Gerard Gannon Properties

Clongriffin Mixed-Use Development

Wind Microclimate Study: Preliminary CFD Results

268321-00 Clongriffin Mixed-Use Development

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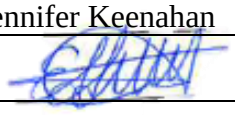
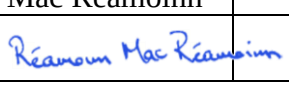
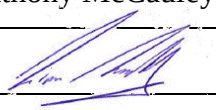
		Signature			
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Contents

Executive Summary

The proposed mixed-use development (Figure E1), which is located in Clongriffin, will consist of 15 blocks, ranging in height from 3 to 17 storeys to accommodate 1950 no. apartments and 22,728m^2 of commercial space.

Figure E1: Proposed Development Layout

The proposed development at Clongriffin will influence the local wind microclimate, affecting the existing and proposed pedestrian environment. A study was carried out using computational fluid dynamics to understand the influence of the development quality of the public realm. The assessment of pedestrian wind comfort has been carried out in accordance with the Lawson Comfort Criteria [1].

The objectives of the wind assessment are as follows:

- Examination of the level of pedestrian comfort within the proposed Clongriffin development;
- Mitigation measure proposals to alleviate pedestrian discomfort and distress where required;
- Assessment of the effectiveness of the mitigation measures, which are adopted in the design, at alleviating pedestrian discomfort and distress.

The local wind climate was determined from historical meteorological data recorded at Dublin Airport. The prevailing wind in Dublin is from the west and southwest. These are relatively warm and often bring rain. The winds from the east and southeast are not as common as the westerlies, however, they are relatively cold, which can make them as annoying as the stronger westerlies. The Wicklow Mountains to the south of Dublin influence the wind microclimate in the

vicinity of Dublin. In order to account for differences in topography and terrain exposure, the local wind data from Dublin Airport was transposed to the development site using the ESDU (Engineering Sciences Data Unit) methodology, which is compatible with Irish practice for wind loading.

The conclusions of the Clongriffin Development wind microclimate study are as follows:

- The critical wind directions for this development in terms of pedestrian comfort are East, Southeast, Southwest and West.
- In general, road and streets across the development are sheltered from wind. The most adverse wind conditions occur on the east side of the development.
- In general, the different spaces within the blocks across the development experience wind conditions that are consistent with their intended function.
- On the west side, the blocks are close to each other and similar in height. Clustering similar height blocks together enables upwind blocks will shelter those further downstream more effectively.
- Many of the retail streets (i.e. Market Lane, Market and the southern portion of Lake Street) are sheltered effectively from the wind.
- The streets to the northwest of the development are more exposed to the wind as similar size blocks do not surround them on all sides. Although these streets tend to be windier, these thoroughfares remain suitable for their intended use.
- More similar scale development is envisaged between Lake and Station Streets north of Block 16. If it does proceed in future, it is anticipated that there will be a reduction in windiness in the northwest of the development.
- It is beneficial that the main block entrances are located towards the centre of the buildings. It reduces pedestrian movements near the corners where the higher speed winds tend to occur.
- Most courtyards and communal spaces are situated in the centre of the block with buildings surrounding them on all sides. This helps to ensure that these communal spaces are sheltered from all wind directions.
- Most balconies are sheltered from the wind.
- Without consideration of landscaping or any suitable mitigation measures, the wind conditions may arise that more vulnerable pedestrians (i.e. the elderly, cyclists etc.) may find distressing in specific areas of the site, which include:
    - The streets and thoroughfares on the east side of the development (i.e. Marrsfield Lane, Railway Lane North and South, Bridge Street and Dargan Lane);
    - The walkway through Block 17 to the courtyard beyond;
    - The small isolated areas of the Block 17 courtyard;
    - The northeastern corner, southwestern corner and main entrance to Block 26;

- A few more exposed balconies (i.e. dual aspect corner or outstand balconies near corners);
- The more exposed roof gardens and terraces.

- Focused wind mitigation measures, to address the areas identified above, have been incorporated into the design to alleviate distress and these include:
  - The provision of planting and soft landscape features at ground level along the main thoroughfares and at corners of blocks;
  - The provision of a solid barrier in conjunction with landscaping along the eastern railway boundary;
  - The provision of wind screens along balustrades between the buildings at block 6, block 8 and block 28;
  - The provision of doors at either end of the walkway through Block 17 to the courtyard beyond;
  - The provision of canopies on the taller blocks (i.e. Blocks 17 and 26).
  - The provision of wind screens on the more exposed balconies (i.e. dual aspect corner or outstand balconies near corners);
  - The provision of wind screens along the edge of roof gardens and terraces;
- It is anticipated that the proposed mitigation measures will help alleviate distress that could be encountered on occasion in certain areas of the site.
- Overall, it is anticipated that the development will be a relatively calm and attractive environment for pedestrians. The development with the adoption of appropriate mitigation measures, where required, will be suited for its intended use.

1 Introduction

1.1 Overview

The proposed development is located in Clongriffin, approximately 9.5km northeast of Dublin city and 6km southeast of Dublin airport. It is situated immediately west to Clongriffin DART station, near Dublin bay (Figure 1.1).

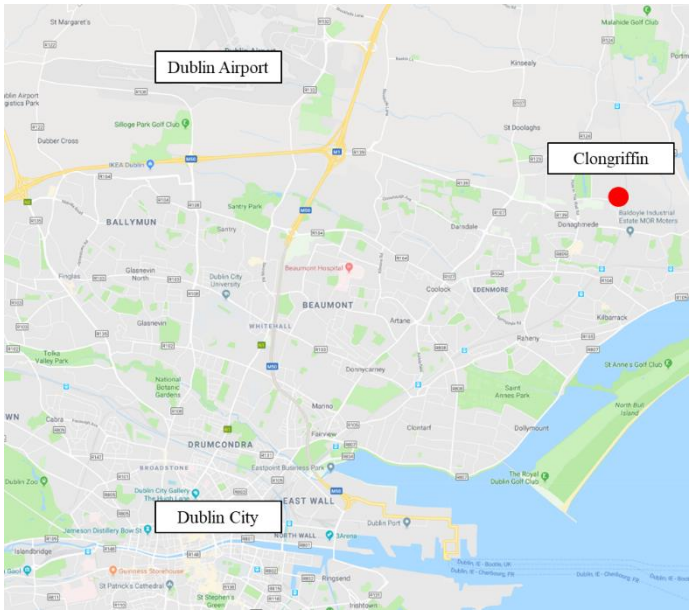


Figure 1.1: Proposed development location

During the design process, the influence of the development on the local wind microclimate and its impact on the quality of the pedestrian environment was examined. This report describes the methods used to assess these impacts in terms of pedestrian comfort and safety and outlines how the findings informed the design process.

This report assesses the impact of the proposed Clongriffin developments on the wind conditions affecting pedestrian activities in areas surrounding the development. The erection of new taller buildings may alter the flow of the wind in the surrounding area. The windiness depends on both the massing of the buildings within their surroundings, their orientation with respect to the wind, and the local climate.

The proposed development at Clongriffin site will influence on the wind environment at ground level. It is necessary to ascertain if the proposed development enhances or reduces the quality of the public realm. The assessment of discomfort and distress of pedestrians has been carried out in accordance with the Lawson Comfort Criteria [1].

1.2 Objectives

The objectives of the wind assessment are as follows:

- Evaluate the local microclimate that is experienced on site and examine the level of pedestrian comfort within the proposed development;
- Propose mitigation measure to alleviate the corresponding issues relating to pedestrian comfort and distress;
- Assessment of the effectiveness of the mitigation measures, which are adopted in the design, at alleviating pedestrian discomfort and distress.

2 Study Methodology

It is important to understand the wind microclimate around a proposed development in order to understand the level of pedestrian comfort. The assessment has been undertaken in the following key locations:

- Recreational areas;
- Entrances;
- Thoroughfares;
- Roof Gardens/Terraces;

In addition, the study has examined if any additional mitigation measures, such as canopies, screens and landscaping.

2.1 Lawson Comfort Criteria

The criteria used to describe windiness in this study are those of TV Lawson of Bristol University, extracted from “The evaluation of the windiness of a building complex before construction”, TV Lawson, London Docklands Development Corporation. These are used widely in Ireland, UK and around the world.

The acceptability of windy conditions is subjective and depends on several other factors, including but not limited to, normal clothing for the time of the year, expectations of the wind environment, air temperature, humidity and sunshine and most notably the activities to be performed in the area being assessed. The Lawson Criteria describe acceptability for particular activities in terms of 'comfort' and 'distress' (or safety). Acceptable conditions for various activities in order of increasing windiness are described in Table 2.1.

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.

Table 2.1: Comfort Criteria as Defined by TV Lawson

Activity	Description
'sitting'	Regular use for reading a newspaper and eating and drinking
'standing'	Appropriate for bus stops, window shopping, building entrances, and public amenity spaces such as parks
'strolling'	General areas of walking and sightseeing
'business walking'	Local areas around tall buildings where people are not expected to linger

Note: *A classification of 'business walking' does not mean that a location will never be suitable for 'sitting', however, it is likely to occur relatively infrequently.*

2.1.1 Comfort Levels

The 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, see above) which is exceeded for 5% of the time. The conditions, as described in Table 2.1 above, are the limiting criteria for comfort. For ideal conditions, the windiness will be a category better than outlined above. For more sensitive activities, such as regular use for external eating, conditions should be well within the 'sitting' category. Ireland is a windier climate than the UK, where these criteria were developed. It is generally accepted that residents in windier climates are more resilient to stronger winds. Therefore, a slight exceedance of the limiting criteria for comfort is not considered significant.

2.1.2 Distress Levels

There is a criterion to define the onset of distress. For the 'General Public', this is equivalent to an hourly mean speed of 15 m/s and a gust speed of 28 m/s 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.

Table 2.2: Distress Criteria as defined by TV Lawson

Activity	Description
General Public Access	Above which the less able and cyclists may at times find conditions physically difficult
Able-bodied Access	Above which it may become impossible at times for an able-bodied person to remain standing

There is a further limiting distress criterion beyond which even 'Able-Bodied' individuals may find themselves in difficulties at times. This corresponds to a mean speed of 20 m/s and a gust speed of 37 m/s to be exceeded less often than once a year. Aerodynamic forces may exceed body weight in stormy conditions, which makes it difficult for anyone to remain standing. Where wind speeds exceed these values, pedestrian access should be limited. .

Table 2.3: Lawson Comfort Criteria

Beaufort Scale	Wind Effects on the Environment	Wind Speed (m/s)		Activity			
		At 10m	threshold	'sitting'	'standing'	'strolling'	'business walking'
0 - 1	Calm – no significant wind	<1.5					
2	Wind felt on the face, leaves rustle	1.5 – 3.3					
3	Leaves and twigs move, wind carries small flags	3.4 – 5.4	**4.0**				
4	Dust and papers raised from the ground, small branches are agitated	5.5 – 7.9	**6.0**				
5	Wind is felt on the body, small trees move	8.0 – 10.7	**8.0**				
6	Difficult to walk straight, umbrellas are difficult to use, large branches begin to move	10.8 – 13.8	**10.0**				
7	Difficult to walk into the wind, trees are completely moving	13.9 – 17.1					
8	Storm – walking is hampered, branches break	17.2 – 20.7	**15.0**				
9	Storm – risk of losing balance, dangerous to walk	> 20.8	**20.0**				

Recreational Area | Entrances | Access Route

Legend

- Acceptable
- Tolerable
- Unacceptable

Comfort Criteria

- Dangerous – General Public including Cyclists
- Dangerous – Able-bodied Pedestrians

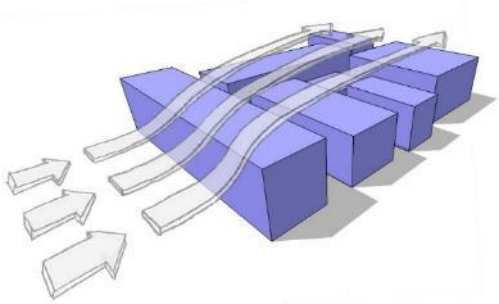
Distress Criteria

2.2 Key Flow Mechanisms

There are certain flow patterns that can result in increased flow velocities. The main flow mechanisms of concern are described below:

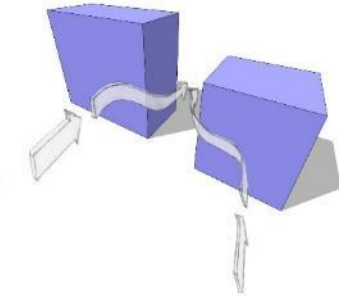
1. Exposure and Shelter:

When buildings of similar height are in close proximity to each other, the first line of buildings can shelter the buildings behind from the wind. However, if the gap is relatively large, the building upstream may not provide adequate shelter. In this case, the higher velocity high level wind from above may descend to ground and therefore, this may create an inclement environment for pedestrians.



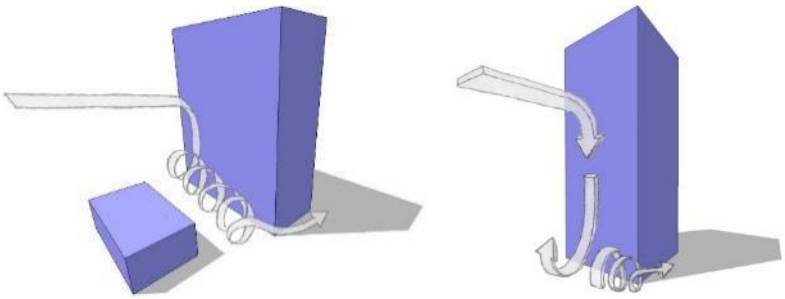
2. Funnelling:

When the gap between buildings is relatively narrow in comparison to their overall width, a large volume of wind is forced through the narrow opening. It is necessary for the wind speed to increase through the opening, which can result in discomfort for pedestrians.



3. Downdraft:

When buildings are considerably taller than the other buildings in their surroundings, they can re-direct the high-speed winds that they interact with at a high level down to ground in the form of a downdraft. The downdraft effect can be further exacerbated by lower level buildings in close proximity upstream.



2.3 Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is a numerical technique to simulate fluid flow, heat and mass transfer, chemical reaction and combustion, multiphase flow, and other phenomena related to fluid flows. Modelling in CFD includes three main stages: pre-processing, simulation and post-processing. Computational Wind Engineering (CWE) is a branch of CFD concerned with behaviour of wind. It can be used to understand the wind flow through an urban environment and the effect of a proposed development on the local wind microclimate.

3 Existing Receiving Environment

3.1 Site Location and Surrounding Area

The development site across a number of plots situated near the centre of Clongriffin (i.e. Station Square) between the DART line to the east and low level residential housing near Fr. Collins Park to the west. Clongriffin is situated on the cusp between the suburban and agricultural lands on the northside of Dublin city. The development is a short distance from the coast with the Broadmeadow Estuary and Dublin Bay nearby to the east.

3.2 Proposed Development

The proposed development comprises of the construction of mixed-use developments spread in 15 blocks, ranging in height from 3 to 17 storeys to accommodate 1950 no. residential units and 22,728m^2 commercial space in total. On the ground floor there are commercial and retail units, and resident's facilities.

Table 3.1: Summary of Blocks

Block	Number of buildings	Number of Storeys
Block 3	2	6
Block 4	2	6
Block 5	1	4-7
Block 6	5	5-7
Block 8	3	3-8
Block 11	1	4-6
Block 13	2	6-7
Block 14	2	6-8
Block 15	2	6
Block 17	1	6-17
Block 25	1	7
Block 26	1	8-15
Block 27	1	6
Block 28	3	7
Block 29	1	4

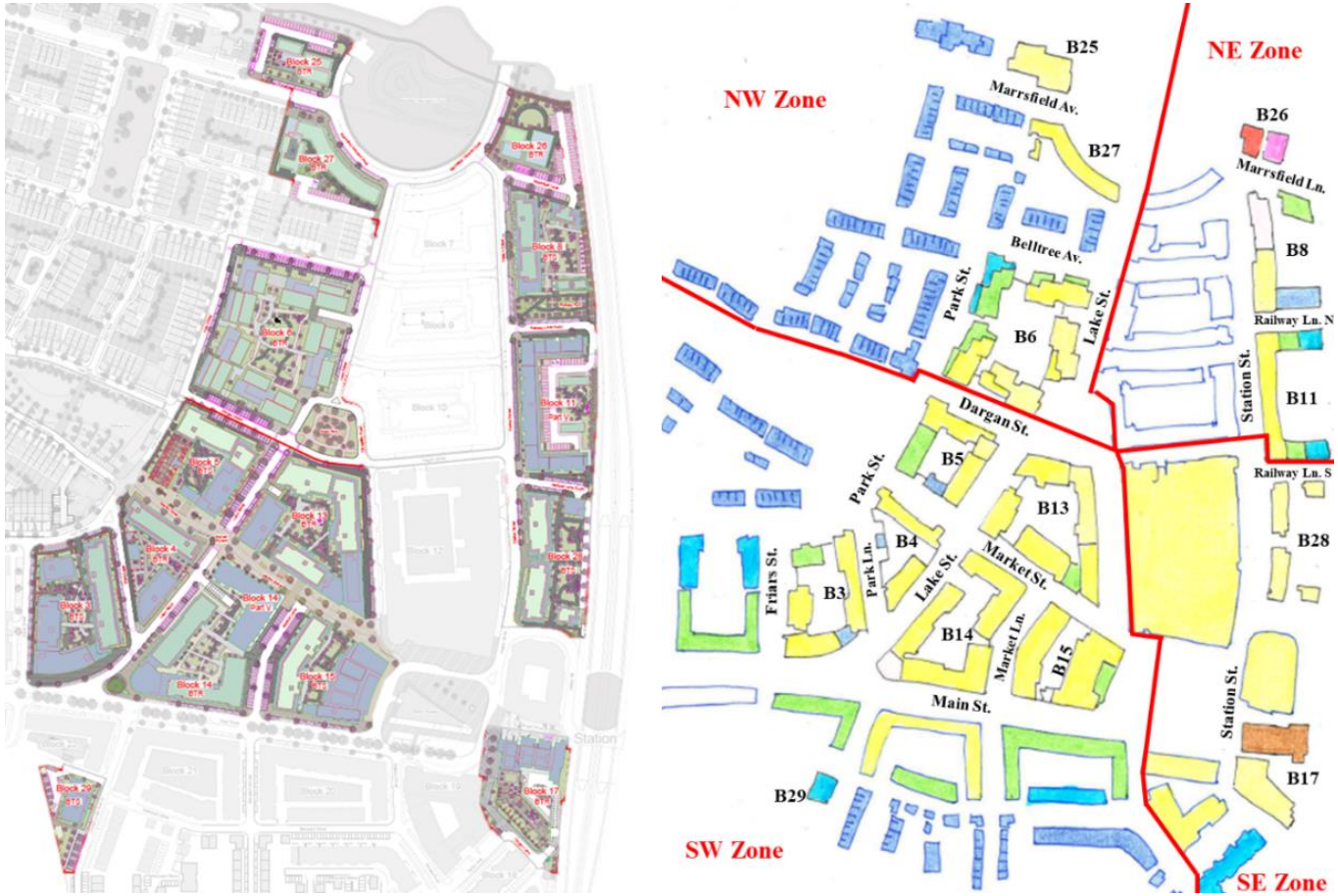


Figure 3.1: Proposed Development

3.3 Wind Microclimate

Met Eireann's meteorological station at Dublin Airport is the closest meteorological station to Dublin and to the site. The expected statistics for wind strength and direction are based on historic wind data recorded at this weather station. The meteorological data, which was associated with the hourly wind speeds recorded over a 30-year period between 1989 and 2018, were analysed. The data is recorded at a weather station at the airport, which is located 10m above ground or 71mOD.

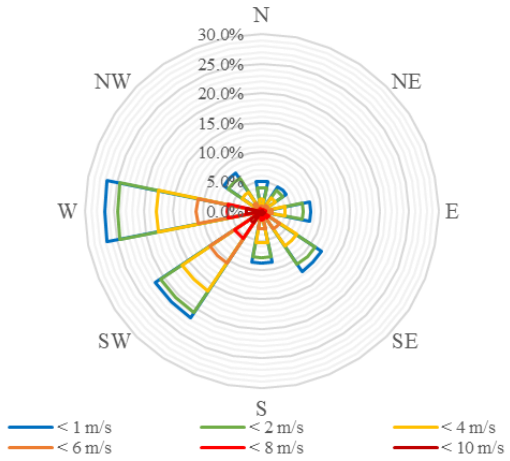


Figure 3.2: Dublin Airport Wind Rose

The prevailing wind in Dublin is from the southwest. These are relatively warm and often bring rain. The winds from the east are not as common as the westerlies, however, they are relatively cold, which can make them as annoying as the stronger westerlies. The Wicklow mountains to the south of Dublin influence the wind microclimate in the vicinity of Dublin and tend to shelter the city from southerly winds.

Due to the proposed development's location in close proximity to the sea, the wind statistics may deviate from the records at Dublin Airport. It is likely the site experiences stronger and more frequent easterly and south-easterly winds, whilst it is sheltered by Dublin city for south and south-westerly winds.

Table 3.1: Weibull distribution parameters (based on wind speed in m/s)

Wind Direction	N	NE	E	SE	S	SW	W	NW
Directional probability, p	6%	5%	9%	13%	9%	22%	28%	8%
Dispersion parameter, c	3.9	5	4.5	5.3	5.7	6.9	6.3	4.7
Shape parameter, k	1.50	1.95	1.65	1.85	1.8	2.2	1.85	1.9

In this study, winds were considered to approach from eight distinct sectors. A Weibull distribution was fitted to the wind data for each sector through the adoption of an appropriate dispersion parameter, c, and shape parameter, k, given in Table 3.1 above.

In order to account for difference in topography and terrain exposure, the local wind data from Dublin Airport was transposed to the development site using the ESDU (Engineering Sciences Data Unit) methodology, which is compatible with the Irish practice for wind loading. The transformation considers the exposure of the site, which is a measure of the terrain roughness (i.e. size and number of obstacles) upstream of the site. The exposure is dependent on the direction of the oncoming wind.

4 Detailed Quantitative Analysis

A comprehensive study was undertaken to quantify the pedestrian comfort level at key locations in the domain using computational fluid dynamics (CFD).

In general, the proposed development is likely to provide a comfortable and attractive environment for pedestrians and occupants. It is exposed to winds which have the potential, on occasions, to cause conditions that pedestrians may find distressing without the appropriate mitigation measures in place.

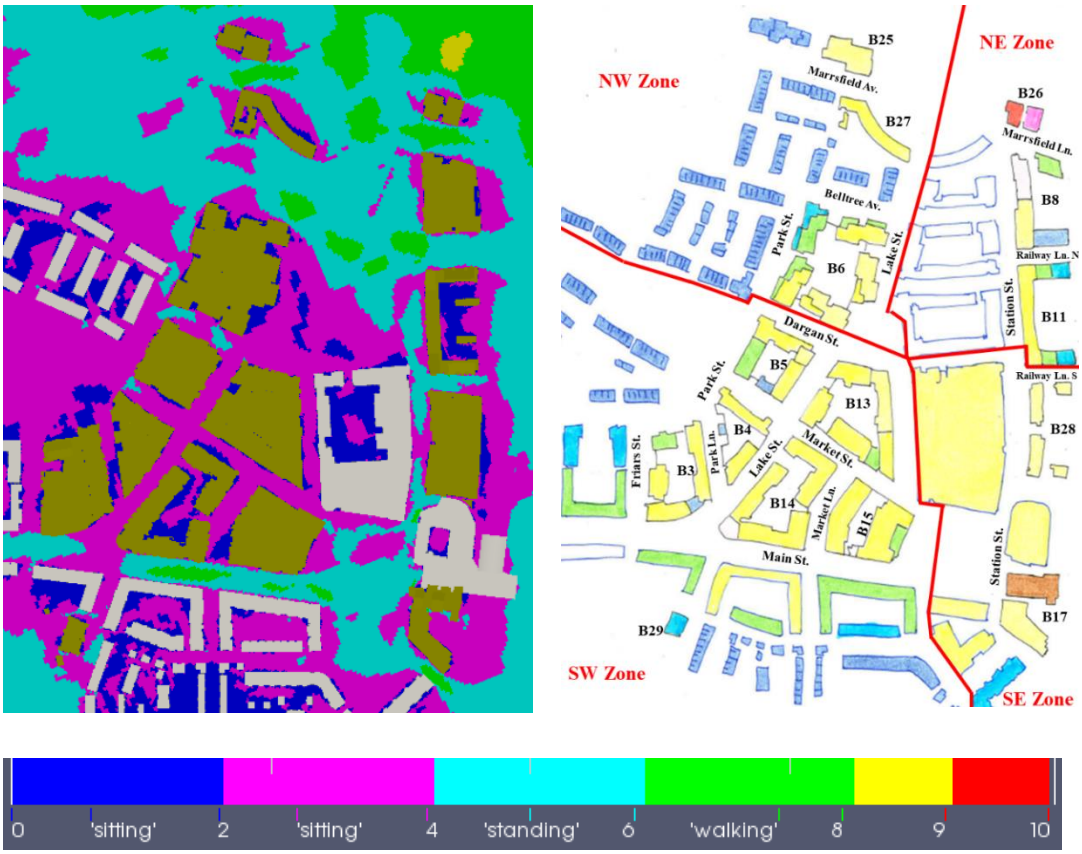


Figure 4.1: Lawson comfort wind speeds across development without any mitigation

4.1 Thoroughfares

In general, road and streets across the development are sheltered from wind.

On the west side, the blocks are close to each other and similar in height. Clustering similar height blocks together enables upwind blocks will shelter those further downstream more effectively. Furthermore, the typically narrow gaps between blocks tends to cause the wind to travel over and around the blocks rather than through the streets.

Many of the retail streets (i.e. Market Lane, Market and the southern portion of Lake Street) are sheltered effectively from the wind. The wind conditions are expected in the 'sitting' to 'standing' range at least. These wind conditions are acceptable for entering or strolling between retail spaces. The proposed landscape treatments along the streets will help disrupt and dissipate the wind. This will help create an attractive amenity space for pedestrians. Slightly windier conditions are anticipated to occur on Main Street (see Section 4.1.1) as this street is more exposed to the wind. However, the provision of landscaping along these streets and near corners will further obstruct and dissipate the wind.

The streets to the northwest of the development are more exposed to the wind as similar size blocks do not surround them on all sides. The wind conditions along these streets (i.e. Dargan, Street, Bellevue Avenue, Park Street, northern portion of Lake Street, Marrsfield Avenue and Marrsfield Crescent West) tend to be higher and they are expected in the 'standing' and occasionally 'walking' ranges. Higher winds are expected to occur near the corners of blocks. However, the provision of trees and landscaping near the corners will help provide further localised shelter from the wind. Although these streets tend to be windier, these thoroughfares remain suitable for their intended use.

It is envisaged that more similar scale development (i.e. Blocks 7, 9 and 10) is envisaged between Lake and Station Streets north of Block 12. If it does proceed in future, it is anticipated that there will be a reduction in windiness in the northwest of the development due to added shelter the developments will afford each other.

The most adverse wind conditions occur on the east side of the development. It is most exposed to the wind due to the agricultural lands. Furthermore, the east-west alignment of many of these streets (i.e. Marrsfield Lane, Railway Lane North, Railway Lane South and Bridge Street) in conjunction with the proximity of the coast ensure the strong winds blow along these streets at times. In addition, the tall blocks at either end of the development have the potential to direct high level winds towards the ground. The winds are expected in the 'walking' range with the potential to exceed the distress threshold for more vulnerable pedestrians in a few specific locations a few hours a year.

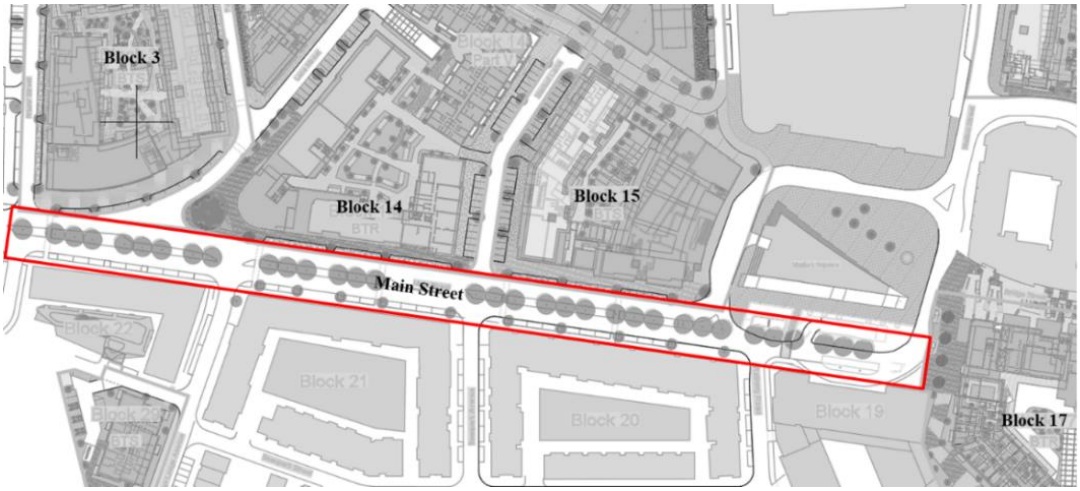


Figure 4.2: Extent of Main Street

4.1.1 Main Street

Main Street (Figure 4.2) is a dual carriageway with footpaths and parking on either side and a planted verge along the centre of the road. It is the main thoroughfare through the development and provides connectivity between the proposed development and its surroundings. The ground floor space of Blocks 14 and 15 facing onto Main Street comprises retail units.

Main Street suffers from windiness due to the funnelling effects of the southeast, west and southwest winds. It is anticipated that the typical wind conditions will be in the 'standing' to 'walking' range and it is considered suitable for its intended use. The provision of trees and landscaping along Main Street will be beneficial in disrupting and obstructing the wind.

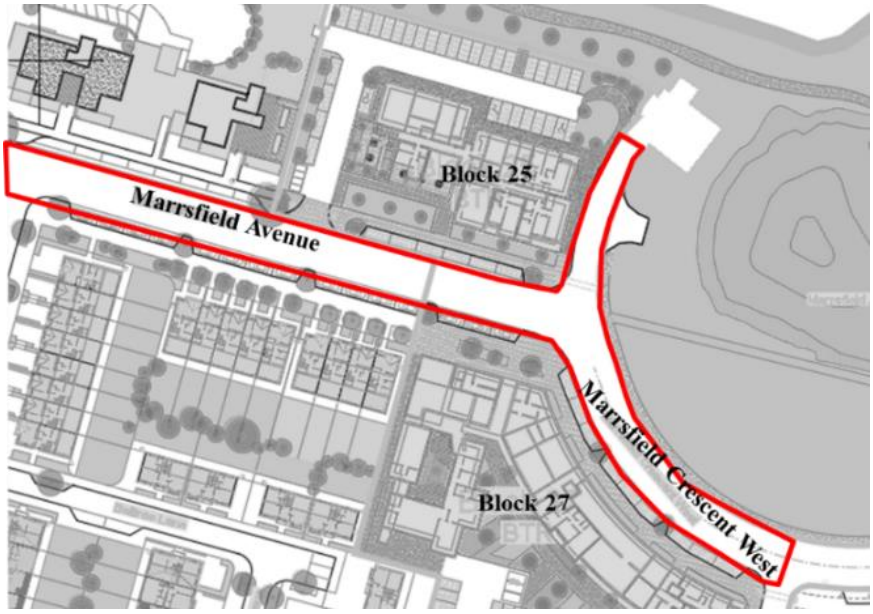


Figure 4.3: Marrsfield Avenue

4.1.2 Marrsfield Avenue and Marrsfield Crescent West

Marrsfield Avenue (Figure 4.3) is runs between Block 25 and north of Block 27. It is a single carriageway road with footpaths, parking and grass verges on either side. The pedestrian and vehicular accesses into Block 25 is off Marrsfield Avenue. Marrsfield Crescent West is situated at the eastern end of Marrsfield Avenue and it skirts around a circular green space in front of Block 27.

The results indicate Marrsfield Avenue will be exposed to some windiness (Figure 5.6). There is potential for wind to funnel between the blocks due to the distance between them given their relative height and scale. The wind speeds are envisaged to be in the 'standing' to 'walking' range with the potential to approach the threshold for distress for more vulnerable pedestrians (i.e. young children, the elderly or cyclists) on occasion. The alignment of walkways is beneficial as it helps guide pedestrians from the stronger winds that occur near corners. In addition, the provision of trees and landscaping at corners and along the avenue will be help disrupt the wind. Both Marrsfield Avenue and Marrsfield Crescent West are considered suitable for their intended use.

4.1.3 Marrsfield Lane and Marrsfield Crescent East

Marrsfield Lane passes between Block 8 and Block 26. The main entrance to Block 26 is accessed off Marrsfield Lane. At the end of the lane, there are two car park entrances (i.e. Blocks 8 and 26). Pedestrians movements along the lane beyond the main entrance to Block 26 will be mostly limited to pedestrians heading towards vehicles in the parking areas.

Due to its exposure to the east, some windiness is expected along Marrsfield Lane. The winds along the lane are expected in the 'standing' to 'walking' range with the strongest winds occurring near the corners of Block 8. The provision of a solid barrier along the railway boundary in conjunction with trees and landscaping will be beneficial in disrupting and dissipating the winds approaching the lane from the east.

4.1.4 Railway Lane North

Railway Lane North (Figure 4.4) passes between Block 8 and Block 11. There is a small landscaped park, Railway Park, on the north side of Railway Lane North. Stairs from the elevated courtyard in Block 8 lead into the centre of the Railway Park. The vehicle entrance to Block 11 is located at the end of Railway Lane North near the boundary with the DART line.

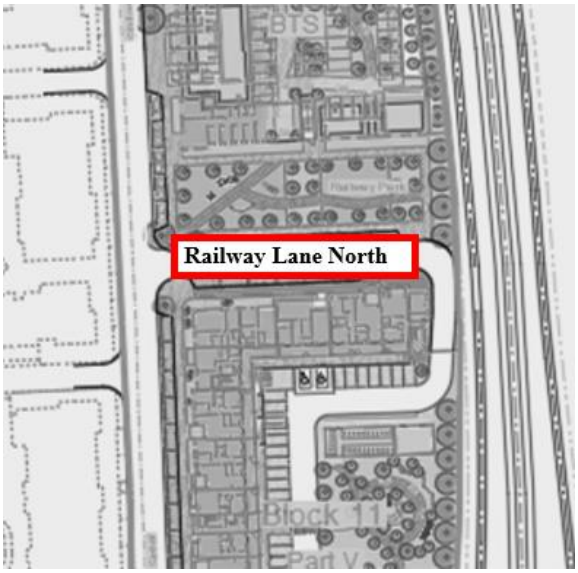


Figure 4.4: Railway Lane North and South

Railway Lane North is exposed to wind from the east. The winds along the lane are expected in the 'walking' range with the potential to exceed the distress threshold for more vulnerable pedestrians on occasion (Figure 5.16). While it is a challenge to fully mitigate the wind along Railway Lane North, it is possible to provide pedestrians with a sheltered route through the Railway Park through careful consideration of the landscaping within the park. In addition, the provision of a solid barrier along the railway boundary in conjunction with trees and landscaping will be beneficial in disrupting and dissipating the winds approaching the lane from the east.

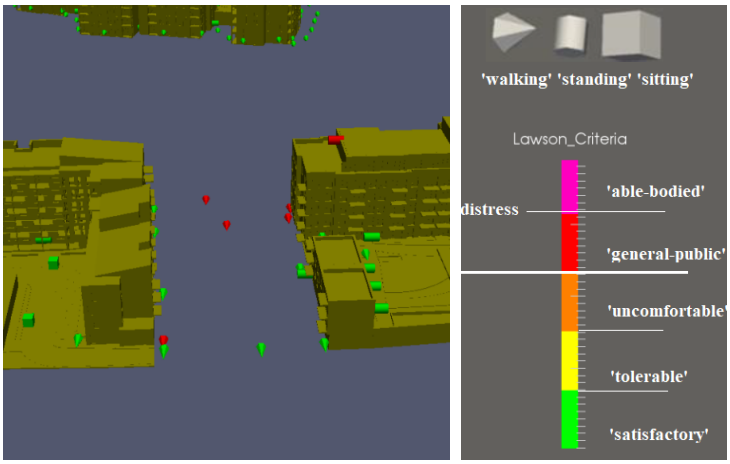


Figure 4.5: Lawson Comfort Criteria for Railway Lane North

4.1.5 Railway Lane South

Railway Lane South passes between Blocks 11 and 28. There is a pedestrian access into the central courtyard of Block 11 at the end of the lane near the DART line boundary.

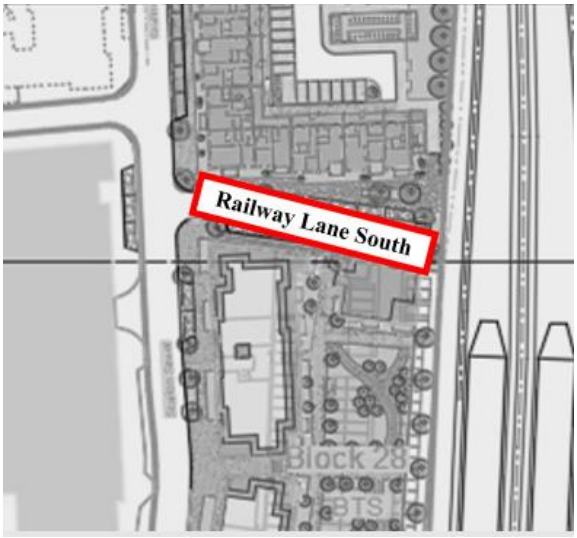


Figure 4.6: Railway Lane North and South

Railway Lane South is exposed to wind from the east and these winds are exacerbated as they funnel between the blocks. The winds along the lane are expected in the ‘walking’ range with the potential to exceed the distress threshold for more vulnerable pedestrians on occasion (Figure 5.16). While it is a challenge to fully mitigate the wind along Railway Lane South, the provision of trees and soft landscaping near the pedestrian access to Block 11 would be beneficial in sheltering pedestrians as they traverse the wind. In addition, the provision of a solid barrier along the railway boundary in conjunction with trees and landscaping will be beneficial in disrupting and dissipating the winds approaching the lane from the east.

4.1.6 Bridge Street

Bridge Street (Figure 5.17) is located immediately north of Block 17. It provides the main pedestrian access from Station Square to the Clongriffin DART Station and ramps upward as it approaches the station.

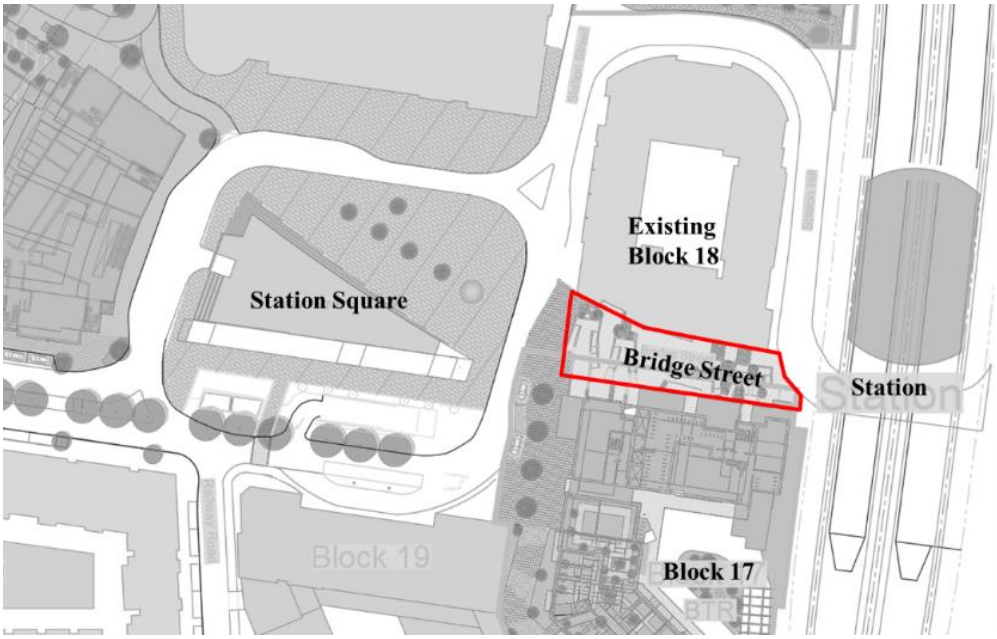


Figure 4.7: Bridge Street

Figure 4.8: Lawson Comfort Criteria for Bridge Street

Bridge Street is likely to suffer from windiness. Wind speeds are expected to be within the ‘standing’ to ‘walking’ range along the street.

Near the station, the street is exposed to winds from the east. The wind conditions are exacerbated when these winds funnel between the blocks. Winds may approach speeds that more vulnerable pedestrians will find distressing on occasion. The provision of robust planting in the raised planters along the ramp on Bridge Street would be helpful in obstructing the wind and providing refuge areas for more vulnerable pedestrians. In addition, the provision of screens within these

planters would provide additional wind protection, however, careful consideration is required in placing these screens to avoid promoting anti-social behaviour.

4.1.7 Dargan Lane

It is anticipated that high speed winds will occur on Dargan Lane at the southern corner of Block 17. The wind conditions are expected in the ‘walking’ range while exceeding wind speeds that more vulnerable pedestrians may find distressing. Strong winds occur when southeasterlies funnel between Blocks 17 and 18. The road cross-section consists of a single carriageway with two pedestrian walkways on either side, which limits the local wind mitigation options. However, the provision of a solid barrier along the railway line boundary in conjunction with denser landscaping at the end of Dargan Lane will likely reduce the windiness at the block corner.

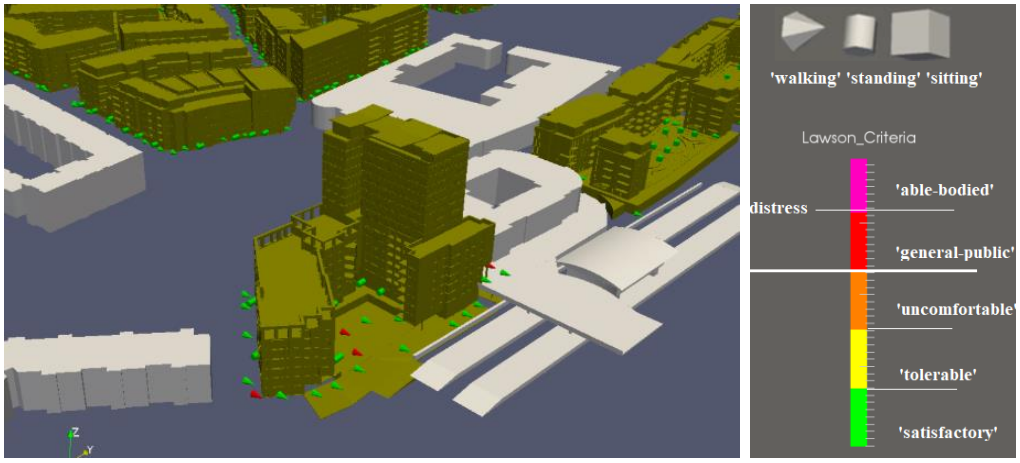


Figure 4.9: Lawson Comfort Criteria for Dargan Lane

4.2 Blocks

In general, the different spaces within the blocks across the development experience wind conditions that are consistent with their intended function. These will be attractive spaces for pedestrians in some instances, while other spots require the provision of wind mitigation measures to ensure adequate protection from the wind.

It is beneficial that the main block entrances are located towards the centre of the buildings. It reduces pedestrian movements near the corners where the higher speed winds tend to occur. Typically, the wind conditions at entrances are in the ‘standing’ range and therefore, they are considered acceptable for their proposed use.

Most courtyards and communal spaces are situated in the centre of the block with buildings surrounding them on all sides. This helps to ensure that these communal spaces are sheltered from all wind directions. Typically, the conditions within these courtyards will be suitable for pedestrian ‘sitting’ or ‘standing’ range. The provision of landscaping within the courtyards will further assist in dissipating

and obstructing the wind. This will help create a calm and attractive environment for pedestrians using these spaces.

The courtyards and communal spaces on the east of the development (i.e. Blocks 8, 11, 17 and 28) are exposed to the east. It is expected that these courtyards and communal spaces will be prone to stronger winds on occasion. However, the winds conditions will suitable for 'standing' with the exception of Block 17. Furthermore, the provision of hard and soft landscaping will further enhance the amenity of the space through obstructing and dissipating the wind.

In general, most balconies are sheltered from the wind. On most balconies, the wind conditions on the balconies will be in the 'sitting' and 'standing' range and therefore, these balconies are considered suitable for their intended use. Dual aspect balconies at corners will be strong winds accelerating around the corner of the block. The provision of a full height screen along the shorter edge of these balconies will impede the wind blowing across through the balcony helping to reduce the windiness on the balcony to more comfortable levels. Similarly, outstand balconies situated near block corners may be exposed to higher speed winds. The provision of 1.8m high screens on both sides of the balcony is necessary to ensure these balconies remain suitable for their intended use.

4.2.1 Block 5

Block 5 (Figure 5.21) consists of three main developments that range from 4 storeys to 6 storeys height, forming a U-shape development with a central courtyard on a raised podium in the centre. There is a provision for underground parking and bicycle storage and amenities spaces for the residents. There will be retail units along Market Street.

The roof garden on Block 5 is sheltered from many wind directions. The southern end of the roof garden could experience some windiness on occasion as it is exposed to southeasterly winds. The provision of a 1.8m high screen along the southern and western edge of the terrace will help protect the roof garden from the worst effects of the wind. Furthermore, the vegetation growth over the pagoda, which extends over a large portion of the roof garden, will further assist in sheltering occupants from the wind.

4.2.2 Block 6

Block 6 (Figure 5.22) consists of five main developments that range from 5 to 7 storeys height, with a central courtyard on a raised podium in the centre. Further amenity spaces for the residents exist on the rooftops of many of the blocks.

It is beneficial that the roof terraces on the buildings on Block 6 are narrow as it helps reduce the windiness on these terraces. It is anticipated that the wind conditions on the roof terraces with a solid balustrade surrounding their edge will be in the 'sitting' and 'standing' range. It is expected that the roof terraces will be suitable for their intended use.

4.2.3 Block 8

Block 8 (Figure 5.24) comprises 3 buildings ranging from 2 to 8 storeys in height, with a central courtyard on a raised podium in the centre. The raised podium acts as an amenity space for residents. There are terraces on the roof of two of buildings adding to the amenity space of the block.

The roof terraces on Block 8 are exposed to the easterly winds blowing in from the coast. Given their height and exposure, the is potential for wind conditions on the rooftops to be distressing to pedestrians on occasion. The provision of a solid balustrade along the edge of the roof terrace will assist in sheltering occupants on the terrace from the wind.

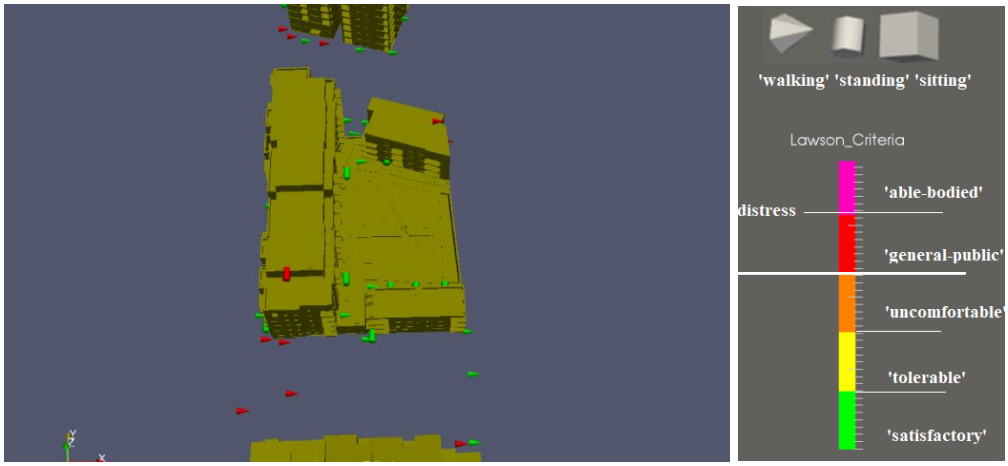


Figure 4.10: Lawson Comfort Criteria for Block 8

4.2.4 Block 17

Block 17 (Figure 5.29) consists of a U-shape development ranging between 5 and 17 storeys with a raised courtyard. It contains retail units that front onto Bridge Street as well as residential apartments. A bicycle store can be accessed from an entrance on Station Street, while the ramp access to underground parking is situated at the end of Dargan Lane.

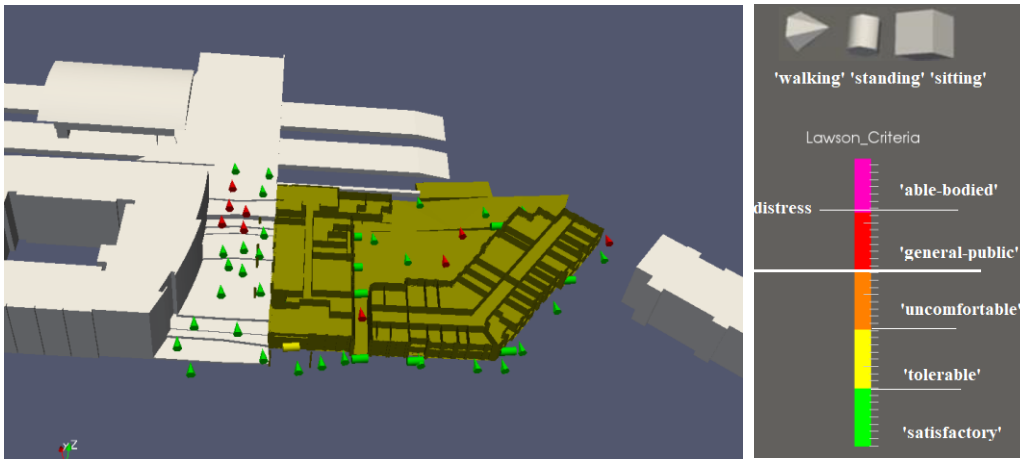


Figure 4.11: Trimmed west view of Lawson Comfort Criteria for Block 17

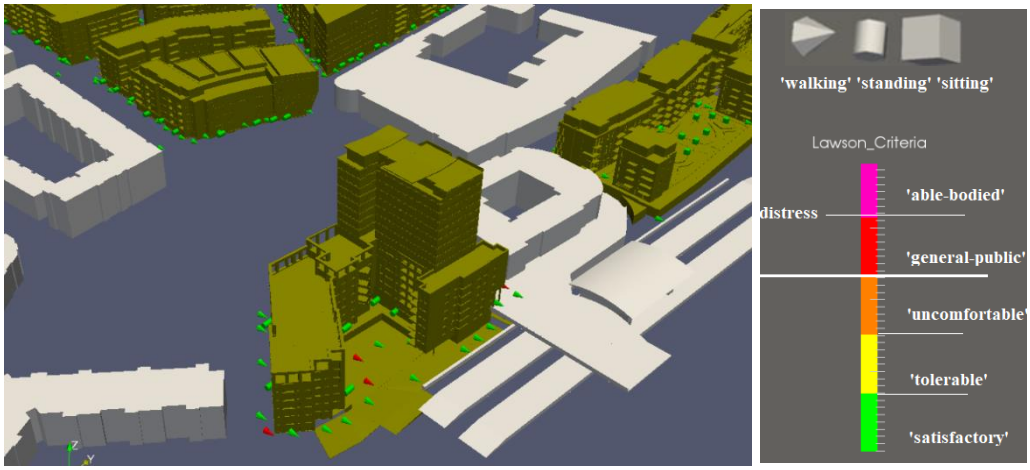


Figure 4.12: Southeast view of Lawson Comfort Criteria for Block 17

It is anticipated that the gated pedestrian walkway into the courtyard from Station Street will suffer from windiness. While wind conditions along the walkway are expected in ‘walking’ range, the winds that more vulnerable pedestrians will find distressing will occur from time to time. The strong winds occur due to westerly winds passing through the gap to reach the courtyard beyond. The downdraft from the tower above further exacerbates the situation. Closing the walkway at two locations with a door or screen will remove the pathway for the wind and therefore, it will alleviate the wind. The provision of a wraparound canopy at the northwestern corner of Block 17 would be beneficial in capturing downdraft air from the tower before it reaches the ground on Bridge or Station Streets.

While the wind conditions in the courtyard are expected in the ‘sitting’ to ‘standing’ range, there are some isolated areas of distress that may occur. The windy conditions arise from distress on occasion due to southerly winds becoming downdraft into the courtyard. The provision of a canopy along the south façade of tall tower will be beneficial to maintain the wind at higher levels and prevent it from down drafting into the courtyard. The provision of landscaping within the courtyard will be helpful in obstructing and dissipating the wind also.

The roof terraces on Block 17 are exposed to the easterly winds blowing in from the coast. Given their height and exposure, the is potential for wind conditions on the rooftops to be distressing to pedestrians on occasion. The provision of a solid balustrade along the edge of the roof terrace will assist in sheltering occupants on the terrace from the wind.

4.2.5 Block 26

Block 26 (Figure 5.32) consists of one building ranging from 8 to 15 storeys with roof terraces on each roof. Roof terraces are present on two roofs at the 8th floor and 13th floor levels.

High speed winds are anticipated at the corner of the block due to its bluff shape. Furthermore, the downdraft air due to the height of the tower is expected to further exacerbate the winds at ground level. The wind conditions are likely suitable for ‘standing’ or ‘walking’ with the worst wind effects occurring near the block corners. There is even the potential for winds to reach and even exceed

conditions more vulnerable pedestrians may find distressing. The worst affected areas are the southwestern and northeastern corners as well as near the main entrance to the block. The provision of canopies at the southwestern and northeastern corners of the tower would help capture and maintain the downdraft air at a height. It is preferable for the southwestern canopy to extend into the central recess on the southside to prevent any descending air reaching the ground along this pathway. These canopies would protect these corners and the main entrance from the worst effects of the wind. In addition, the provision trees and soft landscaping at the other corners would help guide pedestrians away from the windy corners while providing some local wind mitigation also.

The roof terraces on Block 26 are exposed to high level winds. Given their height and exposure, there is a potential for wind conditions on the rooftops to be distressing to pedestrians on occasion. While the canopy over the 8th floor entrance will provide local protection from downdrafts, the provision of a 1.4m high solid balustrade along the edge in combination some careful landscaping on the roof will assist in sheltering occupants on the terrace from the wind.

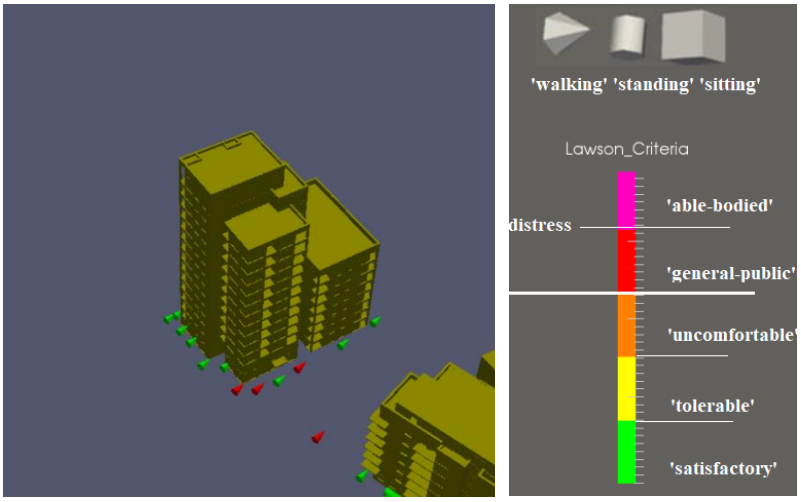


Figure 4.13: Southwest view of Lawson Comfort Criteria for Block 26

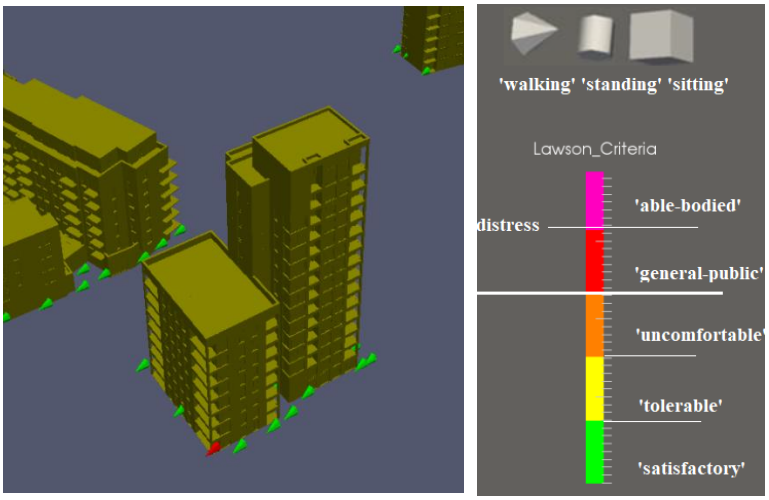


Figure 4.14: Northeast View of Lawson Comfort Criteria for Block 26

5 Mitigation & Residual Impacts

The following mitigation measures are implemented in the design:

5.1 Thoroughfares

- Provision of trees and soft landscaping at ground level along the streets and at block corners
- The provision of a sheltered route through the Railway Park adjacent Railway Lane North.

Figure 5.1: Proposed landscaping along Railway Lane North (left) and South (south)

- The provision of a solid barrier along the railway boundary in conjunction with trees and landscaping will be beneficial in disrupting and dissipating the approaching winds on the Marrsfield Lane, Railway Lane North and South and Dargan Lane.
- The provision of robust planting in the existing raised planters along the ramp on Bridge Street to obstruct and dissipate the wind.
- The provision of wind screens within the existing raised planters on Bridge Street to provide refuge areas from the wind without promoting anti-social behaviour.

5.2 Blocks

5.2.1 Courtyards and Public Spaces

- The provision of landscaping within the courtyards will further assist in dissipating and obstructing the wind.

- The provision of wind screens along balustrades in the gaps between the buildings of Blocks 6, 8 and 28
- The provision of a louvred gate across the pedestrian entrance from Station Avenue into the raised courtyard of Block 28

5.2.2 Balconies

- The provision of a full height wind screen along the shorter edge of the dual aspect corner balconies. These will act to reduce the windiness on the balconies to more comfortable levels.
- The provision of 1.8m high screens on both sides of the outstand balconies to ensure these balconies remain suitable for their intended use.

5.2.3 Roof Terraces

- The provision of a solid balustrade along the edge of the roof terrace will assist in sheltering occupants on the terrace from the wind.

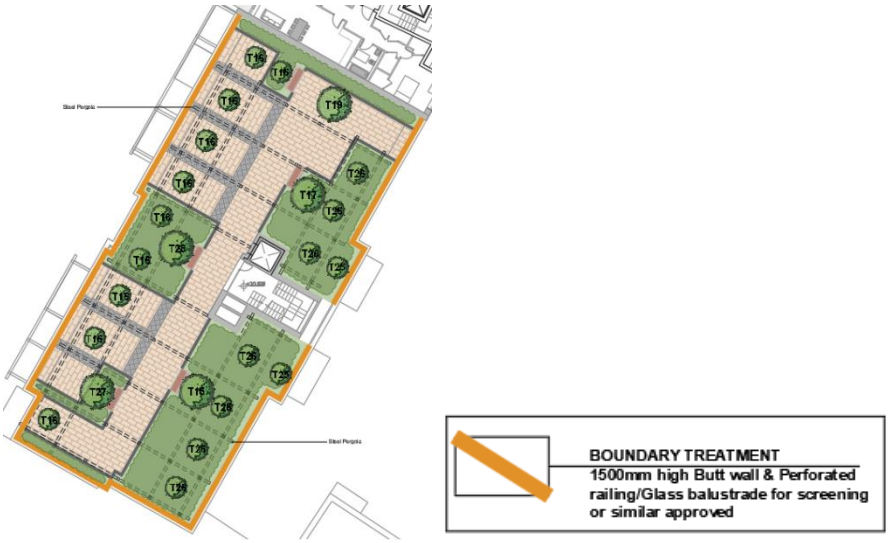


Figure 5.2: Proposed landscaping on Roof Garden of Block 5

- Furthermore, the vegetation growth over the pagoda in the roof garden of Block 5, which extends over a large portion of the roof garden, will further assist in sheltering occupants from the wind.

5.2.4 Block 17

- Closing the walkway at two locations with a door or screen will remove the pathway for the wind and therefore, it will alleviate the wind.
- The provision of a wraparound canopy at the northwestern corner of Block 17 to capture downdraft air from the tower before it reaches the ground on Bridge or Station Streets.
- The provision of a canopy along the south façade of tall tower will be beneficial to maintain the wind at higher levels and prevent it from down drafting into the courtyard.

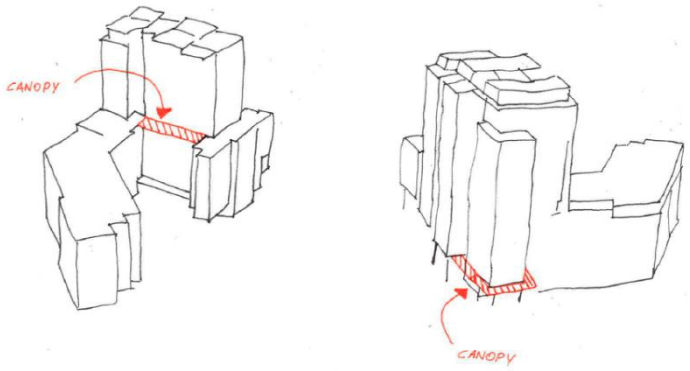


Figure 5.3: Proposed canopies for Block 17

5.2.5 Block 26

- The provision of canopies at the southwestern and northeastern corners of the tower would help capture and maintain the downdraft air at a height.
- the provision trees and soft landscaping at the other corners would help guide pedestrians away from the windy corners while providing some local wind mitigation also.

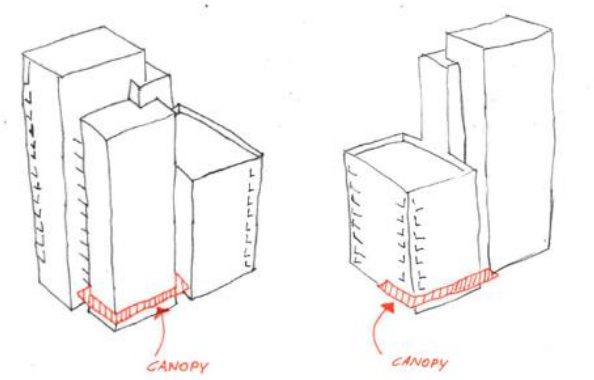


Figure 5.4: Proposed canopies for Block 26

5.3 Residual Impacts

5.3.1 Thoroughfares

The implementation of the wind mitigation measures outlined above will result in a reduction of windiness across the development. The results from the simulations considering landscaping and mitigation measures reveal that Railway Lane North (Figure 5.5), Railway Lane South and Dargan Lane (Figure 5.6) will be suitable for their intended use.

The results suggest that there are other locations where the reduction in windiness does not fully alleviate the wind and more vulnerable pedestrians may still encounter distressing winds on occasion. These locations include isolated zones on Bridge Street and Marrsfield Lane.

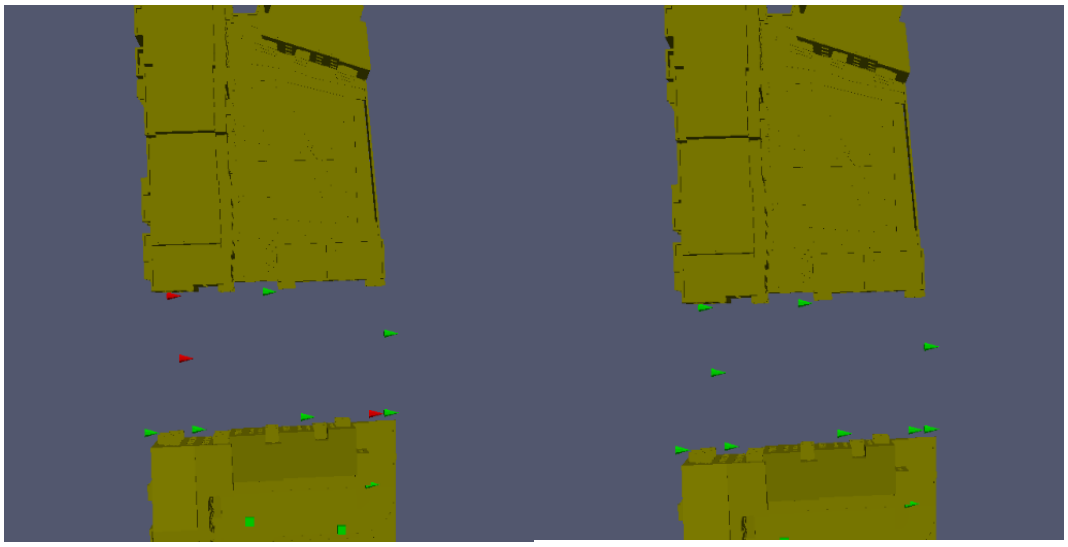


Figure 5.5: Comparison of Lawson Comfort Criteria for Railway Lane North without (left) and with mitigation (right)

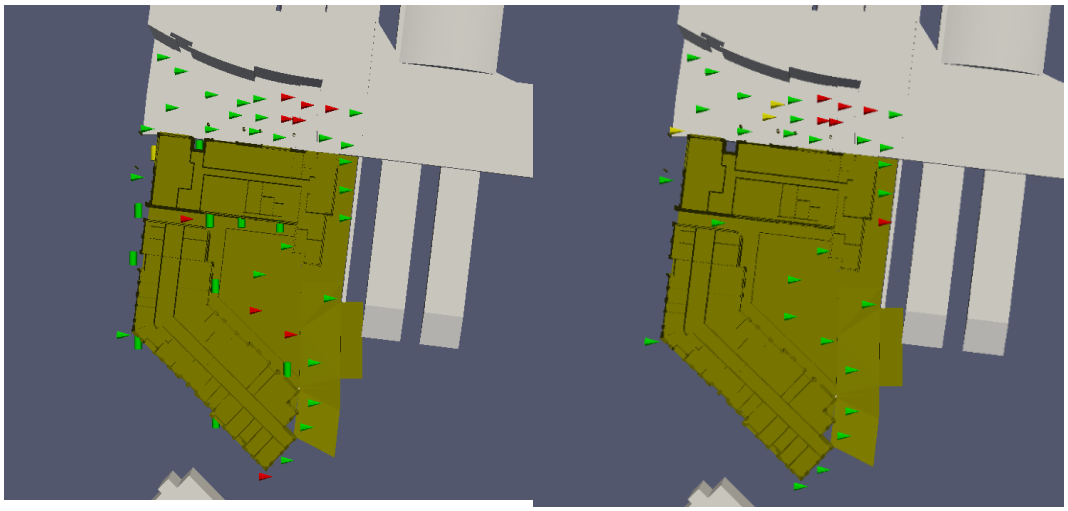


Figure 5.6: Comparison of Lawson Comfort Criteria on Bridge Street and Dargan Street without (left) and with mitigation (right)

The higher speed winds occur at the upper end of Bridge Street near the DART Station. There is a sheltered route for pedestrians along the southern side of Bridge Street (near Block 17) that appears to be unaffected by these winds. Therefore, it is possible for pedestrians to access the DART station safely. On this basis, Bridge Street is considered suitable for its intended use.

The higher speed winds on Marrsfield Lane appear to occur near the centre of the carriageway and it is possible for pedestrians to travel along the lane without encountering these higher speed winds. On this basis, Marrsfield Lane is considered suitable for its intended use.

5.3.2 Blocks

The implementation of the wind mitigation measures outlined above will result in a reduction of windiness across the development. The results from the simulations considering reveal that the wind mitigation measures incorporated into the different blocks are effective in alleviating the worst effects of the wind.

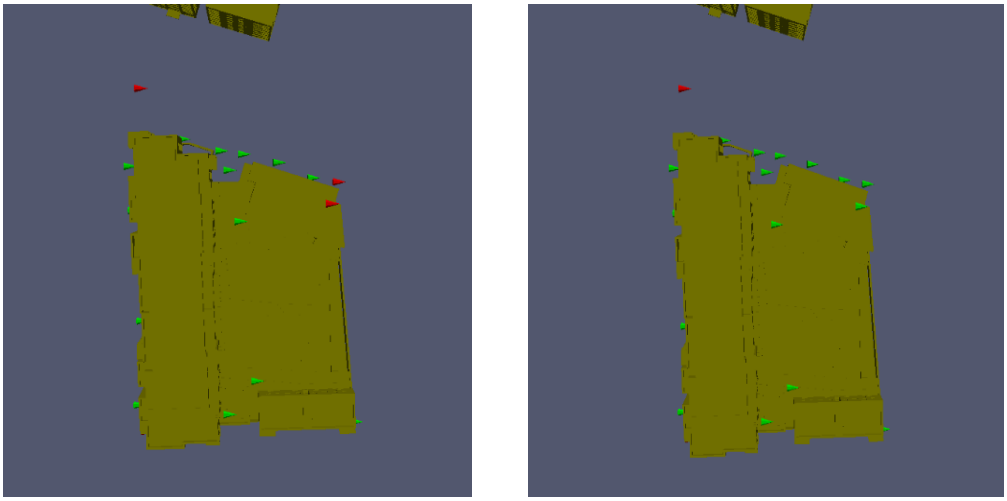


Figure 5.7: Comparison of Lawson Comfort Criteria for Block 8 without (left) and with mitigation (right)

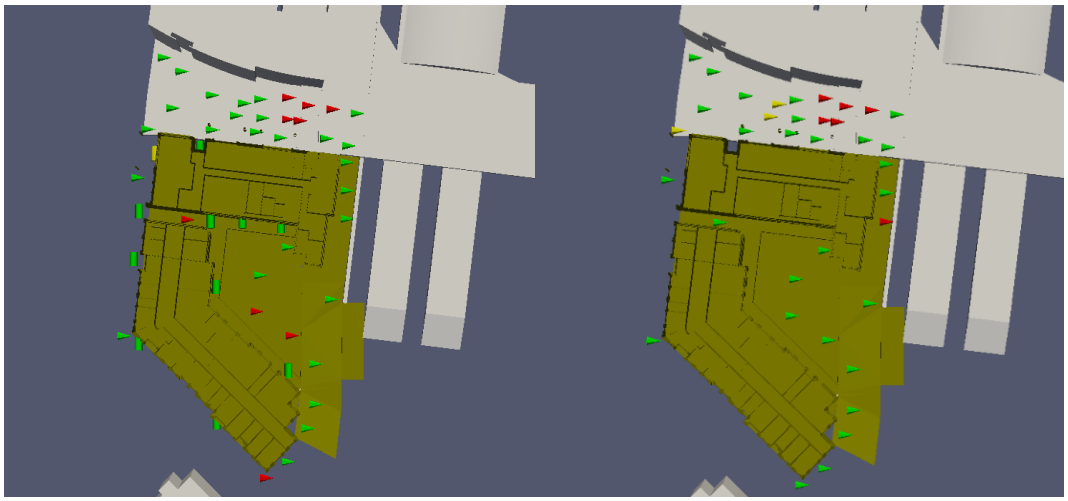


Figure 5.8: Comparison of Lawson Comfort Criteria for Block 17 without (left) and with mitigation (right)

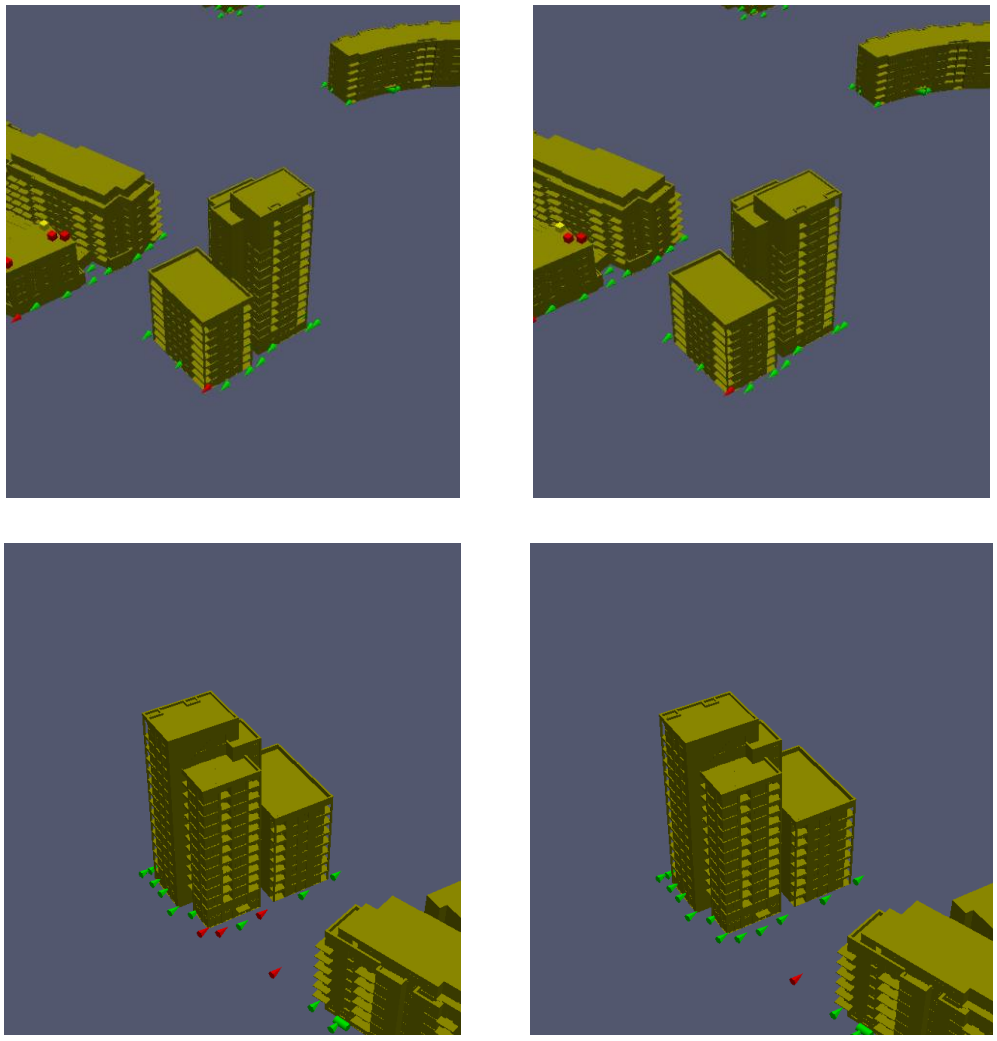


Figure 5.9: Comparison of Lawson Comfort Criteria for Block 26 without (left) and with mitigation (right)

6 Conclusions

The conclusions of the Clongriffin Development wind microclimate study are as follows:

- The critical wind directions for this development in terms of pedestrian comfort are East, Southeast, Southwest and West.
- In general, road and streets across the development are sheltered from wind. The most adverse wind conditions occur on the east side of the development.
- In general, the different spaces within the blocks across the development experience wind conditions that are consistent with their intended function.

- On the west side, the blocks are close to each other and similar in height. Clustering similar height blocks together enables upwind blocks will shelter those further downstream more effectively.
- Many of the retail streets (i.e. Market Lane, Market and the southern portion of Lake Street) are sheltered effectively from the wind.
- The streets to the northwest of the development are more exposed to the wind as similar size blocks do not surround them on all sides. Although these streets tend to be windier, these thoroughfares remain suitable for their intended use.
- More similar scale development is envisaged between Lake and Station Streets north of Block 16. If it does proceed in future, it is anticipated that there will be a reduction in windiness in the northwest of the development.
- It is beneficial that the main block entrances are located towards the centre of the buildings. It reduces pedestrian movements near the corners where the higher speed winds tend to occur.
- Most courtyards and communal spaces are situated in the centre of the block with buildings surrounding them on all sides. This helps to ensure that these communal spaces are sheltered from all wind directions.
- Most balconies are sheltered from the wind.
- Without consideration of landscaping or any suitable mitigation measures, the wind conditions may arise that more vulnerable pedestrians (i.e. the elderly, cyclists etc.) may find distressing in specific areas of the site, which include:
    - The streets and thoroughfares on the east side of the development (i.e. Marrsfield Lane, Railway Lane North and South, Bridge Street and Dargan Lane);
    - The walkway through Block 17 to the courtyard beyond;
    - The small isolated areas of the Block 17 courtyard;
    - The northeastern corner, southwestern corner and main entrance to Block 26;
    - A few more exposed balconies (i.e. dual aspect corner or outstand balconies near corners);
    - The more exposed roof gardens and terraces.
- Focused wind mitigation measures have been incorporated into the design to alleviate distress and these include:
    - The provision of planting and soft landscape features at ground level along the main thoroughfares and at corners of blocks;
    - The provision of a solid barrier in conjunction with landscaping along the eastern railway boundary;
    - The provision of wind screens along balustrades between the buildings at block 6, block 8 and block 28;

- The provision of doors at either end of the walkway through Block 17 to the courtyard beyond;
- The provision of canopies on the taller blocks (i.e. Blocks 17 and 26).
- The provision of wind screens on the more exposed balconies (i.e. dual aspect corner or outstand balconies near corners);
- The provision of wind screens along the edge of roof gardens and terraces;

- It is anticipated that the proposed mitigation measures will help alleviate distress that could be encountered on occasion in certain areas of the site.
- Overall, it is anticipated that the development will be a relatively calm and attractive environment for pedestrians. The development with the adoption of appropriate mitigation measures, where required, will be suited for its intended use.

7 References

[1] Lawson, TV, 2001, 'Building Aerodynamics', Imperial College Press, London.