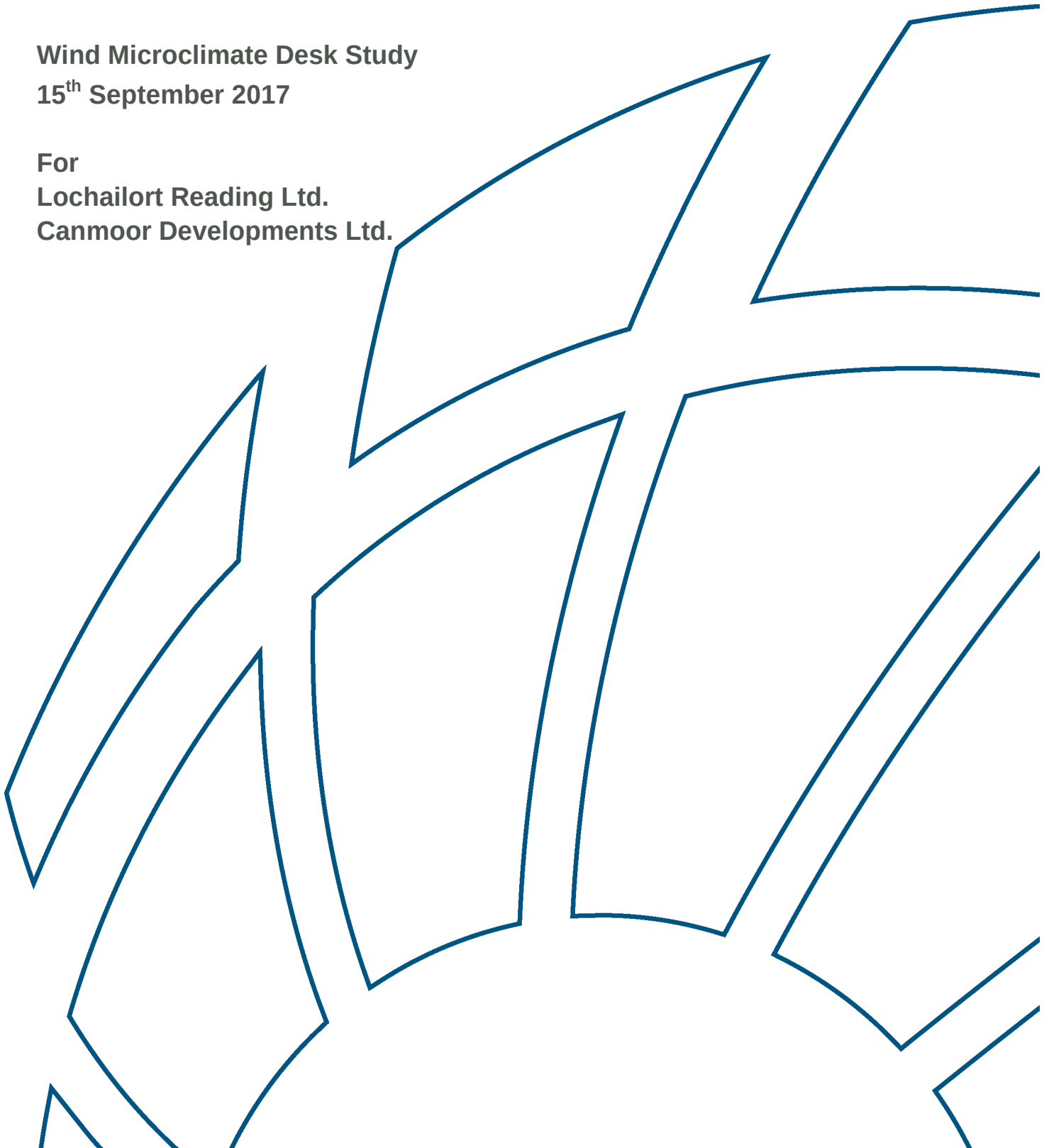


The Arc Reading, UK

Wind Microclimate Desk Study
15th September 2017

For
Lochailort Reading Ltd.
Canmoor Developments Ltd.



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Contents

1.	Introduction	5
2.	Pedestrian Level Wind Environment	8
3.	Conclusions	10
APPENDIX A.	Wind Climate At Site	20
APPENDIX B.	Pedestrian Wind Level Environment	23

EXECUTIVE SUMMARY

Background

A desk study has been carried out by BMT Fluid Mechanics Ltd. (BMT) to provide a qualitative review of the pedestrian level wind environment of the proposed The Arc development in Reading, UK. The study has given consideration to likely wind effects relevant to key pedestrian areas in and around the proposed development.

Conclusions

The study has assessed the wind microclimate for the proposed development within the context of existing and approved future surrounding conditions.

With the introduction of the proposed development, wind conditions within the site and the surrounding area are generally expected to be suitable, in terms of both pedestrian safety and comfort. A sole exception to this is likely to occur at the northwestern entrance where unwelcome winds are expected to give rise to a potential exceedance of the comfort criteria for pedestrian ingress / egress. The use of canopies above entrances at ground level would be beneficial to mitigate the downdraughts effects and soft landscaping at prevailing corners would be recommended as the orientation of building is not favourable.

The study has been informed by wind tunnel test of a previous scheme on the site of similar overall massing.

The Arc Reading, UK Wind Microclimate Study

1. Introduction

1.1. Background

1.1.1. General

This report summarises the results of an experience-based desk study to assess the potential impact of the proposed The Arc development in Reading, UK, upon pedestrian level wind conditions. The study provides a qualitative review of the likely pedestrian level wind climate at the site, following the introduction of the proposed development within the context of existing and approved future surrounds.

1.1.2. Basis for the Study

The assessment is based on information provided by Scott Brownrigg, the architects for the scheme. The study draws on BMT's considerable experience in the assessment of wind effects in the built environment, formed from detailed boundary layer wind tunnel studies for similarly massed schemes in the urban environment, in conjunction with analysis of long-term wind statistics applicable to the site. The data from wind tunnel tests of the proposed development, summarised in BMT's report '432112rep1v4' dated 13th February 2017, were also utilised throughout the assessment, and the proposed development within future surrounds configuration is as per illustrated within this report.

1.2. Approach to Wind Studies

1.2.1. General

The assessment of environmental wind flows in the built environment lies outside the scope of BS EN-1991-1-4: 2005, the European code of practice for the assessment of wind effects on buildings, which focuses mainly upon wind loading issues. In addition, there are no handbooks or engineering methods from which reliable assessments of the environmental wind flows

that shape the pedestrian level wind conditions can be derived. Furthermore, numerical / computational methods such as computational fluid dynamics (CFD) do not apply readily to turbulent wind flows in the built environment.

Nonetheless, this study provides a qualitative assessment of the wind characteristics to provide a preliminary review of the wind conditions in and around the proposed development in relation to planned pedestrian activities and to provide recommendations for wind mitigation or enhancement measures to achieving suitable wind conditions.

A general background discussion of wind environment and assessment criteria is given in Appendix A for information.

1.3. Site Description

1.3.1. Site Location & Surrounding Area

The proposed development site is located in Reading. The site is bounded by Kings Meadow Road / Napier Road to the north, Vastern Road to the west and rails to the south.

At present the area immediately surrounding the proposed development principally comprises mixed developments, mainly commercial, of approximately 2-11 storeys.

1.3.2. Proposed Development

The proposed development consists of 11-storey arched building with a continuous façade / roof from north to south and vertical gable ends at the east and west. The overall height of the proposed development is approximately 65m from local ground level.

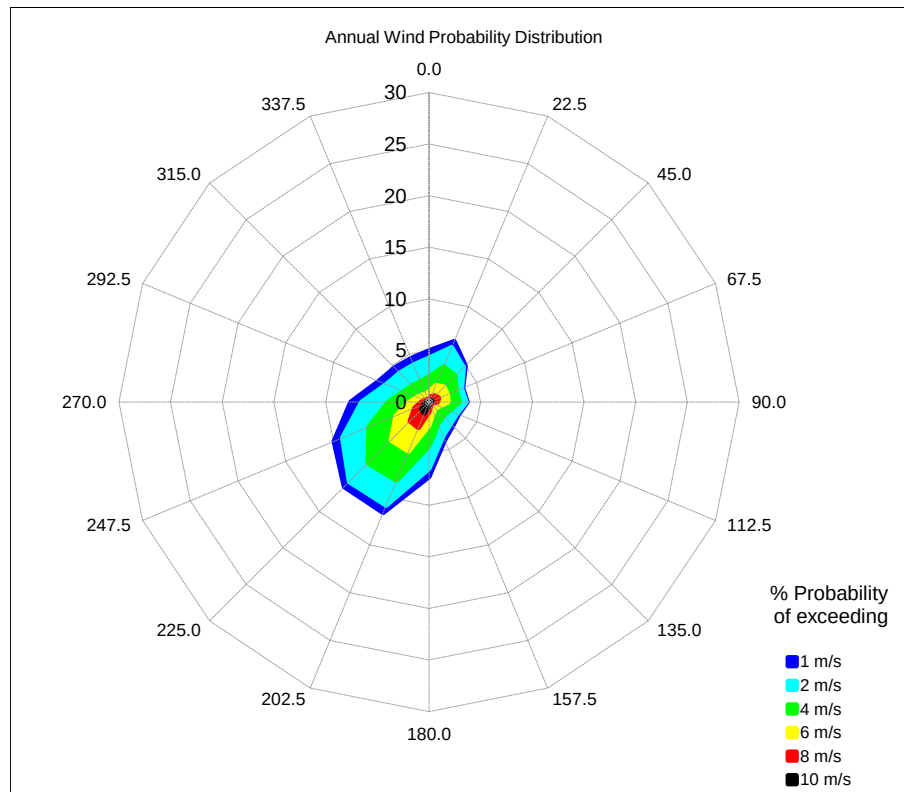
The site location and plan are shown in Figure 1.1 and 1.2, respectively.

1.4. Wind Climate at the Site

Illustrated below is the wind climate to be expected at the site based on long-term wind climate data obtained by BMT.

The wind data from the weather station at the London Heathrow Airport Weather Centre has been transposed to the site, accounting for the general upwind terrain for each wind direction.

The illustration indicates the annual frequency, direction and speed of winds, at a height of 65 metres above the local ground level, at the proposed development site. Details of the seasonal directional and wind speed probability distributions at the site are provided in Appendix B.



The most frequent winds at the site blow from the south-southwest and southwest throughout the year, with winds from south, west-southwest, and west also being very common. Winds from north-northeast are common during spring, though these are generally less strong than those from the southwest quadrant. Prevailing strong winds will be the most common cause of problematic wind comfort conditions due to strong ground level wind acceleration around buildings. Figure 1.3 highlights the relevance of all wind directions in connection with the wind microclimate within the site.

2. Pedestrian Level Wind Environment

The assessment of the pedestrian level wind conditions in and around the site concentrates on the prevailing wind directions. Due consideration is, however, given to non-prevailing wind directions, particularly with regard to safety.

The assessment considers the proposed development, and makes recommendations for enhancement/alleviation measures that are expected to be effective in alleviating unwelcome winds.

Recommendations are made with the distinct aim of ensuring safe and comfortable conditions for planned pedestrian uses in and around the proposed development.

2.1. Proposed Development in Existing Surrounds

The proposed development is partially sheltered from prevailing south-westerly winds by surrounding buildings. Wind conditions are therefore relatively calm in and around the development at lower level.

The development is more exposed to secondary winds coming from east and north-east, travelling unimpeded toward the northern façade. However, the upper-level winds reaching the development are redirected upward by the arch-shaped elevated facades, and would not expect substantial downdraught at the northern façade.

The tunnel under the railway could lead to channelled and accelerated flow from prevailing winds, which would result in faster moving winds in places around the northwestern ground level.

Key wind effects for prevailing or commonly occurring wind directions are presented in Figures 2.1a to 2.1c. The suitability assessment for pedestrian use is summarised graphically in Figure 2.2.

2.1.1. Pedestrian Safety

With the introduction of the proposed development, wind conditions within the site and neighbouring surrounding areas are expected to rate as suitable, in terms of safety, for all intended uses throughout the year.

2.1.2. Pedestrian Comfort

At the ground level, the eastern facade is in the lee of the building, for secondary winds and sheltered from prevailing winds, would be expected to

be suitable for outdoor seating during summer, spring and autumn albeit the scheme does not propose any such provision. Possible exceptions to this are likely to occur at the corners of south-west and north-east exposed to accelerating winds which would be suitable for entrances. The northern and southern façades are rated as suitable for entrances as they are in the lee of the building, for prevailing winds though facing the secondary winds. Otherwise, the wind conditions at the surroundings areas would be expected to be suitable for leisure thoroughfares.

2.1.2.1. Thoroughfares

With the introduction of the proposed development, wind conditions within and around the site are expected to be suitable for thoroughfare and are thus suitable for planned uses.

2.1.2.2. Entrances

With the introduction of the proposed development, entrances in and around the proposed development are generally expected to rate as suitable for use as ingress/egress from buildings. It is expected that wind condition at the northwestern entrance would be suitable for at worst, pedestrian strolling, and would benefit from enhancement measures to ensure comfortable pedestrian ingress / egress throughout the year.

Recessing of the entrances behind the façade line or the selective use of screens with localised soft landscaping would be viable options for enhancing conditions for comfortable ingress / egress as provided in Figures 2.3.

2.2. Proposed Development within Future Surrounds

With the introduction of the sole future building to the south-west of the development, wind conditions in and around the site are likely to be materially similar to existing surrounding conditions and the assessment would be expected to remain unchanged.

3. Conclusions

The study has assessed the wind microclimate for the proposed development within the context of existing and approved future surrounding conditions.

With the introduction of the proposed development, wind conditions within the site and the surrounding area are generally expected to be suitable, in terms of both pedestrian safety and comfort. A sole exception to this is likely to occur at the northwestern entrance where unwelcome winds are expected to give rise to a potential exceedance of the comfort criteria for pedestrian ingress / egress. The use of canopies above entrances at ground level is beneficial to mitigate the downdraughts effects and soft landscaping at prevailing corners would be recommended as the orientation of building is not favourable.

The study has been informed by wind tunnel test of a previous scheme on the site of similar overall massing.

Figure 1.1: Site location



Figure 1.2: Site Plan of the Proposed Development

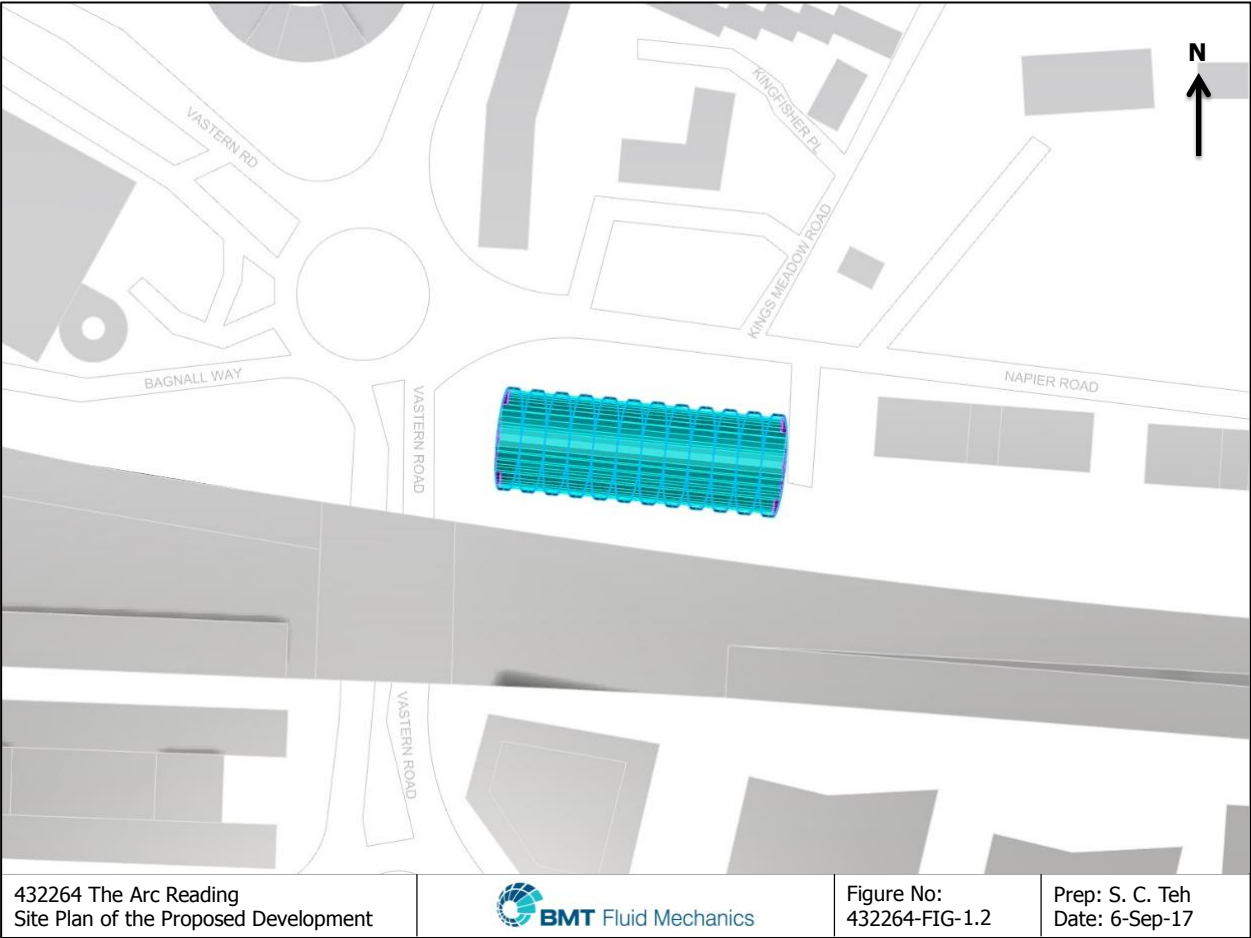


Figure 1.3: Key Wind Effects

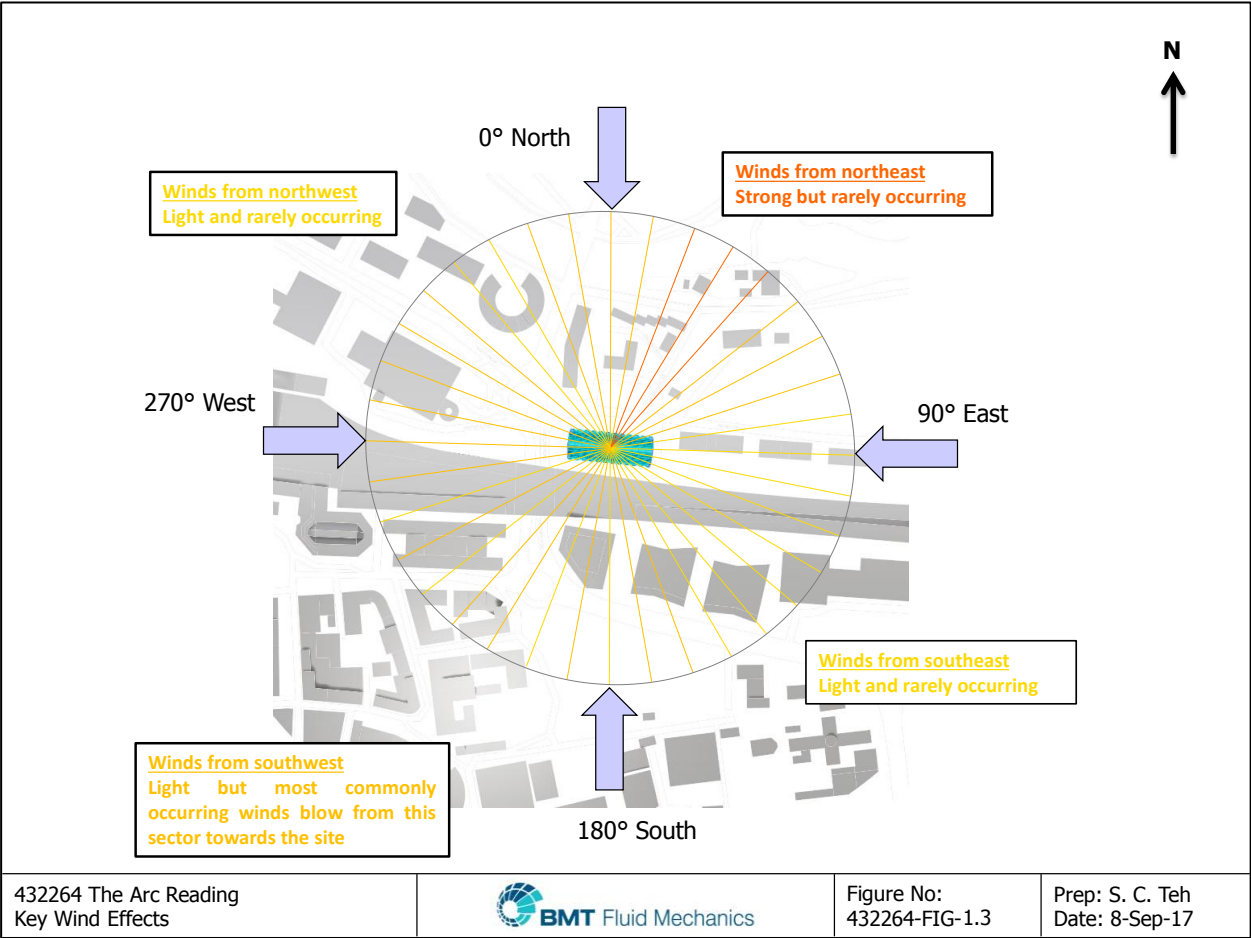


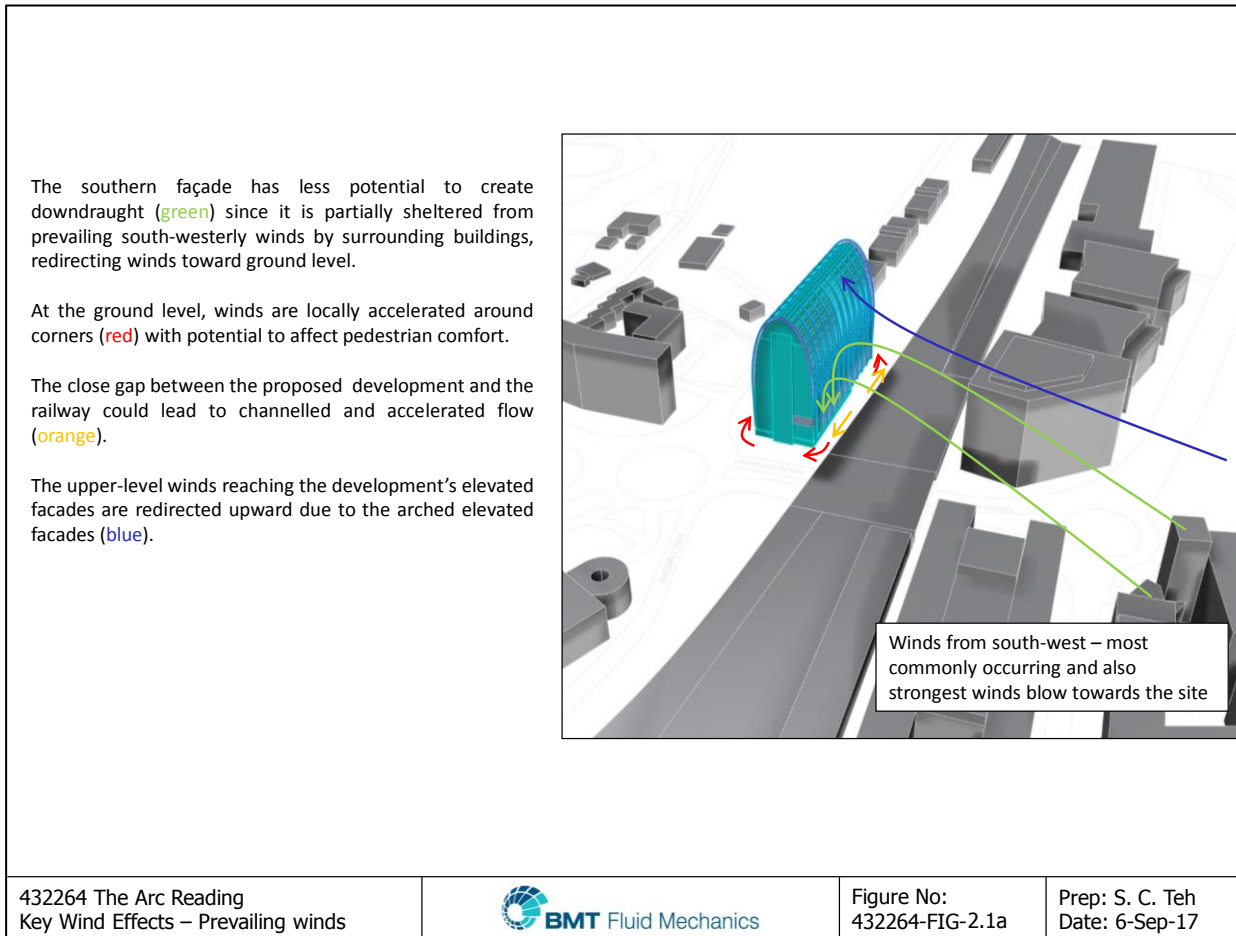
Figure 2.1a: Key Wind Effects – Prevailing Winds

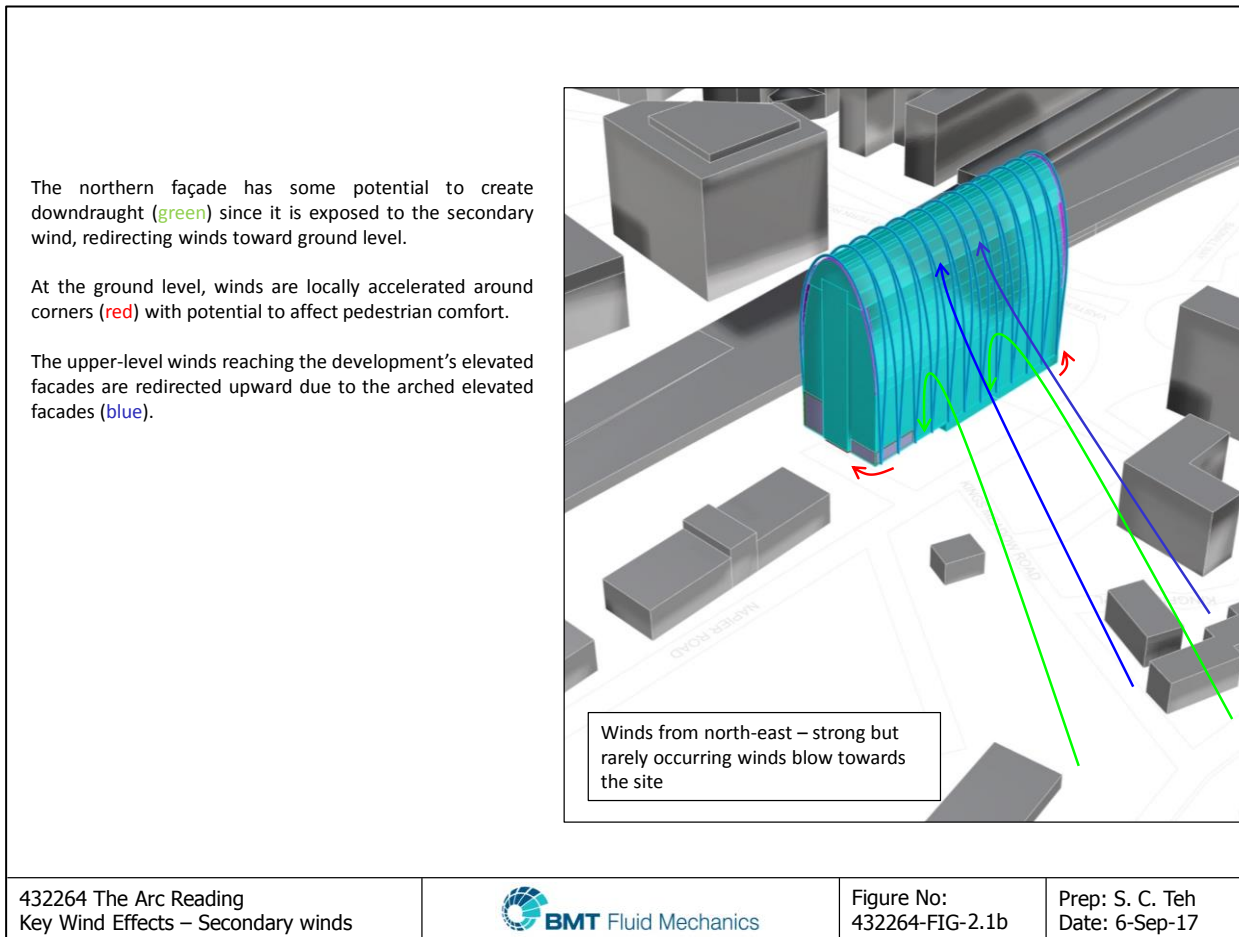
Figure 2.1b: Key Wind Effects – Secondary Winds

Figure 2.1c: Key Wind Effects – Winds From South

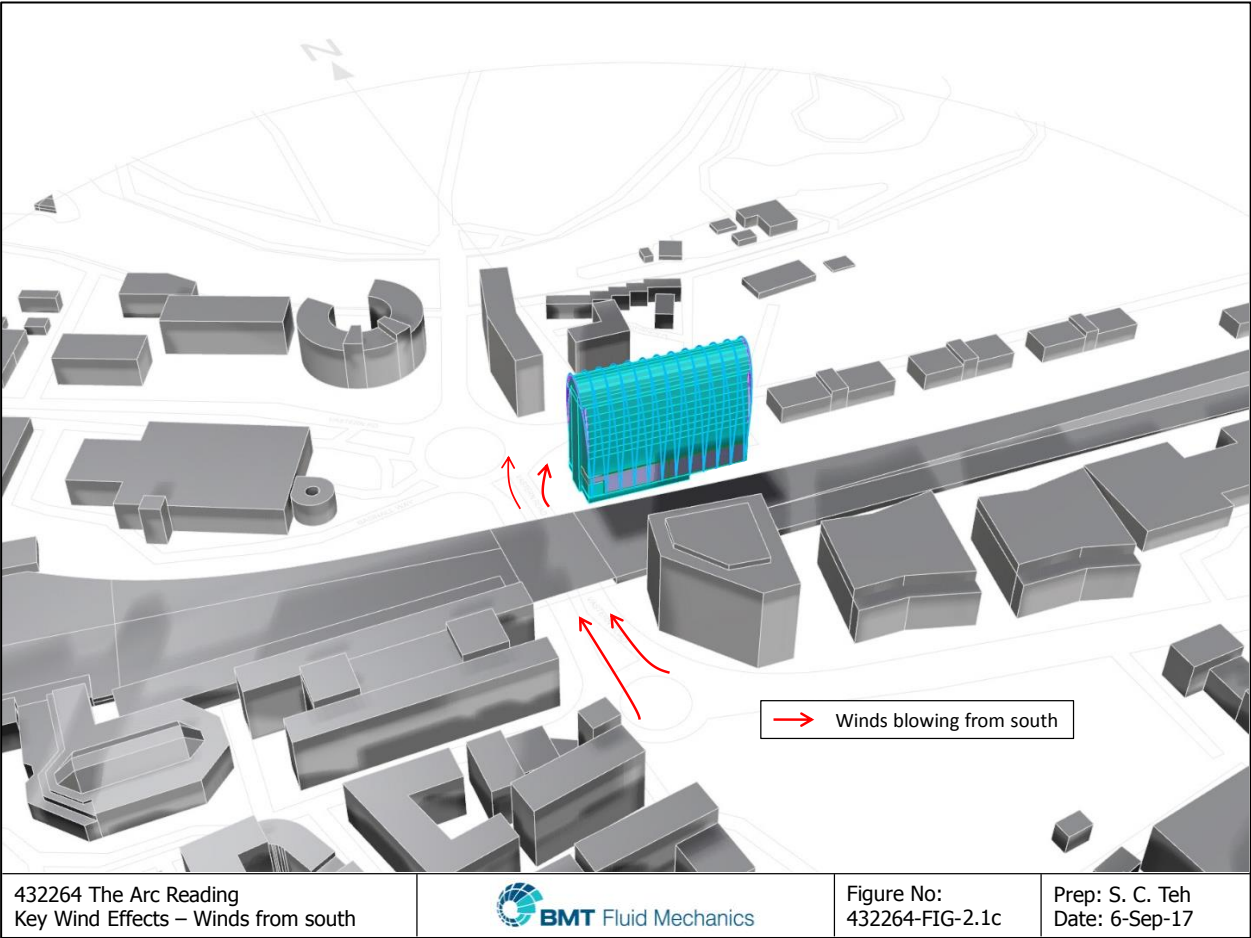


Figure 2.2: Suitability Assessment – Comfort Criteria



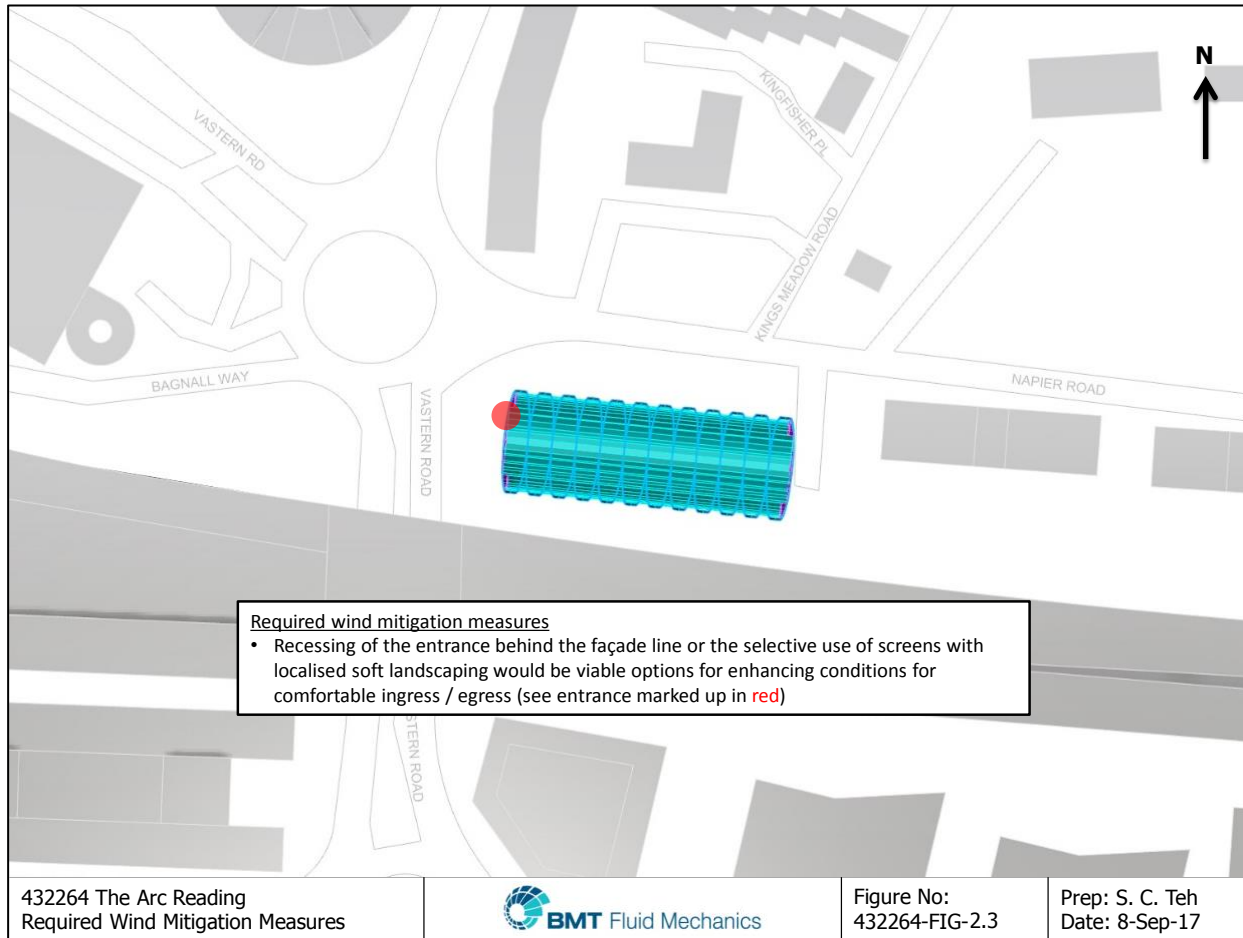
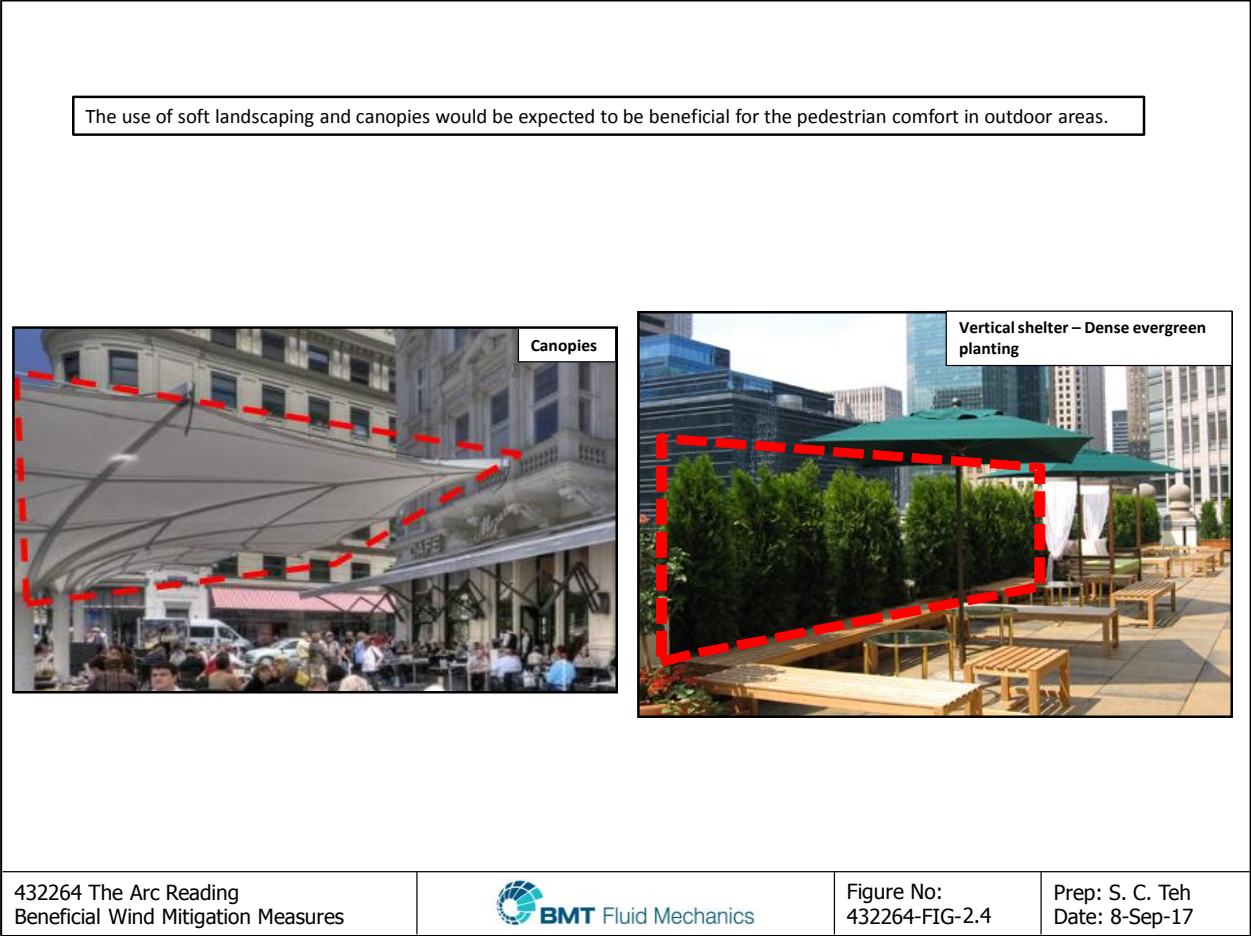
Figure 2.3: Required Wind Mitigation Measures

Figure 2.4: Beneficial Wind Mitigation Measures



APPENDIX A. WIND CLIMATE AT SITE

Figure A.1: Annual and Seasonal Directional Probability Distribution at Site (at 65m height)

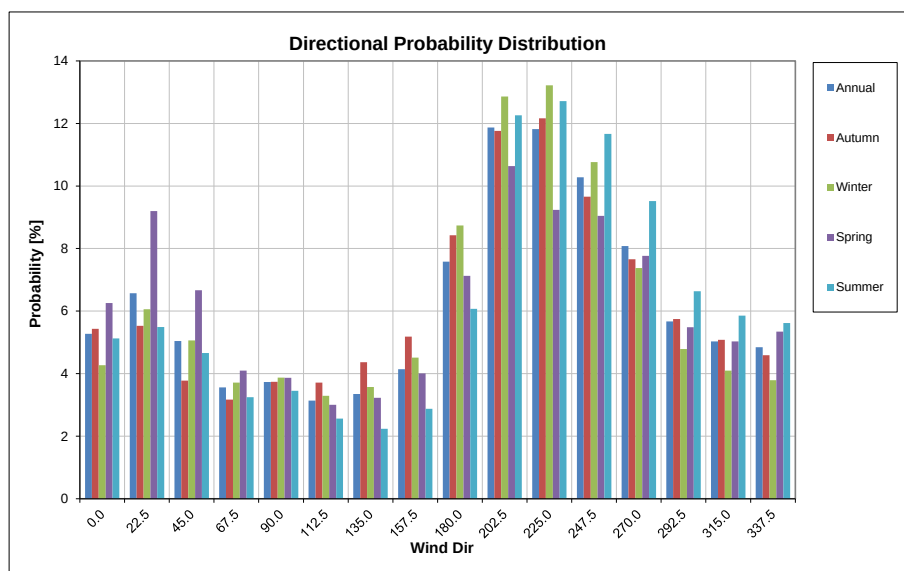


Figure A.2: Annual and Seasonal Wind Speed Probability Distribution at Site (at 65m height)

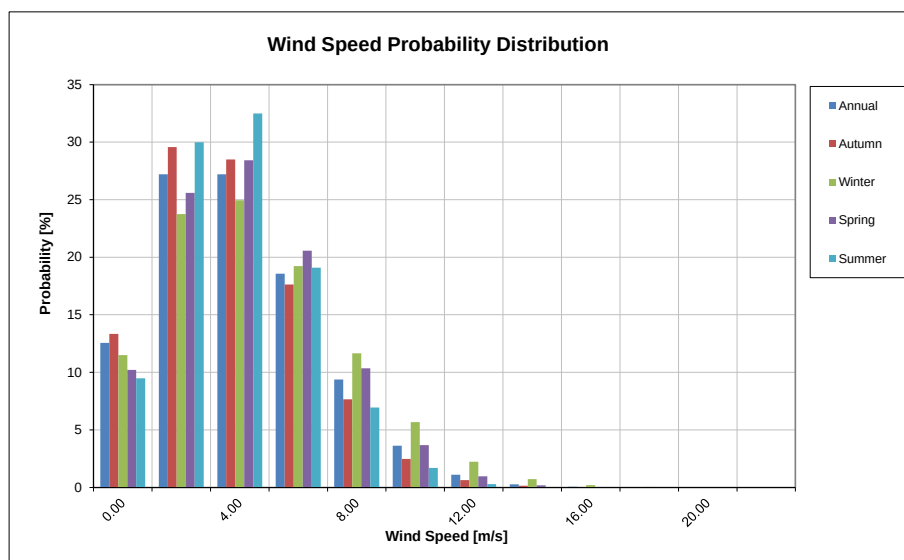


Figure A.3: Autumn Directional Wind speed Probability Distribution (at height of 65m)

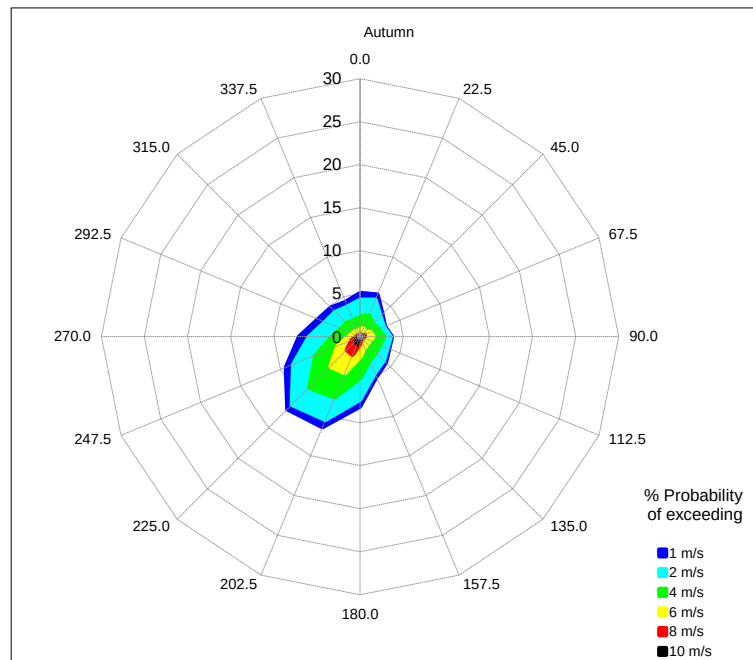


Figure A.4: Winter Directional Wind speed Probability Distribution (at height of 65m)

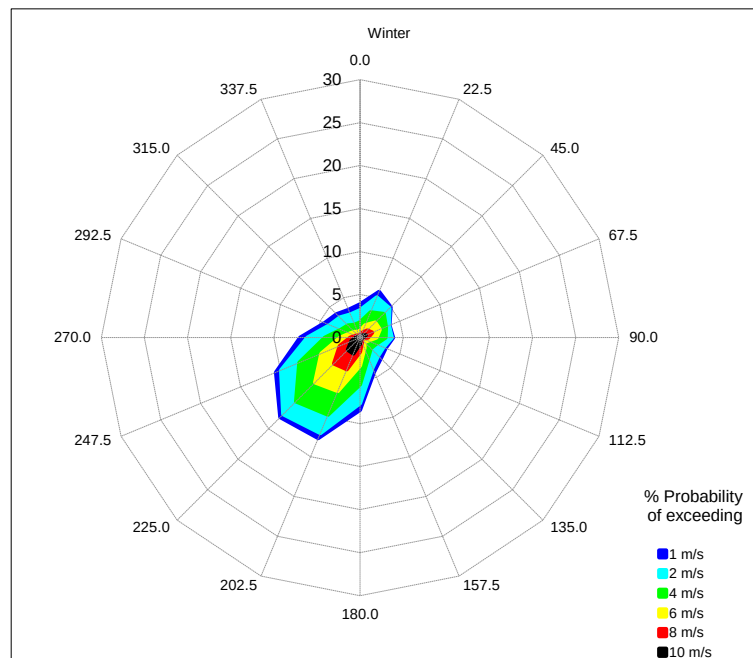


Figure A.5: Spring Directional Wind speed Probability Distribution (at height of 65m)

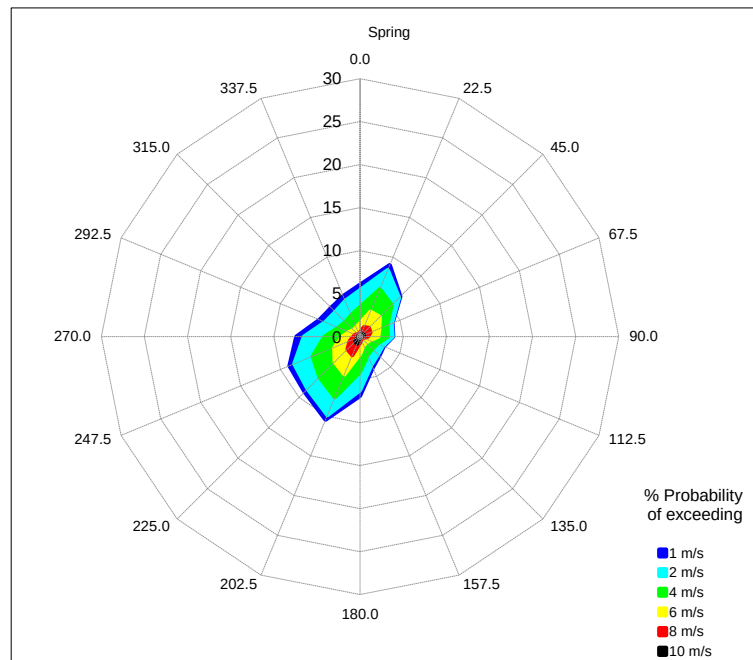
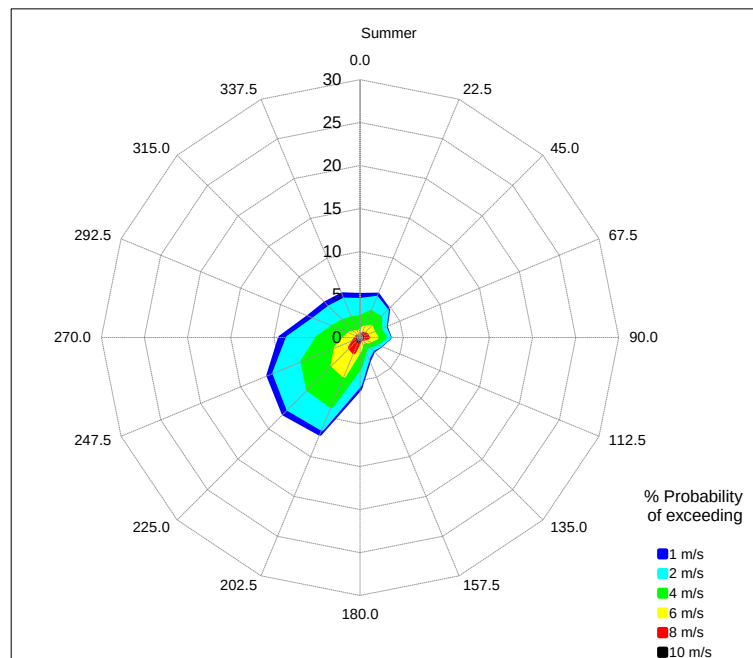


Figure A.6: Summer Directional Wind speed Probability Distribution (at height of 65m)



APPENDIX B. PEDESTRIAN WIND LEVEL ENVIRONMENT

B.1. Introduction

The following discussion provides a general overview of pedestrian level wind environment and the means by which it may be influenced by wind effects around buildings. Further discussion includes the appropriate assessment criteria for pedestrian level wind environments and the method of classification in terms of comfort and safety.

B.2. General Discussion

Wind environment is defined as the wind flow experienced by people and the influence it has on their activities. It is concerned primarily with wind characteristics at pedestrian level. It is well understood that structures influence the pedestrian level wind conditions. Of overriding importance in this context are the implications for comfort and safety of the general public frequenting the pedestrian area in the vicinity of the building structure. It is, in general, not practical to design out all of the factors related to the impact of a particular building development on the pedestrian level wind environment in its vicinity. As a result, it is conventional to provide purposely designed local mitigation where appropriate to minimise risk and discomfort to the general public.

Safety issues in particular, mean that an increasingly important factor in the design and development of new building complexes is the impact on wind environment. In general, the impact depends on the proposed use of areas in the vicinity of the building, and the general expectations of the local population in relation to the prevailing wind climate. For example, a strong gust at a sea-side promenade might not be considered a hazard since the expectation is for it to be windy. The same gust outside a hospital or home for the elderly almost certainly would constitute a hazard. These examples demonstrate that whilst wind force remains the dominant factor, it is the combination of location and wind force which influences the judgements on wind comfort and safety. Consequently, in areas where there is a significant pedestrian population such as a park or other leisure area and the expectation is for comfortable conditions to persist, wind speed tolerances will be lower.

B.3. Wind Effects around Buildings

There are a number of basic features which influence the wind flows around buildings. These include the general building envelope, the cross-sectional shape, the building orientation (particularly in relation to the prevailing wind

direction), the overall height and proximity to other buildings and the general exposure of the site.

The building height relative to the adjacent buildings is particularly important since the higher level winds are deflected by the building towards ground level. In general terms, for a given cross-sectional shape the higher the building, the windier it will be at pedestrian level. Because of this downward deflection of high-level winds, significant wind speed up can occur around the base of a building, particularly near the corners of the building. This is demonstrated by the common experience of windy conditions near tall buildings even on a relatively calm day.

The corner geometry in particular is important because sharp edged corners cause separated flows with strong wind speed gradients (rapid changes over a short distance). Softer, or more rounded corners improve this, although some acceleration still occurs.

The proximity of adjacent buildings is an important consideration with regard to wind shielding and funnelling (channelling). Wind flow speed-up and wind sheltering at pedestrian level due to proximity effects must be taken into account when assessing the local wind environment.

B.4. Assessment Criteria

The criteria adopted by BMT and applied in the present study are based on the so-called Lawson criteria. Details of the comfort criteria are presented in Table B.1 and are based on the exceedance of the threshold wind speeds, based on the mean hourly value and on the gust equivalent mean value, occurring less than 5% of the time. The value of 5% has been established as giving a reasonable allowance for extreme and relatively infrequent winds that are tolerable within each category.

Table B.1: Pedestrian Comfort Criteria

Threshold Wind Speed	Comfort Rating / Activity		Examples
4 m/s	C4	Long-term standing / sitting	Reading a newspaper and eating and drinking
6 m/s	C3	Short-term standing / sitting	Appropriate for bus stops, window shopping and building entrances
8 m/s	C2	Leisure thoroughfare	General areas of walking and sightseeing
10 m/s	C1	Pedestrian transit	Local areas around tall buildings where people are not likely to linger
> 10 m/s	C0	Uncomfortable for all uses	Uncomfortable for all pedestrian activities

Details of the safety criteria are presented in Table B.2 and are based on the exceedance of the threshold wind speeds, based on the mean hourly value and on the gust equivalent mean value, occurring once per annum, equating to a seasonal threshold exceedance of 0.04%. A wind speed greater than 15 metres-per-second occurring once a year is classified as unsuitable for the general public and represents a wind speed with the potential to destabilise the less able members of the public such as the elderly, cyclists and children. Able-bodied users are those determined to experience distress when the wind speed exceeds 20 metres-per-second once per year.

Table B.2: Pedestrian Safety Criteria

Threshold Wind Speed	Safety Rating		Qualifying Comments
> 15 m/s	S2	Unsuitable for general public	Less able and cyclists find conditions physically difficult
> 20 m/s	S1	Unsuitable for able-bodied	Able-bodied persons find conditions difficult. Physically impossible to remain standing during gusts.

A detailed classification of the impact of the Proposed Development in terms of the above criteria relative to existing conditions requires a detailed quantification of wind speed up caused by the Proposed Development which can only be obtained by a purposely designed programme of wind tunnel tests. This lies beyond the scope of the present study, which provides a qualitative discussion of likely wind, flow patterns and their expected impact on the pedestrian level wind environment only. The above discussion of assessment criteria is provided for background information only.