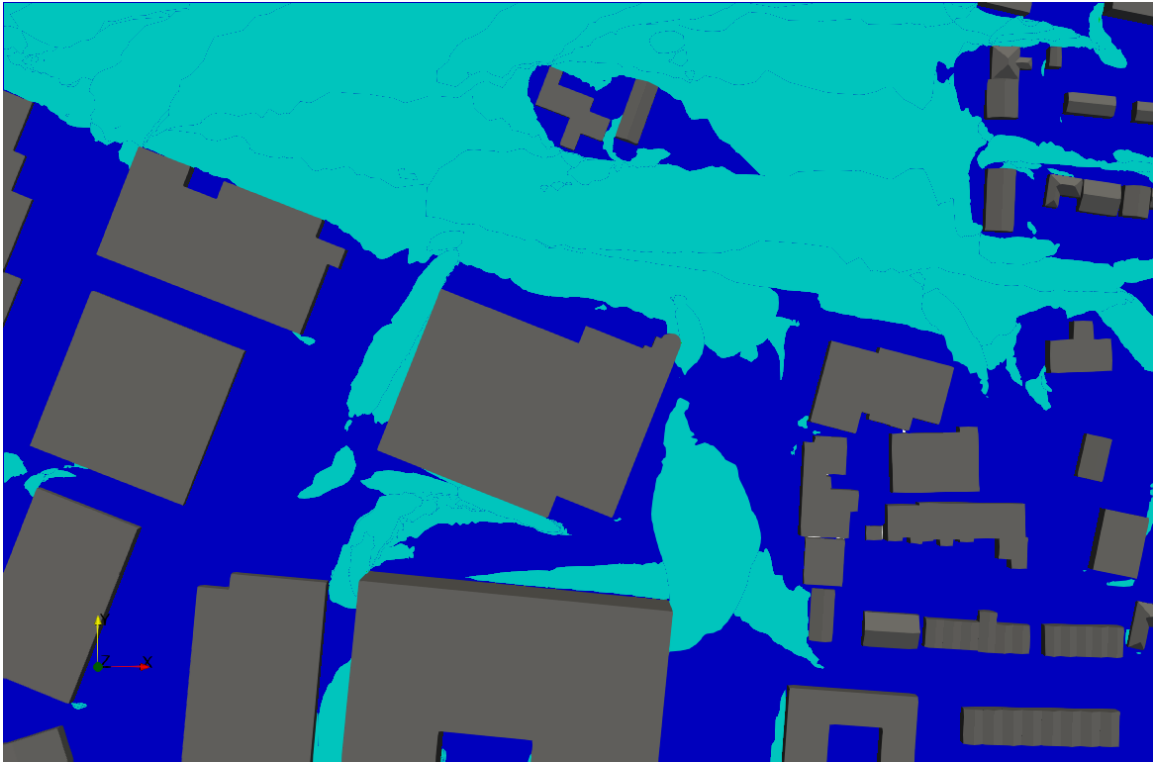


Figure 6.19: Ground Floor - Lawson Discomfort Map - Top View

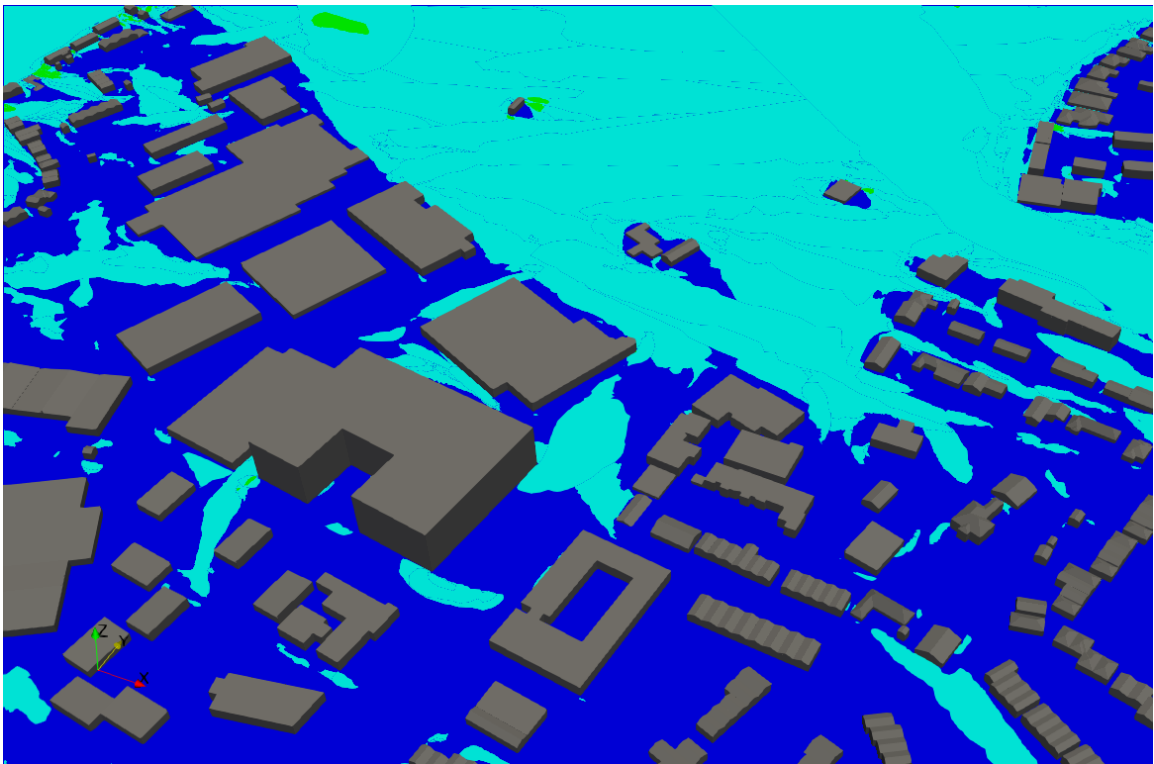


Figure 6.20: Ground Floor - Lawson Discomfort Map - 3D view



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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 short term sitting, the roads in the surrounding are usable for their intended scope (walking).
- At the moment there is no designated area for public long term sitting, however some area of the site present comfortable conditions for this activity.

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## **7. IMPACT OF THE PROPOSED DEVELOPMENT**

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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.

### **7.0.1 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 Chadwicks 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.

### **7.0.2 OPERATIONAL PHASE**

This section shows CFD results of wind microclimate assessment carried out considering the "Operational Phase" of Chadwicks Development. In this case the assessment has considered the impact of wind on the existing area including the proposed Chadwicks 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 7.1: CFD Model of Proposed Scenario

### 7.0.3 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 7.17 in order to assess wind flows at ground floor level of Chadwicks Development.

Wind flow speeds are shown to be within tenable conditions. Some higher velocity indicating minor funnelling effects are found near the South-West side of the development. However, as it can be seen, both areas were mitigated with landscaping and the flow velocities shown in the Lawson map indicate that the areas can be utilised for the intended use.

Therefore, it can be concluded that the wind speeds do not attain critical levels around the development.

The courtyard between Block A and B is well protected, and it compromises the pedestrian comfort, according to the Lawson Criteria, as shown in the next sections.

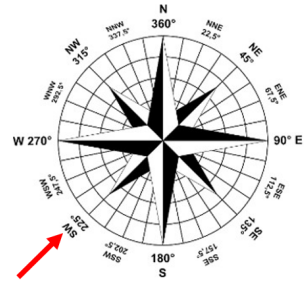
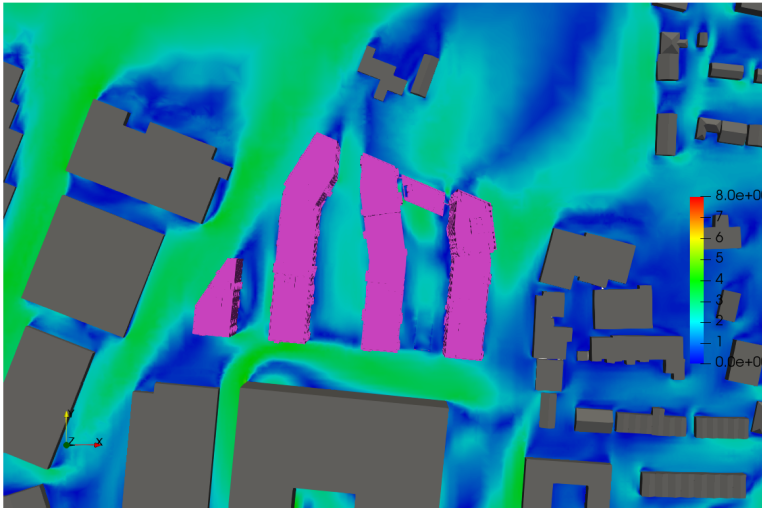


Figure 7.2: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 225°

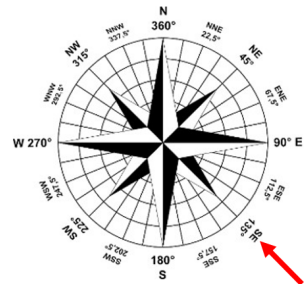
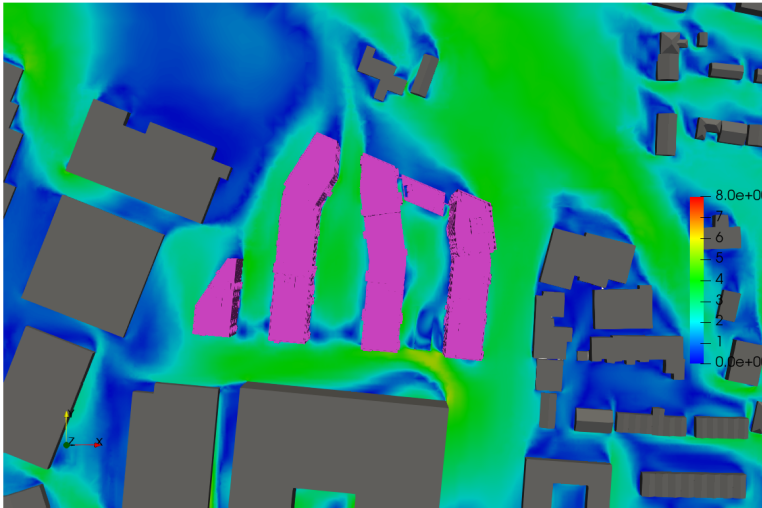


Figure 7.3: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 135°

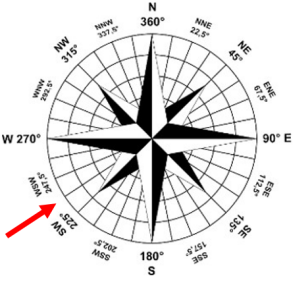
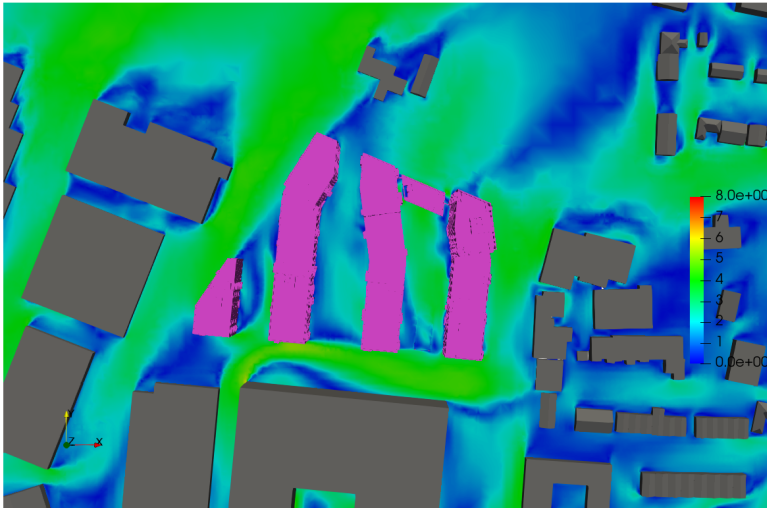


Figure 7.4: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 236°

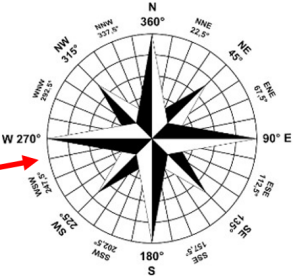
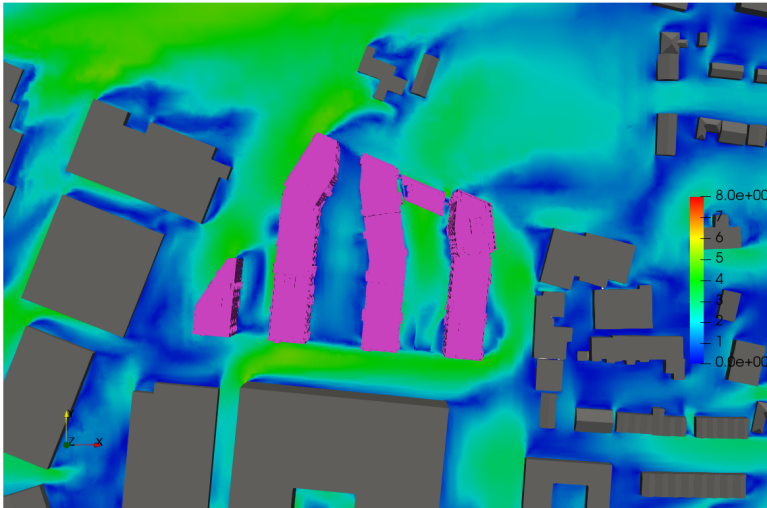


Figure 7.5: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 258°

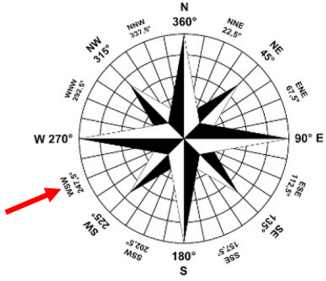
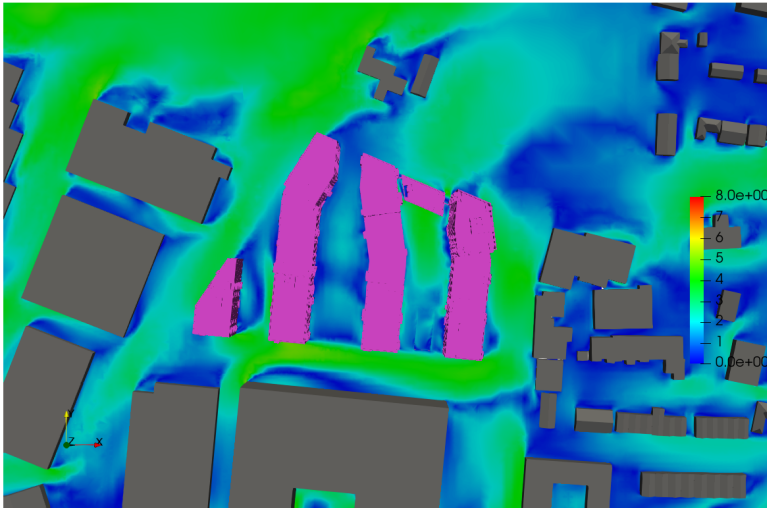


Figure 7.6: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 247°

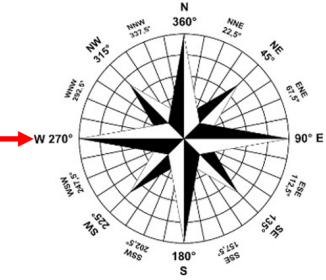
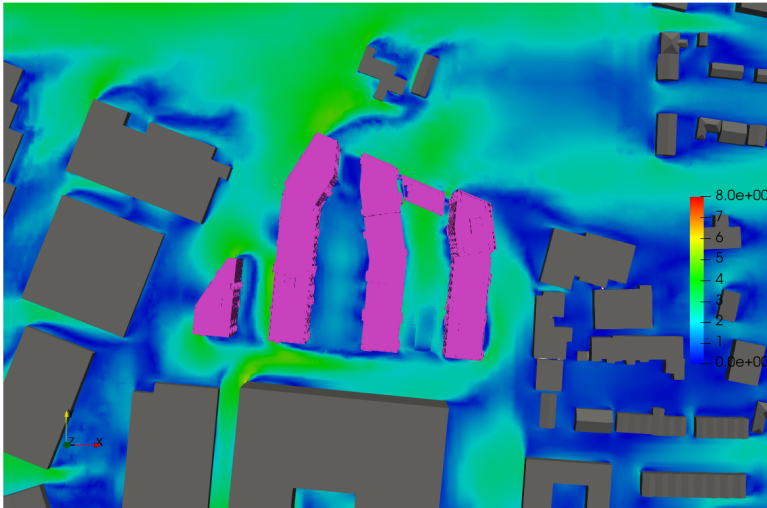


Figure 7.7: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 270°

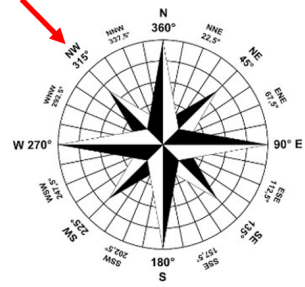
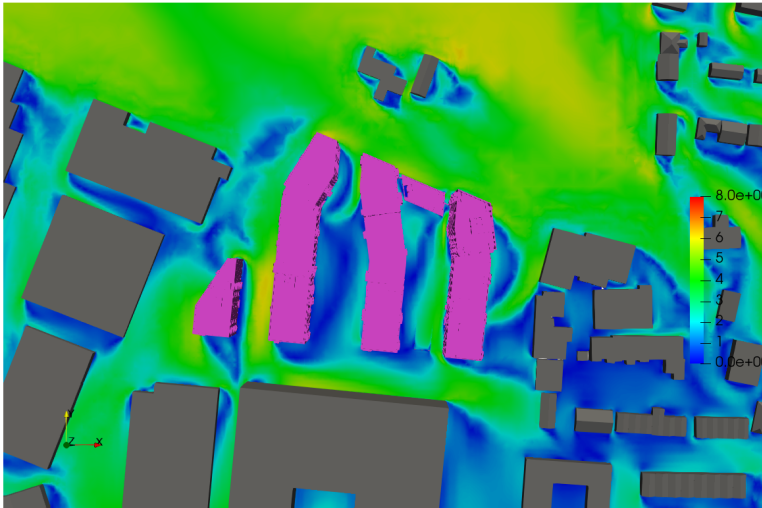


Figure 7.8: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 315°

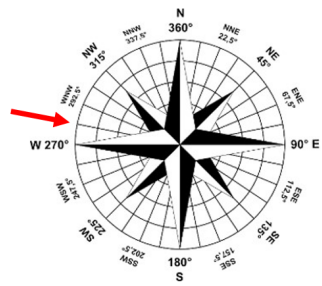
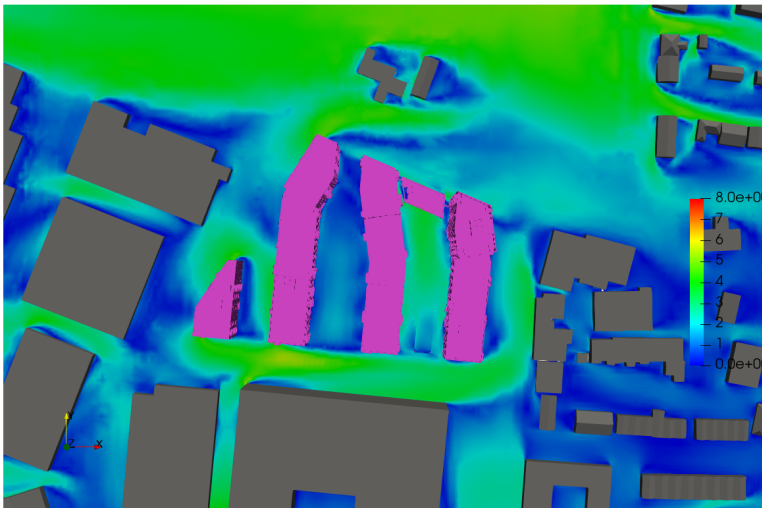


Figure 7.9: Ground Floor Level - Flow Velocity Results at Z=1.5m above the ground - Wind Direction: 281°



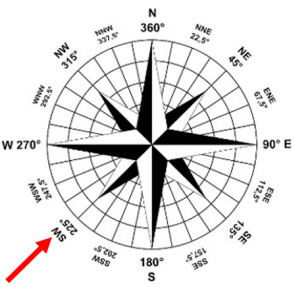
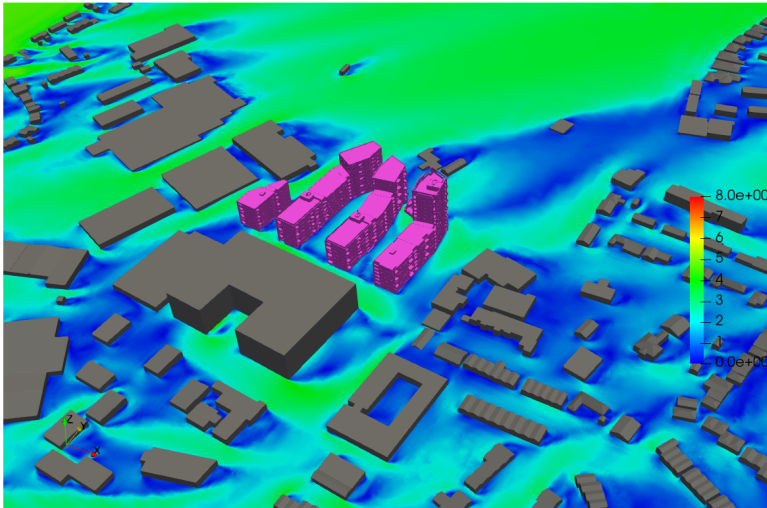


Figure 7.10: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 225°

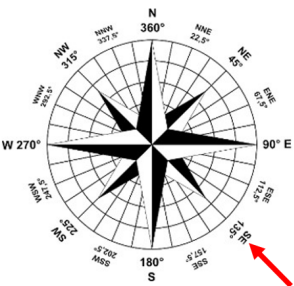
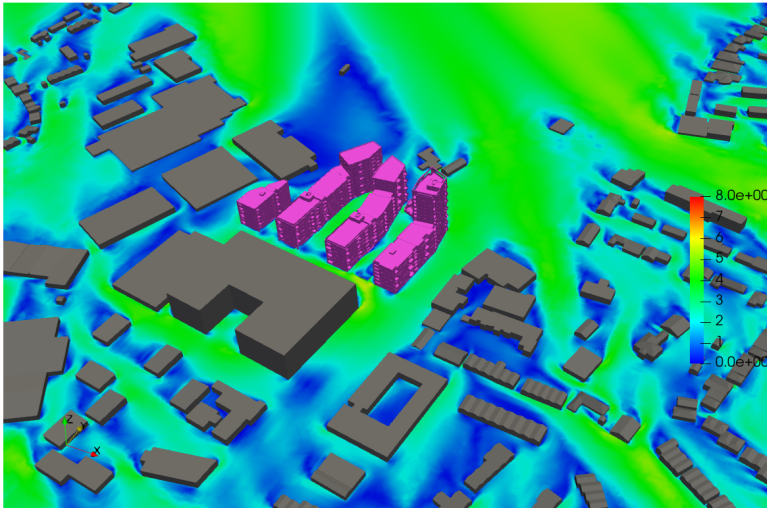


Figure 7.11: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 135°

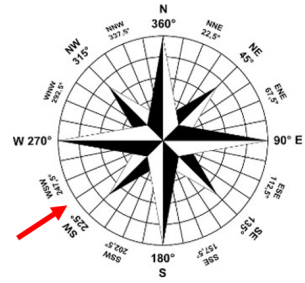
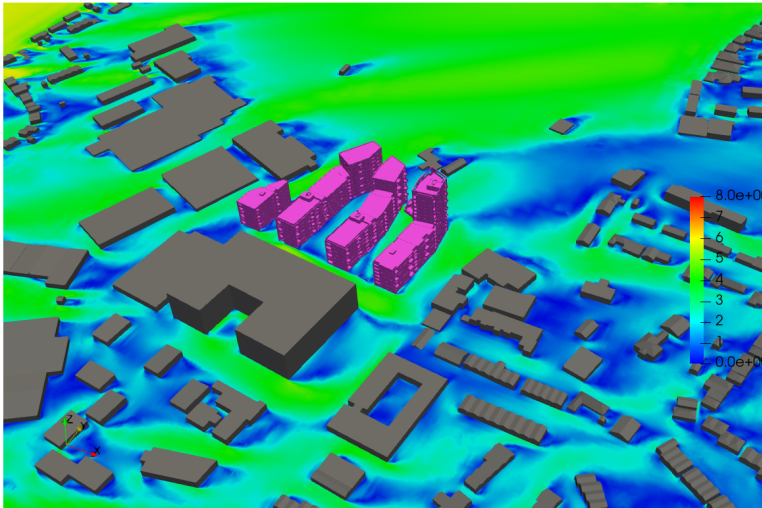


Figure 7.12: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 236°

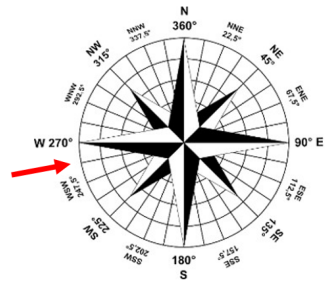
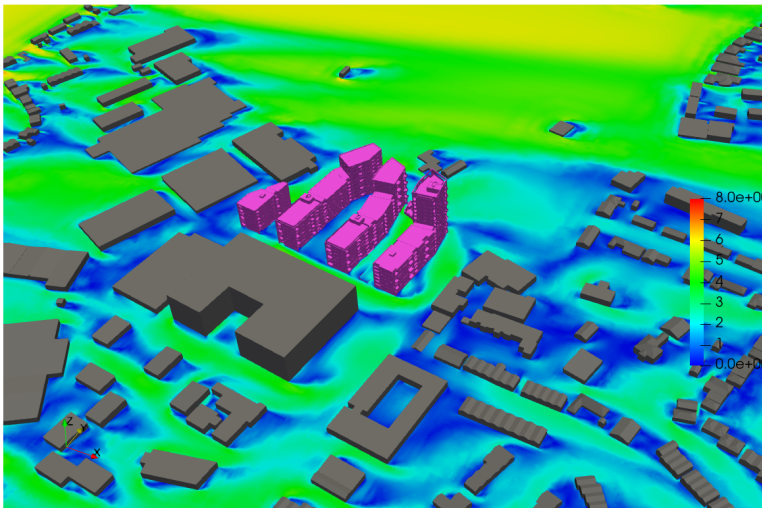


Figure 7.13: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 258°

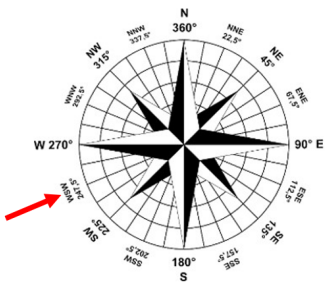
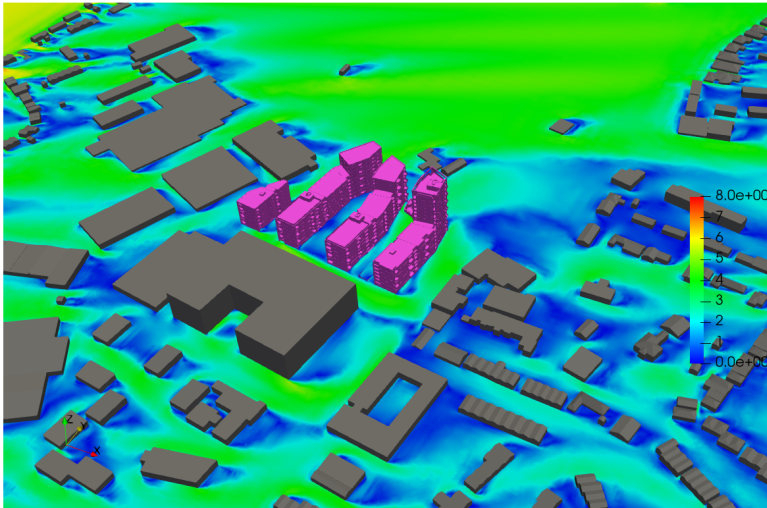


Figure 7.14: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 247°

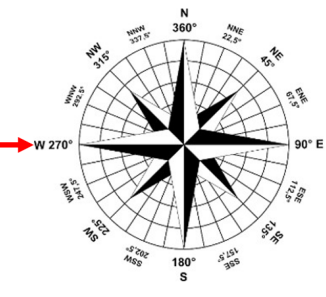
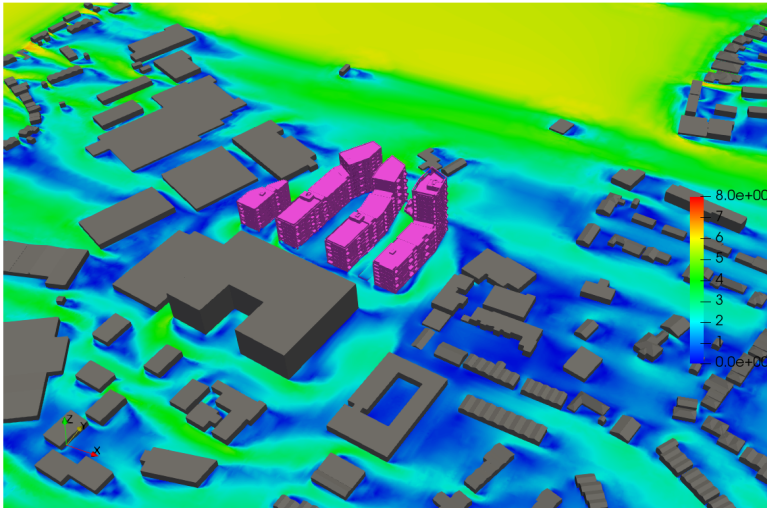


Figure 7.15: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 270°

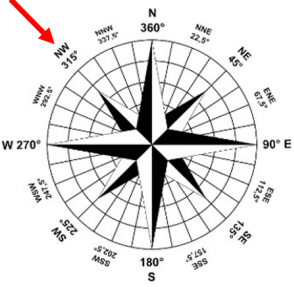
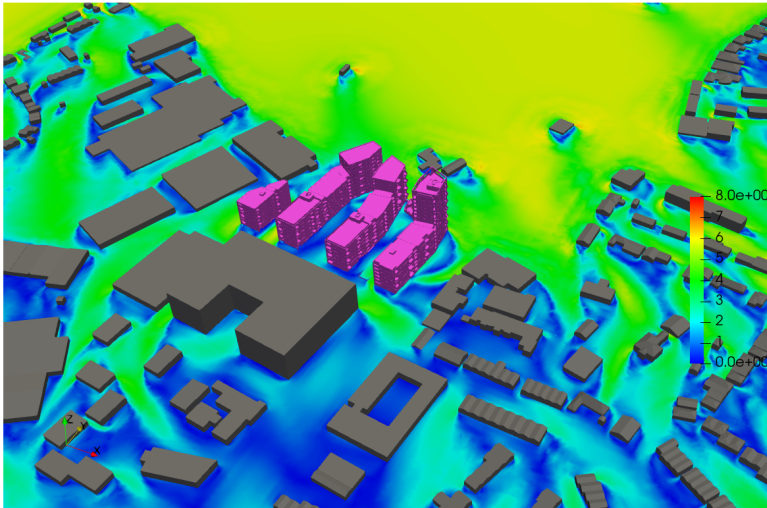


Figure 7.16: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 315°

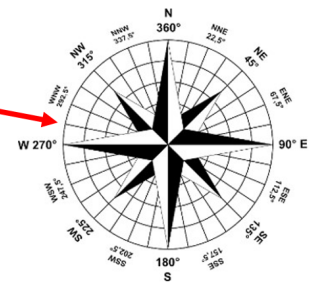
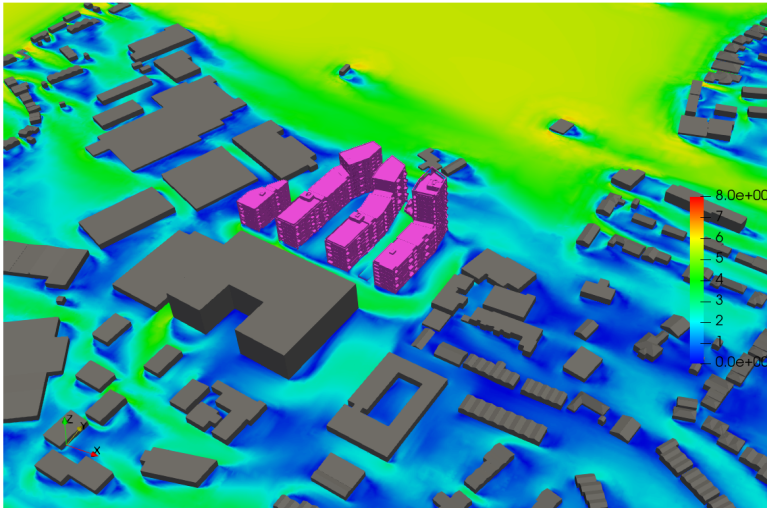


Figure 7.17: Wind Speed Results at 1.5m Above Development Ground Floor - 3D View - Wind Direction: 281°

## 7.0.4 WIND SPEEDS - Terraces

Figures from 7.18 to 7.21 show the position of the four terraces on the development.

Results of velocity at slice location of 1.5m above the terraces for development are presented in Figures 7.22 to 7.53, for wind assessment of the Terrace of the Chadwicks Development (Block C and Block D).

The analysis show that the areas are well protected by a combination of glazed screen. On the roof terrace on Block D, there are small areas suitable for short term sitting instead of long term sitting. However, this analysis has been performed considering the worst case scenario conditions, considering the whole year. Terraces are not areas that are used all year around and long term sitting is an activity performed during spring/summer months, when the frequency of such high wind is below 5%.

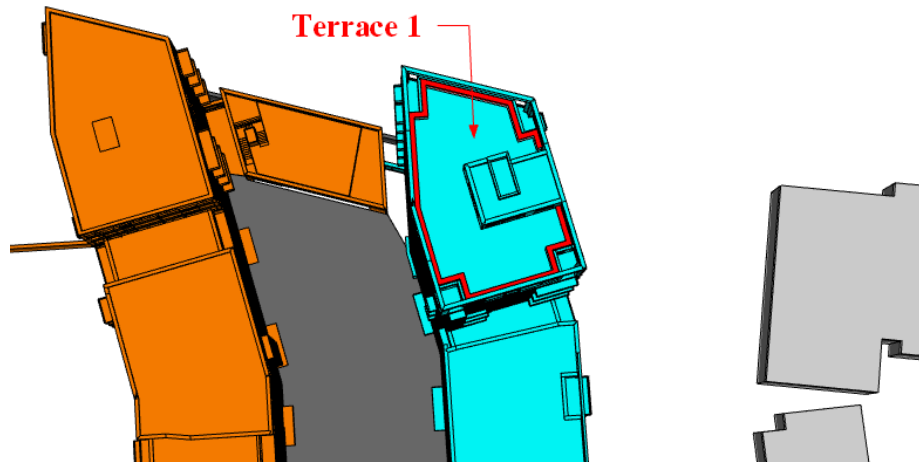


Figure 7.18: location of roof terrace on Block A/B

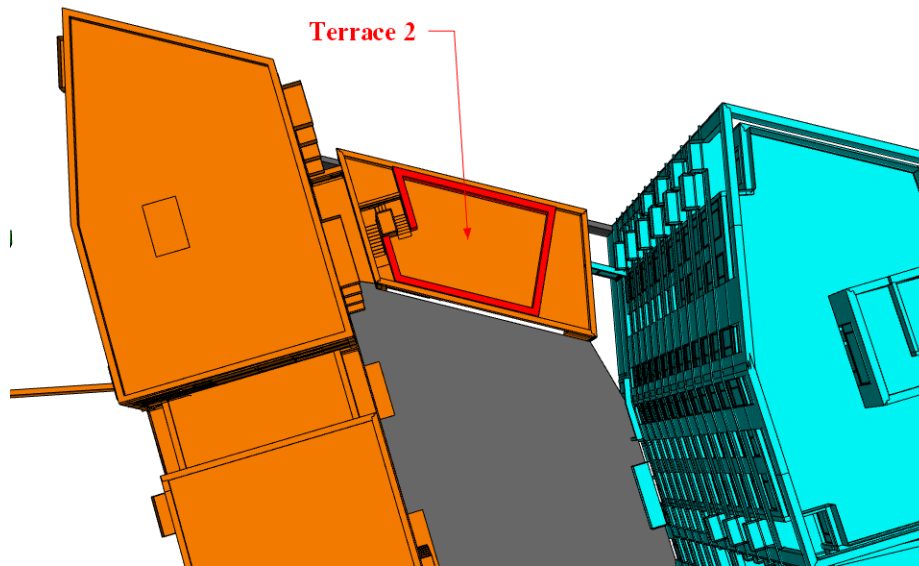


Figure 7.19: location of roof terrace between Block A/B and C/D



Figure 7.20: location of roof terrace on Block C/D

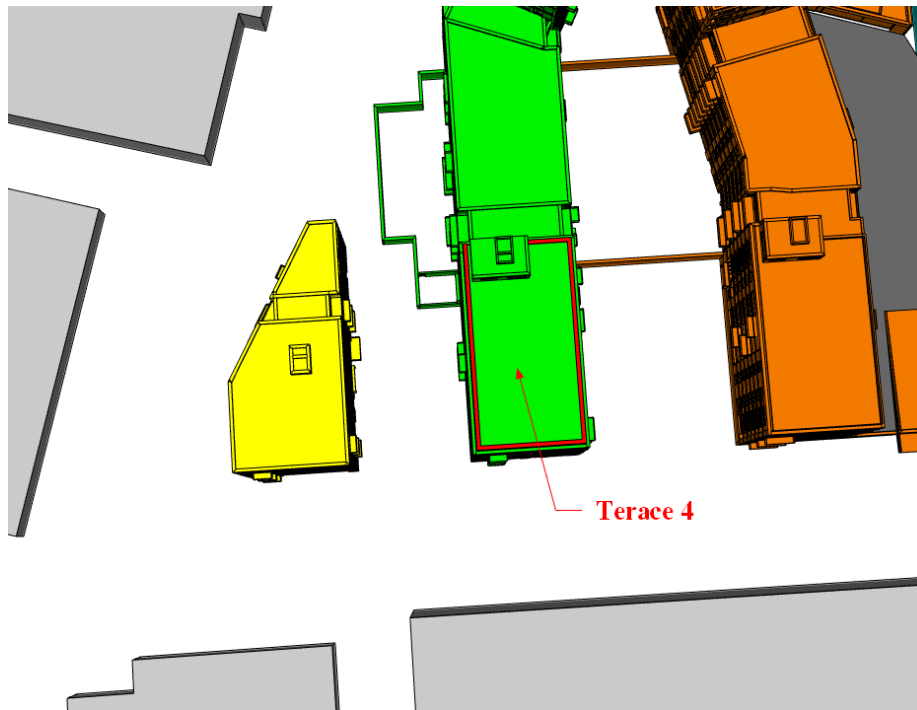


Figure 7.21: location of roof terrace on Block E/F

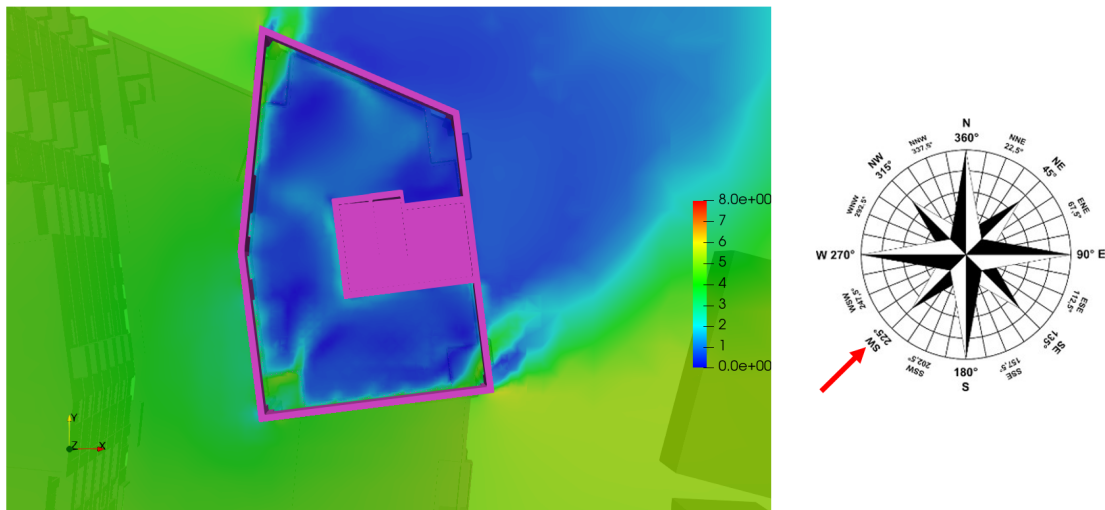


Figure 7.22: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 225°

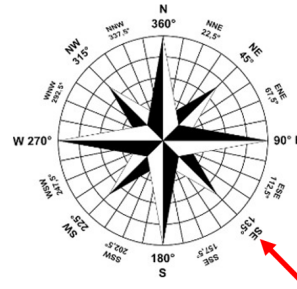
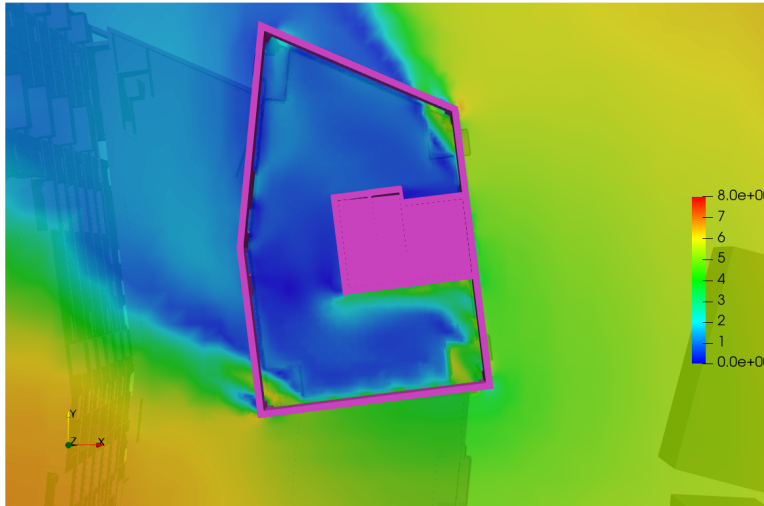


Figure 7.23: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 135°

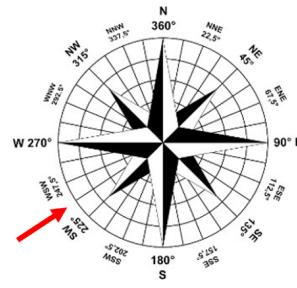
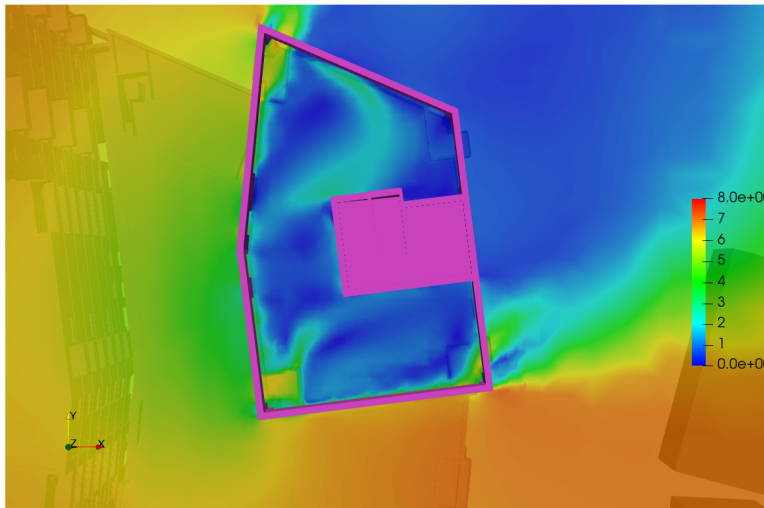


Figure 7.24: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 236°



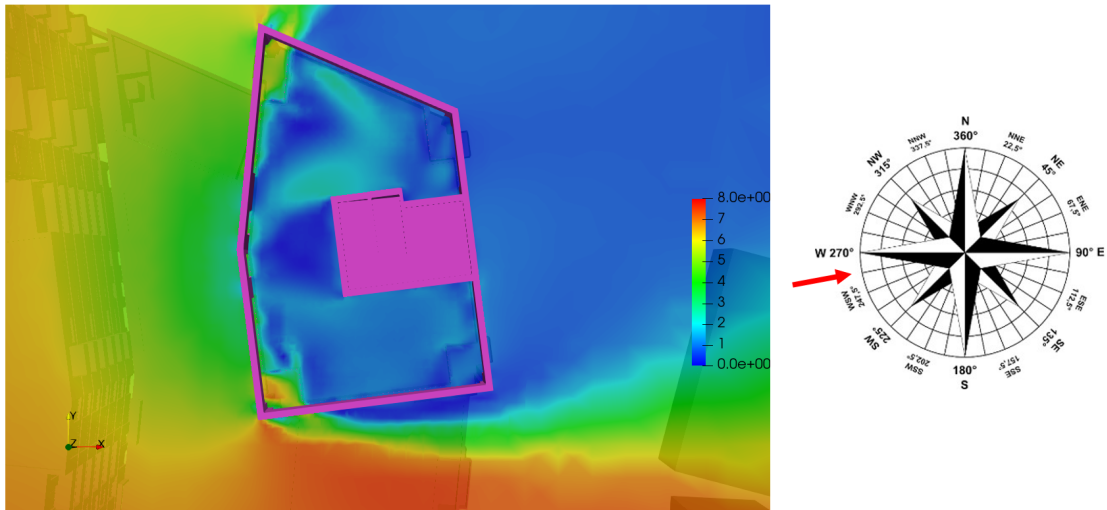


Figure 7.25: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 258°

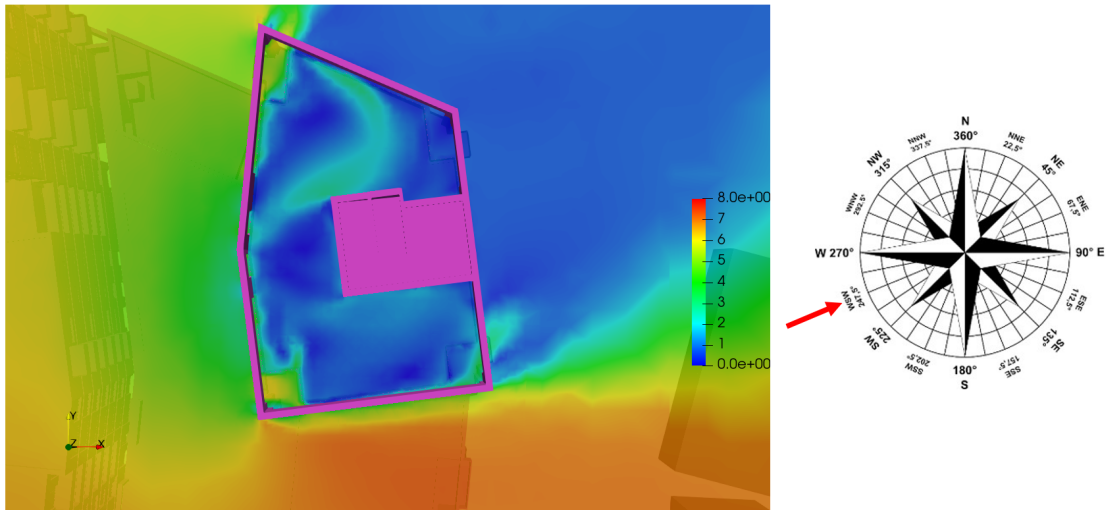


Figure 7.26: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 247°

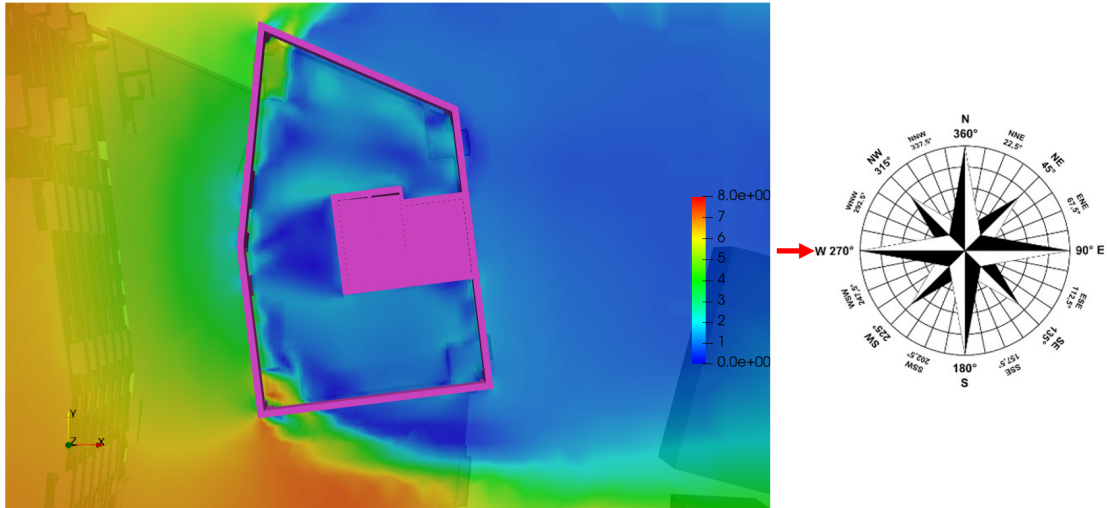


Figure 7.27: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 270°

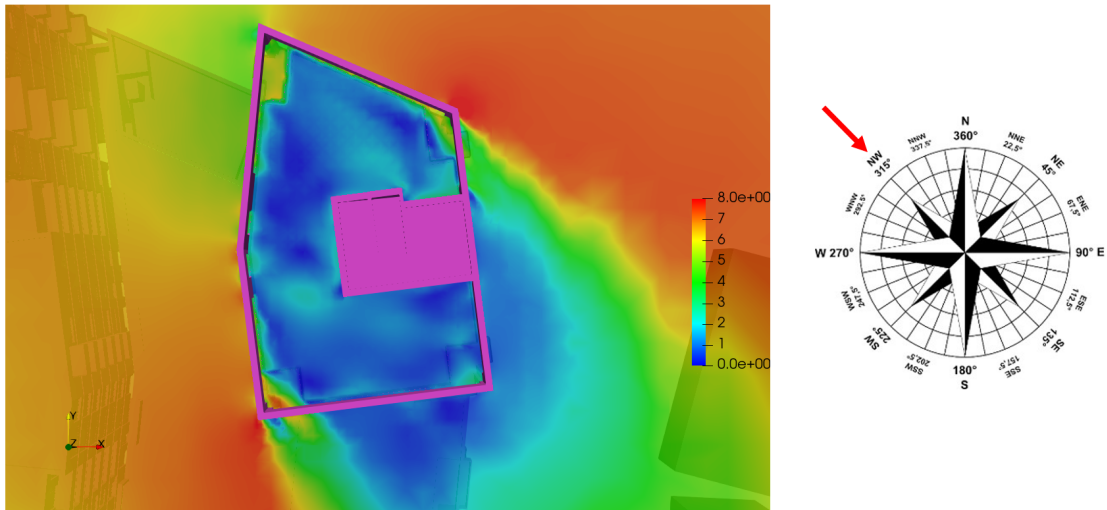


Figure 7.28: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 315°

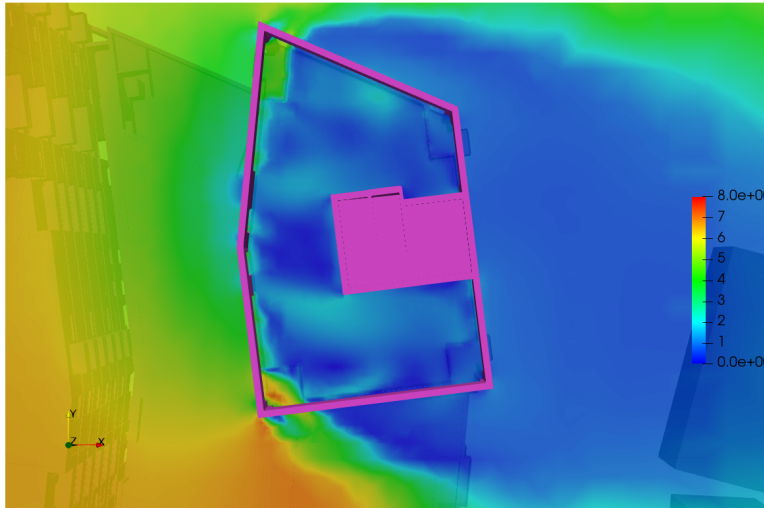


Figure 7.29: Terrace 1 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 281°

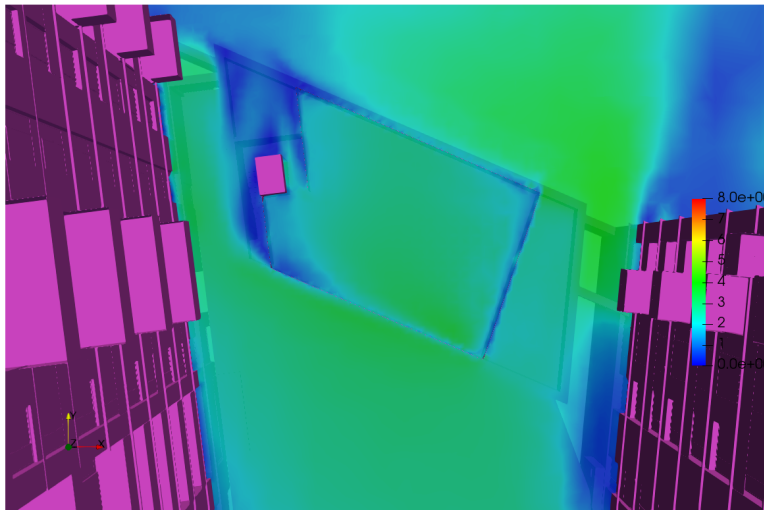


Figure 7.30: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 225°

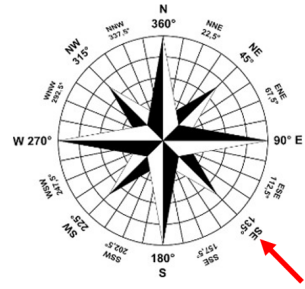
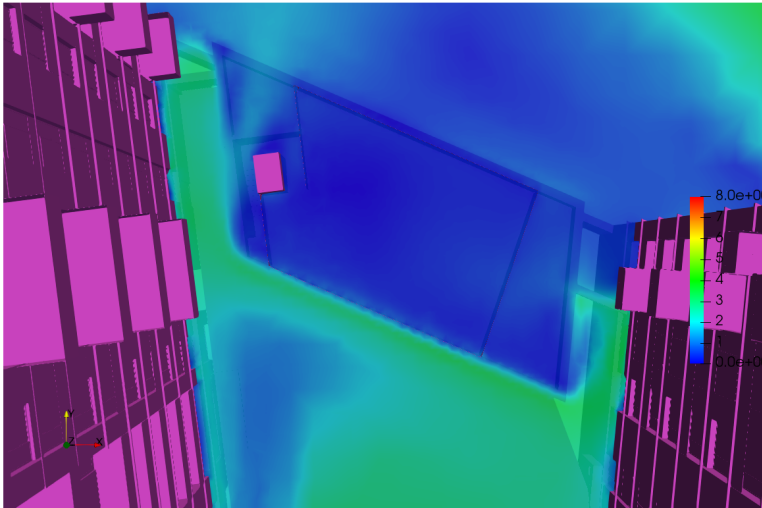


Figure 7.31: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 135°

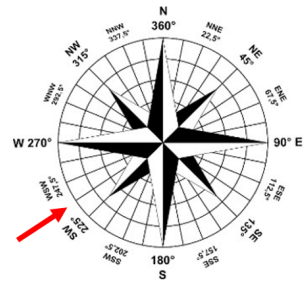
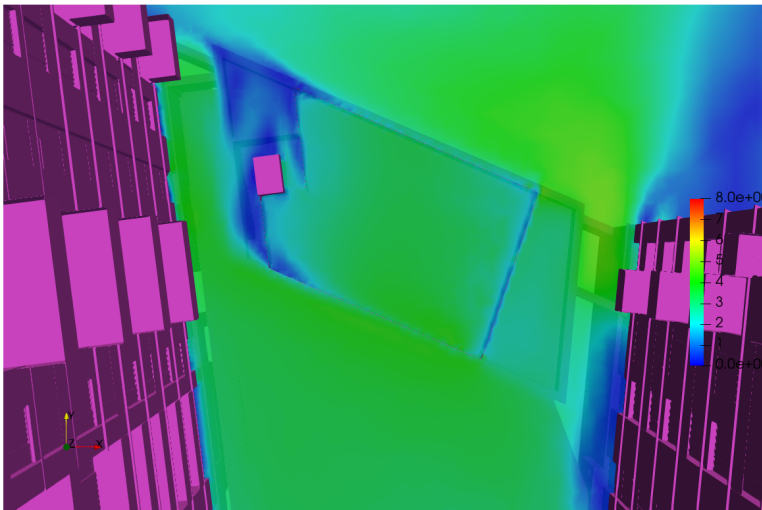


Figure 7.32: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 236°

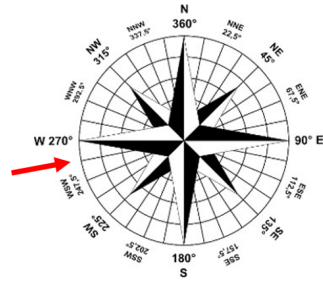
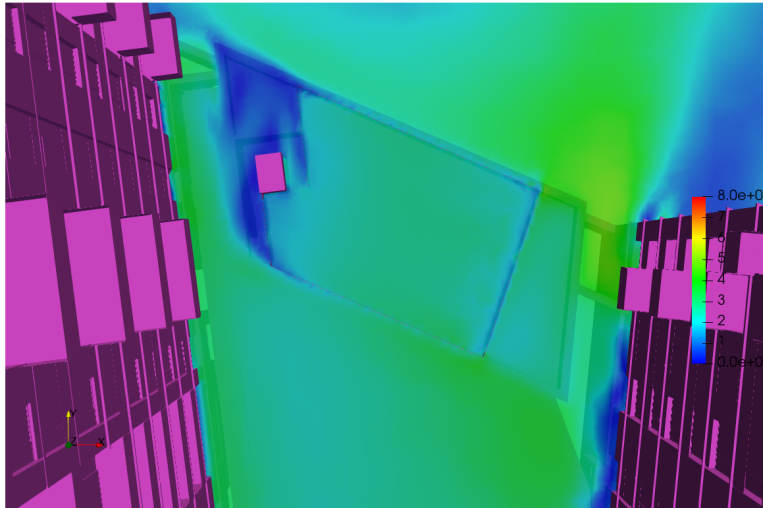


Figure 7.33: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 258°

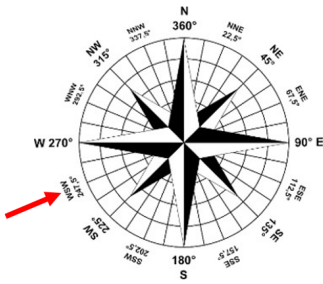
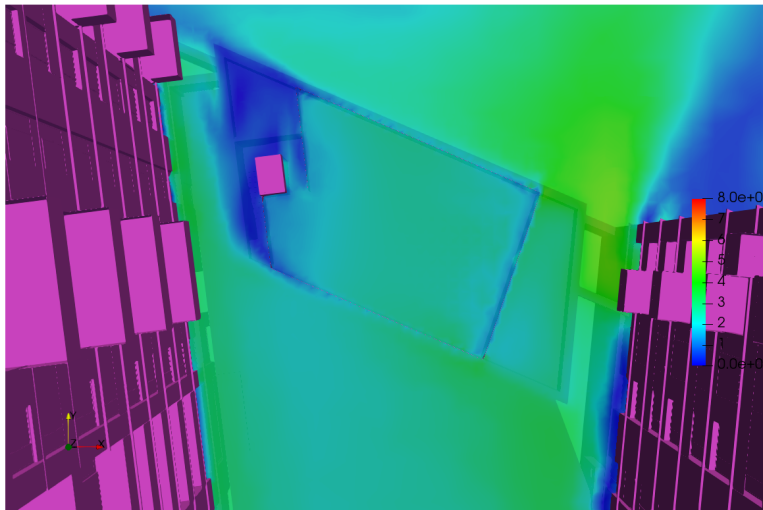


Figure 7.34: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 247°

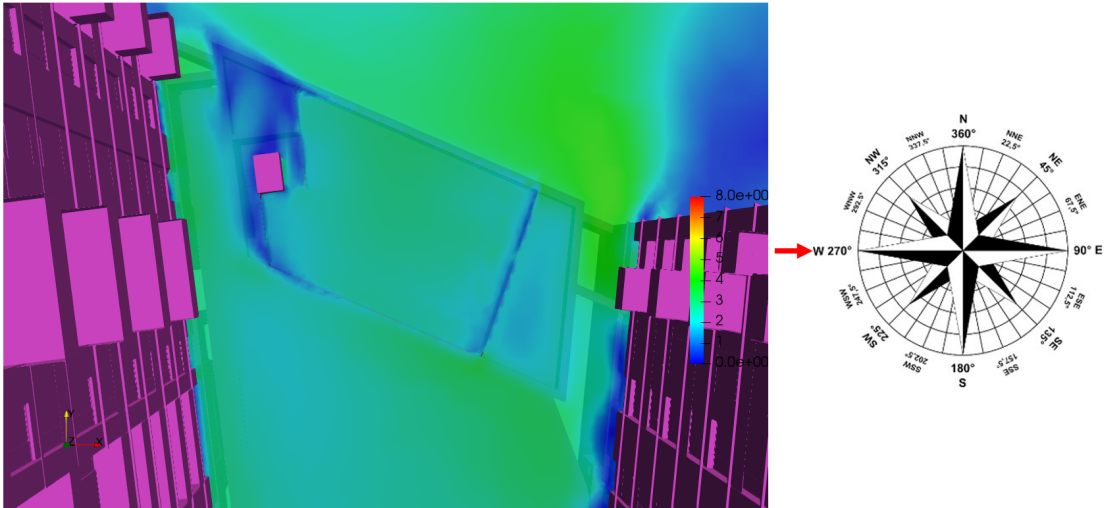


Figure 7.35: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 270°

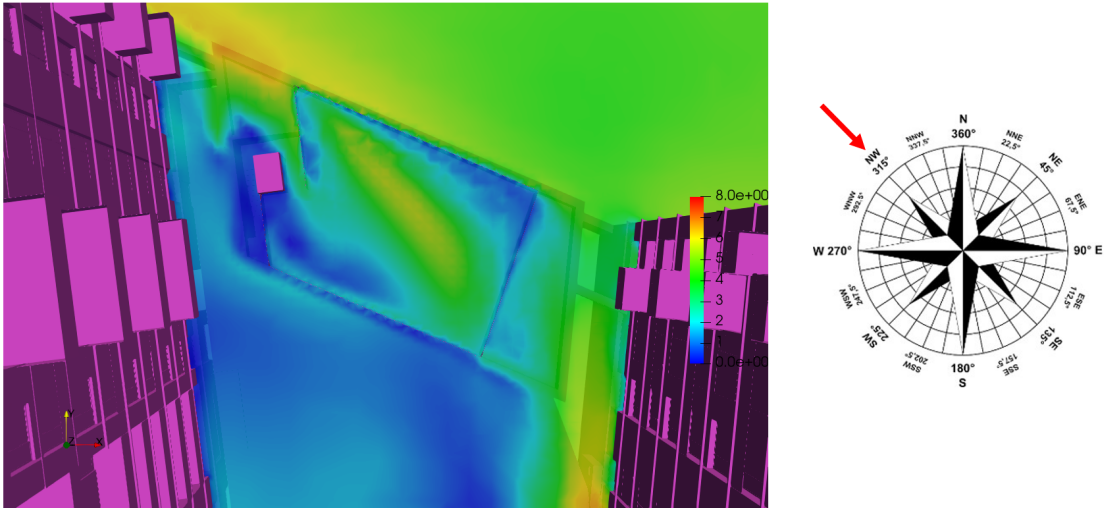


Figure 7.36: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 315°

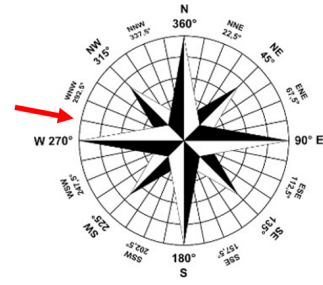
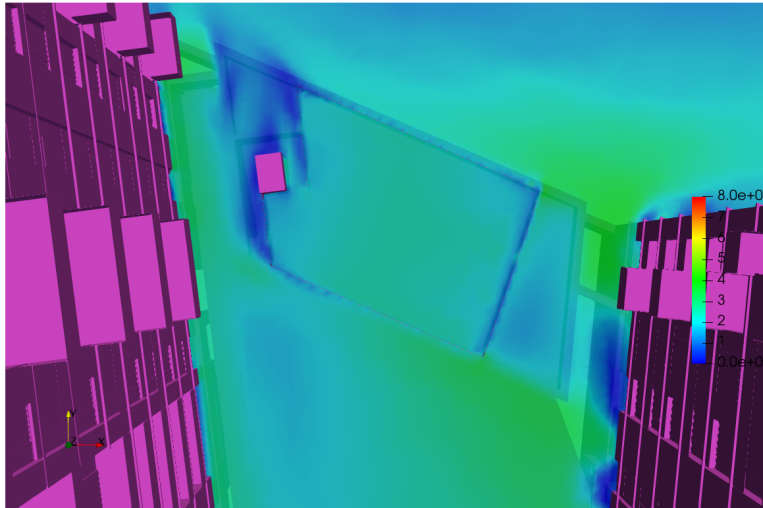


Figure 7.37: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 281°

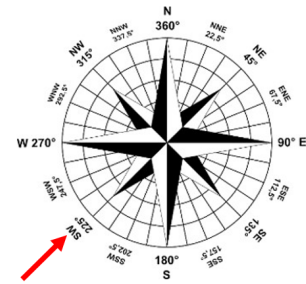
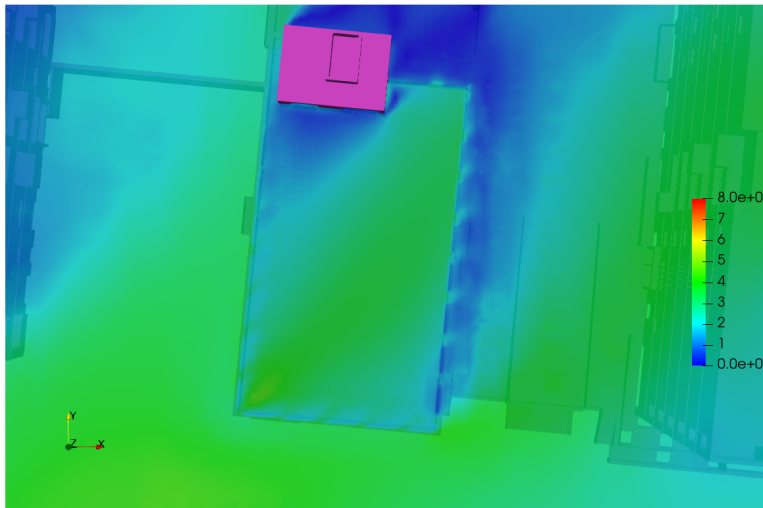


Figure 7.38: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 225°

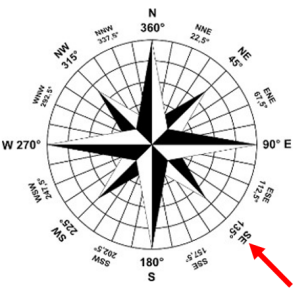
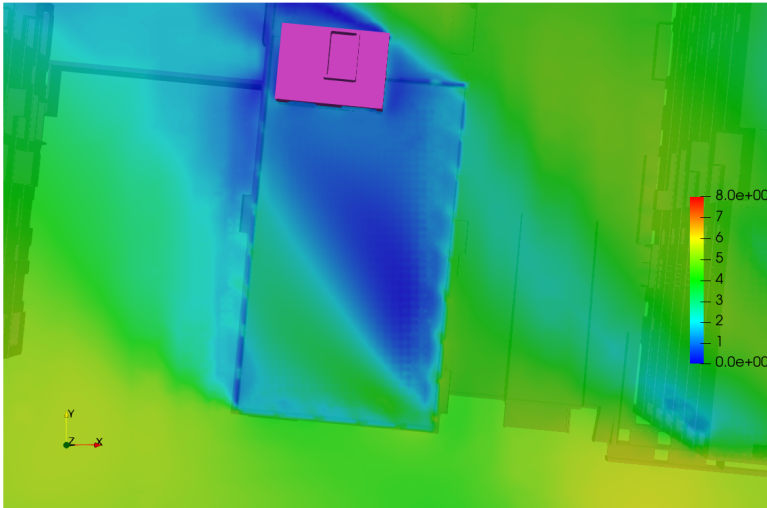


Figure 7.39: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 135°

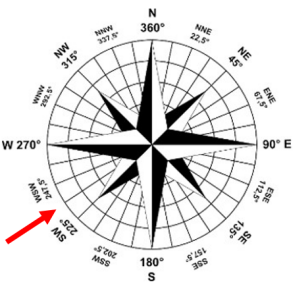
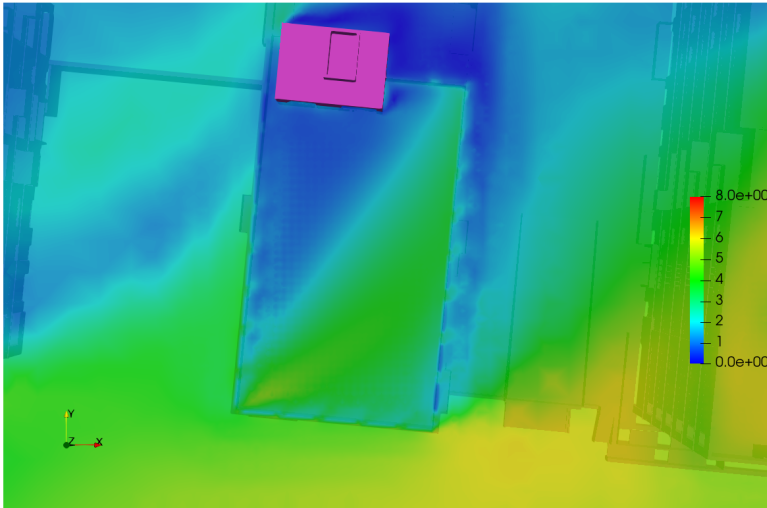


Figure 7.40: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 236°



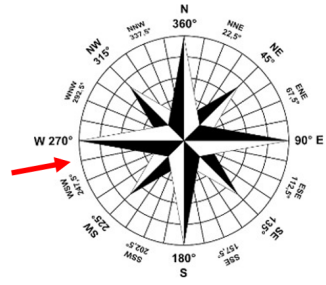
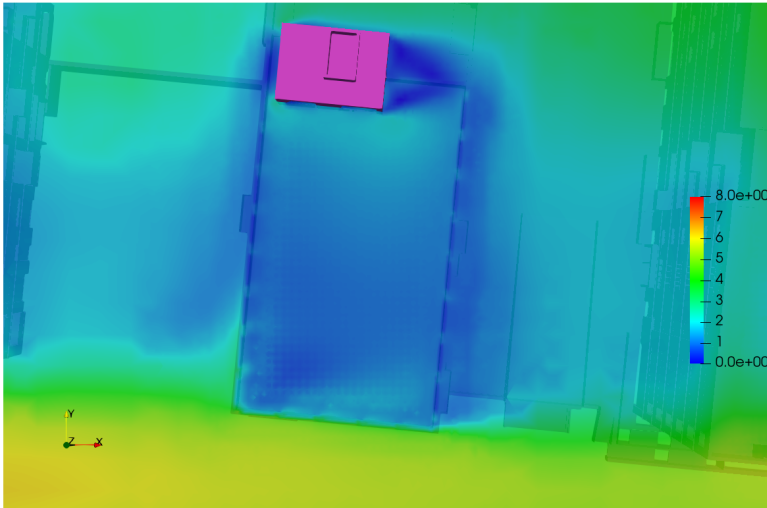


Figure 7.41: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 258°

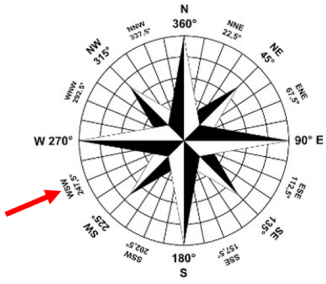
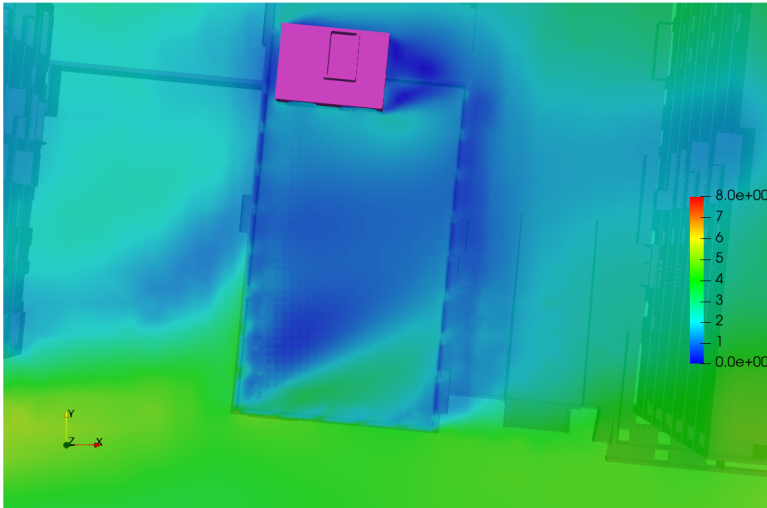


Figure 7.42: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 247°

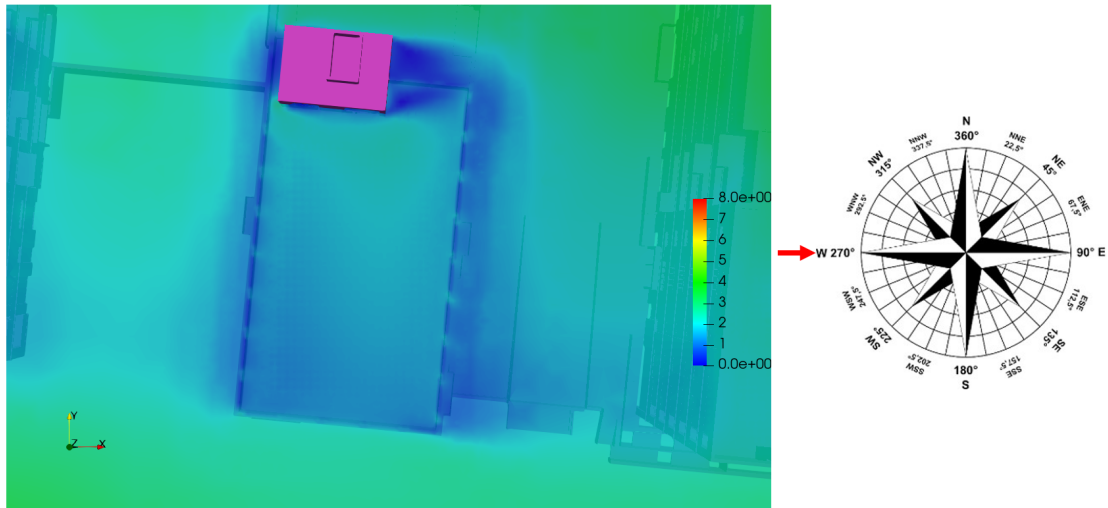


Figure 7.43: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 270°

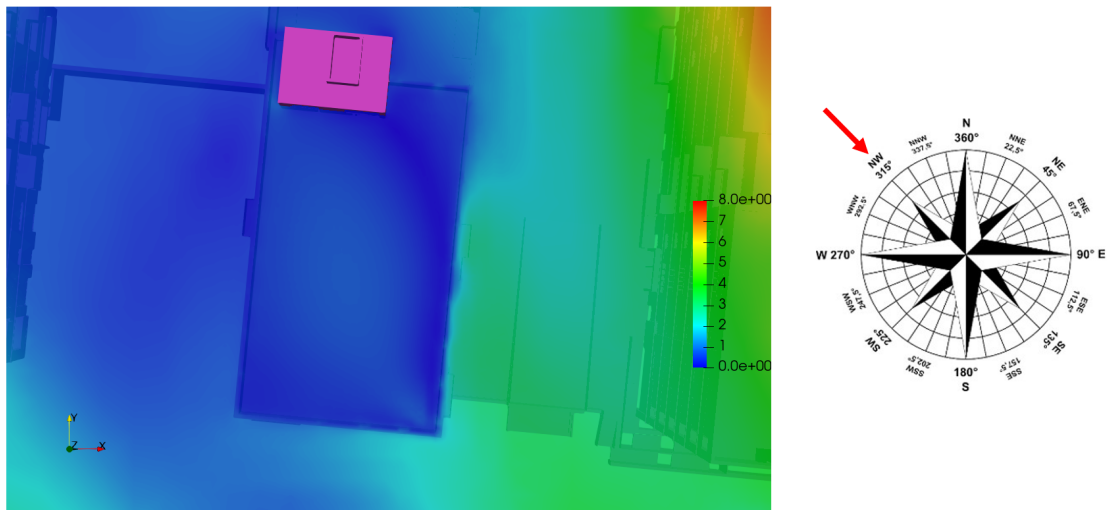


Figure 7.44: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 315°

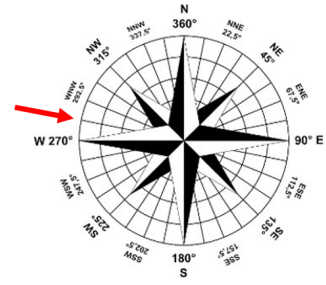
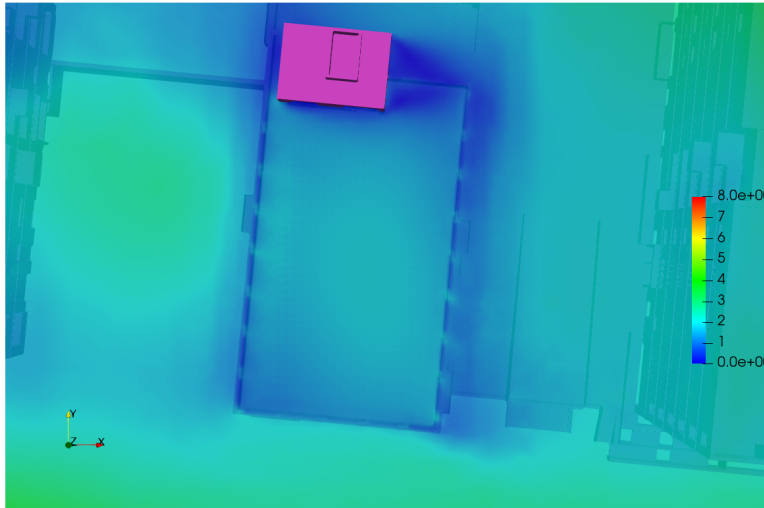


Figure 7.45: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 281°

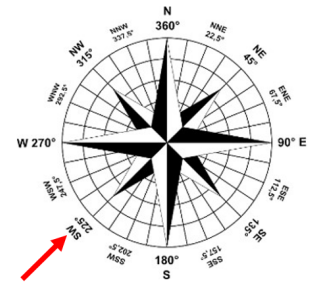
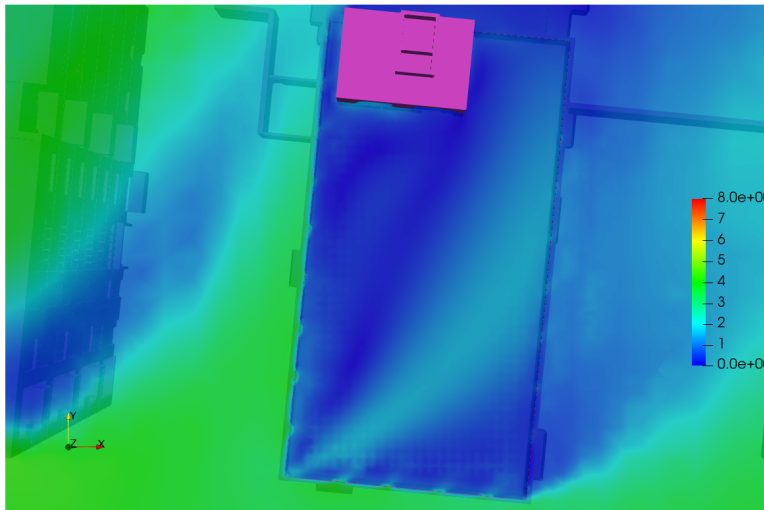


Figure 7.46: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 225°

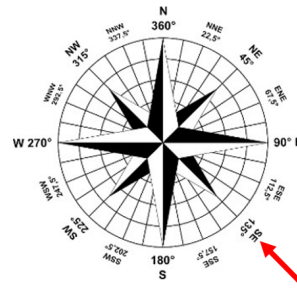
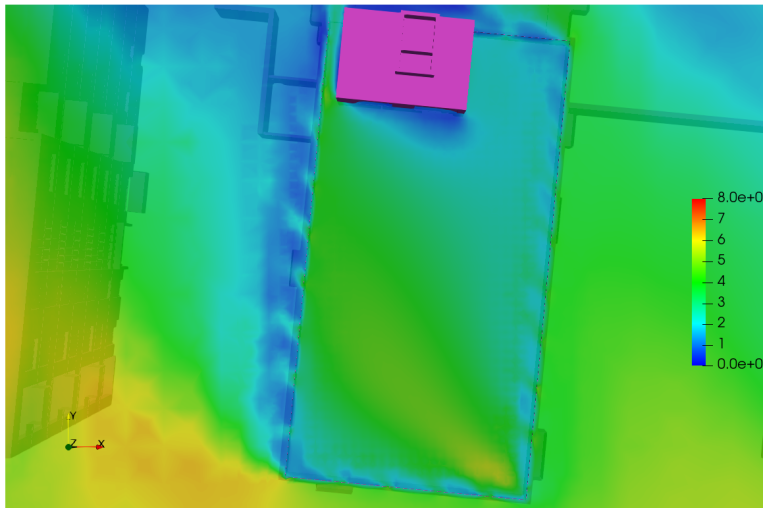


Figure 7.47: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 135°

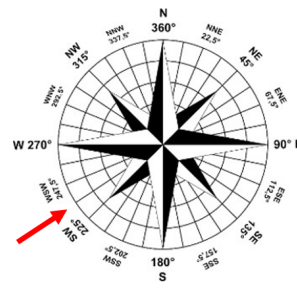
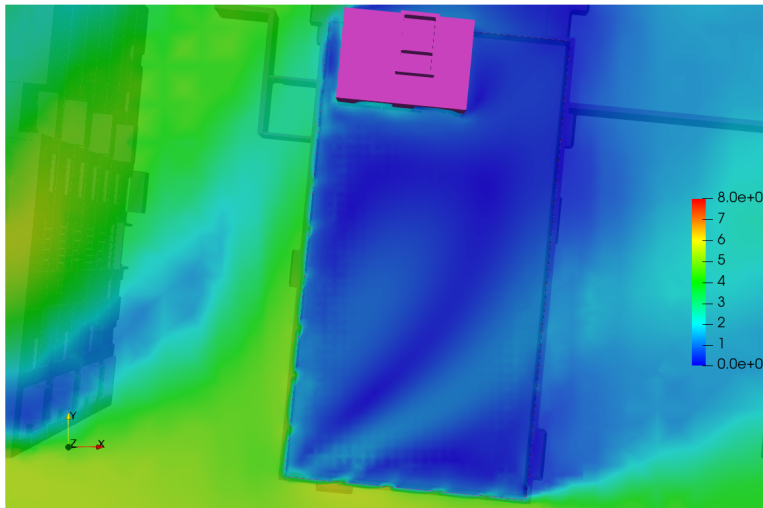


Figure 7.48: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 236°

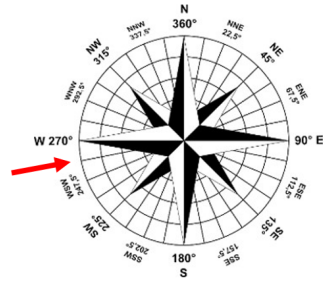
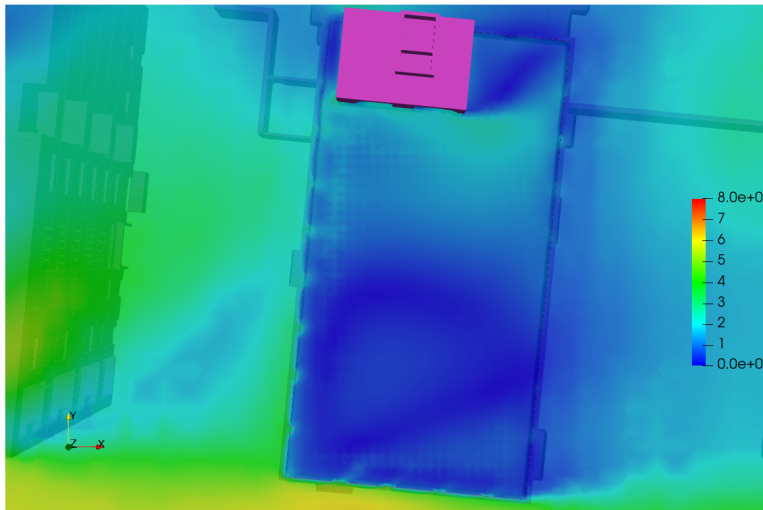


Figure 7.49: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 258°

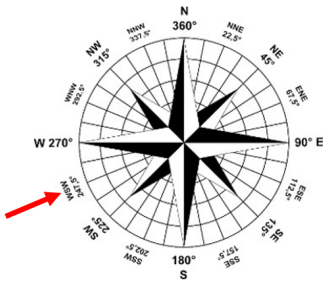
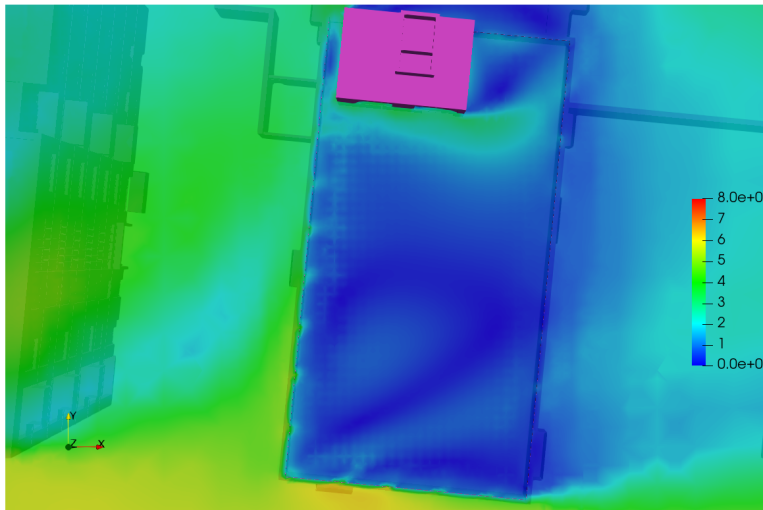


Figure 7.50: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 247°

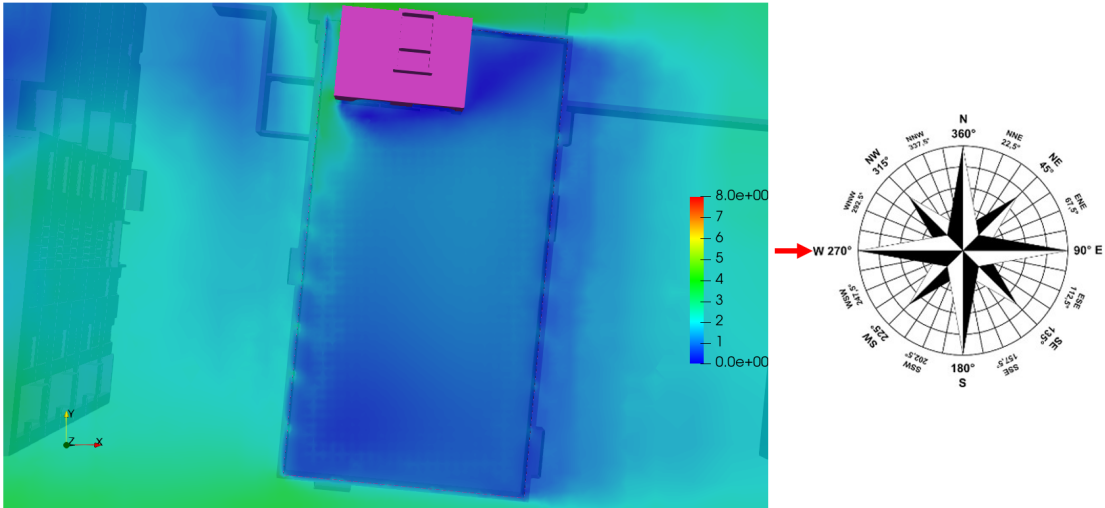


Figure 7.51: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 270°

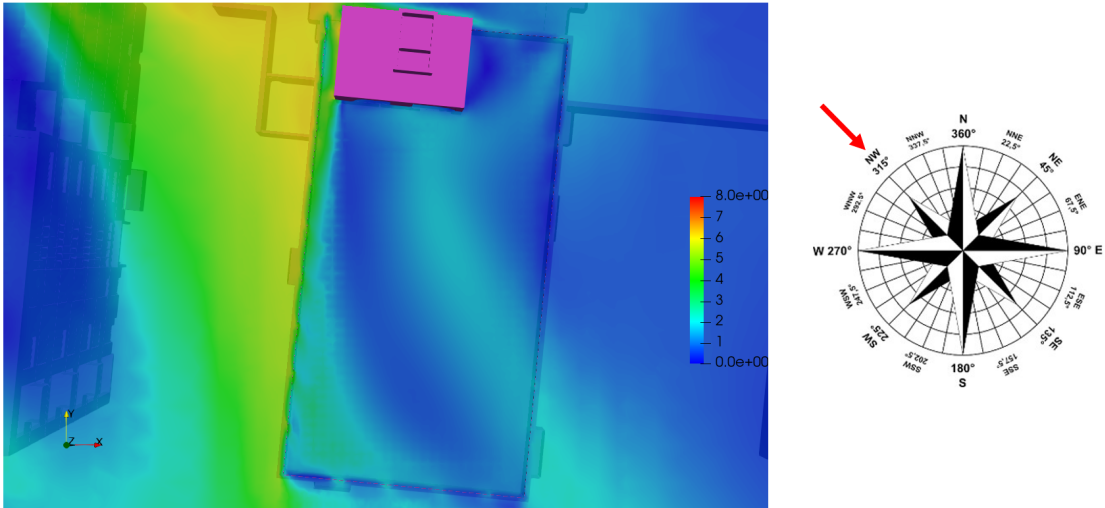


Figure 7.52: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 315°

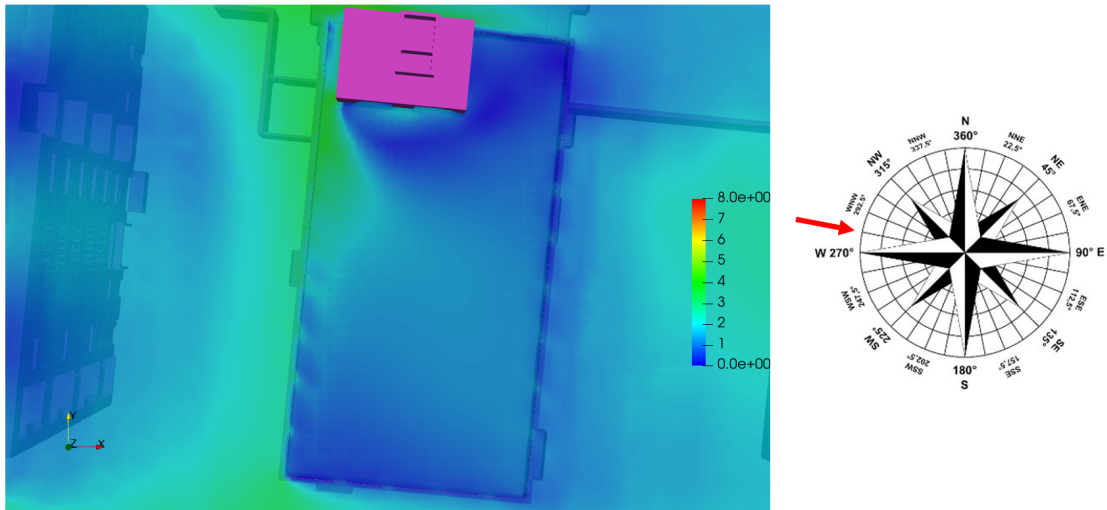


Figure 7.53: Terrace 2 - Flow Velocity Results at Z=1.5m above the terrace - Wind Direction: 281°

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### 7.0.5 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. The comfort/distress conditions are presented using a colour coded diagram below formulated in accordance with the Lawson Criteria.

#### Plot Colour:

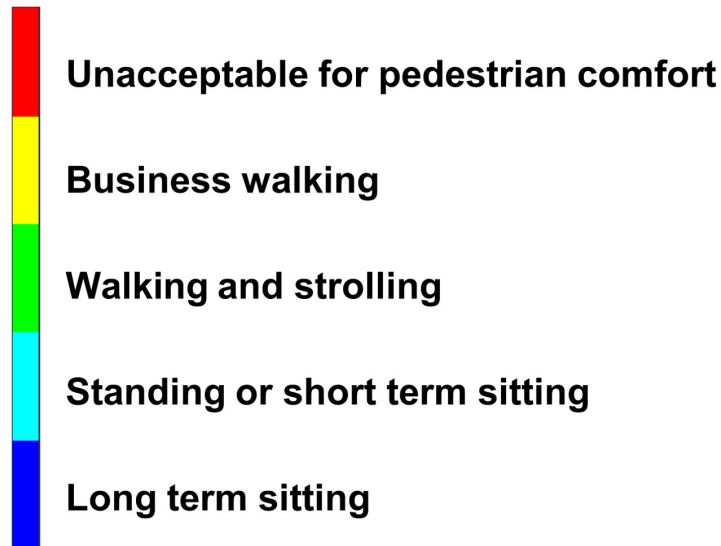


Figure 7.54: Lawson Comfort Categories



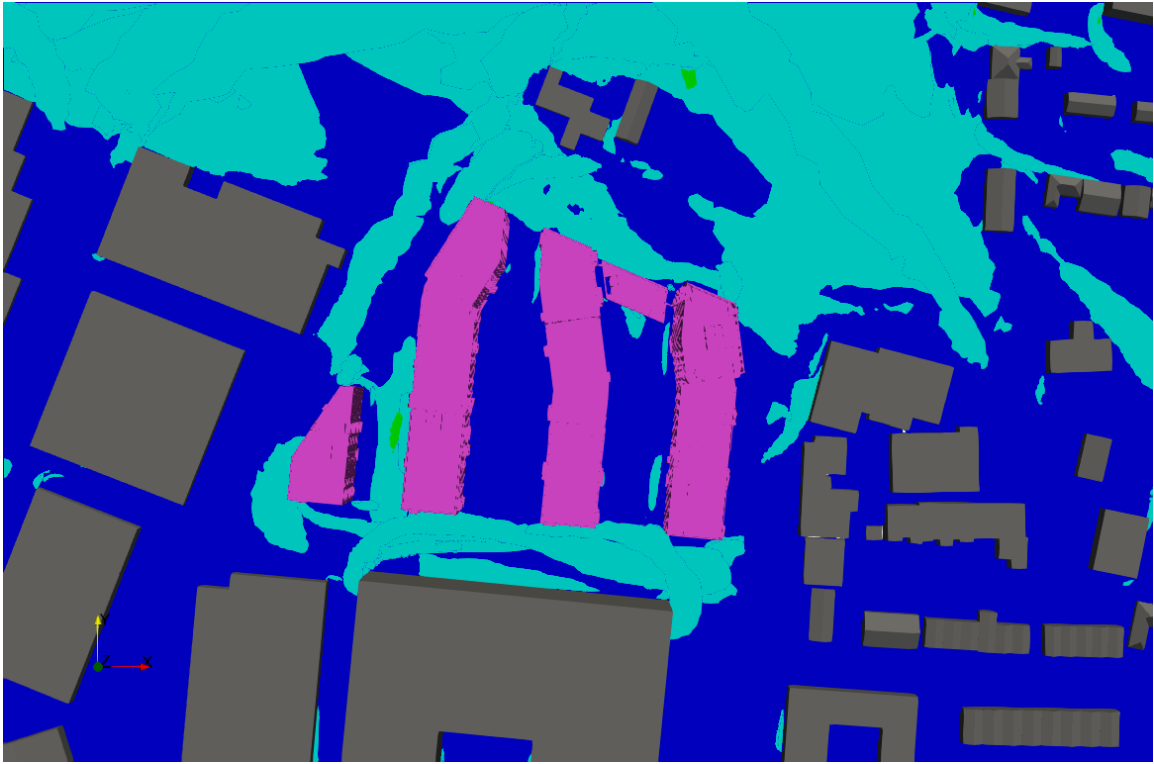


Figure 7.55: Ground Floor - Lawson Discomfort Map - Top View

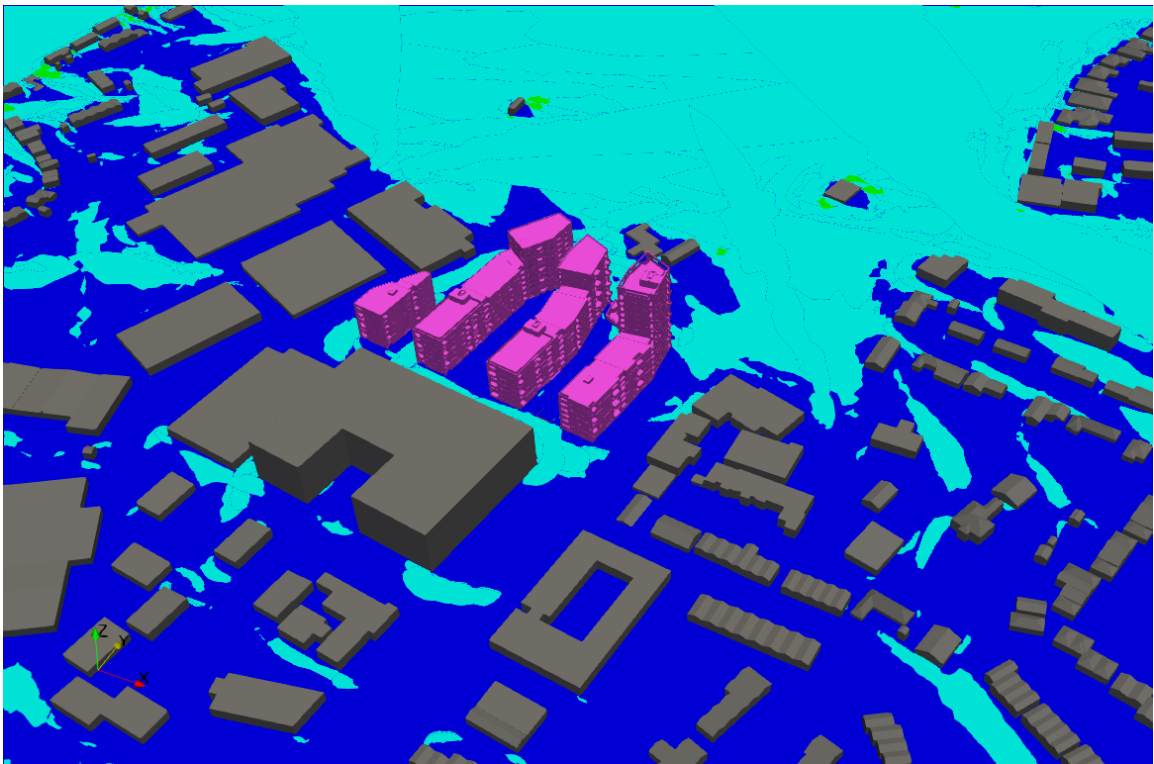


Figure 7.56: Ground Floor - Lawson Discomfort Map - 3D view

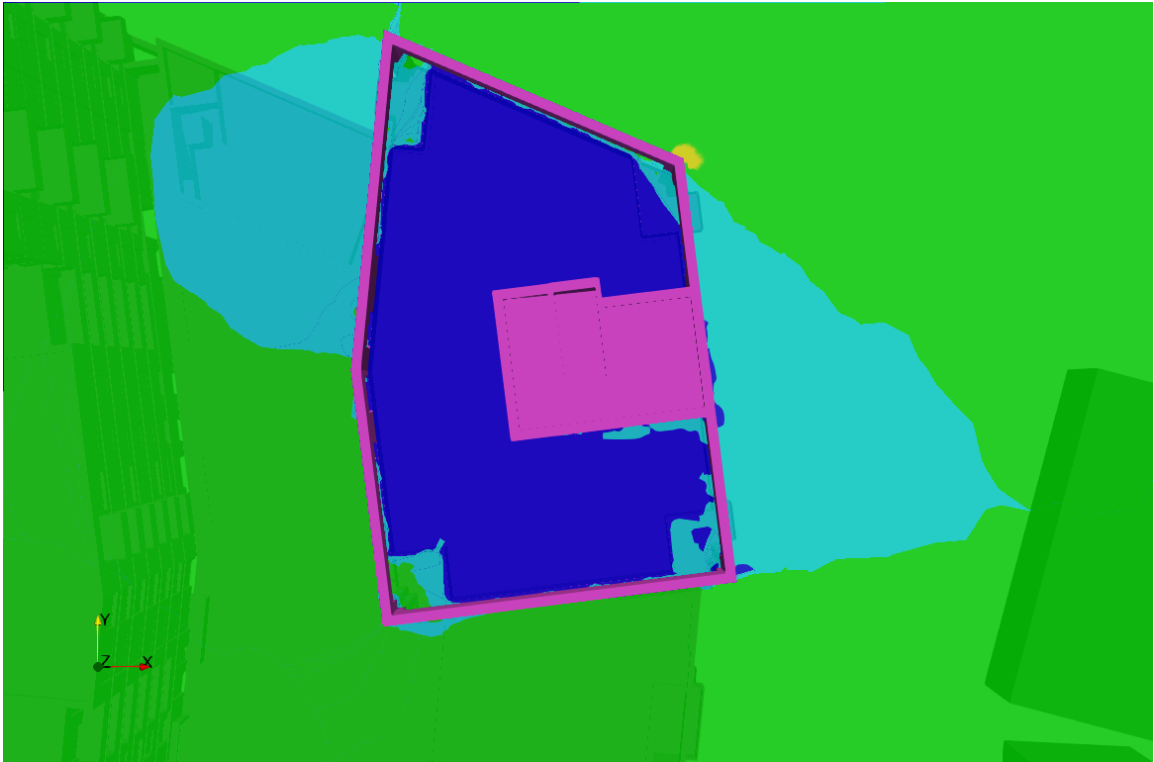


Figure 7.57: Terrace 1 - Lawson Discomfort Map at Z=1.5m above the terrace

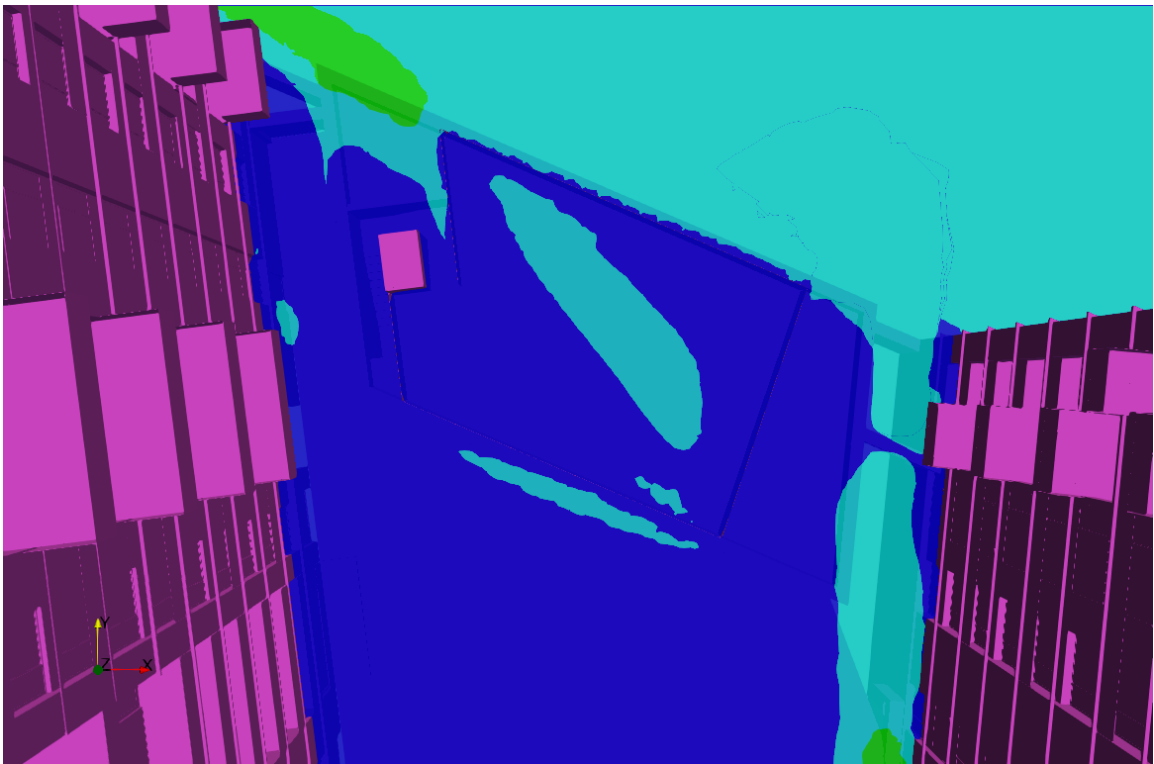


Figure 7.58: Terrace 2 - Lawson Discomfort Map at Z=1.5m above the terrace



Figure 7.59: Terrace 3 - Lawson Discomfort Map at Z=1.5m above the terrace

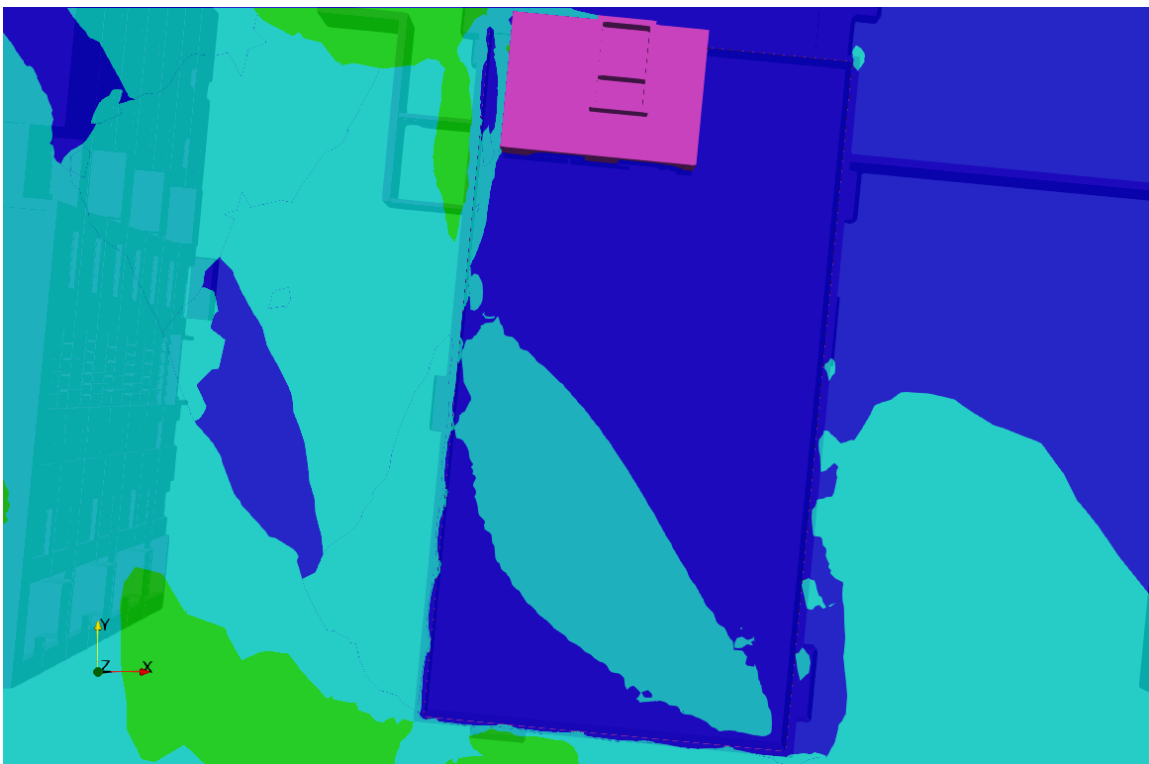


Figure 7.60: Terrace 4 - Lawson Discomfort Map at Z=1.5m above the terrace

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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 (walking).
- The proposed Communal and Open Public Areas can be used for long-term sitting/short term-sitting.
- The wind microclimate of the proposed development is comfortable and usable for pedestrians.

As result of the proposed development construction, the wind on the surrounding urban context is also mitigated when compared with the baseline situation, in this sense the proposed development has a beneficial effect on the surrounding wind microclimate and can create comfortable pedestrian areas and public spaces.

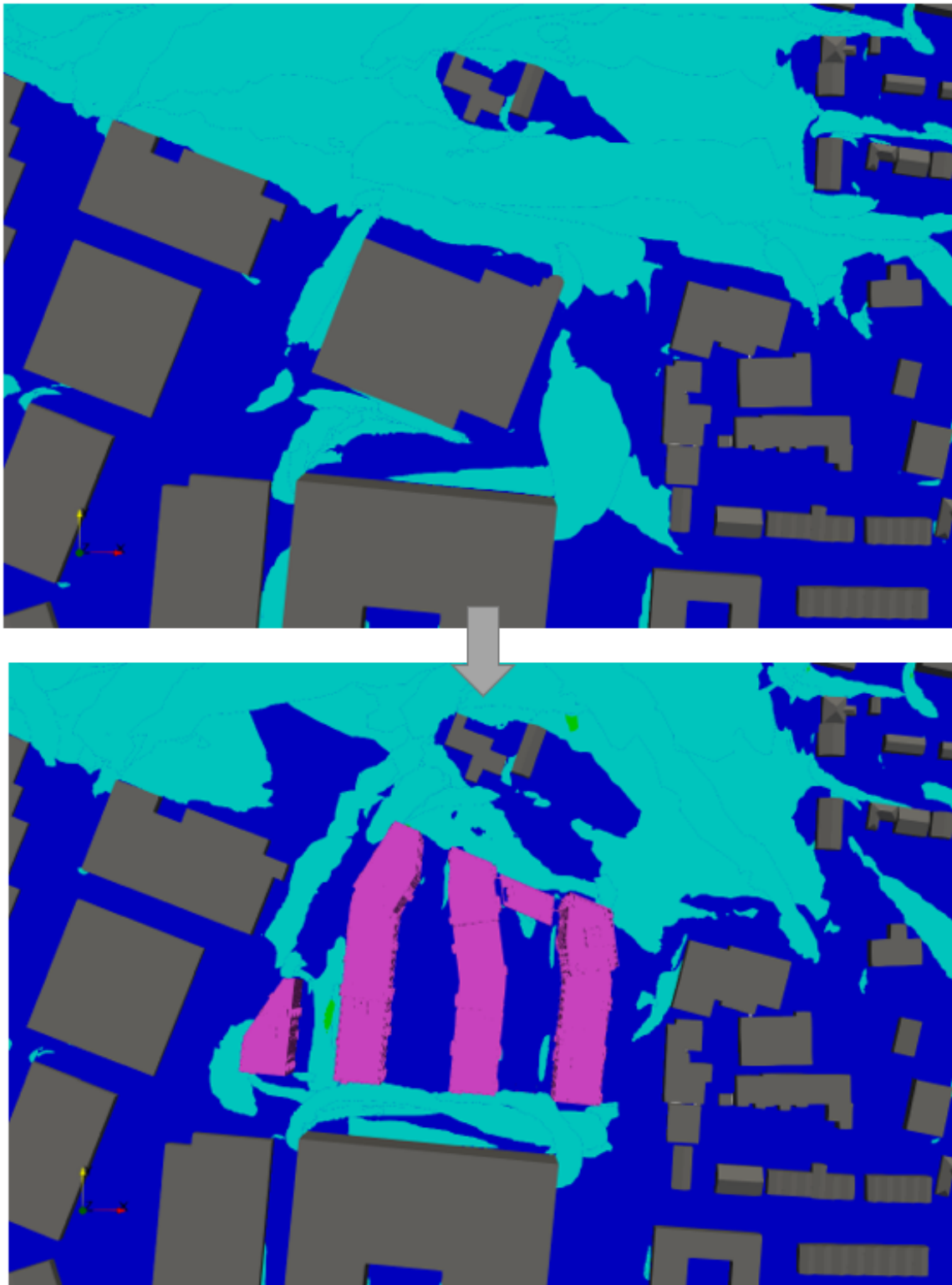


Figure 7.61: Comparison Wind Microclimate Conditions -Baseline Scenario versus Proposed DevelopmentScenario (Lawson Comfort/Distress Map)

Potential Receptors (on-site)	Baseline Conditions	Proposed Development Conditions	Impact Significance
Roads	Conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	<i>Beneficial/</i>
Entrances	Not applicable	Conditions are "suitable" for the intended pedestrian use.	<i>Negligible</i>
Public Areas	On the location designated for this use, conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	<i>Beneficial</i>
Communal Areas	On the location designated for this use conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	<i>Beneficial</i>
Pedestrian circulation areas	On the location designated for this use conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	<i>Beneficial</i>
Potential Receptors (off-site)	Baseline Conditions	Proposed Development Conditions	Impact
Off-Site Area-North	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions on the North area became windier for one comfort category passing from long-term sitting to short term sitting, however the conditions still remain suitable and calmer than required for the intended pedestrian use (walking).	<i>Negligible</i>
Off-Site Area-South	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	<i>Negligible</i>
Off-Site Area-East	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	<i>Negligible</i>
Off-Site Area-West	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	<i>Negligible</i>

Figure 7.62: Identification of Impact on On-Site and Off-Site Receptors

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## 8. CONCLUSIONS

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## 8.1 CONCLUSIONS and COMMENTS ON MICROCLIMATE STUDY

This report presents the CFD modelling assumptions and results of Wind and Microclimate Modelling of Chadwicks Development, at the junction of Santry Avenue and Swords Road, Santry, Dublin 9.

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 Armstrong Fenton Associates to configure the optimal layout for Chadwicks 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. In particular, the local wind climate was determined from historical meteorological data recorded 10m above ground level at Dublin Airport.
- The prevailing wind directions for the site are identified in the West, West South-West and South-East with magnitude of approximately 6m/s.
- Microclimate Assessment of Chadwicks Development and its environment was performed utilizing a CFD (Computational Fluid Dynamics) methodology.
- The proposed Chadwicks Development has been designed in order to produce a high-quality environment that is attractive and comfortable for pedestrians of all categories. To achieve this objective, throughout the design process, the impact of wind has been considered and analysed, in the areas where critical patterns were found, the appropriate mitigation measures were introduced.
- As a result of the final proposed and mitigated design, wind flow speeds at ground floor are shown to be within tenable conditions. Some higher velocity indicating minor funnelling effects are found near the South-West side of the development. However, as it is shown in the Lawson map indicate that the area can be utilised for the intended use.
- 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.
- The proposed development does not impact or give rise to negative or critical wind speed profiles at the nearby adjacent roads, or nearby buildings.
- During the construction of Chadwicks Development the predicted impacts are classified as negligible.

Therefore, the CFD study carried out has shown that under the assumed wind conditions



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typically occurring within Dublin for the past 30 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.**
- **As result of the proposed development construction, the wind on the surrounding urban context is also mitigated when compared with the baseline situation, in this sense the proposed development has a beneficial effect on the surrounding wind microclimate and can create comfortable pedestrian areas and public spaces.**

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## 9. REFERENCES

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