WATERLOO SOUTH MASTERPLAN

PEDESTRIAN WIND ENVIRONMENT STUDY

WD510-10F02(REV3) - WE REPORT

MARCH 25, 2020

Prepared for:

Land and Housing Corporation

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EXECUTIVE SUMMARY

This report presents the results of a detailed investigation into the wind environment impact of the proposed Waterloo South masterplan. Testing was performed at Windtech's boundary layer wind tunnel facility. The wind tunnel has a 3.0m wide working section and a fetch length of 14m, and measurements were taken from 16 wind directions at 22.5 degree increments. Testing was carried out using a 1:400 detailed scale model of the development. The effects of nearby buildings and land topography have been accounted for through the use of a proximity model which represents an area with a radius of 600m. The existing site conditions and proposed massing of Waterloo South were tested and are detailed within this report.

Peak gust and mean wind speeds were measured at selected critical outdoor trafficable locations within and around the subject development. Wind velocity coefficients representing the local wind speeds are derived from the wind tunnel and are combined with a statistical model of the regional wind climate (which accounts for the directional strength and frequency of occurrence of the prevailing regional winds) to provide the equivalent full-scale wind speeds at the site. The wind speed measurements are compared with criteria for pedestrian comfort and safety, based on Gust-Equivalent Mean (GEM) and annual maximum gust winds, respectively.

Wind tunnel testing of the existing site wind conditions allowed for a baseline case for the proposed development precinct to be established, taking into account the prevailing wind directions for the area, as well as the local topographical effects of the terrain and the surrounding buildings of the proposed site. An assessment of the wind conditions has been made to identify the wind conditions and patterns, with the information used to coordinate a massing model.

Wind tunnel testing of the proposed Waterloo South masterplan was undertaken, based on the drawing package by the project architect Turner, received February 2020. The results of the study indicate that wind conditions for the majority of trafficable outdoor locations within and around the development will be suitable for their intended uses. For areas where the comfort and/or safety criteria were exceeded additional treatments have been incorporated into the design. The recommended treatments, which have been tested in the wind tunnel are summarised as follows:

- Recommended wrap around awning on western and southern aspects of Building Q1.
- Recommended wrap around awning on western and southern aspects of Building U2.
- Recommended wrap around awning on western and southern aspects of Building Y1.
- Recommended chamfering of south-east building corner on Building Z5.
- Recommended wrap around awning on eastern and southern aspects of Building Z5.
- Recommended porous screen at north-west corner of Building U4.

- Retention of trees as noted in tree retention plan (No.: 17018, Dwg.: 710.3, dated: 18.2.20)

Comparison between the existing site wind conditions and the proposed Waterloo South indicate that a majority of areas are similar to the existing site conditions. The proposed building and tower forms, podium setbacks, and Lot layouts combined with the recommended treatments demonstrates that the ground level wind conditions satisfy both the comfort and safety criteria.

Further wind tunnel testing of the ground level and elevated areas within the proposed Waterloo South masterplan is recommended to be investigated during the detailed design development stages to further verify the suitability of areas for their intended purpose.

Number	Study Requirements	Addressed at Section No.
19.1	Provide a complete understanding of the existing wind characteristics of the precinct. Consider the wind climate of Sydney, local characteristics such as topography that modify this wind climate for the precinct and the impact of existing buildings, in particular, the tower and slab blocks, on wind conditions.	6
19.2	Identify significant locations for wind sensitivity within the public domain, including bus stops, public plazas and other public domain areas for the purpose of modelling wind impacts of the proposed development.	7.2
19.3	Ensure early consideration of potential wind impacts and amelioration approaches through the layout and arrangement of the public domain and the built form.	7, 8
19.4	Advise on measures to ensure the suitability of areas for their intended use with regard to the impact of wind on comfort and safety. In particular, this is to focus on the public space areas intended to be used for seating (i.e. the park, outdoor dining areas on footpaths and public plazas) and standing (i.e. building entries); and, also for outdoor private recreation areas to be suitable for sitting (e.g. balconies, decks and outdoor communal private open space). Advise on the placement, orientation, shape and external design of buildings, and relevant wind mitigation devices.	8, 9
19.5	Any advice on landscaping of public space must accord with the City of Sydney Public Design Manual and the Public Domain design. In general landscaping can only be used for wind mitigation if it is already in place.	8.2
19.6	Include areas surrounding the precinct that may be wind affected as a result of the proposal.	7.2, 8.1
19.7	Undertake an assessment to demonstrate that subject to any recommended measures, wind will not have an unacceptable impact on the proposal, and the proposal will not generate unacceptable wind impacts.	8
19.8	Wind tunnel testing is required	6, 7, 8

CONTENTS

Executive Summary iii

1 Introduction 1

1.1 Waterloo Estate 2

1.2 Waterloo South 3

1.3 Redevelopment Vision 4

1.4 Purpose of this Report 5

1.5 Waterloo South Planning Proposal 6

2 Wind Tunnel Testing 9

3 Boundary Layer Wind Profiles at the Site 10

4 Regional Wind Model 13

5 Pedestrian Wind Comfort and Safety 16

5.1 Measured Wind Speeds 16

5.2 Wind Speed Criteria Used for This Study 16

6 Baseline Investigations 18

6.1 Existing Site Wind Tunnel Model 18

6.2 Layout of Study Points 21

6.3 Results 26

6.4 Discussion of Results 33

7 Implementation Plan & Strategy 35

7.1 The Wind Tunnel Model 36

7.2 Layout of Study Points, and Relevant Wind Speed Criteria 39

7.3 Discussion 47

8 Assessment 48

8.1 Ground Level Results 48

8.2 Proposed Treatments 63

8.3 Ground Level Treatment Results 67

9 Conclusion 81

References 83

APPENDIX A - Directional Plots of the Wind Tunnel Results

APPENDIX B - Velocity and Turbulence Intensity Profiles

APPENDIX C - Published Environmental Criteria

APPENDIX D - Data Acquisition

1 INTRODUCTION

The Greater Sydney Region Plan and Eastern City District Plan seek to align growth with infrastructure, including transport, social and green infrastructure. With the catalyst of Waterloo Metro Station, there is an opportunity to deliver urban renewal to Waterloo Estate that will create great spaces and places for people to live, work and visit.

The proposed rezoning of Waterloo Estate is to be staged over the next 20 years to enable a coordinated renewal approach that minimises disruption for existing tenants and allows for the up-front delivery of key public domain elements such as public open space. Aligned to this staged approach, Waterloo Estate comprises three separate, but adjoining and inter-related stages:

- Waterloo South;
- Waterloo Central; and
- Waterloo North.

Waterloo South has been identified as the first stage for renewal. The lower number and density social housing dwellings spread over a relatively large area, makes Waterloo South ideal as a first sub-precinct, as new housing can be provided with the least disruption for existing tenants and early delivery of key public domain elements, such as public open space.

A planning proposal for Waterloo South is being led by NSW Land and Housing Corporation (LAHC). This will set out the strategic justification for the proposal and provide an assessment of the relevant strategic plans, state environmental planning policies, ministerial directions and the environmental, social and economic impacts of the proposed amendment. The outcome of this planning proposal will be a revised planning framework that will enable future development applications for the redevelopment of Waterloo South. The proposed planning framework that is subject of this planning proposal, includes:

- Amendments to the Sydney Local Environmental Plan 2012 – This will include amendments to the zoning and development standards (i.e. maximum building heights and floor space ratio) applied to Waterloo South. Precinct-specific local provisions may also be included.
- A Development Control Plan (DCP) – This will be a new part inserted into 'Section 5: Specific Areas' of the Sydney DCP 2012 and include detailed controls to inform future development of Waterloo South.
- An infrastructure framework – in depth needs analysis of the infrastructure required to service the needs of the future community including open space, community facilities and servicing infrastructure.

1.1 Waterloo Estate

Waterloo Estate is located approximately 3.3km south-south-west of the Sydney CBD in the suburb of Waterloo (refer to Figure 1). It is located entirely within the City of Sydney local government area (LGA). Waterloo Estate is situated approximately 0.6km from Redfern train station and 0.5km from Australia Technology Park. The precinct adjoins the new Waterloo Metro Station, scheduled to open in 2024. The Waterloo Metro Quarter adjoins Waterloo Estate and includes the station and over station development, and was rezoned in 2019. Waterloo Estate comprises land bounded by Cope, Phillip, Pitt and McEvoy Street, including an additional area bounded by Wellington, Gibson, Kellick and Pitt Streets. It has an approximate gross site area of 18.98 hectares (14.4 hectares excluding roads). Waterloo Estate currently comprises 2,012 social housing dwellings owned by LAHC, 125 private dwellings, a small group of shops and community uses on the corner of Wellington and George Streets, and commercial properties on the south-east corner of Cope and Wellington Streets.

A map of Waterloo Estate and relevant boundaries is illustrated in Figure 2.

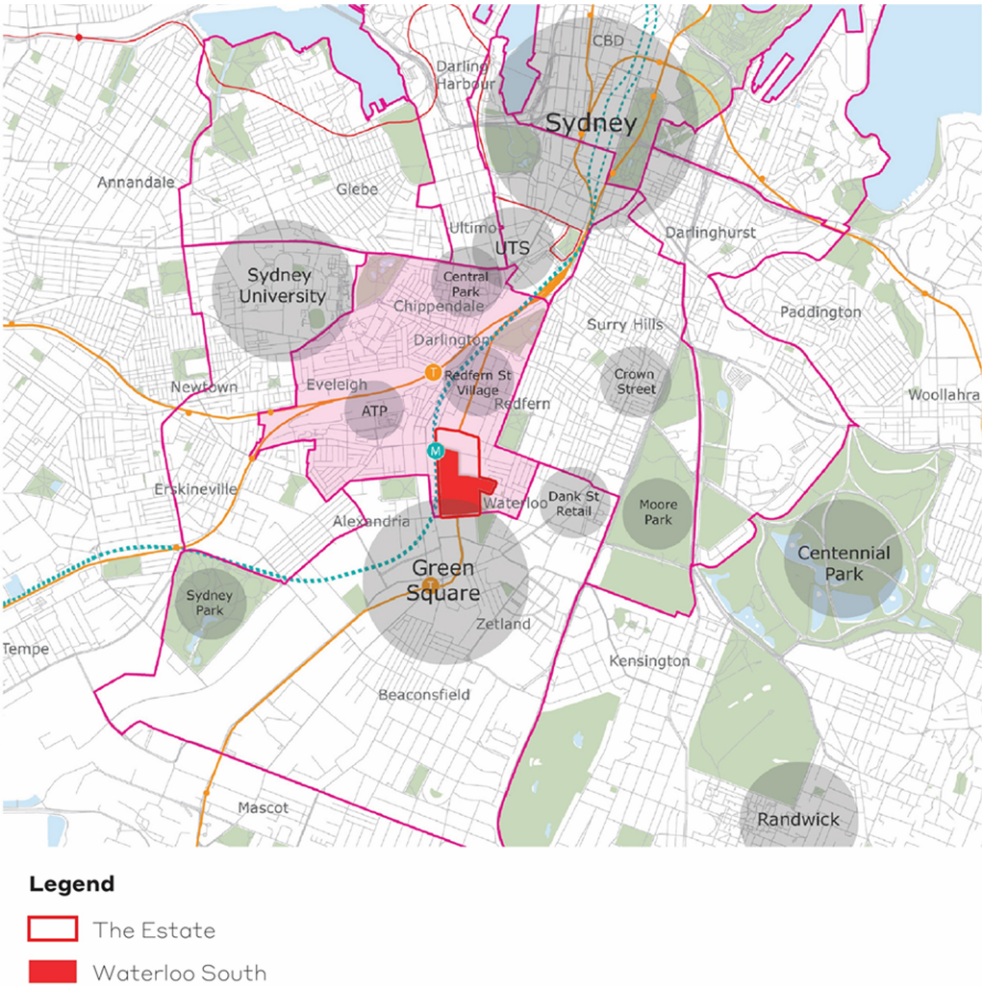

Figure 1: Location plan of Waterloo Estate and Waterloo South (Source: Turner Studio)

1.2 Waterloo South

Waterloo South includes land bounded by Cope, Raglan, George, Wellington, Gibson, Kellick, Pitt and McEvoy Streets, and has an approximate gross site area of 12.32 hectares (approximately 65% of the total Estate).

Waterloo South currently comprises 749 social housing dwellings owned by LAHC, 125 private dwellings, and commercial properties on the south-east corner of Cope and Wellington Streets. Existing social housing within Waterloo South is predominantly walk up flat buildings constructed in the 1950s and '60s, and mid-rise residential flat buildings (Drysdale, Dobell & 76 Wellington Street) constructed in the 1980s. Listed Heritage Items within Waterloo South include the Duke of Wellington Hotel, Electricity Substation 174 on the corner of George and McEvoy Streets, the terrace houses at 229-231 Cope Street and the Former Waterloo Pre-School at 225-227 Cope Street. The State Heritage listed 'Potts Hill to Waterloo Pressure Tunnel and Shafts' passes underneath the precinct.

A map of Waterloo South and relevant boundaries is illustrated in Figure 2.

Figure 2: Waterloo Precinct (Source: Ethos Urban)

1.3 Redevelopment Vision

The transition of Waterloo Estate will occur over a 20-year timeframe, replacing and providing fit for purpose social (affordable rental) housing as well as private housing to create a new integrated and inclusive mixed-tenure community.

This aligns with Future Directions for Social Housing in NSW – the NSW Government's vision for social housing. It also aligns with LAHC's Communities Plus program, which is tasked with achieving three key objectives:

1. Provide more social housing
2. Provide a better social housing experience
3. Provide more opportunities and support for social housing tenants

The following is LAHC's Redevelopment Vision for Waterloo Estate, which was derived from extensive consultation and technical studies:

Source: Let's Talk Waterloo: Waterloo Redevelopment (Elton Consulting, 2019)

Culture and Heritage

- Recognise and celebrate the significance of Waterloo's Aboriginal history and heritage across the built and natural environments.
- Make Waterloo an affordable place for more Aboriginal people to live and work.
- Foster connection to culture by supporting authentic storytelling and recognition of artistic, cultural and sporting achievements.

Communal and Open Space

- Create high quality, accessible and safe open spaces that connect people to nature and cater to different needs, purposes and age groups.
- Create open spaces that bring people together and contribute to community cohesion and wellbeing.

Movement and Connectivity

- Make public transport, walking and cycling the preferred choice with accessible, reliable and safe connections and amenities.
- Make Waterloo a desired destination with the new Waterloo Station at the heart of the Precinct's transport network – serving as the gateway to a welcoming, safe and active community.

Character of Waterloo

- Strengthen the diversity, inclusiveness and community spirit of Waterloo.
- Reflect the current character of Waterloo in the new built environment by mixing old and new.

Local Employment Opportunities

- Encourage a broad mix of businesses and social enterprise in the area that provides choice for residents and creates local job opportunities.

Community Services, Including Support for Those Who Are Vulnerable

- Ensure that social and human services support an increased population and meet the diverse needs of the community, including the most vulnerable residents.

- Provide flexible communal spaces to support cultural events, festivals and activities that strengthen community spirit.

Accessible Services

- Deliver improved and affordable services that support the everyday needs of the community, such as health and wellbeing, grocery and retail options.

Design Excellence

- Ensure architectural design excellence so that buildings and surrounds reflect community diversity, are environmentally sustainable & people friendly – contributing to lively, attractive and safe neighbourhoods.
- Recognise and celebrate Waterloo's history and culture in the built environment through artistic and creative expression.
- Create an integrated, inclusive community where existing residents and newcomers feel welcome, through a thoughtfully designed mix of private, and social (affordable rental) housing.

1.4 Purpose of this Report

This report relates to the Waterloo South planning proposal. While it provides comprehensive baseline investigations for Waterloo Estate, it only assesses the proposed planning framework amendments and Indicative Concept Proposal for Waterloo South.

The key matters addressed as part of this study, include:

- Preparation of a scale model of the development, including surrounding buildings and land topography.
- Wind tunnel testing to be performed so that measurements are taken from 16 wind directions at 22.5 degree increments and configured to the appropriate boundary layer wind profile.
- Wind tunnel study to assess existing site ground level wind conditions.
- Wind tunnel study to assess ground level wind conditions at selected critical outdoor trafficable areas within and around Waterloo South masterplan.
- Identify key areas that do not satisfy the relevant pedestrian comfort and safety criterion.
- Implement and test treatment strategies to ameliorate the measured wind conditions of the proposed Waterloo South masterplan.
- Provide a detail outline of the recommended treatment strategies that result in compliance with the pedestrian comfort and safety criteria.

1.5 Waterloo South Planning Proposal

The planning proposal will establish new land use planning controls for Waterloo South, including zoning and development standards to be included in Sydney LEP 2012, a new section in Part 5 of DCP 2012, and an infrastructure framework. Turner Studio and Turf has prepared an Urban Design and Public Domain Study which establishes an Indicative Concept Proposal presenting an indicative renewal outcome for Waterloo South. The Urban Design and Public Domain Study provides a comprehensive urban design vision and strategy to guide future development of Waterloo South and has informed the proposed planning framework. The Indicative Concept Proposal has also been used as the basis for testing, understanding and communicating the potential development outcomes of the proposed planning framework.

The Indicative Concept Proposal comprises:

- Approximately 2.57 hectares of public open space representing 17.8% of the total Estate (Gross Estate area - existing roads) proposed to be dedicated to the City of Sydney Council, comprising:
    - Village Green – a 2.25 hectare park located next to the Waterloo Metro Station; and
    - Waterloo Common and adjacent – 0.32 hectares located in the heart of the Waterloo South precinct.
    - The 2.57 hectares all fall within the Waterloo South Planning Proposal representing 32.3% of public open space (Gross Waterloo South area – proposed roads).
- Retention of 52% of existing high and moderate value trees (including existing fig trees) and the planting of three trees to replace each high and moderate value tree removed.
- Coverage of 30% of Waterloo South by tree canopy.
- Approximately 257,000 sqm of GFA on the LAHC land, comprising:
    - Approximately 239,100 sqm GFA of residential accommodation, providing for approximately 3,048 dwellings comprising a mix of market and social (affordable rental) housing dwellings;
    - Approximately 11,200 sqm of GFA for commercial premises, including, but not limited to, supermarkets, shops, food & drink premises and health facilities; and
    - Approximately 6,700 sqm of community facilities and early education and child care facilities.

The key features of the Indicative Concept Proposal are:

- It is a design and open space led approach.
- Creation of two large parks of high amenity by ensuring good sunlight access.
- Creation of a pedestrian priority precinct with new open spaces and a network of roads, lanes and pedestrian links.
- Conversion of George Street into a landscaped pedestrian and cycle friendly boulevard and creation of a walkable loop designed to cater to the needs of all ages.
- A new local retail hub located centrally within Waterloo South to serve the needs of the local community.
- A target of 80% of dwellings to have local retail services and open space within 200m of their building entry.
- Achievement of a 6 Star Green Star Communities rating, with minimum 5-star Green Star – Design & As-Built (Design Review certified).
- A range of Water Sensitive Urban Design (WSUD) features.

The proposed land allocation for the Waterloo South precinct is described in Table 1 below.

Table 1: Breakdown of allocation of land within the Waterloo South

Land allocation	Existing	Proposed
Roads	3.12ha / 25.3%	4.38ha / 35.5%
Developed area (Private sites)	0.86ha / 6.98%	0.86ha / 7%
Developed area (LAHC property)	8.28ha / 67.2%	4.26ha / 34.6%
Public open space (proposed to be dedicated to the City of Sydney)	Nil / 0%	2.57ha / 20.9% (32.3% excluding roads)
Other publicly accessible open space (Including former roads and private/LAHC land)	0.06ha / 0.5%	0.25ha / 2%
TOTAL	12.32ha	12.32ha

The Indicative Concept Proposal for the Waterloo South is illustrated in Figure 3 below.

Figure 3: Indicative Concept Proposal (Source: Turner Studio)

2 WIND TUNNEL TESTING

A wind tunnel study has been undertaken to assess the ground level wind speeds at selected critical outdoor trafficable areas within and around Waterloo South. The test procedures followed for this wind tunnel study were based on the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2019), ASCE 7-16 (Chapter C31), and CTBUH (2013).

A scale model of the development was prepared, including the surrounding buildings and land topography. Testing was performed at Windtech's boundary layer wind tunnel facility. The wind tunnel has a 3.0m wide working section and a fetch length of 14m, and measurements were taken from 16 wind directions at 22.5 degree increments. The wind tunnel was configured to the appropriate boundary layer wind profile for each wind direction. Wind speeds were measured using Dantec hot-wire probe anemometers, positioned to monitor wind conditions at critical outdoor trafficable areas of the development.

The model was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, etc., which are not already shown in the architectural drawings. The wind speeds measured during testing were combined with a statistical model of the regional wind climate to provide the equivalent full-scale wind speeds at the site. The measured wind speeds were compared against appropriate criteria for pedestrian comfort and safety. Treatments have been recommended and tested for any area which was exposed to strong winds. These treatments could be in the form of retaining vegetation that is already proposed for the site, or including screens, awnings, etc.

3 BOUNDARY LAYER WIND PROFILES AT THE SITE

The roughness of the surface of the earth has the effect of slowing down the wind near the ground. This effect is observed up to the boundary layer height, which can range between 500m to 3km above the earth's surface depending on the roughness of the surface (ie: oceans, open farmland, etc). Within this range the prevailing wind forms a boundary layer wind profile.

Various wind codes and standards and other publications classify various types of boundary layer wind flows depending on the surface roughness z_0. Descriptions of typical boundary layer wind profiles, based on Deaves & Harris (1978), are summarised as follows:

- Flat terrain (0.002m < z_0 < 0.003m). Examples include inland water bodies such as lakes, dams, rivers, etc, and the open ocean.
- Semi-open terrain (0.006m < z_0 < 0.01m). Examples include flat deserts and plains.
- Open terrain (0.02m < z_0 < 0.03m). Examples include grassy fields, semi-flat plains, and open farmland (without buildings or trees).
- Semi-suburban/semi-forest terrain (0.06m < z_0 < 0.1m). Examples include farmland with scattered trees and buildings and very low-density suburban areas.
- Suburban/forest terrain (0.2m < z_0 < 0.3m). Examples include suburban areas of towns and areas with dense vegetation such as forests, bushland, etc.
- Semi-urban terrain (0.6m < z_0 < 1.0m). Examples include centres of small cities, industrial parks, etc.
- Urban terrain (2.0m < z_0 < 3.0m). Examples include centres of large cities with many high-rise towers, and also areas with many closely-spaced mid-rise buildings.

The boundary layer wind profile does not change instantly due to changes in the terrain roughness. It can take many kilometres (at least 100km) of a constant surface roughness for the boundary layer wind profile to achieve a state of equilibrium. Hence an analysis of the effect of changes in the upwind terrain roughness is necessary to determine an accurate boundary layer wind profile at the development site location.

For this study this has been undertaken based on the method given in AS/NZS1170.2:2011, which uses a "fetch" length of 60 times the study reference height. However, it should be noted that this "fetch" commences *beyond* a "lag distance" area, which has a length of 20 times the study reference height (in accordance with AS/NZS1170.2:2011), so the actual "fetch" of terrain analysed is the area between 20 and 60 times the study reference height away from the site. The proximity model accounts for the effect of the near field topographic effects as well as the influence of the local built forms.

An aerial image showing the surrounding terrain is presented in Figure 4 for a range of 2.7km from the edge of the proximity model used for the wind tunnel study. The resulting mean and gust terrain and height multipliers at the site location are presented in Table 2. The terrain and height multipliers are referenced to the study reference height (approximately half of the height of the subject development since typically we are most interested in the wind effects at the ground plane). Details of the boundary layer wind profiles at the site are combined with the regional wind model (see Section 4) to determine the site wind speeds.

Table 2: Approaching Boundary Layer Wind Profile Analysis Summary (at the study reference height)

Wind Sector (degrees)	Terrain and Height Multiplier			Turbulence Intensity	Equivalent Terrain Category
	$k_{tr,T=1hr}$ *(hourly)*	$k_{tr,T=10min}$ *(10min)*	$k_{tr,T=3s}$ *(3sec)*	I_v	*(AS/NZS1170.2:2011 naming convention)*
0	0.56	0.61	1.02	0.271	3.5
30	0.56	0.61	1.02	0.271	3.5
60	0.70	0.74	1.12	0.200	2.8
90	0.75	0.79	1.15	0.177	2.5
120	0.70	0.74	1.12	0.200	2.8
150	0.68	0.72	1.10	0.209	3.0
180	0.64	0.68	1.07	0.232	3.2
210	0.56	0.61	1.02	0.271	3.5
240	0.67	0.71	1.10	0.212	3.0
270	0.67	0.71	1.10	0.212	3.0
300	0.61	0.65	1.05	0.248	3.3
330	0.72	0.76	1.13	0.190	2.7

For each of the 16 wind directions tested in this study, the approaching boundary layer wind profiles modelled in the wind tunnel closely matched the profiles listed in Table 2. Plots of the boundary layer wind profiles used for the wind tunnel testing are presented in Appendix B of this report.

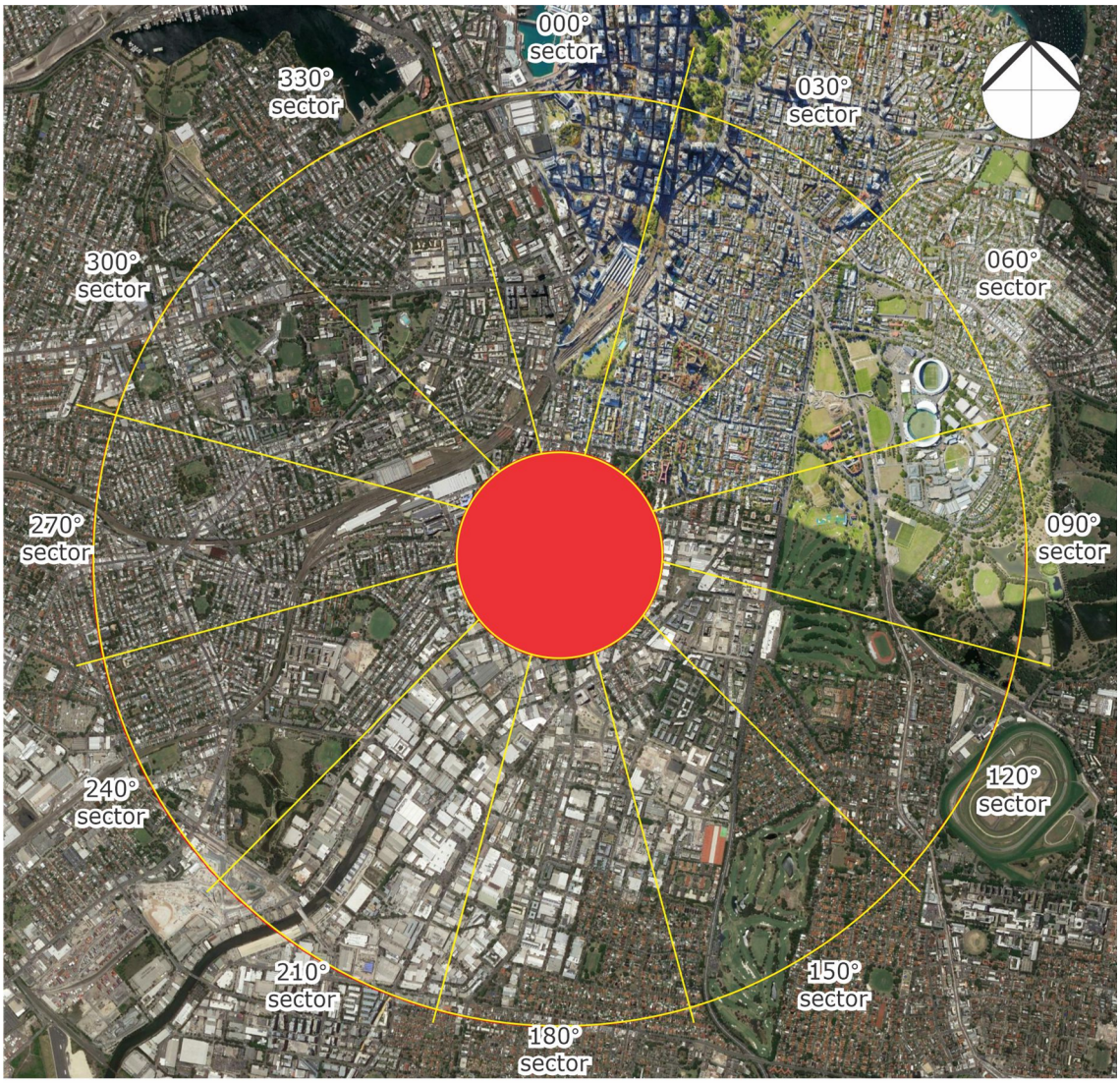

Figure 4: Aerial Image of the Surrounding Terrain
(radius of 2.7km from the edge of the proximity model, which is coloured red)

4 REGIONAL WIND MODEL

The regional wind model used in this study was determined from an analysis of measured directional mean wind speeds obtained at the meteorological recording station located at Kingsford Smith Airport (Sydney Airport). Data was collected from 1995 to 2016 between 6am to 10pm and corrected so that it represents wind speeds over standard open terrain at a height of 10m above ground for each wind direction. From this analysis, directional probabilities of exceedance and directional wind speeds for the region are determined. The directional wind speeds are summarised in Table 3. The directional wind speeds and corresponding directional frequencies of occurrence are presented in Figure 5.

The data indicates that the southerly winds are by far the most frequent winds for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently occur during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

The recurrence intervals examined in this study are for exceedances of 5% (per 90 degree sector) for the pedestrian comfort criteria using Gust-Equivalent Mean (GEM) wind speeds, and annual maximum wind speeds (per 22.5 degree sector) for the pedestrian safety criterion. Note that the 5% probability wind speeds presented in Table 3 are only used for the directional plot presented in Figure 5 and are not used for the integration of the probabilities.

Table 3: Directional Wind Speeds (m/s)
(hourly means, referenced to 10m above ground in standard open terrain)

Wind Direction	5% Exceedance	Annual Maximum
N	5.9	9.9
NNE	9.9	12.9
NE	9.7	12.3
ENE	7.5	10.0
E	6.3	9.3
ESE	6.2	9.1
SE	7.0	10.1
SSE	8.5	12.2
S	10.3	13.9
SSW	10.0	14.1
SW	6.9	11.9
WSW	9.3	13.6
W	9.8	14.4
WNW	8.8	14.3
NW	6.7	12.6
NNW	5.5	10.7

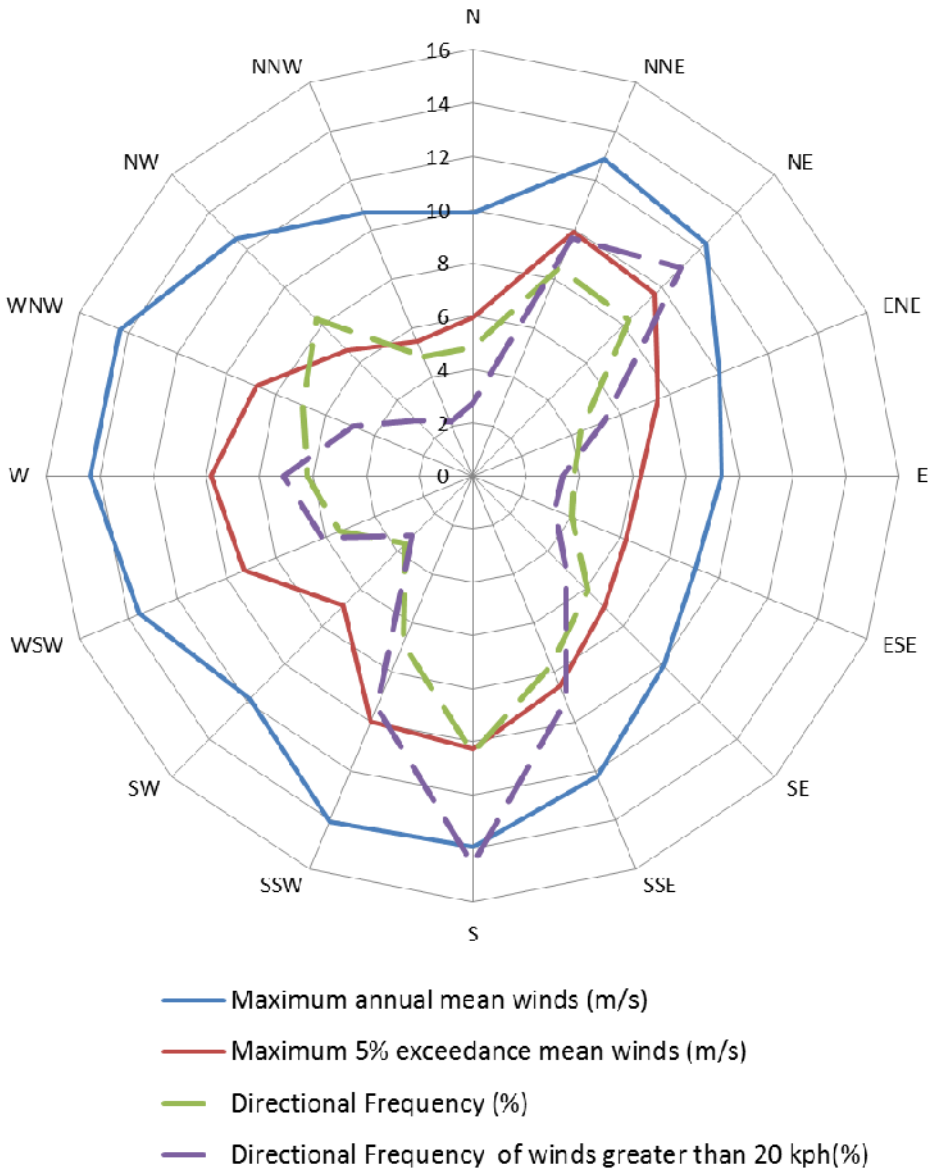

Figure 5: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (referenced to 10m above ground in standard open terrain)

5 PEDESTRIAN WIND COMFORT AND SAFETY

The acceptability of wind conditions of an area is determined by comparing the measured wind speeds against an appropriate criteria. This section outlines how the measured wind speeds were obtained, the criteria considered for the development, as well as the critical trafficable areas that were assessed and their corresponding criteria designation.

5.1 Measured Wind Speeds

Wind speeds were measured using Dantec hot-wire probe anemometers, positioned to monitor wind conditions at critical outdoor trafficable areas of the development. The reference mean free-stream wind speed measured in the wind tunnel, which is at a full-scale height of 200m and measured 3m upstream of the study model.

Measurements were acquired for 16 wind directions at 22.5 degree increments using a sample rate of 1,024Hz. The full methodology of determining the wind speed measurements at the site from the Dantec Hot-wire probe anemometers is provided in Appendix D. Based on the results of the analysis of the boundary layer wind profiles at the site (see Section 4), and incorporating the regional wind model (see Section 5), the data sampling length of the wind tunnel test for each wind direction corresponds to a full-scale sample length ranging between 30 minutes and 1 hour. Research by A.W. Rofail and K.C.S. Kwok (1991) has shown that, in addition to the mean and standard deviation of the wind being stable for sample lengths of 15 minutes or more (full-scale), the peak value determined using the upcrossing method is stable for sample lengths of 30 minutes or more.

5.2 Wind Speed Criteria Used for This Study

For this study, the measured wind conditions for the various critical outdoor trafficable areas around the subject development are compared against the criteria presented in the Sydney Development Control Plan 2012 - Central Sydney Planning Review Amendment, which supersedes the criteria detailed in the City of Sydney Development Control Plan 2012 (SDCP2012).

For pedestrian comfort, the Sydney DCP 2012 requires that the hourly mean wind speed, or Gust-Equivalent Mean (GEM) wind speed (whichever is greater for each wind direction), must not exceed 8m/s for walking, 6m/s for standing, and 4m/s for sitting. These are based on a 5% probability of exceedance.

For pedestrian safety, the Sydney DCP 2012 defines a safety limit criterion of 24m/s, based on an annual maximum 0.5 second gust wind speed, which applies to all areas.

Furthermore, in accordance with the provisions of the Sydney DCP 2012, the existing conditions for the pedestrian footpaths around the site are also analysed as part of this study to determine the impact of the subject development. If it is found that the existing conditions exceed the relevant criteria, then the target wind speed for that area with the inclusion of the proposed development is to at least match the existing site conditions.

In accordance with the provisions of the Sydney DCP 2012, the wind speed assessment is undertaken for winds occurring between 6am and 10pm (AEST). A more detailed comparison of published criteria for pedestrian wind comfort and safety is provided in Appendix C. For this study the measured wind conditions of the selected critical outdoor trafficable areas are compared against two sets of criteria; one for pedestrian safety, and one for pedestrian comfort. The safety criterion is applied to the annual maximum gust winds, and the comfort criteria is applied to Gust Equivalent Mean (GEM) winds. In accordance with ASCE (2003), the GEM wind speed is defined as follows:

$$GEM = max\left(\bar{V}, \frac{\hat{V}}{1.85}\right) \quad (5.1)$$

Where:

$\bar{V}$ is the mean wind speed.

$\hat{V}$ is the gust wind speed.

The criteria considered in this study are summarised in Table 4 and

Table 5 for pedestrian comfort and safety, respectively. The results of the wind tunnel study are presented in the form of directional plots attached in Appendix A of this report. For each study point there is a plot of the GEM wind speeds using the comfort criteria, and a plot for the annual maximum gust wind speeds using the safety criterion.

Table 4: Pedestrian Comfort Criteria (Sydney DCP 2012)

Classification	Description	Maximum 5% Exceedance GEM Wind Speed (m/s)
Sitting	Outdoor areas that involve seating such as dining areas in restaurants, amphitheatres, etc.	4
Standing	Short duration stationary activities (generally less than 1 hour), including window shopping, waiting areas, etc.	6
Walking	For pedestrian thoroughfares, private swimming pools, most communal areas, private balconies and terraces, etc.	8

Table 5: Pedestrian Safety Criterion (Draft Sydney DCP 2012)

Classification	Description	Annual Maximum Gust Wind Speed (m/s)
Safety	Safety criterion applies to all trafficable areas.	24

6 BASELINE INVESTIGATIONS

This section will address study requirements 19.1 and 19.8 through the analysis of the existing site wind conditions via wind tunnel testing.

Testing of the entire Waterloo precinct was undertaken for the existing site conditions, based on the architectural drawing packages received May 2017. The results provide a baseline wind case for the existing site wind conditions for the proposed development site to be established, taking into account the prevailing wind directions for the region, as well as the local topographical effects of the terrain and the surrounding buildings of the proposed site.

6.1 Existing Site Wind Tunnel Model

The existing site study model incorporates all necessary architectural features on the development to ensure an accurate wind flow is achieved. The effect of nearby buildings and land topography has been accounted for through the use of a proximity model, which represents a radius of approximately 600m. Photographs of the wind tunnel model are presented below for the existing site in Figure 6a – 6d on the following pages. Figure 6e depicts a plan view of the proximity model.

The model of the proposed development was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, awnings, etc., which are not already shown in the architectural drawings.

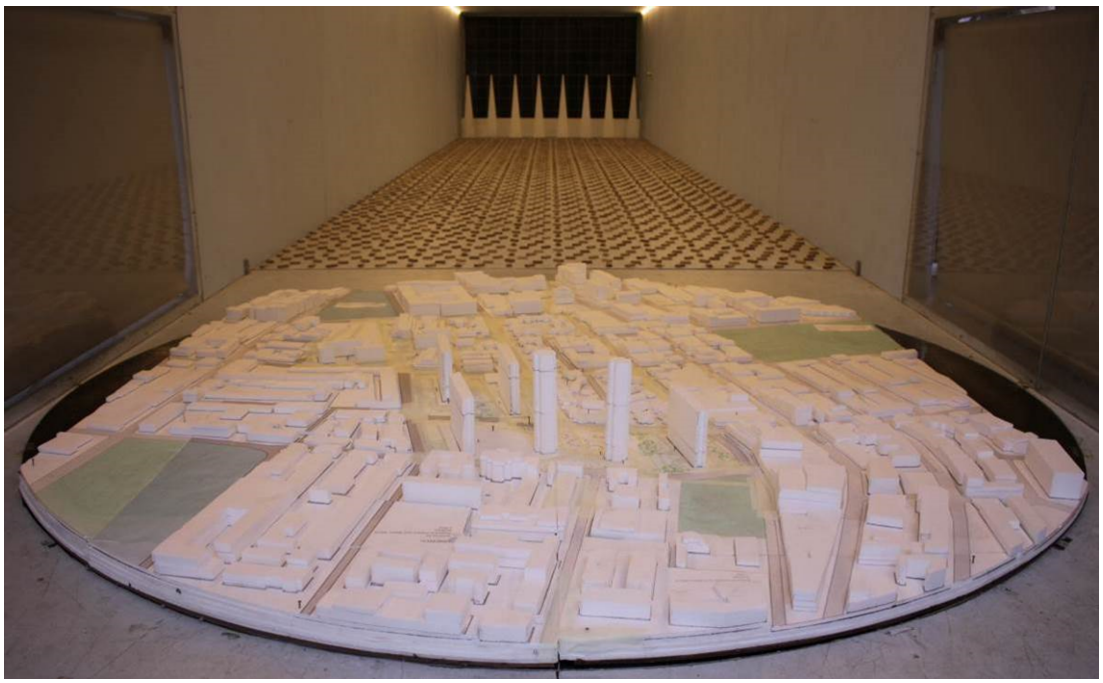

Figure 6a: Photograph of the Wind Tunnel Model – (View from the North)

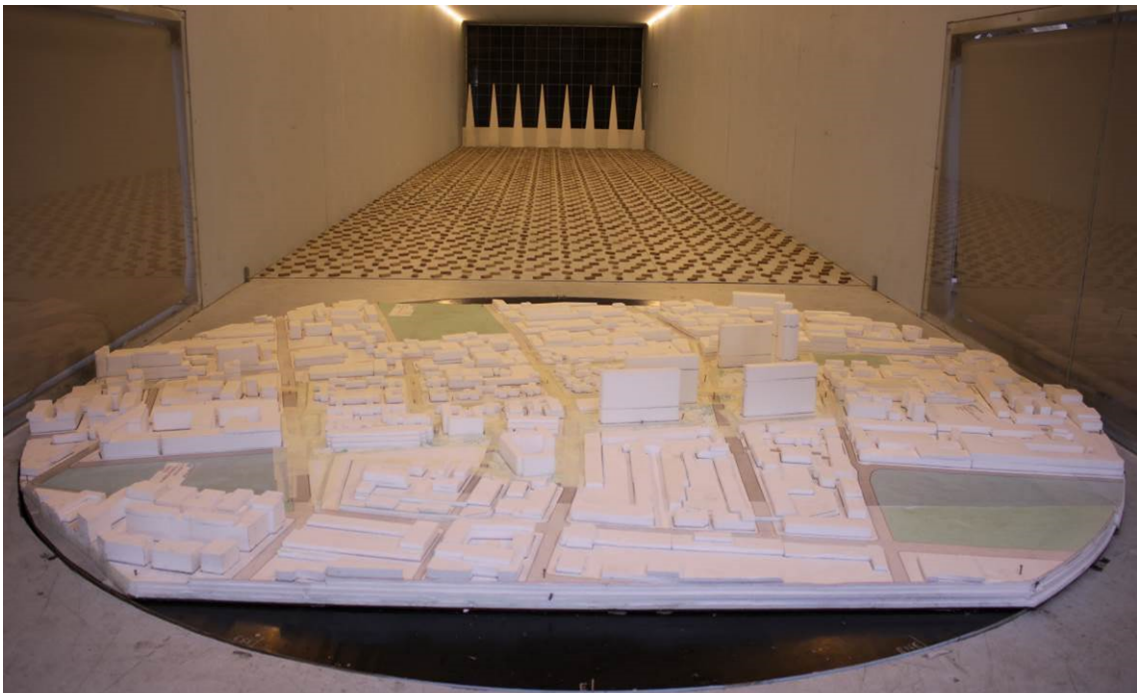

Figure 6b: Photograph of the Wind Tunnel Model – (View from the East)

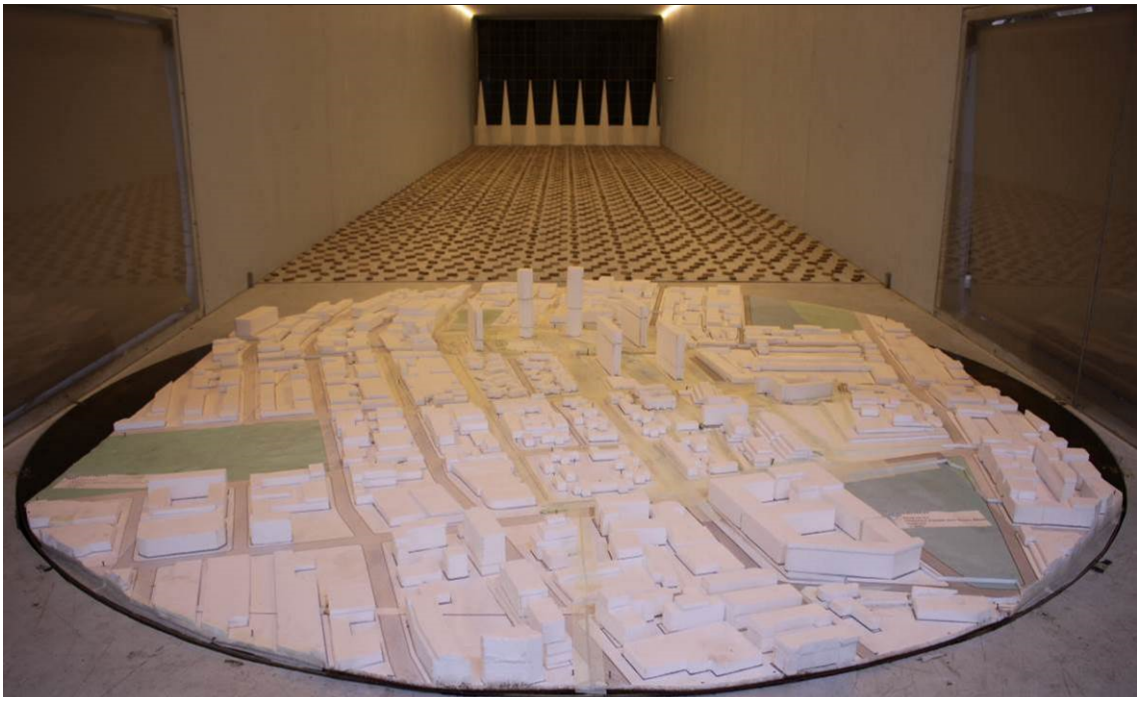

Figure 6c: Photograph of the Wind Tunnel Model – (View from the South)

Figure 6d: Photograph of the Wind Tunnel Model – (View from the West)

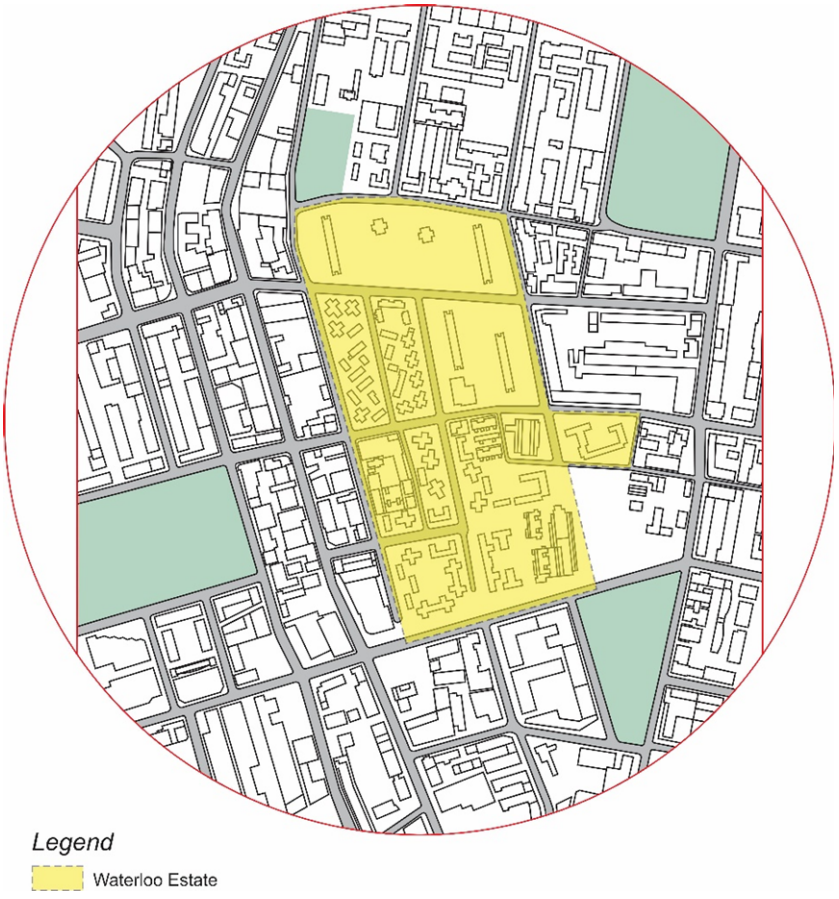

Figure 6e: Map of Proximity Model – Existing Site (Waterloo Estate Boundary)

6.2 Layout of Study Points

For this study a total of 81 ground level study points have been selected for analysis in the wind tunnel located within and around the proposed Waterloo Estate site boundary.

The locations of the various study points tested are presented in Figures 7a to 7d in the form of marked-up plan drawings. The target wind speed criteria for the outdoor trafficable areas within and around the development is also indicated in these figures.

The most critical outdoor locations of the development have been selected for analysis which will help with the masterplan design input. The areas for consideration are the corner areas of the proposed development site due to the alignment of the city street grid coinciding with two of the prevailing winds for the Sydney region, which are the southerly and westerly winds. These areas may be subject to adverse wind effects due to a combination of direct winds and corner accelerations.

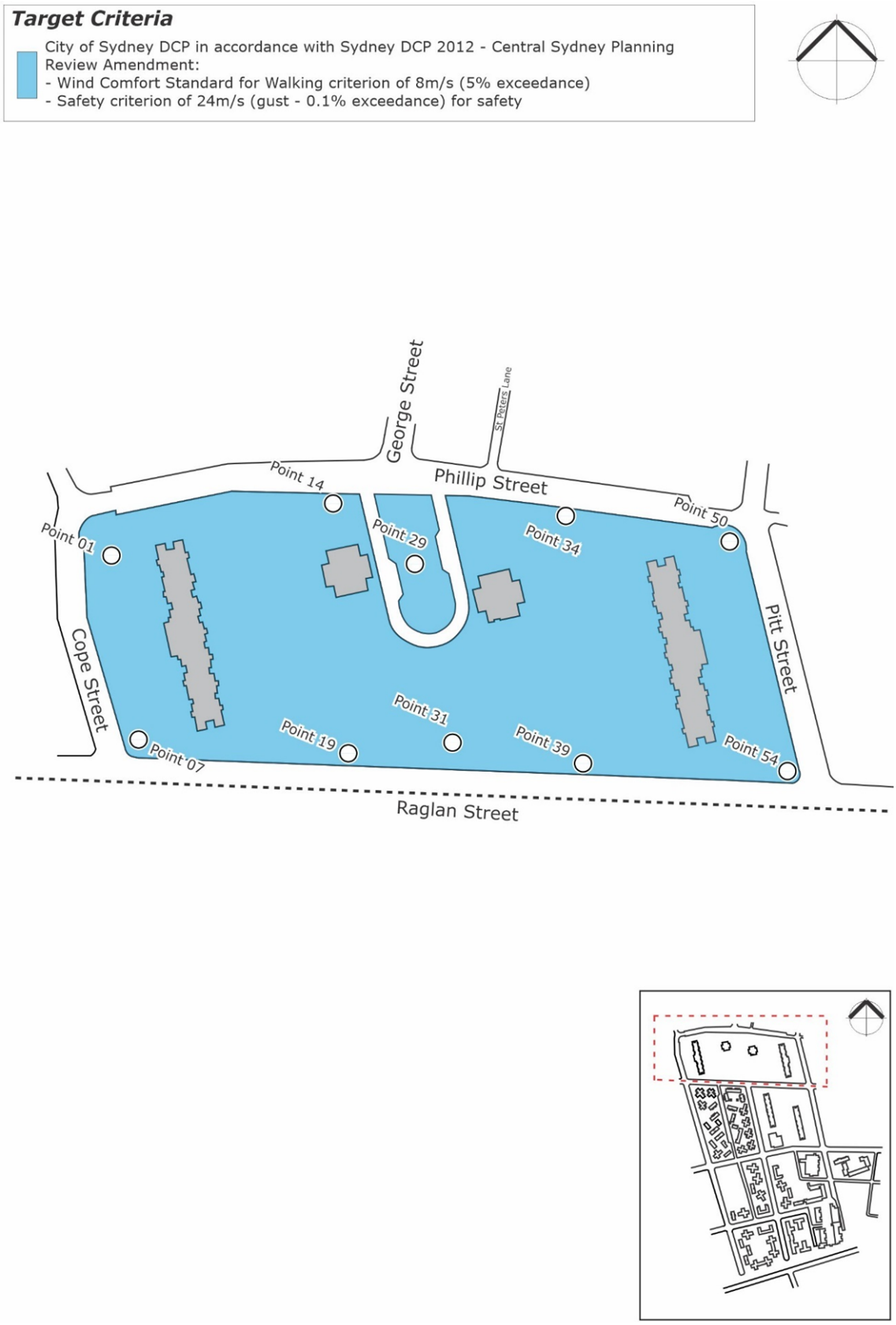

Figure 7a: Study Point Locations and Target Criteria – Phillip to Raglan Street - Existing Site of Waterloo Estate Masterplan

Figure 7b: Study Point Locations and Target Criteria – Raglan to Wellington Street- Existing Site of Waterloo Estate Masterplan

Figure 7c: Study Point Locations and Target Criteria – Wellington to McEvoy Street - Existing Site of Waterloo Estate Masterplan

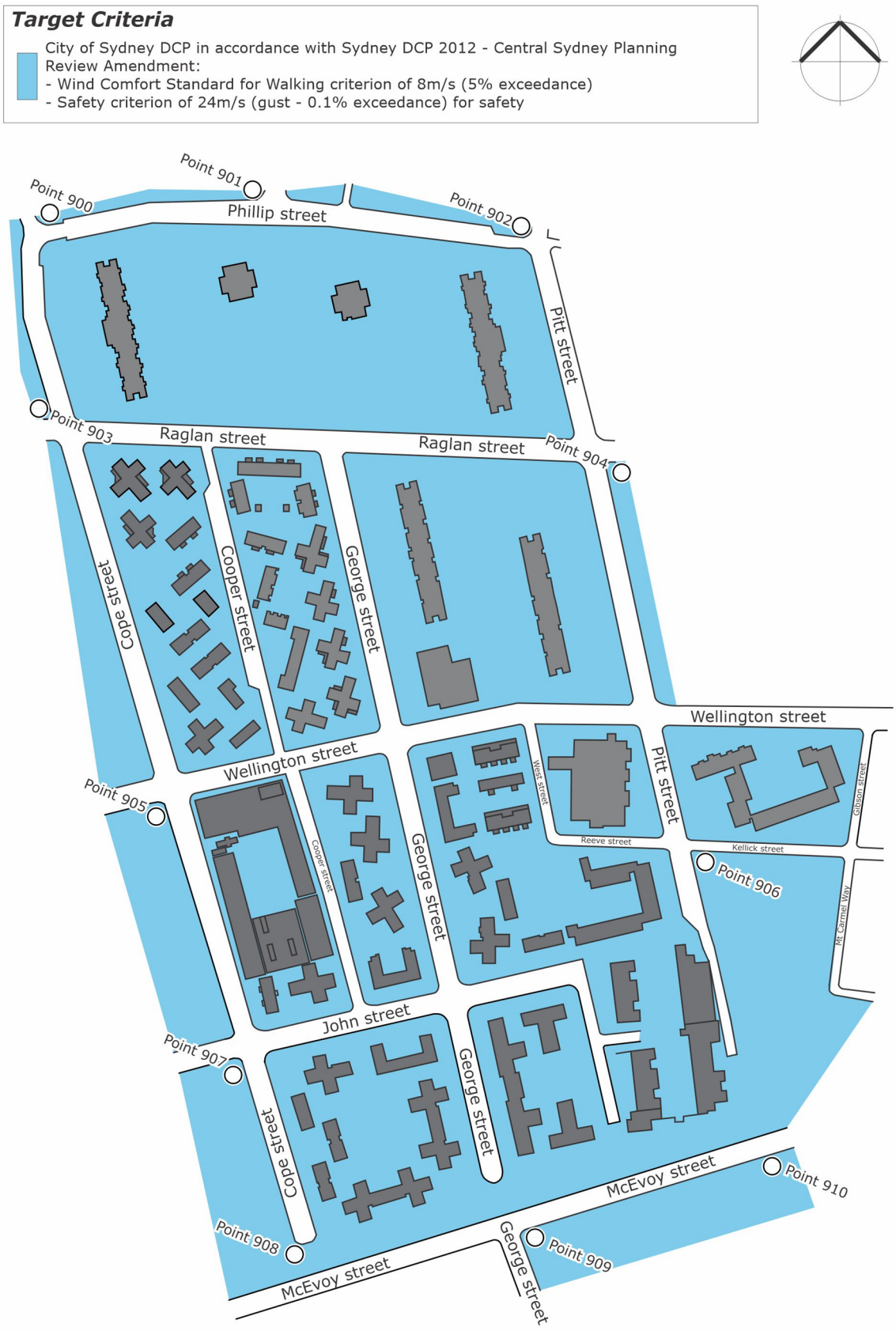

Figure 7d: Study Point Locations and Target Criteria – Surrounding Points - Existing Site of Waterloo Estate Masterplan

6.3 Results

The results for the existing site point locations are presented in the form of directional plots in Appendix A, summarised in Table 6, and shown on marked-up plans in Figures 8a – 8d below. The wind speed criteria for the existing site has been assessed against the walking criterion, as listed in Table 6 for each study point location, as well as shown in Figures 7a – 7d.

Table 6: Wind Tunnel Results Summary – Existing Site Conditions (Sydney DCP 2012)

Study Point	Wind Speed Criteria and Overall Rating			
	Weekly GEM (m/s)	Rating	Annual Peak (m/s)	Rating
Point 01	8.0	PASS	24.0	PASS
Point 07	8.0	PASS	24.0	PASS
Point 14	8.0	PASS	24.0	PASS
Point 19	8.0	PASS	24.0	PASS
Point 29	8.0	FAIL	24.0	PASS
Point 31	8.0	PASS	24.0	PASS
Point 34	8.0	PASS	24.0	PASS
Point 39	8.0	PASS	24.0	PASS
Point 50	8.0	PASS	24.0	PASS
Point 54	8.0	PASS	24.0	PASS
Point 60	8.0	PASS	24.0	PASS
Point 68	8.0	PASS	24.0	PASS
Point 70	8.0	PASS	24.0	PASS
Point 77	8.0	PASS	24.0	PASS
Point 79	8.0	FAIL	24.0	PASS
Point 81	8.0	PASS	24.0	PASS
Point 82	8.0	PASS	24.0	PASS
Point 85	8.0	PASS	24.0	PASS
Point 87	8.0	PASS	24.0	PASS
Point 89	8.0	PASS	24.0	PASS
Point 90	8.0	PASS	24.0	PASS
Point 96	8.0	PASS	24.0	PASS
Point 100	8.0	PASS	24.0	PASS
Point 104	8.0	PASS	24.0	PASS
Point 107	8.0	FAIL	24.0	PASS
Point 109	8.0	PASS	24.0	PASS
Point 110	8.0	FAIL	24.0	PASS
Point 111	8.0	PASS	24.0	PASS
Point 118	8.0	PASS	24.0	PASS

Study Point	Wind Speed Criteria and Overall Rating			
	Weekly GEM (m/s)	Rating	Annual Peak (m/s)	Rating
Point 119	8.0	FAIL	24.0	FAIL
Point 120	8.0	PASS	24.0	PASS
Point 122	8.0	PASS	24.0	PASS
Point 124	8.0	PASS	24.0	PASS
Point 125	8.0	PASS	24.0	PASS
Point 127	8.0	PASS	24.0	PASS
Point 131	8.0	PASS	24.0	PASS
Point 133	8.0	PASS	24.0	PASS
Point 136	8.0	PASS	24.0	PASS
Point 137	8.0	PASS	24.0	PASS
Point 143	8.0	PASS	24.0	PASS
Point 146	8.0	PASS	24.0	PASS
Point 147	8.0	PASS	24.0	PASS
Point 151	8.0	PASS	24.0	PASS
Point 153	8.0	PASS	24.0	PASS
Point 173	8.0	PASS	24.0	PASS
Point 156	8.0	PASS	24.0	PASS
Point 158	8.0	PASS	24.0	PASS
Point 179	8.0	PASS	24.0	PASS
Point 164	8.0	PASS	24.0	PASS
Point 166	8.0	PASS	24.0	PASS
Point 168	8.0	PASS	24.0	PASS
Point 170	8.0	PASS	24.0	PASS
Point 178	8.0	PASS	24.0	PASS
Point 181	8.0	PASS	24.0	PASS
Point 183	8.0	PASS	24.0	PASS
Point 184	8.0	FAIL	24.0	PASS
Point 187	8.0	PASS	24.0	PASS
Point 192	8.0	PASS	24.0	PASS
Point 193	8.0	PASS	24.0	PASS
Point 198	8.0	PASS	24.0	PASS
Point 202	8.0	PASS	24.0	PASS
Point 206	8.0	PASS	24.0	PASS
Point 207	8.0	PASS	24.0	PASS
Point 211	8.0	PASS	24.0	PASS
Point 215	8.0	PASS	24.0	PASS
Point 227	8.0	PASS	24.0	PASS
Point 232	8.0	PASS	24.0	PASS
Point 235	8.0	PASS	24.0	PASS

Study Point	Wind Speed Criteria and Overall Rating			
	Weekly GEM (m/s)	Rating	Annual Peak (m/s)	Rating
Point 238	8.0	PASS	24.0	PASS
Point 900	8.0	PASS	24.0	PASS
Point 901	8.0	PASS	24.0	PASS
Point 902	8.0	PASS	24.0	PASS
Point 903	8.0	PASS	24.0	PASS
Point 904	8.0	PASS	24.0	PASS
Point 905	8.0	PASS	24.0	PASS
Point 906	8.0	PASS	24.0	PASS
Point 907	8.0	PASS	24.0	PASS
Point 908	8.0	PASS	24.0	PASS
Point 909	8.0	PASS	24.0	PASS
Point 910	8.0	FAIL	24.0	FAIL

Note that when classifying a "Pass" or "Fail" for the weekly GEM wind speeds, the desired criterion is exceeded if the probability of exceedance is greater than 5% and hence awarded a "Fail".

The baseline conditions established from the pedestrian wind environment testing will be compared against the results of the wind tunnel testing of the Waterloo South masterplan, as summarised in Table 7. For the Waterloo South masterplan assessment it should be noted that certain study point locations will be assessed against stricter criteria. Similarly, point naming between the existing scenario and proposed scenarios are not the same. As such, comparison will be made for each existing site study point against the equivalent criteria and equivalent point.

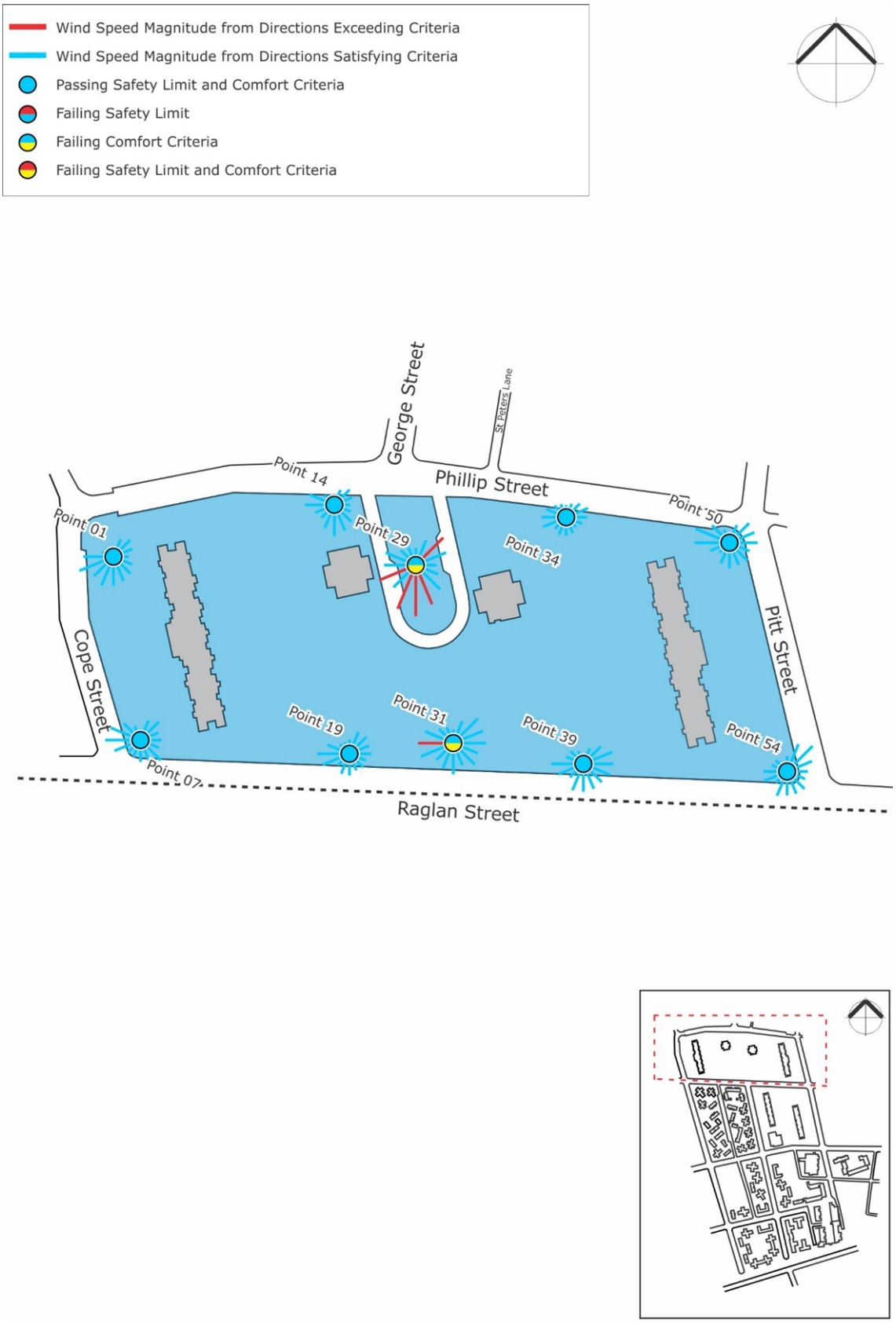

Figure 8a: Wind Directionality Plots – Ground Level - Existing Site of Waterloo Estate Masterplan

Figure 8b: Wind Directionality Plots – Ground Level - Existing Site of Waterloo Estate Masterplan

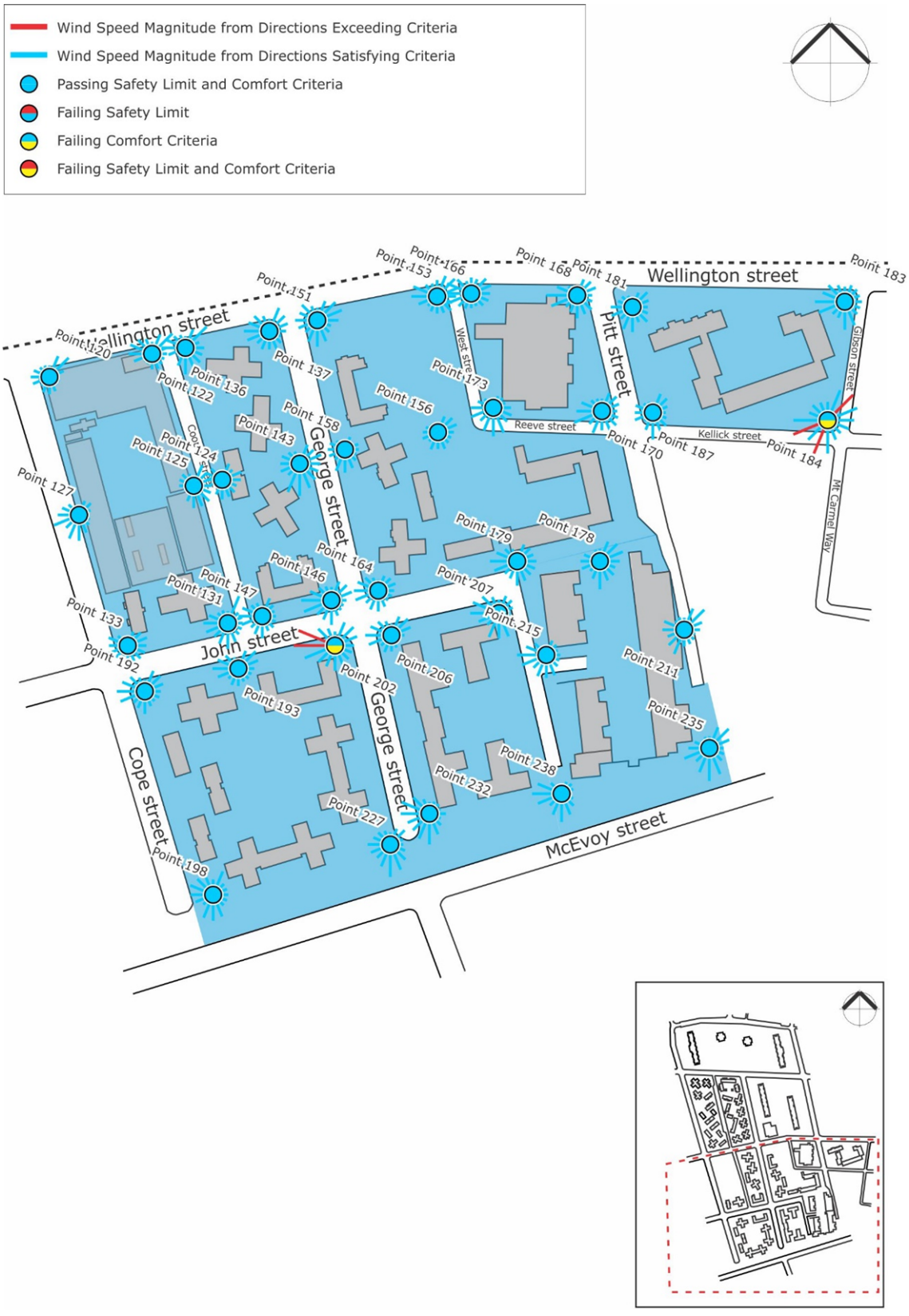

Figure 8c: Wind Directionality Plots – Ground Level - Existing Site of Waterloo Estate Masterplan

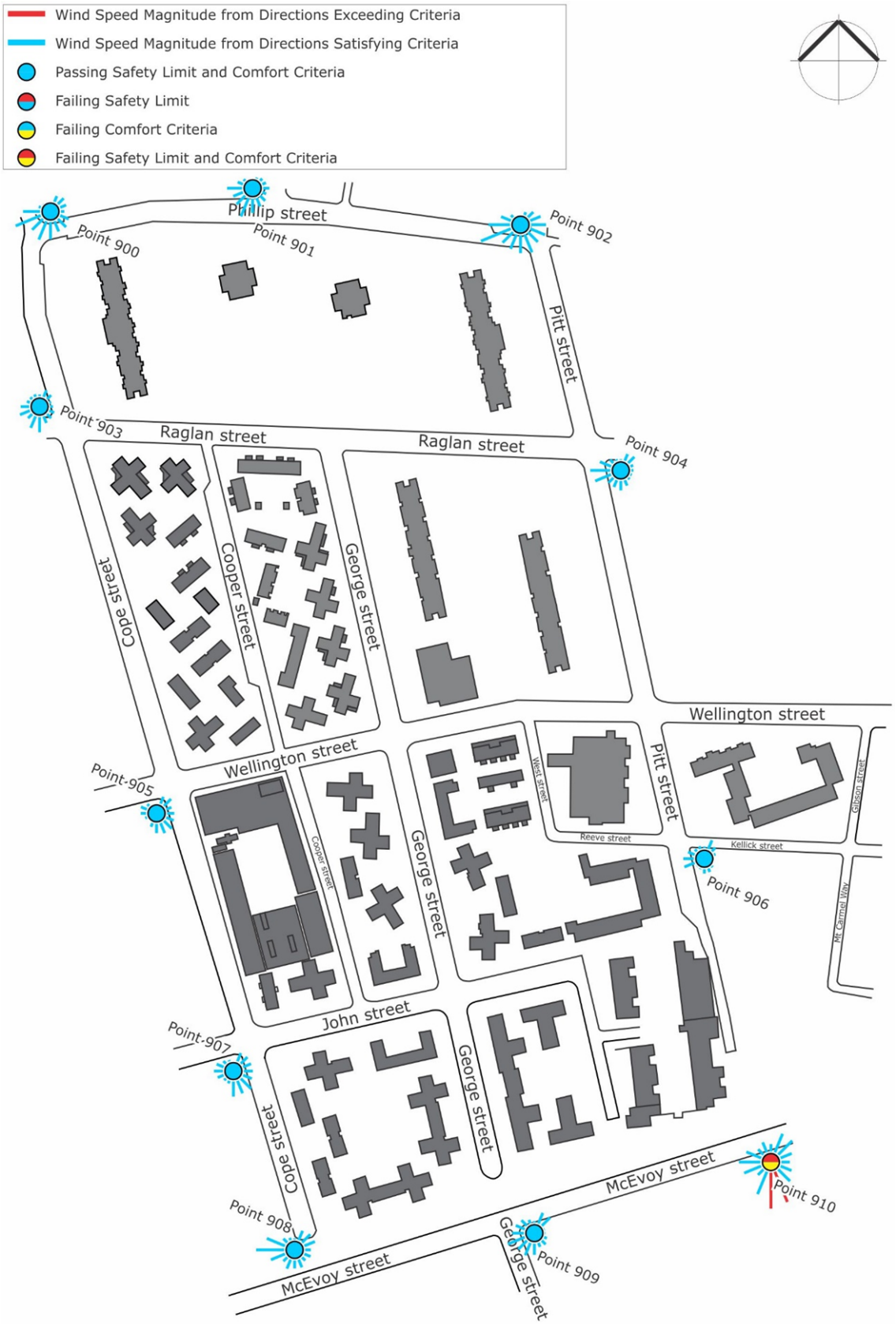

Figure 8d: Wind Directionality Plots – Ground Level - Existing Site of Waterloo Estate Masterplan

6.4 Discussion of Results

Wind tunnel testing was performed to determine the existing site wind conditions for the proposed Masterplan development. The prevailing wind directions for the region, as well as the local topographical effects of the terrain and the surrounding buildings of the proposed site were considered. The results allow for design guidance and comparison with the wind tunnel testing results of the proposed Waterloo South development.

It is important to note that due to the relatively low-rise and scattered nature of the existing buildings within and around the study site, the wind conditions from the wind tunnel test generally indicate the exposed nature of the site to the predominant wind directions for the Sydney region. However, due to the exposed nature of the overall site to the predominant winds, medium to high rise buildings have the potential to induce wind effects onto the surrounding streetscape, as discussed below.

Along the northern part of the proposed Waterloo Masterplan development site the study points along Phillip Street indicate exposure to the predominant westerly winds for the region. Similarly, along Raglan Street, the westerly winds are shown to impact the region spanning from Cope Street up until Pitt Street. This is a direct result of the exposure of the region to the predominant westerly winds in conjunction with a relatively uninterrupted low-rise region of developments to the west of the development site. The north-easterly winds are also observed to effect the corner of Pitt Street and Raglan Street, however this is seen to be a localised wind effect due to the proximity of the two mid-rise buildings on the north-eastern aspect of the site, resulting in the funnelling of the north-easterly winds. In a similar manner, the southerly winds are observed to funnel between the two mid-rise buildings adjacent to George Street.

Within the middle region of the development site, the area bounded by Raglan Street, Cope Street, Wellington Street and Pitt Street, the predominant wind directions are observed to effect the general streetscapes of the region. In particular, the north-easterly, westerly as well as the southerly winds are all observed to impact the streetscapes within and around the region. In particular, the westerly winds are seen to be prevalent along both Raglan Street and Wellington Street. This is a direct result of the orientation of these streetscapes to the westerly winds, in conjunction with their exposed nature due to the low-rise and scattered developments in the surrounding regions. The two medium-rise rectangular building forms to the west of Pitt Street are also shown to have a significant effect on the wind conditions around this region. As shown from the wind tunnel results, the westerly winds are observed to be further accentuated towards the eastern aspect of both Raglan Street and Wellington Street, highlighting the effect of the medium-rise rectangular building forms. Similarly, funnelling effects are observed between the two medium-rise rectangular buildings forms, as the westerly and southerly winds are accelerated between the two building forms. From this it is important to note the significant increase in wind speeds adjacent to the existing medium rise buildings which are causing the prevailing winds to downwash and side-stream around the built form. This is driven by the noted exposure upstream and hence should be accounted for during the design development of the masterplan.

Towards the southern aspect of the development site similar wind effects are observed throughout the streetscapes and surrounding areas. The predominant north-easterly, westerly and southerly winds are all seen to impact the various study point locations throughout the region, due to its' exposed topographical nature. In particular, the southerly winds are observed to be more dominant along the southern aspect of the development, in comparison to the regions further north. This is a result of the existing low-rise building forms baffling the southerly winds as they travel upstream towards the northern portion of the development site. Additionally, the streetscapes are once again observed to be governed by westerly and southerly winds, due to their orientation to the predominant winds. The effect of the medium-rise building forms is once again present, with the influence of the developments bounded by Wellington Street, Pitt Street, Kellick Street and Gibson Street apparent from the wind tunnel results. As observed, the westerly and southerly winds are further accentuated around this region due to the incoming winds being accelerated around this building form.

The noted reduction in the southerly winds at the northern end of the site compared to the southern end helps to verify the importance of controlling the rise in built form to encourage the winds to move up and over the precinct instead of funnelling between the built forms. The inclusion of a "wall" or buildings at the perimeter of the precinct will result in notable adverse conditions around these buildings due to the exposed upstream nature. Alternatively by aligning the perimeter tower forms to the respective prevailing winds will also help to minimise these effects while also allowing winds to pass through the precinct which will assist with natural ventilation and air quality outcomes.

7 IMPLEMENTATION PLAN & STRATEGY

This section will address study requirements 19.2, 19.6 and 19.8 to identify key wind sensitive ground locations within and around the site which will be quantitatively assessed by conducting a wind tunnel test of the Waterloo South massing model.

In analysing the initial wind conditions of the existing site a baseline scenario has been established, which has provided design guidance for the massing model. The existing site wind conditions as outlined in Section 6.3 and 6.4 have been considered and a proposed massing model has been developed for Waterloo South by the design team within the design parameters and principles presented during the concept design stage.

The results of a detailed investigation of the ground level wind environment conditions for the proposed massing model of the Waterloo South has been undertaken, based on the drawing package received February 2020 from Turner. Elevated pedestrian accessible areas were not tested and will be further investigated during the detailed design stage. Waterloo Metro Quarter site is also included, however it is not part of the detailed wind investigation undertaken in this report.

For areas not achieving appropriate wind conditions, treatments have been formulated and tested in the wind tunnel to ensure their effectiveness and discussed in Section 8.2.

7.1 The Wind Tunnel Model

Measurements were made in the wind tunnel at selected critical trafficable outdoor locations within and around the development from 16 wind directions at 22.5 degree increments using a 1:400 scale detailed model of the development. The Waterloo South study model incorporates all necessary architectural features on the development to ensure an accurate wind flow is achieved. Photographs of the wind tunnel model are presented in Figures 9a – 9d. Figure 9e depicts a plan view of the proximity model.

The model of the proposed development was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, awnings, etc., which are not already shown in the architectural drawings. The effect of vegetation was also excluded from the initial testing.

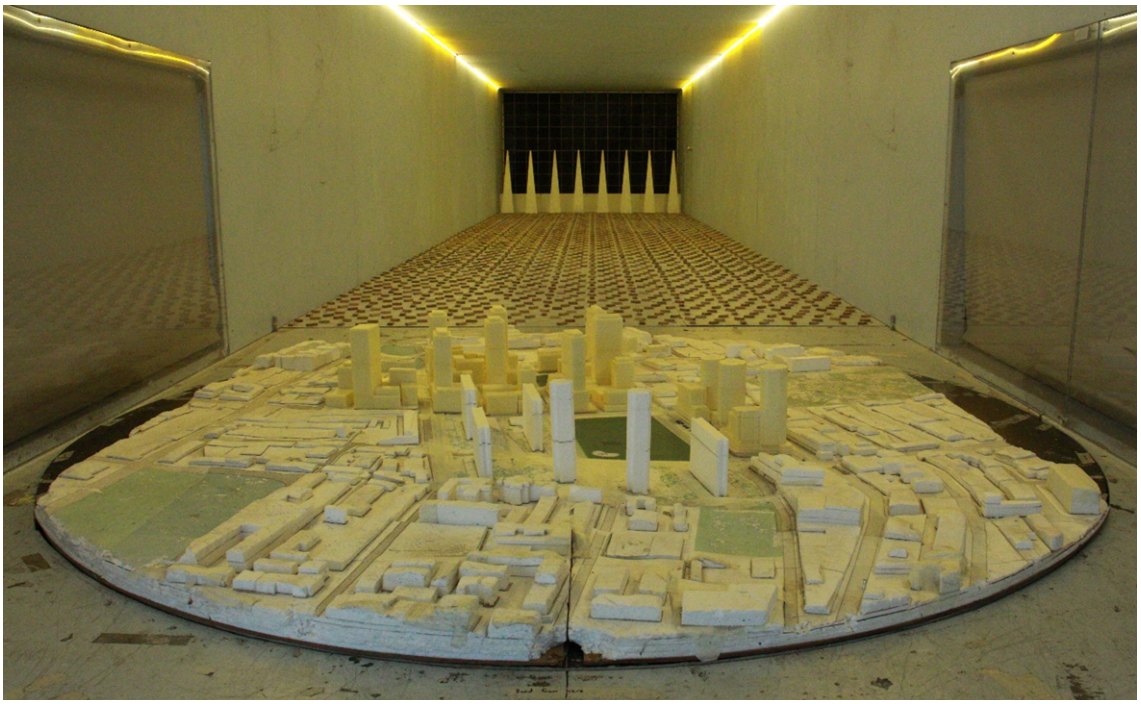

Figure 9a: Photograph of the Wind Tunnel Model – (View from the North)

Figure 9b: Photograph of the Wind Tunnel Model – (View from the East)

Figure 9c: Photograph of the Wind Tunnel Model – (View from the South)

Figure 9d: Photograph of the Wind Tunnel Model – (View from the West)

Figure 9e: Map of Proximity Model

7.2 Layout of Study Points, and Relevant Wind Speed Criteria

For this study a total of 125 ground level study points have been selected for analysis in the wind tunnel located within and around various locations of the Waterloo South site.

The locations of the study points tested for this study are presented in Figures 10a – 10g in the form of marked-up plan drawings. The target wind speed criteria for the outdoor trafficable areas within and around the development is also indicated in these figures.

It should also be noted that only the most critical outdoor locations of the development have been selected for analysis. The areas identified are the large open spaces, public open spaces, pedestrian laneways and the corner areas of the proposed development site due to the alignment of the city street grid coinciding with two of the prevailing winds for the Sydney region, which are the southerly and westerly winds.

Elevated pedestrian accessible areas were not tested and will be investigated at a later detailed design stage.

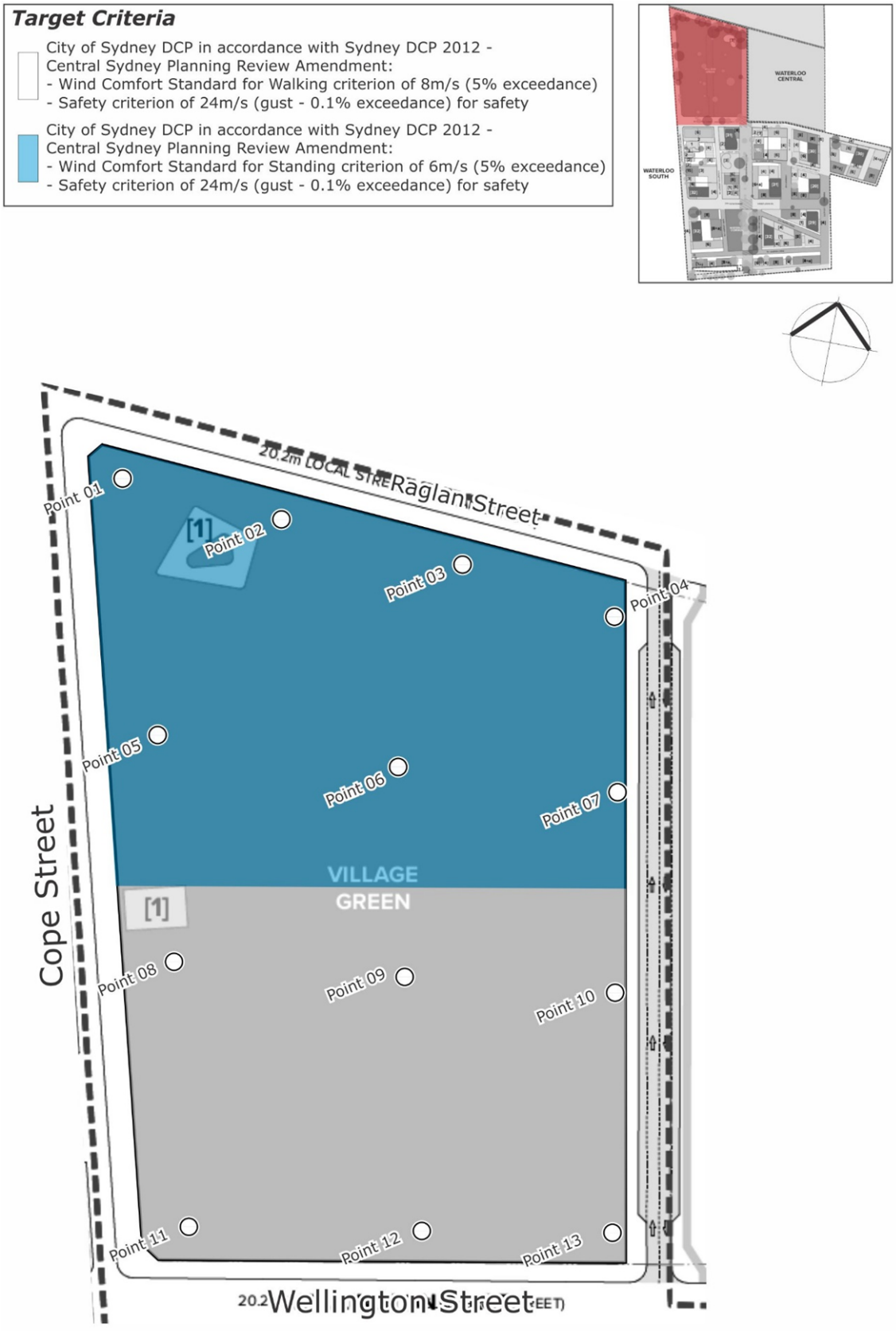

Figure 10a: Study Point Locations and Target Criteria – Village Green

Figure 10b: Study Point Locations and Target Criteria – Lot L, M, PS, R and Q

Figure 10c: Study Point Locations and Target Criteria – Lot PS, O, S and T

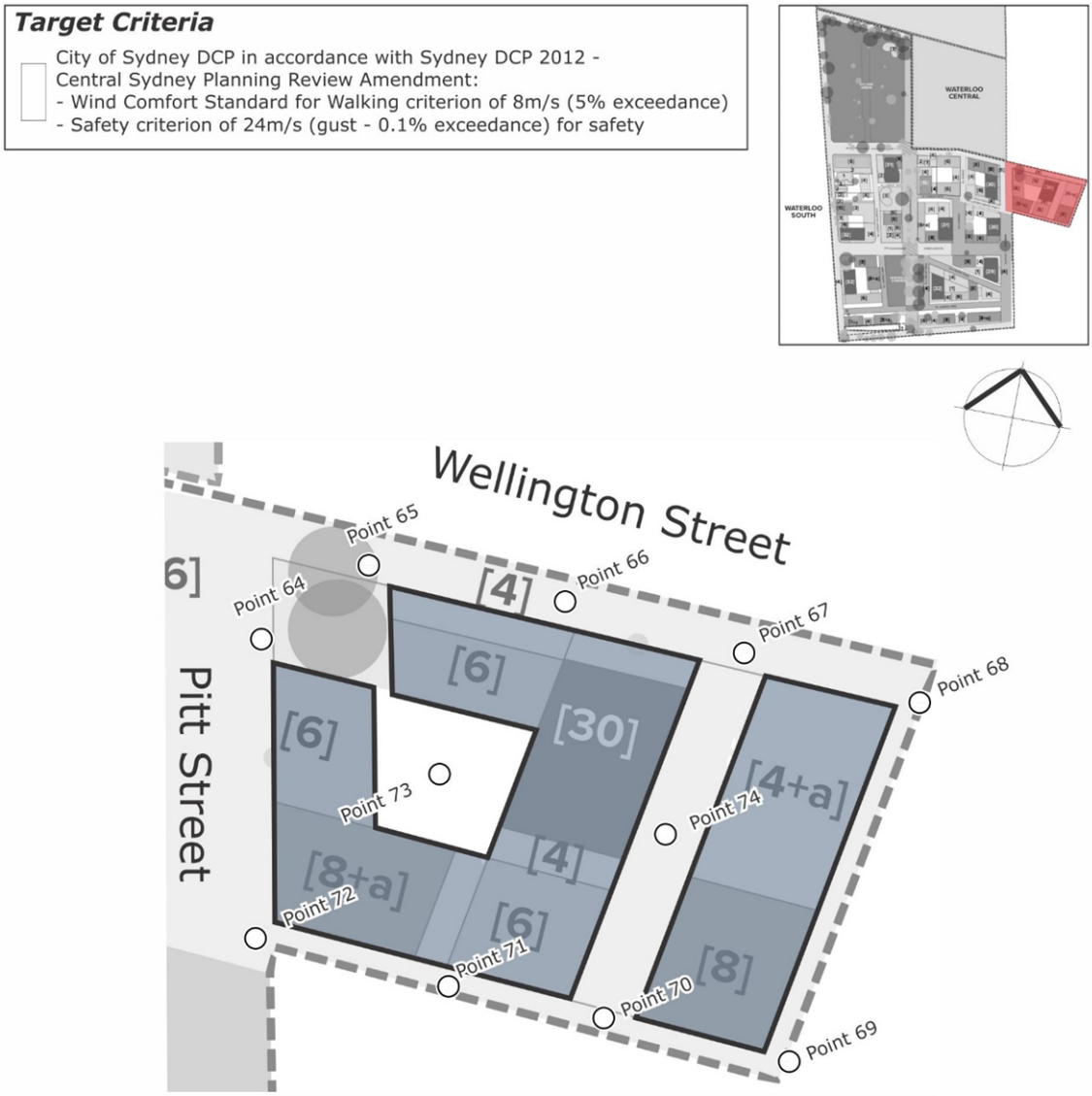

Figure 10d: Study Point Locations and Target Criteria – Lot P

Figure 10e: Study Point Locations and Target Criteria – Lot U and Y

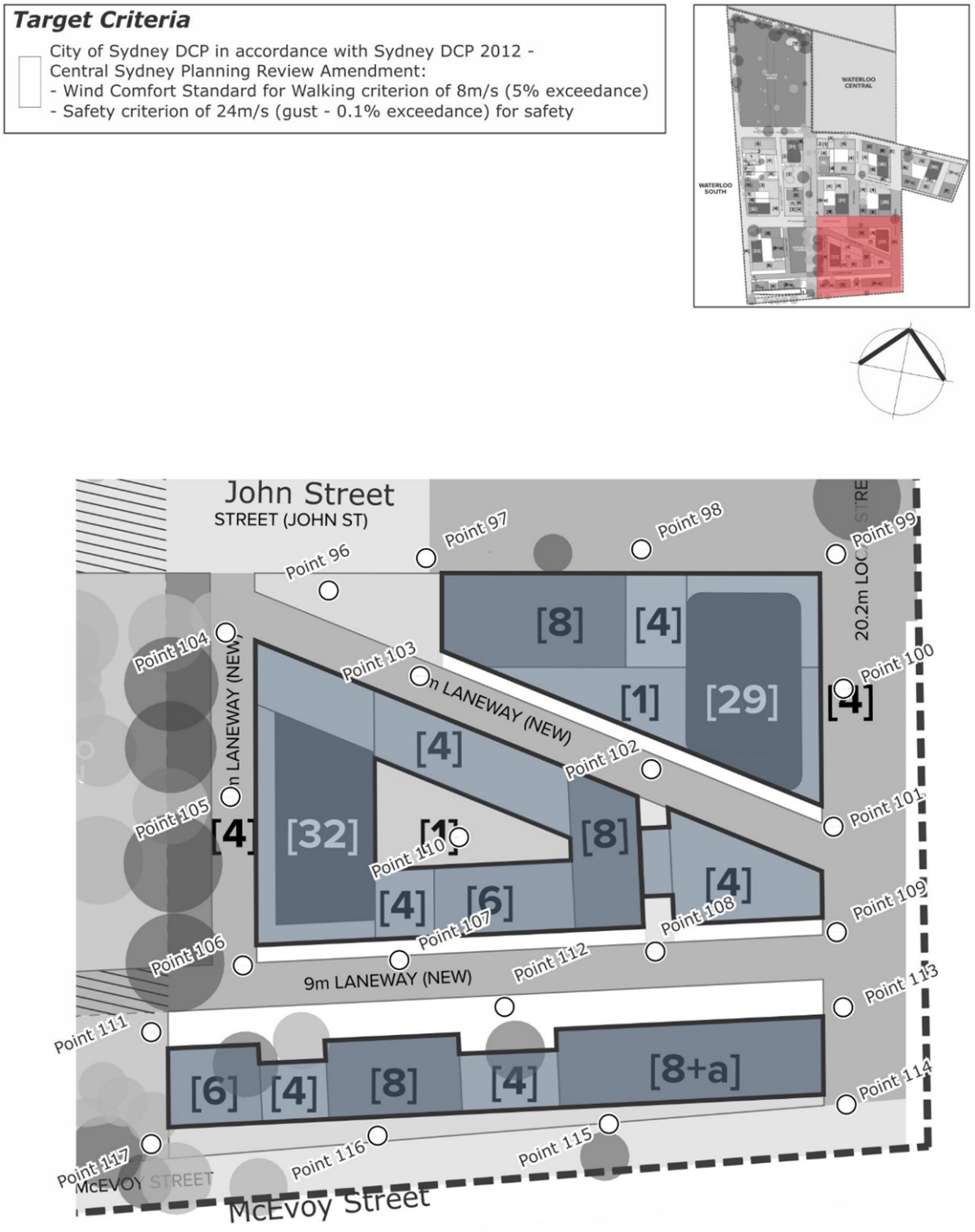

Figure 10f: Study Point Locations and Target Criteria – Lot W, X and Z

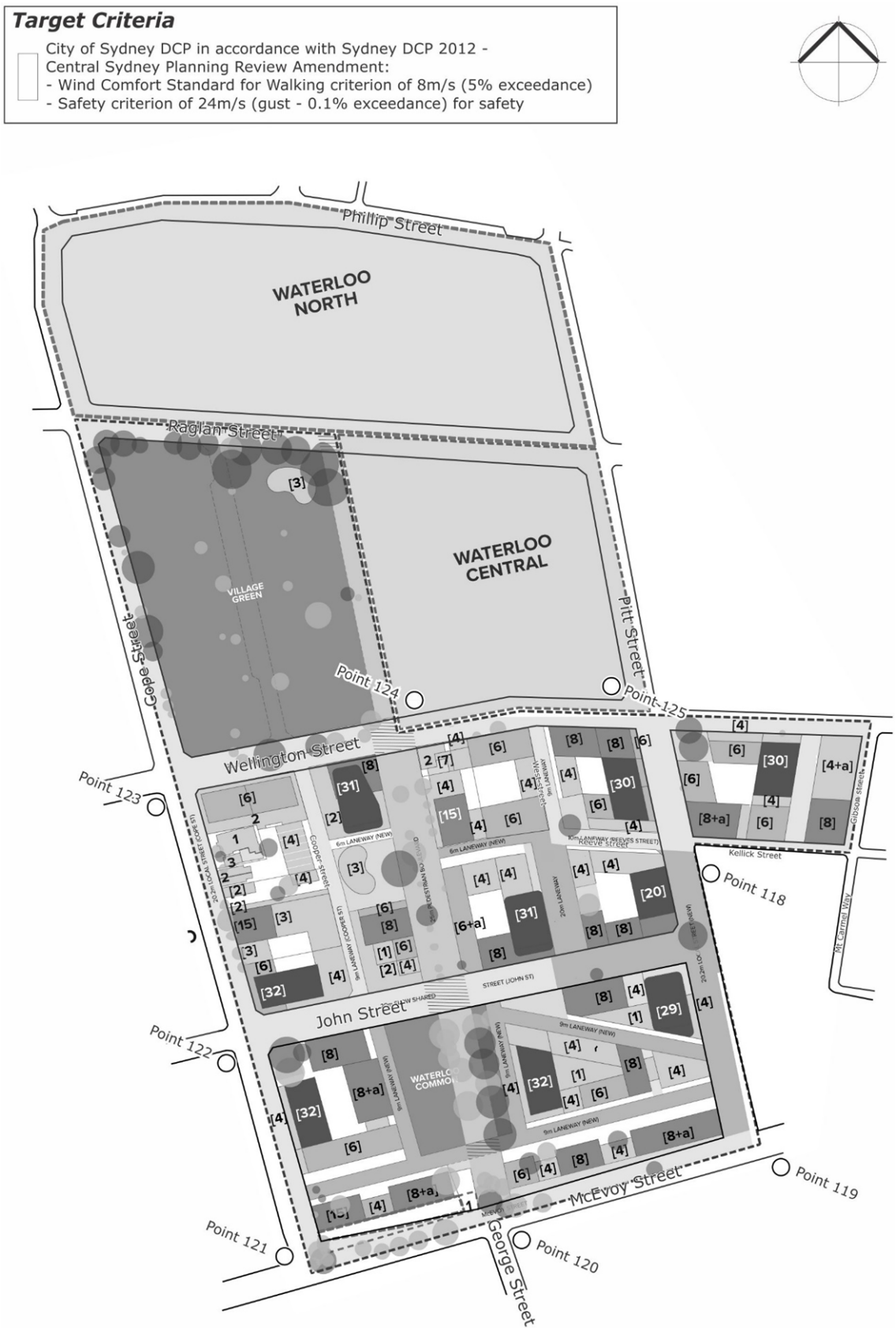

Figure 10g: Study Point Locations and Target Criteria – Surrounding Areas

7.3 Discussion

This section addressed study requirements 19.2, 19.6 and 19.8 by conducting a detailed wind environment test of the massing model to identify the key wind sensitive areas within and around the development site. The results allow the opportunity to design and develop the proposed Waterloo South site to further improve the wind conditions within and around the public, pedestrian and communal areas to achieve the comfort and safety criterion.

8 ASSESSMENT

This section will address study requirements 19.3, 19.4, 19.5, 19.6 and 19.7 by providing a detailed review of the wind tunnel conditions obtained from the wind tunnel test of the Waterloo South massing model.

Wind tunnel testing of the Waterloo South massing model was undertaken to identify the wind conditions and the findings used to devise wind amelioration strategies, outlined in Section 8.1. For areas not achieving appropriate wind conditions, treatments have been formulated and tested in the wind tunnel to ensure their effectiveness, outlined in Section 8.2. These treatments could be in the form of wind deflective elements such as screens, awnings, etc or vegetation that is already proposed for the site in the Tree Retention plan.

8.1 Ground Level Results

The results of the wind tunnel study are summarised in Table 7a. The wind speed criteria that the wind conditions should achieve at each study point location are also listed in Table 7a and shown on marked-up plans in Figure 10a – 10g. The results for all study points locations can be seen in the form of directional wind speed plots presented in Figures 11a – 11g.

Table 7b summarises the results of the study points with the inclusion of the treatment strategies. Appendix A consists of directional wind speed plots for all the study point locations for the Waterloo South massing with and without the inclusion of treatments.

Due to the relatively low to mid rise developments surrounding Waterloo South, the site receives limited shielding and is exposed to the predominant north-easterly, westerly and southerly winds for the region. The scattered nature of the proposed low to high rise towers of Waterloo South, as well as the close proximity of the Lots is seen to help stagnate and disrupt strong wind flow conditions and adverse funnelling through the laneways. The proposed setbacks are beneficial in providing a disturbance to downwash winds from the tower forms above.

The staggered alignment of the laneways is beneficial in minimising the potential for funnelling effects of the predominant winds. The landscaping intended to be maintained through the tree retention plan is expected to further assist in filtering the winds flowing throughout the site.

Localised corners at various Lots have been noted to experience corner accelerating winds resulting in wind conditions that exceed the comfort and/or safety criteria. These wind conditions are due to the interaction of the prevailing winds with the development built-form. The location of longer duration areas at the corners of buildings places them in an area where there is a high potential for adverse winds. Appropriate treatments can be implemented adjacent to the building corners to assist.

Strategic treatments are investigated in Section 8.2 to ameliorate the wind conditions for the proposed sites. Further wind tunnel testing of the Waterloo South ground level and elevated areas is recommended to be undertaken during the design development stage to further verify the suitability of specific areas for their intended purpose/usage.

Table 7a: Wind Tunnel Results Summary (Without the inclusion of treatments)

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Point 01	6.0	11%	Fail	24	22	Pass	Fail
Existing		11%	Fail		22	Pass	Fail
Point 02	6.0	16%	Fail	24	21	Pass	Fail
Existing		14%	Fail		21	Pass	Fail
Point 03	6.0	3%	Pass	24	17	Pass	Pass
Existing		8%	Fail		18	Pass	Fail
Point 04	6.0	3%	Pass	24	17	Pass	Pass
Existing		4%	Pass		17	Pass	Pass
Point 05	6.0	6%	Fail	24	18	Pass	Fail
Existing		2%	Pass		15	Pass	Pass
Point 06	6.0	5%	Pass	24	16	Pass	Pass
Existing		1%	Pass		14	Pass	Pass
Point 07	6.0	6%	Fail	24	17	Pass	Fail
Existing		5%	Pass		19	Pass	Pass
Point 08	8.0	1%	Pass	24	19	Pass	Pass
Point 09	8.0	1%	Pass	24	18	Pass	Pass
Point 10	8.0	1%	Pass	24	16	Pass	Pass
Point 11	8.0	9%	Fail	24	22	Pass	Fail
Existing		0%	Pass		13	Pass	Pass
Point 12	8.0	1%	Pass	24	17	Pass	Pass
Existing		0%	Pass		13	Pass	Pass
Point 13	8.0	2%	Pass	24	21	Pass	Pass
Existing		0%	Pass		12	Pass	Pass
Point 14	8.0	1%	Pass	24	19	Pass	Pass
Existing		0%	Pass		16	Pass	Pass
Point 15	8.0	0%	Pass	24	16	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Existing		0%	Pass		16	Pass	Pass
Point 16	8.0	0%	Pass	24	16	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 17	8.0	0%	Pass	24	12	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 18	8.0	2%	Pass	24	20	Pass	Pass
Point 19	8.0	1%	Pass	24	20	Pass	Pass
Existing		0%	Pass		13	Pass	Pass
Point 20	8.0	1%	Pass	24	19	Pass	Pass
Point 21	8.0	2%	Pass	24	19	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 22	8.0	0%	Pass	24	17	Pass	Pass
Existing		0%	Pass		12	Pass	Pass
Point 23	8.0	0%	Pass	24	16	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 24	8.0	0%	Pass	24	15	Pass	Pass
Existing		0%	Pass		12	Pass	Pass
Point 25	8.0	0%	Pass	24	15	Pass	Pass
Point 26	8.0	1%	Pass	24	18	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 27	8.0	2%	Pass	24	20	Pass	Pass
Existing		1%	Pass		19	Pass	Pass
Point 28	8.0	4%	Pass	24	21	Pass	Pass
Existing		0%	Pass		15	Pass	Pass
Point 29	8.0	3%	Pass	24	20	Pass	Pass
Point 30	8.0	8%	Pass	24	22	Pass	Pass
Existing		0%	Pass		16	Pass	Pass
Point 31	8.0	0%	Pass	24	15	Pass	Pass
Point 32	8.0	1%	Pass	24	19	Pass	Pass
Existing		0%	Pass		18	Pass	Pass
Point 33	8.0	2%	Pass	24	20	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Existing		0%	Pass		18	Pass	Pass
Point 34	8.0	0%	Pass	24	16	Pass	Pass
Existing		0%	Pass		18	Pass	Pass
Point 35	8.0	1%	Pass	24	19	Pass	Pass
Point 36	8.0	0%	Pass	24	15	Pass	Pass
Point 37	8.0	0%	Pass	24	13	Pass	Pass
Point 38	8.0	4%	Pass	24	21	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 39	8.0	1%	Pass	24	15	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 40	8.0	3%	Pass	24	20	Pass	Pass
Existing		1%	Pass		19	Pass	Pass
Point 41	8.0	2%	Pass	24	18	Pass	Pass
Existing		1%	Pass		17	Pass	Pass
Point 42	8.0	1%	Pass	24	17	Pass	Pass
Point 43	8.0	1%	Pass	24	17	Pass	Pass
Existing		0%	Pass		18	Pass	Pass
Point 44	8.0	1%	Pass	24	19	Pass	Pass
Existing		1%	Pass		20	Pass	Pass
Point 45	8.0	9%	Fail	24	21	Pass	Fail
Point 46	8.0	11%	Fail	24	22	Pass	Fail
Existing		1%	Pass		18	Pass	Pass
Point 47	8.0	3%	Pass	24	19	Pass	Pass
Existing		0%	Pass		16	Pass	Pass
Point 48	8.0	0%	Pass	24	17	Pass	Pass
Point 49	8.0	11%	Fail	24	23	Pass	Fail
Existing		1%	Pass		17	Pass	Pass
Point 50	8.0	3%	Pass	24	21	Pass	Pass
Existing		1%	Pass		17	Pass	Pass
Point 51	8.0	4%	Pass	24	22	Pass	Pass
Existing		0%	Pass		16	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Point 52	8.0	3%	Pass	24	23	Pass	Pass
Point 53	8.0	1%	Pass	24	17	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 54	8.0	3%	Pass	24	19	Pass	Pass
Point 55	8.0	0%	Pass	24	13	Pass	Pass
Point 56	8.0	0%	Pass	24	15	Pass	Pass
Point 57	8.0	1%	Pass	24	17	Pass	Pass
Existing		0%	Pass		12	Pass	Pass
Point 58	8.0	3%	Pass	24	20	Pass	Pass
Point 59	8.0	0%	Pass	24	17	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 60	8.0	0%	Pass	24	13	Pass	Pass
Point 61	8.0	0%	Pass	24	10	Pass	Pass
Point 62	8.0	3%	Pass	24	21	Pass	Pass
Point 63	8.0	1%	Pass	24	19	Pass	Pass
Point 64	8.0	0%	Pass	24	15	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 65	8.0	3%	Pass	24	19	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 66	8.0	1%	Pass	24	17	Pass	Pass
Point 67	8.0	4%	Pass	24	19	Pass	Pass
Point 68	8.0	1%	Pass	24	18	Pass	Pass
Existing		1%	Pass		20	Pass	Pass
Point 69	8.0	28%	Fail	24	30	Fail	Fail
Existing		8%	Fail		22	Pass	Fail
Point 70	8.0	1%	Pass	24	18	Pass	Pass
Point 71	8.0	2%	Pass	24	19	Pass	Pass
Point 72	8.0	3%	Pass	24	19	Pass	Pass
Existing		0%	Pass		15	Pass	Pass
Point 73	8.0	1%	Pass	24	17	Pass	Pass
Point 74	8.0	1%	Pass	24	16	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Point 75	8.0	9%	Pass	24	22	Pass	Pass
Existing		1%	Pass		18	Pass	Pass
Point 76	8.0	5%	Pass	24	23	Pass	Pass
Existing		0%	Pass		17	Pass	Pass
Point 77	8.0	0%	Pass	24	10	Pass	Pass
Point 78	8.0	5%	Pass	24	23	Pass	Pass
Point 79	8.0	0%	Pass	24	12	Pass	Pass
Point 80	8.0	15%	Fail	24	30	Fail	Fail
Point 81	8.0	1%	Pass	24	20	Pass	Pass
Point 82	8.0	4%	Pass	24	21	Pass	Pass
Existing		1%	Pass		18	Pass	Pass
Point 83	8.0	0%	Pass	24	14	Pass	Pass
Point 84	8.0	2%	Pass	24	20	Pass	Pass
Existing		0%	Pass		17	Pass	Pass
Point 85	8.0	1%	Pass	24	18	Pass	Pass
Existing		1%	Pass		20	Pass	Pass
Point 86	8.0	1%	Pass	24	17	Pass	Pass
Point 87	8.0	4%	Pass	24	25	Fail	Fail
Point 88	8.0	2%	Pass	24	21	Pass	Pass
Point 89	8.0	2%	Pass	24	17	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 90	8.0	0%	Pass	24	14	Pass	Pass
Point 91	8.0	3%	Pass	24	21	Pass	Pass
Point 92	8.0	1%	Pass	24	19	Pass	Pass
Existing		1%	Pass		19	Pass	Pass
Point 93	8.0	2%	Pass	24	20	Pass	Pass
Point 94	8.0	2%	Pass	24	20	Pass	Pass
Point 95	8.0	16%	Fail	24	27	Fail	Fail
Existing		1%	Pass		16	Pass	Pass
Point 96	8.0	2%	Pass	24	20	Pass	Pass
Existing		1%	Pass		16	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Point 97	8.0	1%	Pass	24	18	Pass	Pass
Point 98	8.0	2%	Pass	24	18	Pass	Pass
Existing		1%	Pass		20	Pass	Pass
Point 99	8.0	9%	Fail	24	21	Pass	Fail
Point 100	8.0	1%	Pass	24	17	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 101	8.0	14%	Fail	24	23	Pass	Fail
Existing		1%	Pass		16	Pass	Pass
Point 102	8.0	2%	Pass	24	19	Pass	Pass
Existing		1%	Pass		19	Pass	Pass
Point 103	8.0	2%	Pass	24	19	Pass	Pass
Point 104	8.0	0%	Pass	24	17	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 105	8.0	2%	Pass	24	21	Pass	Pass
Point 106	8.0	1%	Pass	24	17	Pass	Pass
Point 107	8.0	0%	Pass	24	14	Pass	Pass
Point 108	8.0	1%	Pass	24	17	Pass	Pass
Point 109	8.0	3%	Pass	24	18	Pass	Pass
Existing		1%	Pass		16	Pass	Pass
Point 110	8.0	0%	Pass	24	14	Pass	Pass
Point 111	8.0	0%	Pass	24	14	Pass	Pass
Existing		2%	Pass		19	Pass	Pass
Point 112	8.0	1%	Pass	24	18	Pass	Pass
Point 113	8.0	1%	Pass	24	18	Pass	Pass
Existing		1%	Pass		18	Pass	Pass
Point 114	8.0	19%	Fail	24	24	Pass	Fail
Existing		1%	Pass		18	Pass	Pass
Point 115	8.0	5%	Pass	24	20	Pass	Pass
Existing		1%	Pass		18	Pass	Pass
Point 116	8.0	9%	Fail	24	22	Pass	Fail
Existing		1%	Pass		18	Pass	Pass

Study Point	GEM (5% exceedance)			Annual Gust			Final Result
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade	
Point 117	8.0	1%	Pass	24	20	Pass	Pass
Existing		2%	Pass		19	Pass	Pass
Point 118	8.0	2%	Pass	24	20	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 119	8.0	1%	Pass	24	17	Pass	Pass
Existing		8%	Fail		23	Pass	Fail
Point 120	8.0	4%	Pass	24	21	Pass	Pass
Existing		1%	Pass		19	Pass	Pass
Point 121	8.0	2%	Pass	24	22	Pass	Pass
Existing		3%	Pass		23	Pass	Pass
Point 122	8.0	4%	Pass	24	21	Pass	Pass
Existing		0%	Pass		14	Pass	Pass
Point 123	8.0	2%	Pass	24	22	Pass	Pass
Existing		0%	Pass		13	Pass	Pass
Point 124	8.0	0%	Pass	24	15	Pass	Pass
Existing		0%	Pass		16	Pass	Pass
Point 125	8.0	1%	Pass	24	21	Pass	Pass
Existing		6%	Fail		25	Fail	Fail

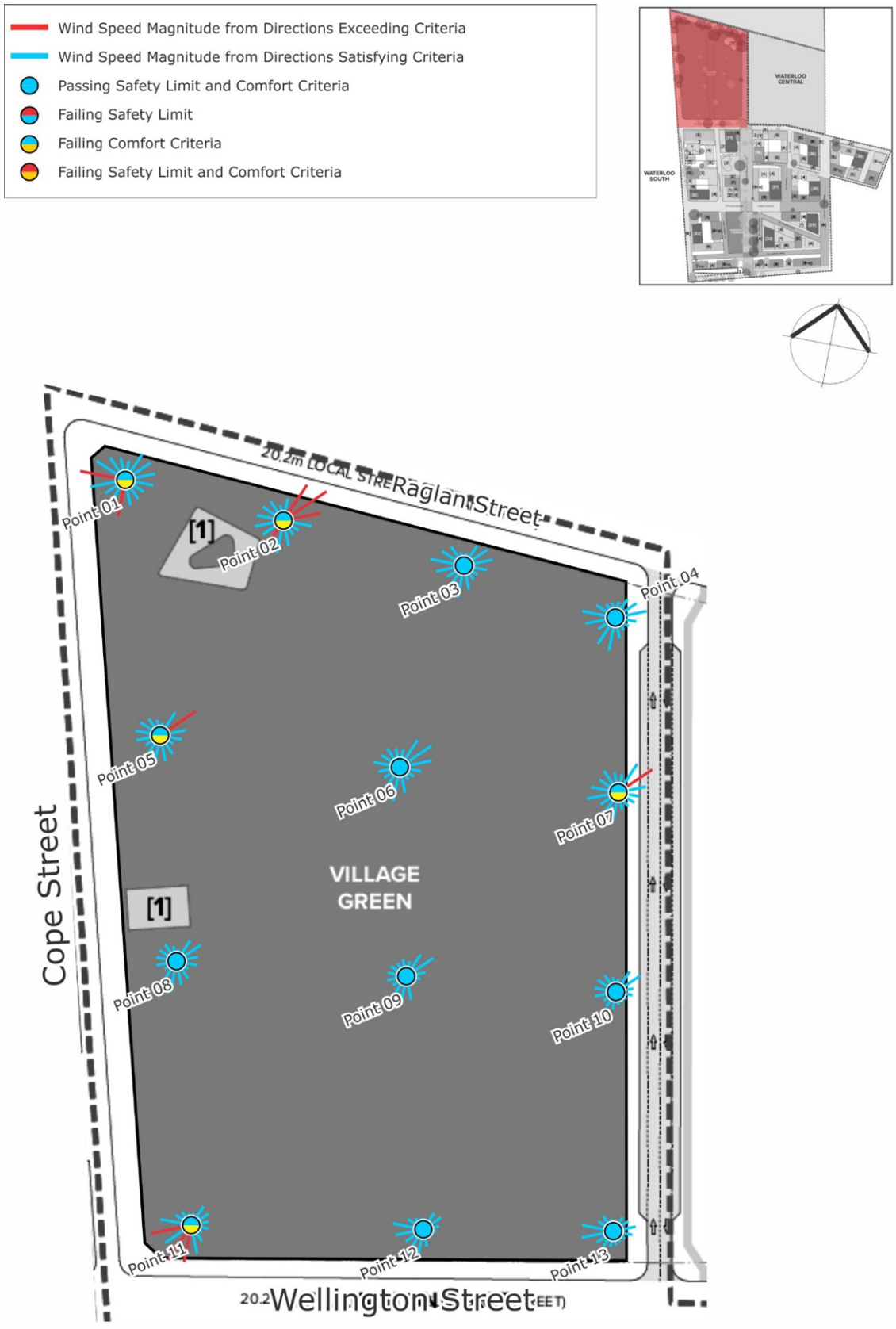

Figure 11a Wind Directionality Plots – Lot A, B, C
(without treatments applied)

Figure 11b: Wind Directionality Plots – Lot D and E
(without treatments applied)

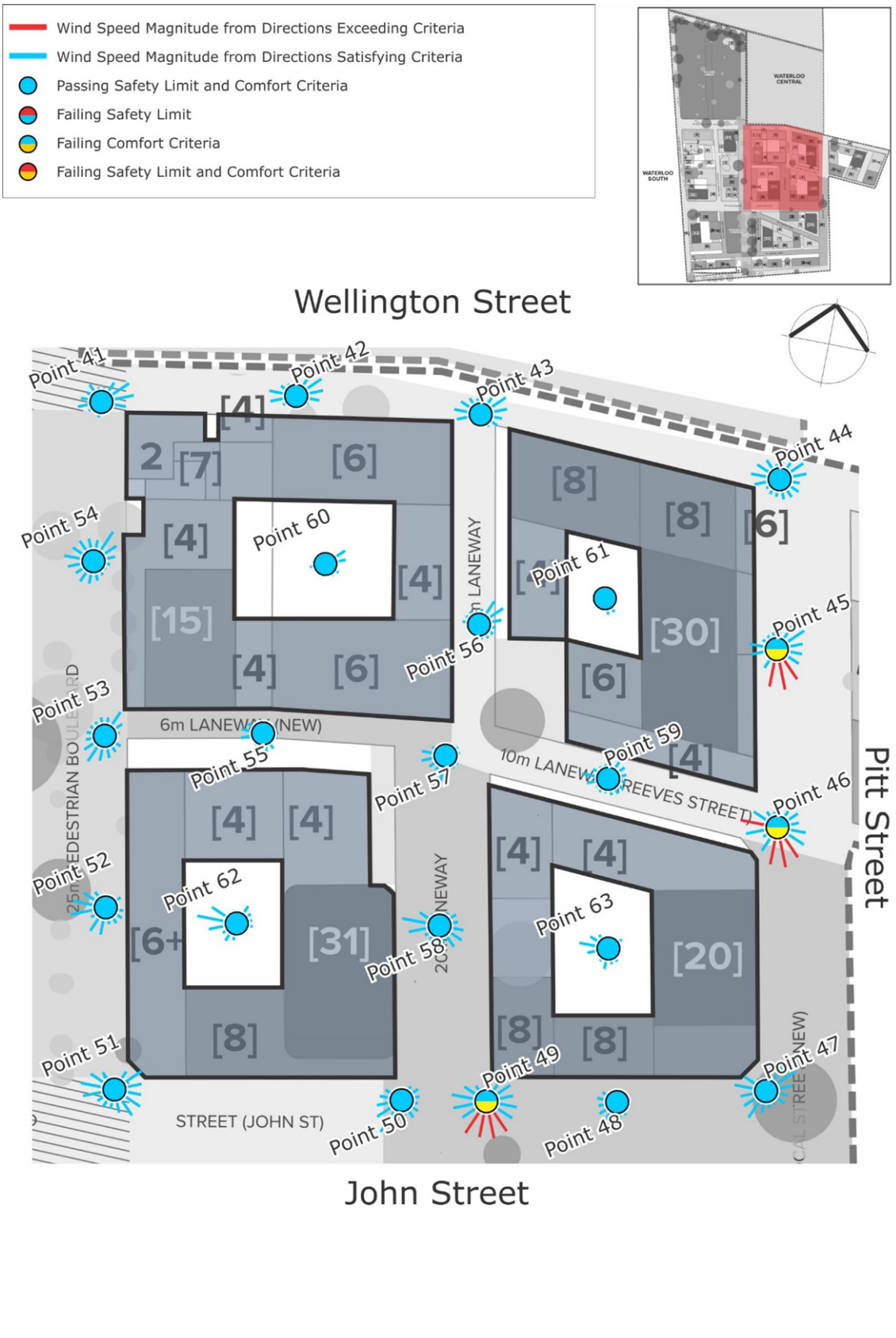

Figure 11c: Wind Directionality Plots – Lot F and Village Green (without treatments applied)

Figure 11d: Wind Directionality Plots – Lot H, I, J and K
(without treatments applied)

Figure 11e: Wind Directionality Plots – Lot L, M, Q and R
(without treatments applied)

Figure 11f: Wind Directionality Plots – Lot N, O, P, S and T
(without treatments applied)

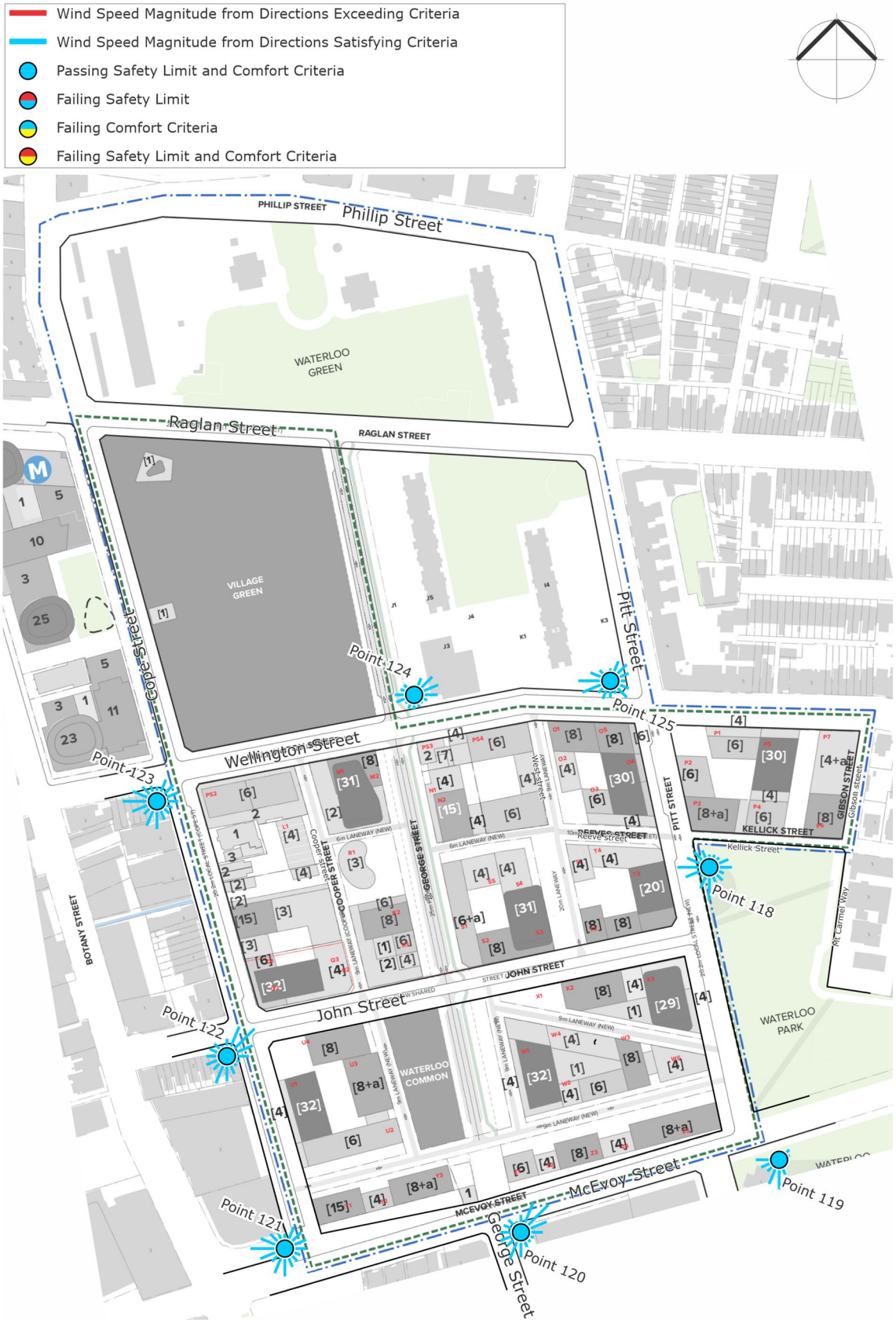

Figure 11g: Wind Directionality Plots – Surrounding Areas (without treatments applied)

8.2 Proposed Treatments

The results of the study indicate that treatments are required at particular locations to achieve the desired criteria for pedestrian comfort and safety. The recommended treatments, which have been tested in the wind tunnel are summarised as follows:

- Recommended wrap around awning on western and southern aspects of Building Q1, as shown in Figure 12a.
- Recommended wrap around awning on western and southern aspects of Building U2, as shown in Figure 12b.
- Recommended wrap around awning on western and southern aspects of Building Y1, as shown in Figure 12b.
- Recommended chamfering of south-east building corner on Building Z5, as shown in Figure 12c.
- Recommended wrap around awning on eastern and southern aspects of Building Z5, as shown in Figure 12c.
- Recommended porous screen at north-west corner of Building U4, as shown in Figure 12b.
- Retention of trees as noted in tree retention plan (No.: 17018, Dwg.: 710.3, dated: 18.2.20).

With the inclusion of these recommended treatments to the proposed Waterloo South masterplan, the results of the study indicate that the ground level wind conditions within and around the precinct satisfy the pedestrian comfort and safety criteria. The proposed building and tower forms, podium setbacks, and Lot layouts combined with the recommended treatments demonstrates that acceptable wind comfort and safety conditions are met for all areas. Table 7b summarises the results of the study points with the inclusion of the treatment strategies.

Furthermore, the Waterloo South masterplan with the inclusion of the recommended treatments indicates that a majority of pedestrian footpaths, public areas and communal spaces within and around the Lots satisfy the Standing criteria. This includes the majority of the Village Green and sections of Waterloo Common.

For specific areas to achieve the Sitting criteria, further treatments would be required to be implemented, which would be investigated during a detailed design stage to develop strategic treatments via wind tunnel testing. The location of areas to meet the Sitting criteria near building corners places them in an area where there is the high potential for adverse winds to occur. The treatments could be in the form of additional localised screening (impermeable or porous), densely foliating tree and/or hedge planting or mobile/operable screens, which are

recommended to be implemented adjacent to areas that are intended to be used for short or long duration activities.

Further wind tunnel testing of the Waterloo South ground level and elevated areas is recommended to be undertaken during the design development stage to further verify the suitability of the areas for their intended usage/purpose.

Figure 12a: Recommended Treatments – Lot L, M, PS, R and Q

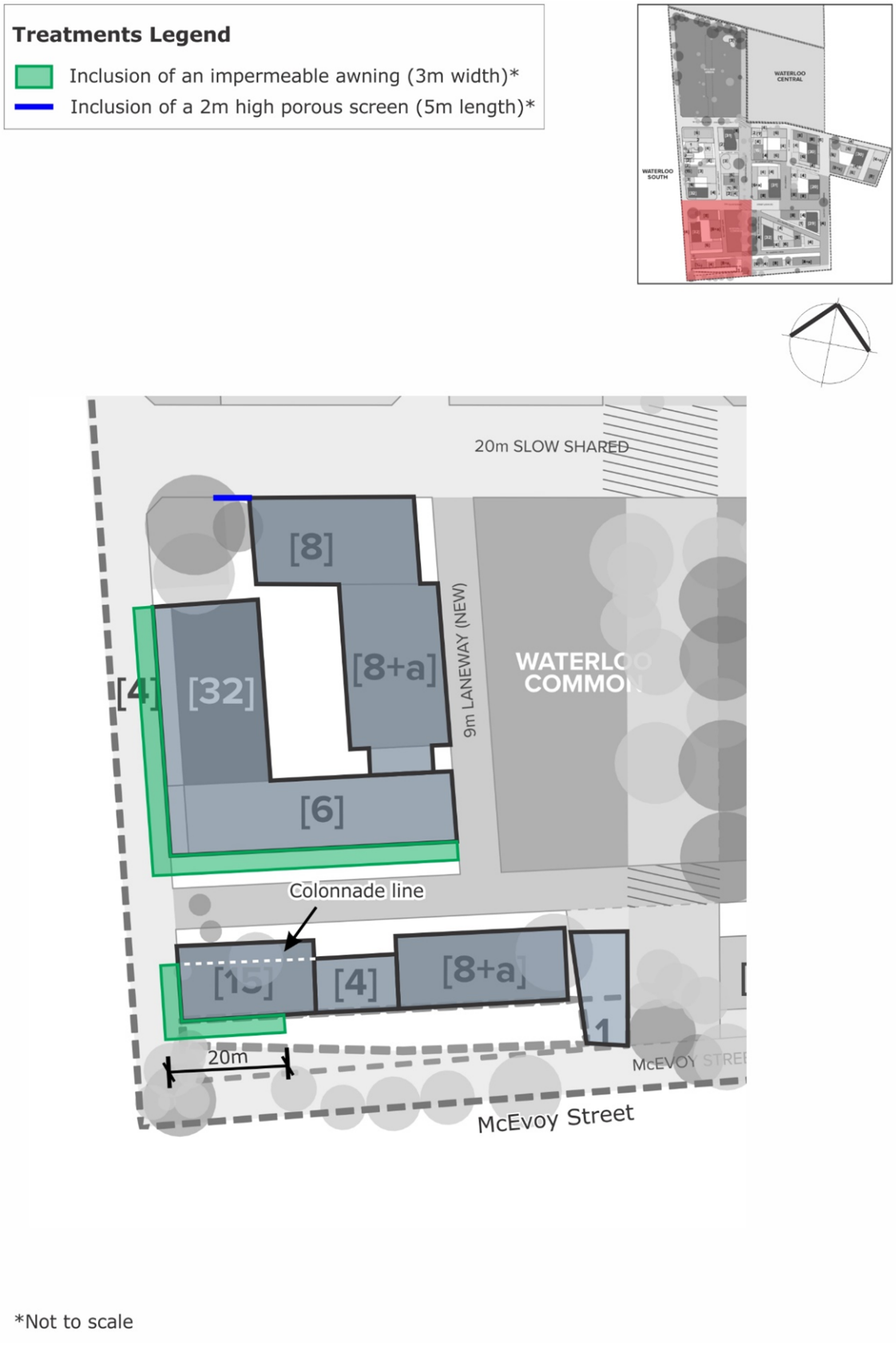

Figure 12b: Recommended Treatments – Lot U and Y

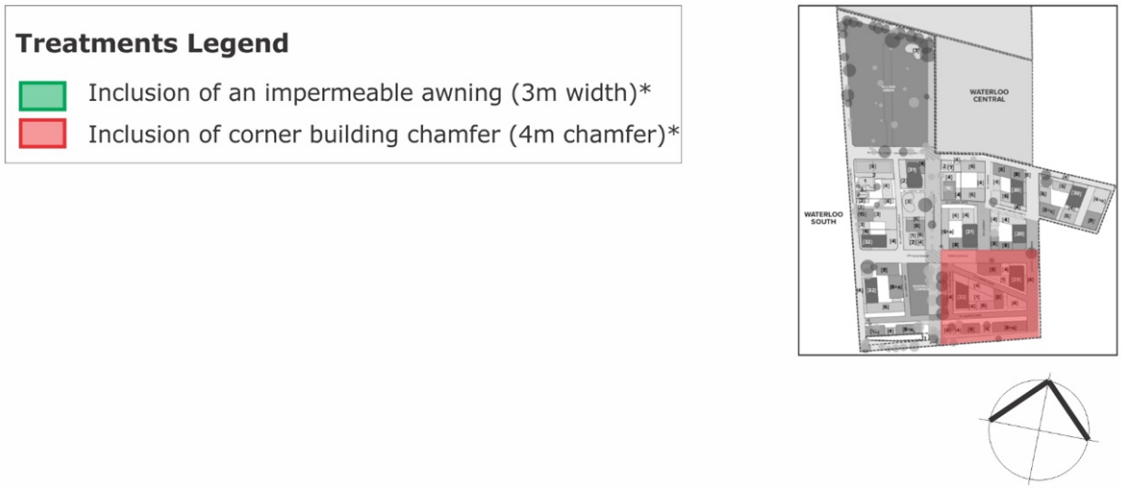

Figure 12c: Recommended Treatments – Lot W, X and Z

8.3 Ground Level Treatment Results

The recommended treatments have been tested in the wind tunnel. The results of the wind conditions for the study points exceeding the comfort and/or safety criteria with the inclusion of the treatments are summarised in Table 7b. The wind speed criteria that the wind conditions should achieve at each study point location are also listed in Table 7b. For study points that did not require a treatment strategy the description in Table 7b has been left blank intentionally and the results translated from Table 7a.

Appendix A consists of directional wind speed plots for all the study point locations for the Waterloo South massing with and without the inclusion of treatments.

The results for study points locations can be seen in the form of directional wind speed plots presented in Figures 13a – 13g.

Table 7b: Wind Tunnel Results Summary (With the inclusion of treatments)

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 01	6.0	4%	Pass	24	16	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		11%	Fail		22	Pass	Fail	
Point 02	6.0	5%	Pass	24	15	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		14%	Fail		21	Pass	Fail	
Point 03	6.0	3%	Pass	24	17	Pass	Pass	
Existing		8%	Fail		18	Pass	Fail	
Point 04	6.0	3%	Pass	24	17	Pass	Pass	
Existing		4%	Pass		17	Pass	Pass	
Point 05	6.0	1%	Pass	24	13	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		2%	Pass		15	Pass	Pass	
Point 06	6.0	5%	Pass	24	16	Pass	Pass	
Existing		1%	Pass		14	Pass	Pass	
Point 07	6.0	2%	Pass	24	15	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		5%	Pass		19	Pass	Pass	
Point 08	8.0	1%	Pass	24	19	Pass	Pass	
Point 09	8.0	1%	Pass	24	18	Pass	Pass	
Point 10	8.0	1%	Pass	24	16	Pass	Pass	
Point 11	8.0	0%	Pass	24	16	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Existing		0%	Pass		13	Pass	Pass	With inclusion of Existing and Retained Trees
Point 12	8.0	1%	Pass	24	17	Pass	Pass	
Existing		0%	Pass		13	Pass	Pass	
Point 13	8.0	2%	Pass	24	21	Pass	Pass	
Existing		0%	Pass		12	Pass	Pass	
Point 14	8.0	1%	Pass	24	19	Pass	Pass	
Existing		0%	Pass		16	Pass	Pass	
Point 15	8.0	0%	Pass	24	16	Pass	Pass	
Existing		0%	Pass		16	Pass	Pass	
Point 16	8.0	0%	Pass	24	16	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 17	8.0	0%	Pass	24	12	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 18	8.0	2%	Pass	24	20	Pass	Pass	
Point 19	8.0	1%	Pass	24	20	Pass	Pass	
Existing		0%	Pass		13	Pass	Pass	
Point 20	8.0	1%	Pass	24	19	Pass	Pass	
Point 21	8.0	2%	Pass	24	19	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 22	8.0	0%	Pass	24	17	Pass	Pass	
Existing		0%	Pass		12	Pass	Pass	
Point 23	8.0	0%	Pass	24	16	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 24	8.0	0%	Pass	24	15	Pass	Pass	
Existing		0%	Pass		12	Pass	Pass	
Point 25	8.0	0%	Pass	24	15	Pass	Pass	
Point 26	8.0	1%	Pass	24	18	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 27	8.0	2%	Pass	24	20	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 28	8.0	4%	Pass	24	21	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Existing		0%	Pass		15	Pass	Pass	
Point 29	8.0	3%	Pass	24	20	Pass	Pass	
Point 30	8.0	4%	Pass	24	21	Pass	Pass	Awning along Western and Southern façade of LOT Q
Existing		0%	Pass		16	Pass	Pass	
Point 31	8.0	0%	Pass	24	15	Pass	Pass	
Point 32	8.0	1%	Pass	24	19	Pass	Pass	
Existing		0%	Pass		18	Pass	Pass	
Point 33	8.0	2%	Pass	24	20	Pass	Pass	
Existing		0%	Pass		18	Pass	Pass	
Point 34	8.0	0%	Pass	24	16	Pass	Pass	
Existing		0%	Pass		18	Pass	Pass	
Point 35	8.0	1%	Pass	24	19	Pass	Pass	
Point 36	8.0	0%	Pass	24	15	Pass	Pass	
Point 37	8.0	0%	Pass	24	13	Pass	Pass	
Point 38	8.0	4%	Pass	24	21	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 39	8.0	1%	Pass	24	15	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 40	8.0	3%	Pass	24	20	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 41	8.0	2%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		17	Pass	Pass	
Point 42	8.0	1%	Pass	24	17	Pass	Pass	
Point 43	8.0	1%	Pass	24	17	Pass	Pass	
Existing		0%	Pass		18	Pass	Pass	
Point 44	8.0	1%	Pass	24	19	Pass	Pass	
Existing		1%	Pass		20	Pass	Pass	
Point 45	8.0	2%	Pass	24	20	Pass	Pass	With inclusion of Existing and Retained Trees
Point 46	8.0	5%	Pass	24	22	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		1%	Pass		18	Pass	Pass	
Point 47	8.0	3%	Pass	24	19	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Existing		0%	Pass		16	Pass	Pass	
Point 48	8.0	0%	Pass	24	17	Pass	Pass	
Point 49	8.0	1%	Pass	24	17	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		1%	Pass		17	Pass	Pass	
Point 50	8.0	3%	Pass	24	21	Pass	Pass	
Existing		1%	Pass		17	Pass	Pass	
Point 51	8.0	4%	Pass	24	22	Pass	Pass	
Existing		0%	Pass		16	Pass	Pass	
Point 52	8.0	3%	Pass	24	23	Pass	Pass	
Point 53	8.0	1%	Pass	24	17	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 54	8.0	3%	Pass	24	19	Pass	Pass	
Point 55	8.0	0%	Pass	24	13	Pass	Pass	
Point 56	8.0	0%	Pass	24	15	Pass	Pass	
Point 57	8.0	1%	Pass	24	17	Pass	Pass	
Existing		0%	Pass		12	Pass	Pass	
Point 58	8.0	3%	Pass	24	20	Pass	Pass	
Point 59	8.0	0%	Pass	24	17	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 60	8.0	0%	Pass	24	13	Pass	Pass	
Point 61	8.0	0%	Pass	24	10	Pass	Pass	
Point 62	8.0	3%	Pass	24	21	Pass	Pass	
Point 63	8.0	1%	Pass	24	19	Pass	Pass	
Point 64	8.0	0%	Pass	24	15	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 65	8.0	3%	Pass	24	19	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 66	8.0	1%	Pass	24	17	Pass	Pass	
Point 67	8.0	4%	Pass	24	19	Pass	Pass	
Point 68	8.0	1%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		20	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 69	8.0	2%	Pass	24	20	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		8%	Fail		22	Pass	Fail	
Point 70	8.0	1%	Pass	24	18	Pass	Pass	
Point 71	8.0	2%	Pass	24	19	Pass	Pass	
Point 72	8.0	3%	Pass	24	19	Pass	Pass	
Existing		0%	Pass		15	Pass	Pass	
Point 73	8.0	1%	Pass	24	17	Pass	Pass	
Point 74	8.0	1%	Pass	24	16	Pass	Pass	
Point 75	8.0	5%	Pass	24	22	Pass	Pass	Inclusion of porous screen - 5m length x 2m height adjacent Building U4
Existing		1%	Pass		18	Pass	Pass	
Point 76	8.0	5%	Pass	24	23	Pass	Pass	
Existing		0%	Pass		17	Pass	Pass	
Point 77	8.0	0%	Pass	24	10	Pass	Pass	
Point 78	8.0	5%	Pass	24	23	Pass	Pass	
Point 79	8.0	0%	Pass	24	12	Pass	Pass	
Point 80	8.0	3%	Pass	24	20	Pass	Pass	Awning along Western and Southern façade of LOT U
Point 81	8.0	1%	Pass	24	20	Pass	Pass	
Point 82	8.0	4%	Pass	24	21	Pass	Pass	
Existing		1%	Pass		18	Pass	Pass	
Point 83	8.0	0%	Pass	24	14	Pass	Pass	
Point 84	8.0	2%	Pass	24	20	Pass	Pass	
Existing		0%	Pass		17	Pass	Pass	
Point 85	8.0	1%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		20	Pass	Pass	
Point 86	8.0	1%	Pass	24	17	Pass	Pass	
Point 87	8.0	0%	Pass	24	17	Pass	Pass	Awning along Western and Southern façade of LOT U
Point 88	8.0	2%	Pass	24	21	Pass	Pass	
Point 89	8.0	2%	Pass	24	17	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 90	8.0	0%	Pass	24	14	Pass	Pass	
Point 91	8.0	3%	Pass	24	21	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 92	8.0	1%	Pass	24	19	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 93	8.0	2%	Pass	24	20	Pass	Pass	
Point 94	8.0	2%	Pass	24	20	Pass	Pass	
Point 95	8.0	0%	Pass	24	16	Pass	Pass	Wrap around awning along Western Façade and part of Southern of Building Y1
Existing		1%	Pass		16	Pass	Pass	
Point 96	8.0	1%	Pass	24	16	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		1%	Pass		16	Pass	Pass	
Point 97	8.0	1%	Pass	24	18	Pass	Pass	
Point 98	8.0	2%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		20	Pass	Pass	
Point 99	8.0	1%	Pass	24	18	Pass	Pass	With inclusion of Existing and Retained Trees
Point 100	8.0	1%	Pass	24	17	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 101	8.0	3%	Pass	24	17	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		1%	Pass		16	Pass	Pass	
Point 102	8.0	2%	Pass	24	19	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 103	8.0	2%	Pass	24	19	Pass	Pass	
Point 104	8.0	0%	Pass	24	17	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 105	8.0	2%	Pass	24	21	Pass	Pass	
Point 106	8.0	1%	Pass	24	17	Pass	Pass	
Point 107	8.0	0%	Pass	24	14	Pass	Pass	
Point 108	8.0	1%	Pass	24	17	Pass	Pass	
Point 109	8.0	3%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		16	Pass	Pass	
Point 110	8.0	0%	Pass	24	14	Pass	Pass	
Point 111	8.0	0%	Pass	24	14	Pass	Pass	
Existing		2%	Pass		19	Pass	Pass	
Point 112	8.0	1%	Pass	24	18	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 113	8.0	1%	Pass	24	18	Pass	Pass	
Existing		1%	Pass		18	Pass	Pass	
Point 114	8.0	2%	Pass	24	19	Pass	Pass	Awning along Eastern and part of Southern Façade and chamfer of Building Z5
Existing		1%	Pass		18	Pass	Pass	
Point 115	8.0	5%	Pass	24	20	Pass	Pass	
Existing		1%	Pass		18	Pass	Pass	
Point 116	8.0	0%	Pass	24	13	Pass	Pass	With inclusion of Existing and Retained Trees
Existing		1%	Pass		18	Pass	Pass	
Point 117	8.0	1%	Pass	24	20	Pass	Pass	
Existing		2%	Pass		19	Pass	Pass	
Point 118	8.0	2%	Pass	24	20	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 119	8.0	1%	Pass	24	17	Pass	Pass	
Existing		8%	Fail		23	Pass	Fail	
Point 120	8.0	4%	Pass	24	21	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 121	8.0	2%	Pass	24	22	Pass	Pass	
Existing		3%	Pass		23	Pass	Pass	
Point 122	8.0	4%	Pass	24	21	Pass	Pass	
Existing		0%	Pass		14	Pass	Pass	
Point 123	8.0	2%	Pass	24	22	Pass	Pass	
Existing		0%	Pass		13	Pass	Pass	
Point 124	8.0	0%	Pass	24	15	Pass	Pass	
Existing		0%	Pass		16	Pass	Pass	
Point 125	8.0	1%	Pass	24	21	Pass	Pass	
Existing		6%	Fail		25	Fail	Fail	

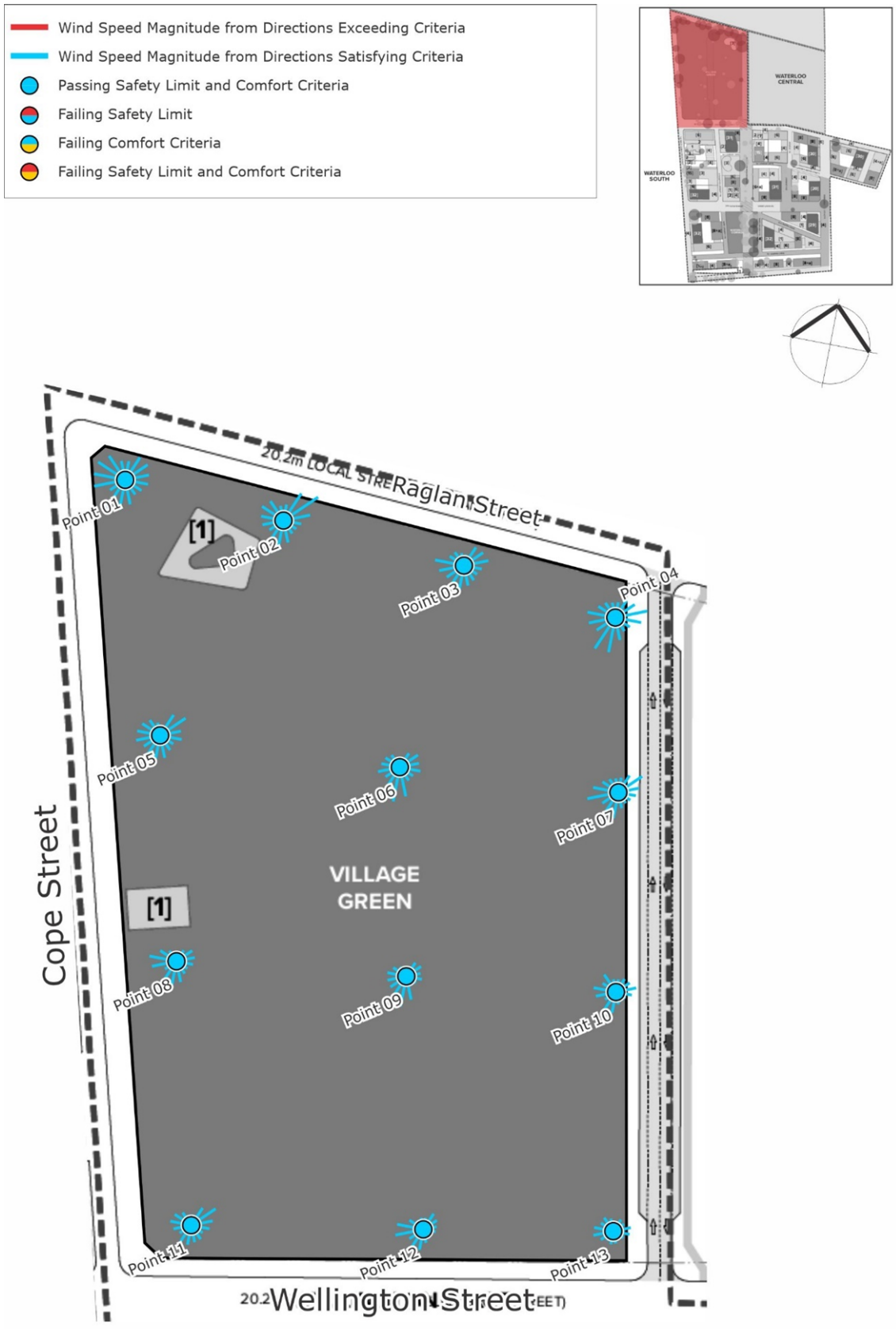

Figure 13a Wind Directionality Plots – Village Green
(with treatments applied)

Figure 13b: Wind Directionality Plots – Lot L, M, PS, R and Q (with treatments applied)

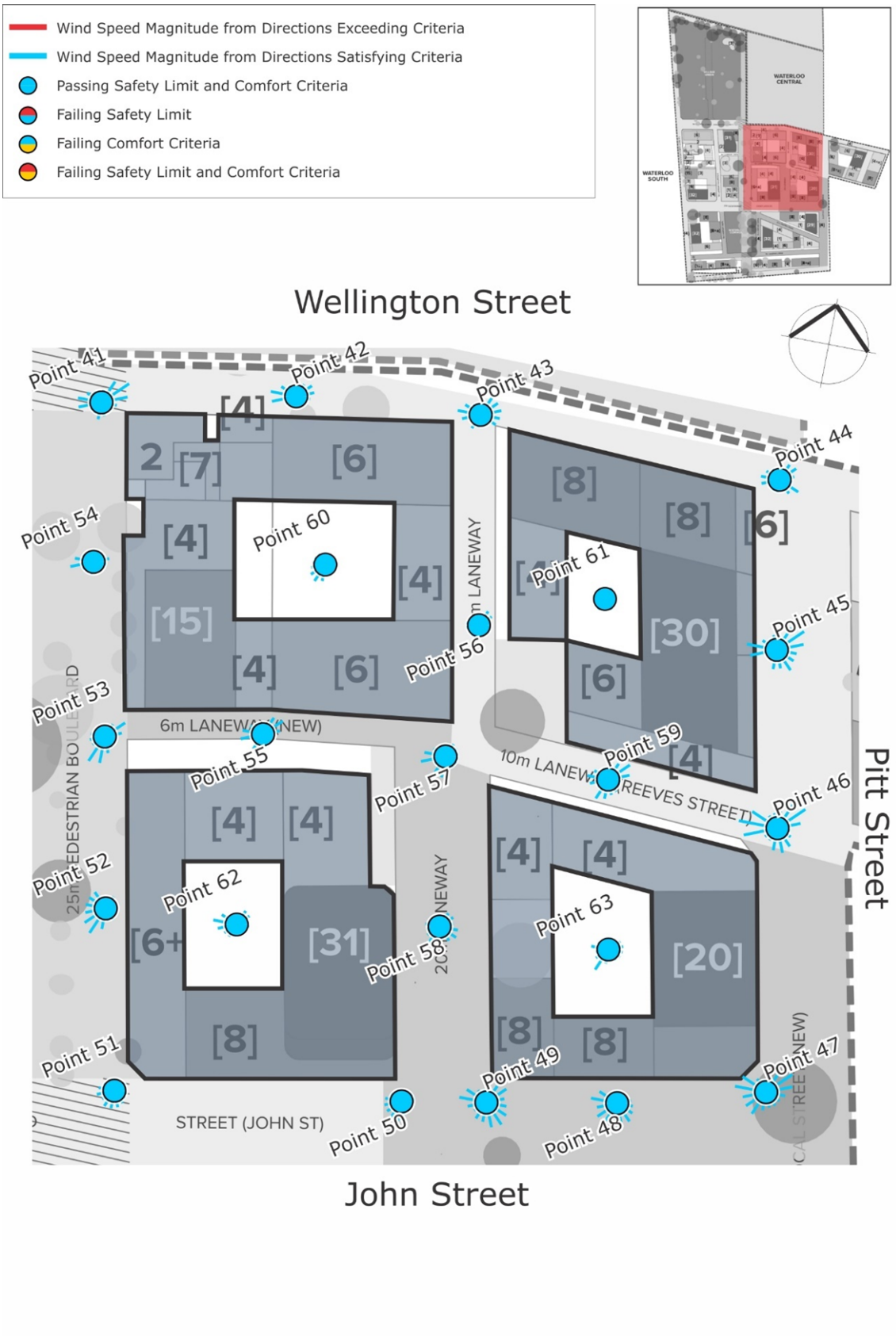

Figure 13c: Wind Directionality Plots – Lot PS, O, S and T
(with treatments applied)

Figure 13d: Wind Directionality Plots – Lot P
(with treatments applied)

Figure 13e: Wind Directionality Plots – Lot U and Y
(with treatments applied)

Figure 13f: Wind Directionality Plots – Lot W, X and Z
(with treatments applied)

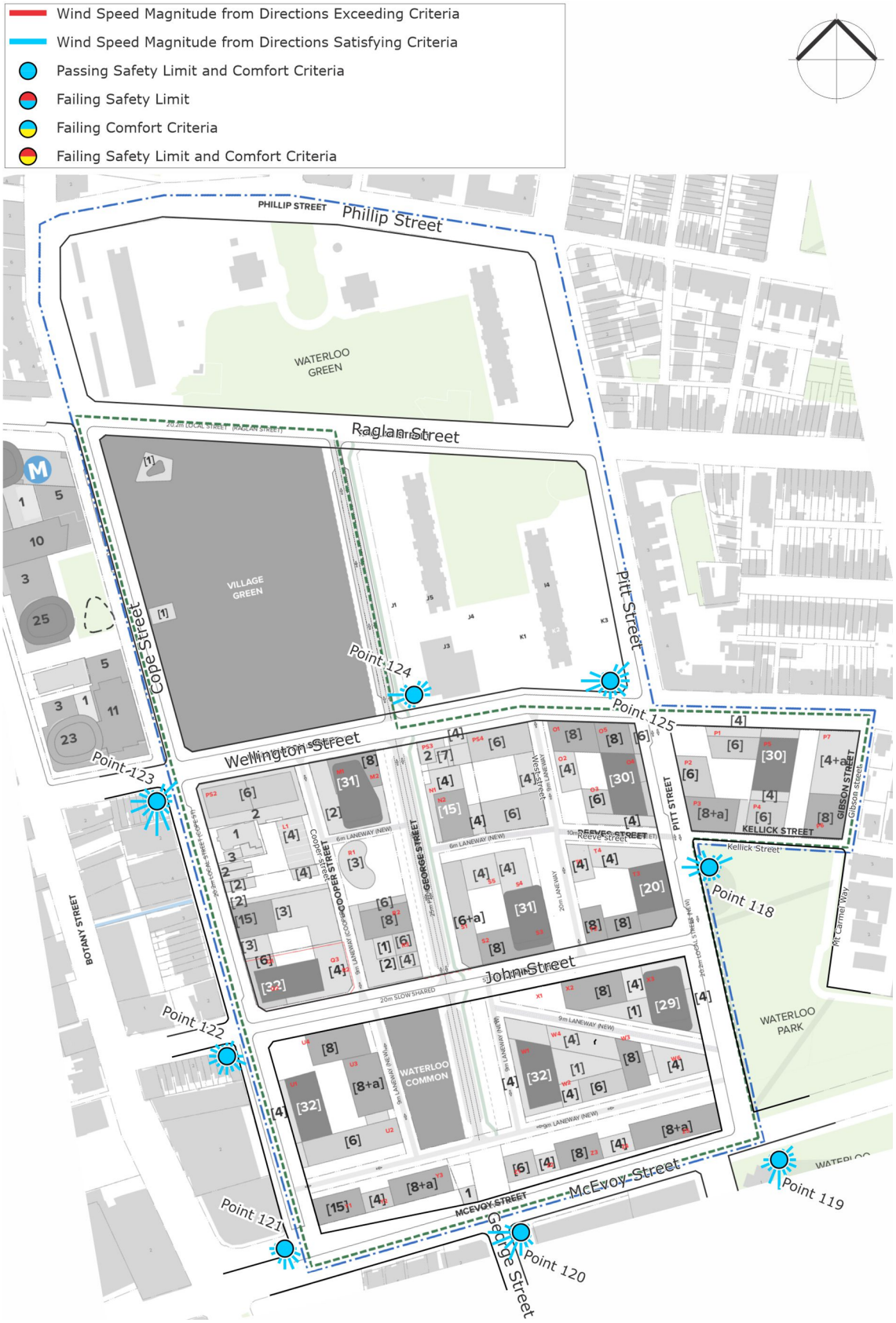

Figure 13g: Wind Directionality Plots – Lot U, V, W, X, Y and Z (with treatments applied)

9 CONCLUSION

This report presents the results of a detailed investigation into the wind environment conditions for the proposed Waterloo South development site. The wind conditions for the existing site and proposed massing model of Waterloo South were tested at critical ground level locations within and around the site.

Wind tunnel testing was performed at Windtech's boundary layer wind tunnel facility. The wind tunnel has a 3.0m wide working section and a fetch length of 14m, and measurements were taken from 16 wind directions at 22.5 degree increments. Testing was carried out using a 1:400 detailed scale model of the development. The effects of nearby buildings and land topography have been accounted for through the use of a proximity model which represents an area with a radius of 600m. The testing procedures were based on the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2017), ASCE 7-10 (Chapter C31), and CTBUH (2013).

Peak gust and mean wind speeds were measured at selected critical outdoor trafficable locations within and around the subject development. Wind velocity coefficients representing the local wind speeds are derived from the wind tunnel and are combined with a statistical model of the regional wind climate (which accounts for the directional strength and frequency of occurrence of the prevailing regional winds) to provide the equivalent full-scale wind speeds at the site. The wind speed measurements are compared with criteria for pedestrian comfort and safety, based on Gust-Equivalent Mean (GEM) and annual maximum gust winds, respectively.

The existing site wind conditions were measured with the incorporation of the existing site developments. Wind tunnel testing allowed for a baseline wind case for the existing site conditions of the proposed development precinct to be established, taking into account the prevailing wind directions for the area, as well as the local topographical effects of the terrain and the surrounding buildings of the proposed site. An assessment of the wind conditions was made and the information used by the design team to coordinate a massing model.

Wind tunnel testing of the proposed Waterloo South masterplan was undertaken, based on the drawing package prepared by the project architect Turner, received February 2020. The results of the study indicate that wind conditions for the majority of trafficable outdoor locations within and around the development will be suitable for their intended uses. Areas where the comfort and/or safety criteria were exceeded additional treatments have been incorporated into the design. The recommended treatments, which have been tested in the wind tunnel are summarised as follows:

- Recommended wrap around awning on western and southern aspects of Building Q1.
- Recommended wrap around awning on western and southern aspects of Building U2.
- Recommended wrap around awning on western and southern aspects of Building Y1.

- Recommended chamfering of south-east building corner on Building Z5.
- Recommended wrap around awning on eastern and southern aspects of Building Z5.
- Recommended porous screen at north-west corner of Building U4.
- Retention of trees as noted in tree retention plan (No.: 17018, Dwg.: 710.3, dated: 18.2.20)

Comparison between the existing site wind conditions and the proposed Waterloo South indicate that a majority of areas are similar to the existing site conditions. The proposed building and tower forms, podium setbacks, and Lot layouts combined with the recommended treatments demonstrates that the ground level wind conditions satisfy both the comfort and safety criteria.

Further wind tunnel testing of the ground level and elevated areas within the proposed Waterloo South will be investigated during the design development stage to further verify the suitability of the areas for their intended purpose.

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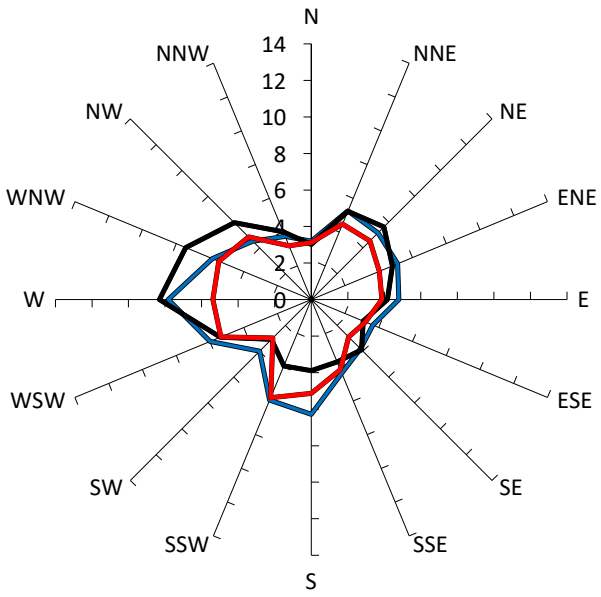
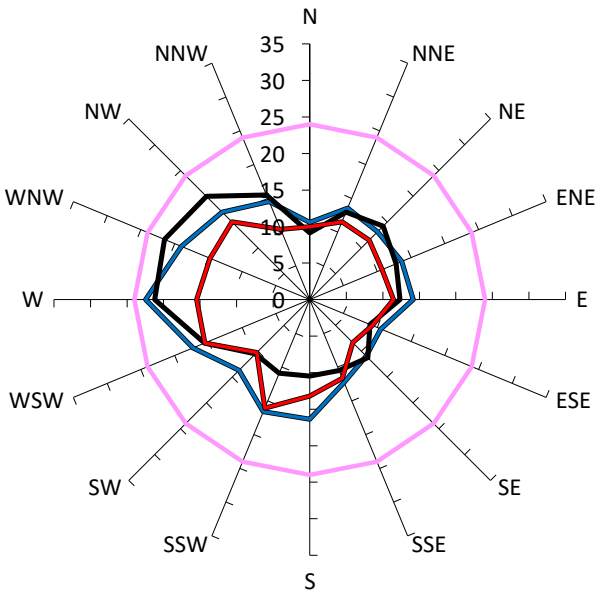
APPENDIX A - DIRECTIONAL PLOTS OF THE WIND TUNNEL RESULTS

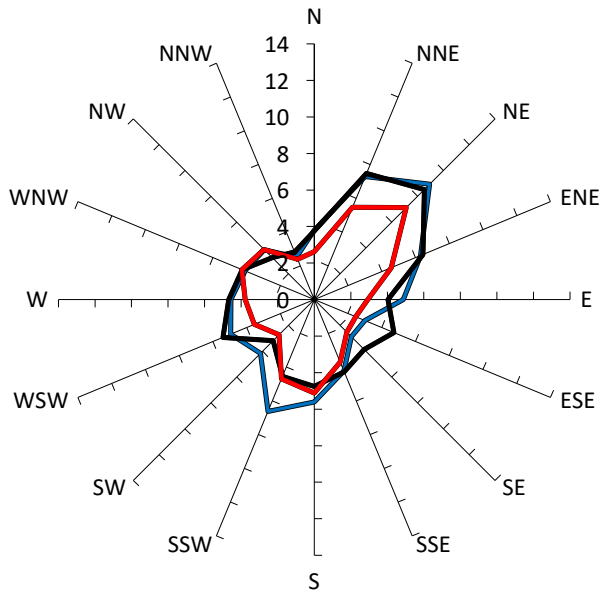
Results for Point 01

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 6m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	11%	22
Existing Site	11%	22
With inclusion of Existing and Retained Trees	4%	16

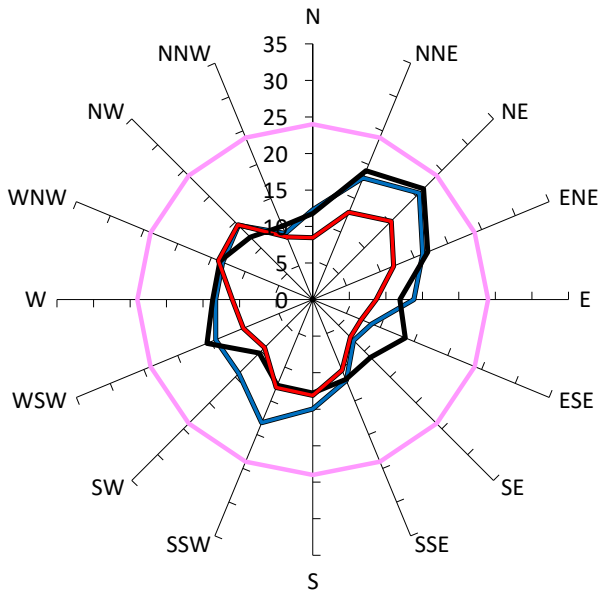
Results for Point 02

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

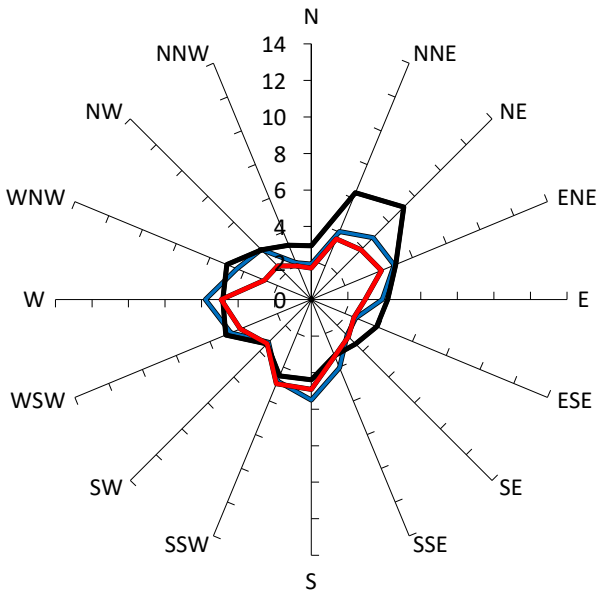
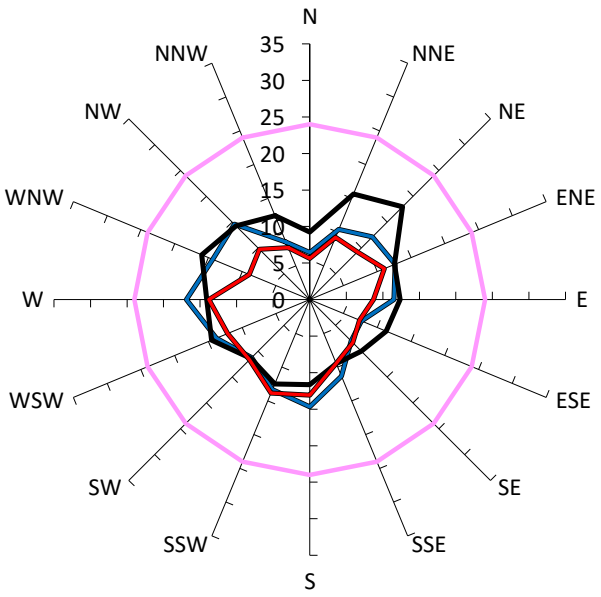
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	16%	21
Existing Site	14%	21
With inclusion of Existing and Retained Trees	5%	15

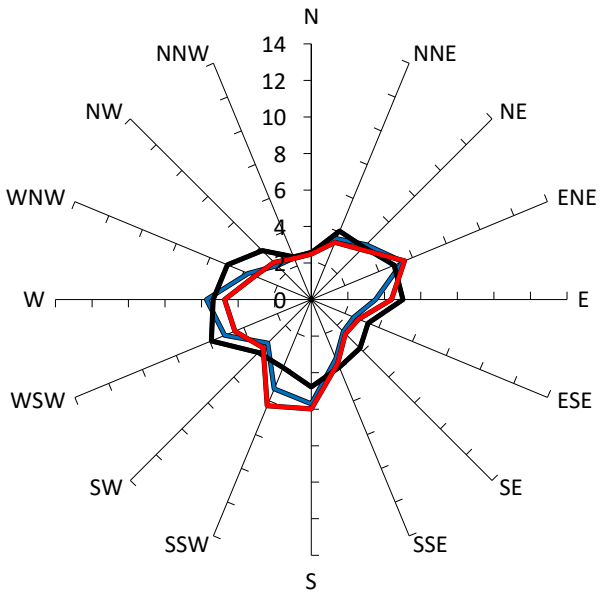
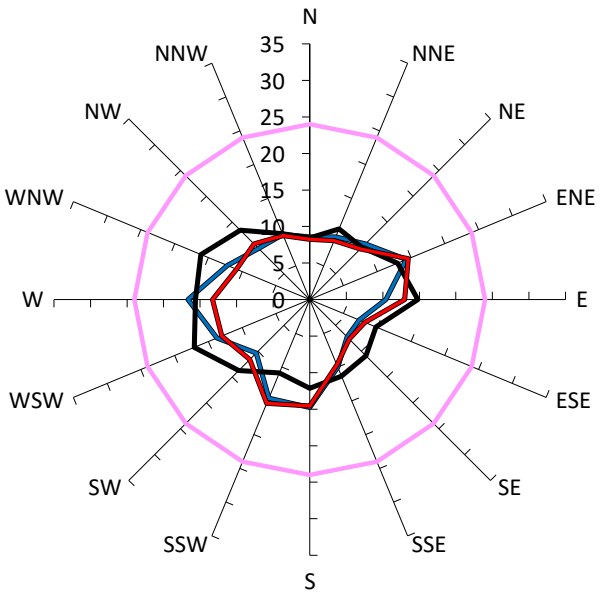
Results for Point 03

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 6m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	17
Existing Site	8%	18
With inclusion of Existing and Retained Trees	1%	14

WD510-10 Waterloo South 7/02/2020

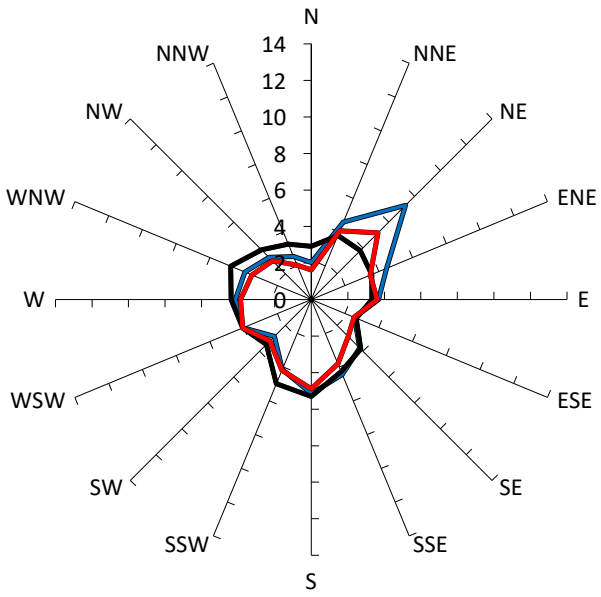
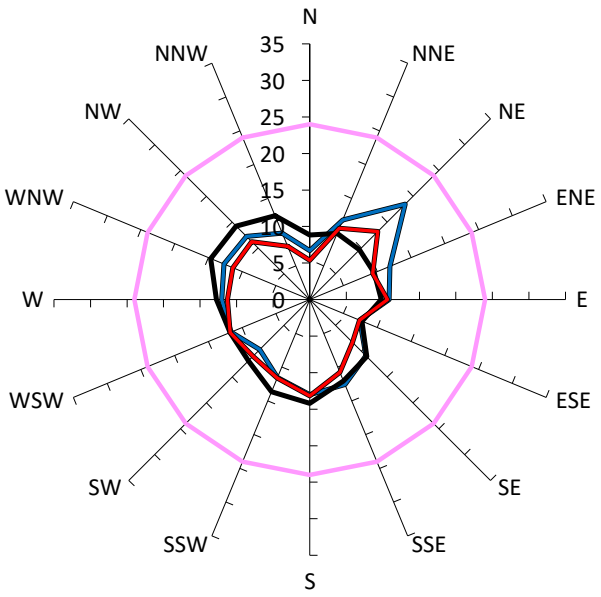
Results for Point 04

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 6m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	17
Existing Site	4%	17
With inclusion of Existing and Retained Trees	4%	15

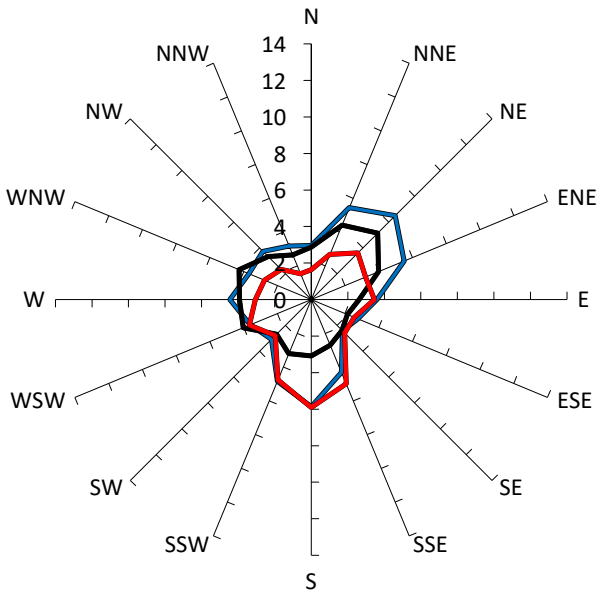
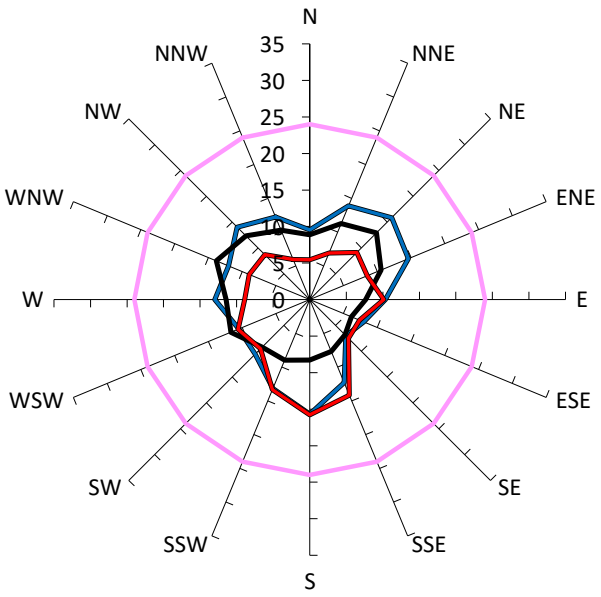
WD510-10 Waterloo South 7/02/2020

Results for Point 05

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 6m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	6%	18
Existing Site	2%	15
With inclusion of Existing and Retained Trees	1%	13

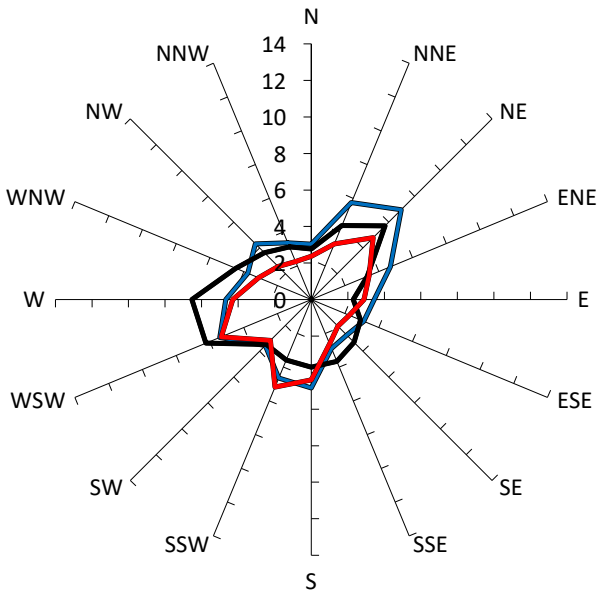
Results for Point 06

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 6m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	5%	16
Existing Site	1%	14
With inclusion of Existing and Retained Trees	2%	16

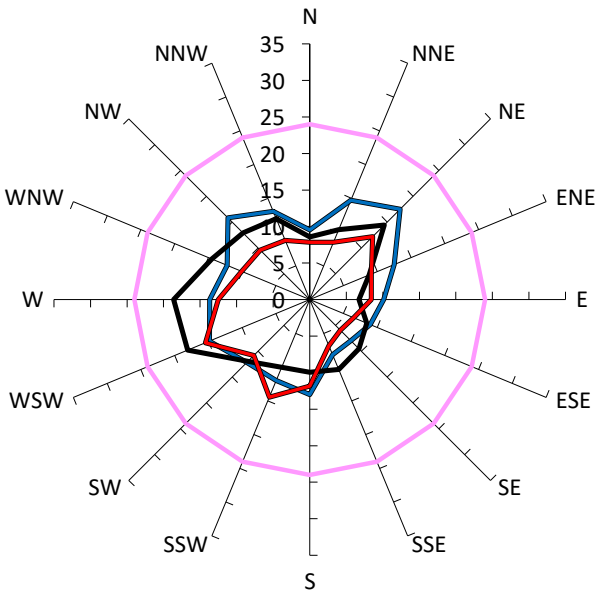
Results for Point 07

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

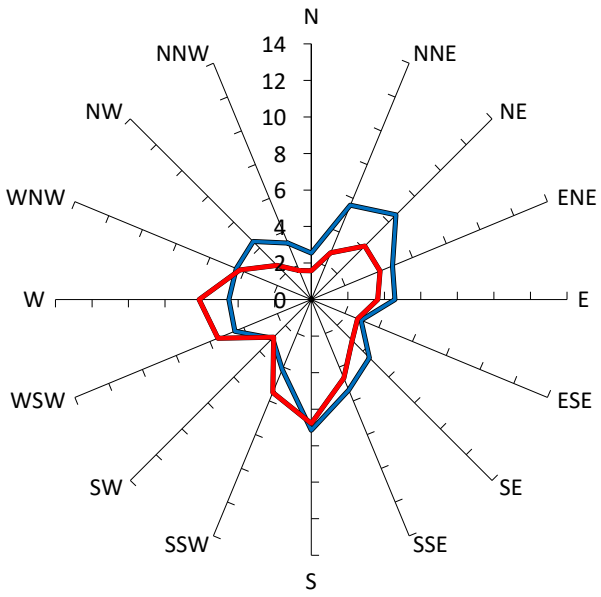
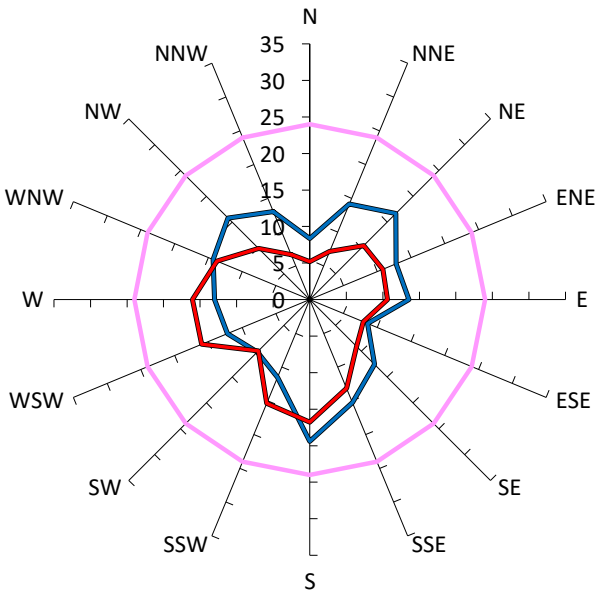
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Short Exposure Activities (6m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	6%	17
Existing Site	5%	19
With inclusion of Existing and Retained Trees	2%	15

Results for Point 08

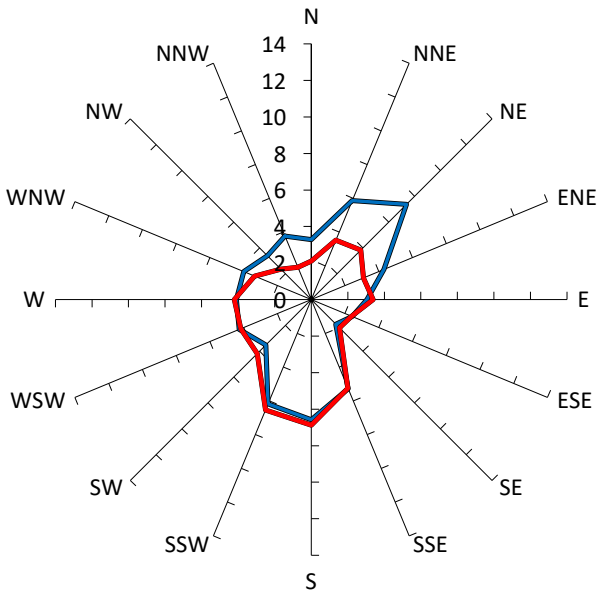
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

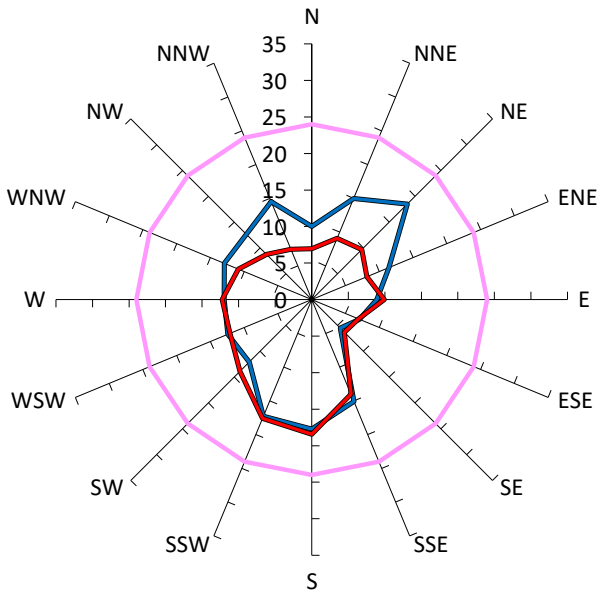
Results for Point 09

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

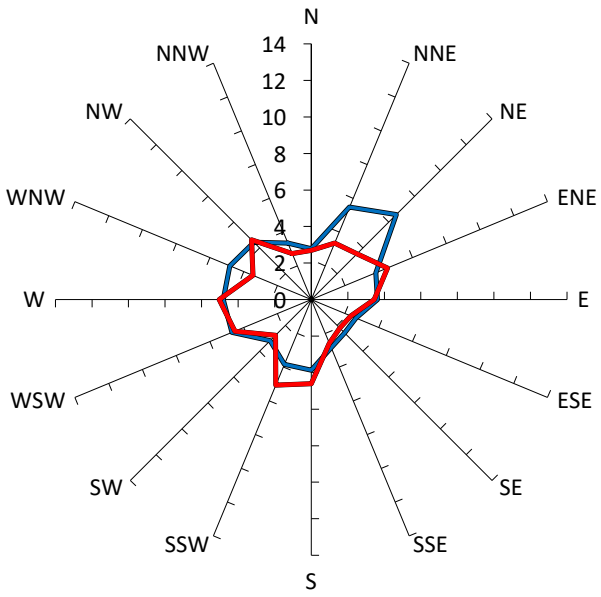
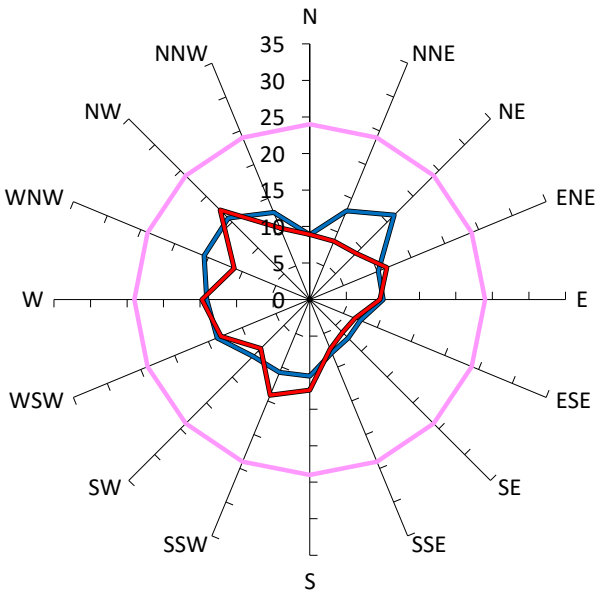


Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
With inclusion of Existing and Retained Trees	1%	18

WD510-10 Waterloo South 7/02/2020

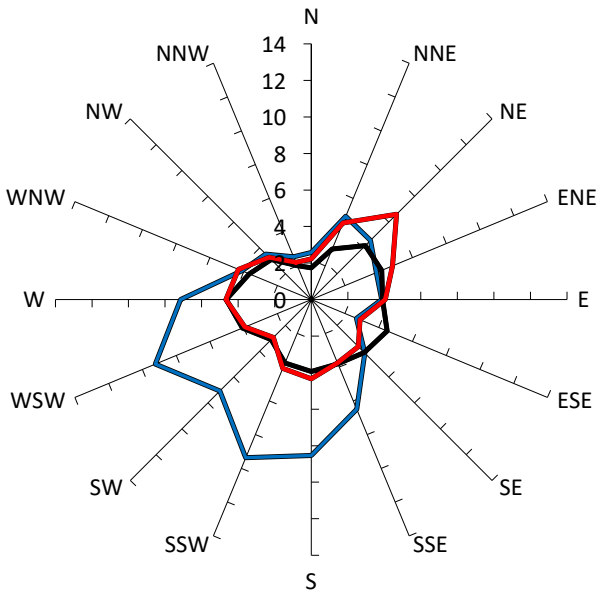
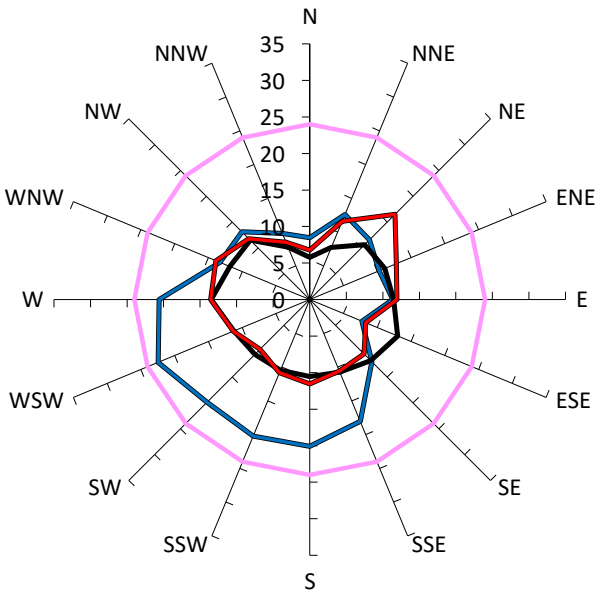
Results for Point 10

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	16
With inclusion of Existing and Retained Trees	0%	17

WD510-10 Waterloo South 7/02/2020

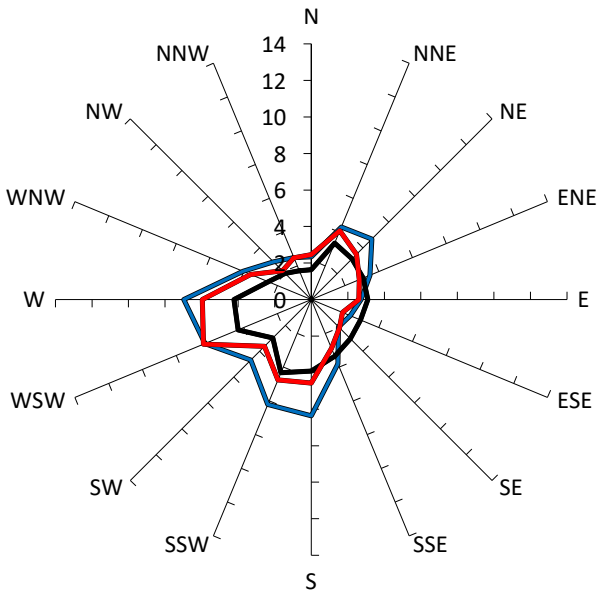
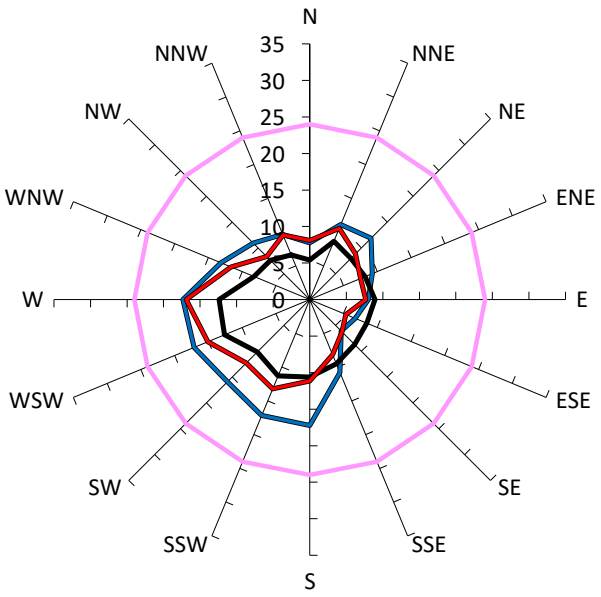
Results for Point 11

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	9%	22
Existing Site	0%	13
With inclusion of Existing and Retained Trees	0%	16

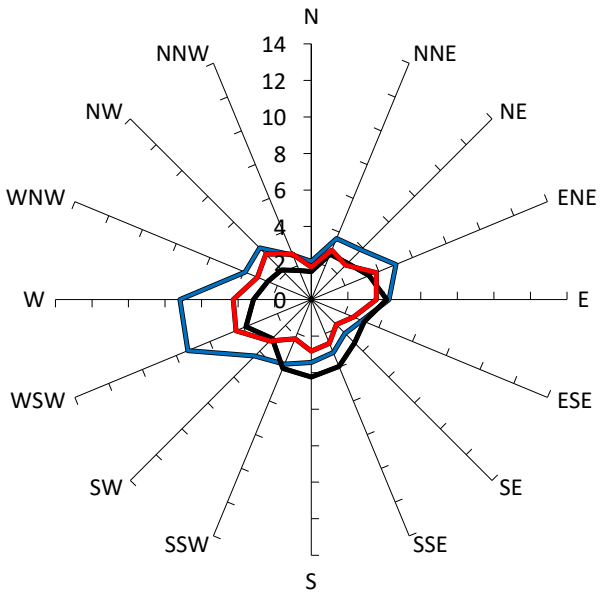
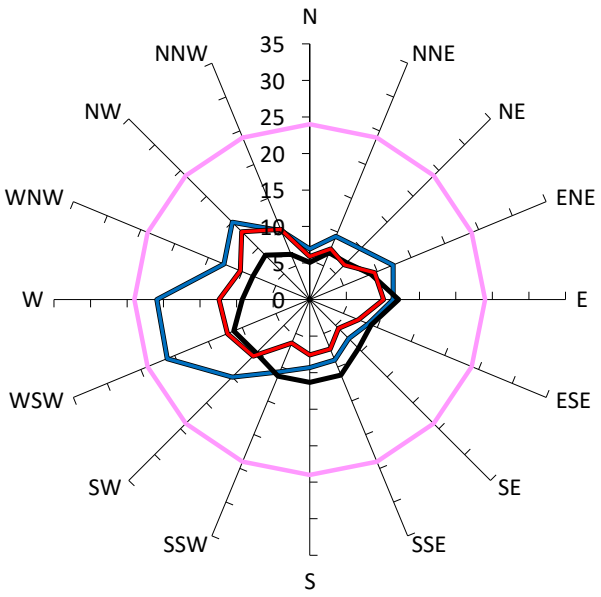
WD510-10 Waterloo South 7/02/2020

Results for Point 12

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	0%	13
With inclusion of Existing and Retained Trees	1%	17

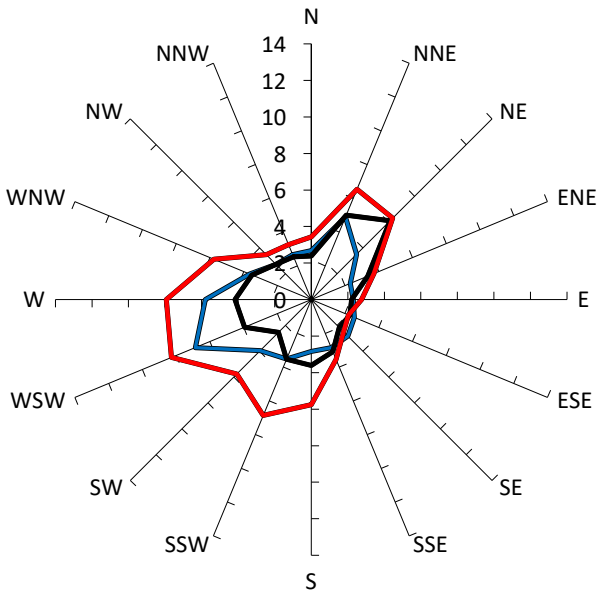
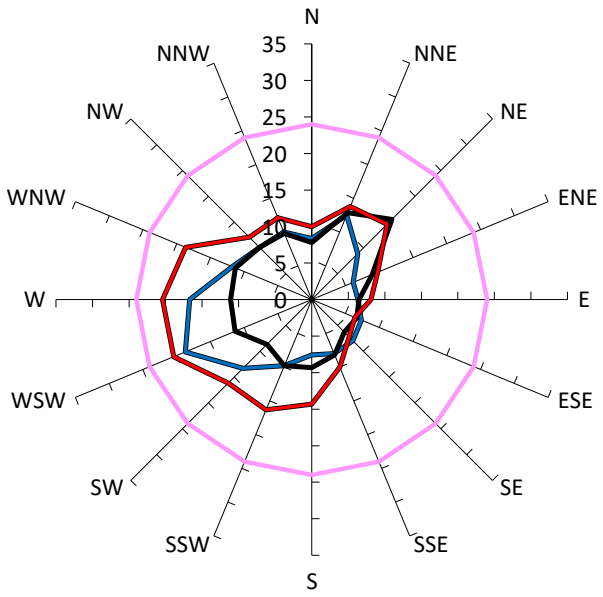
Results for Point 13

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	21
Existing Site	0%	12
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

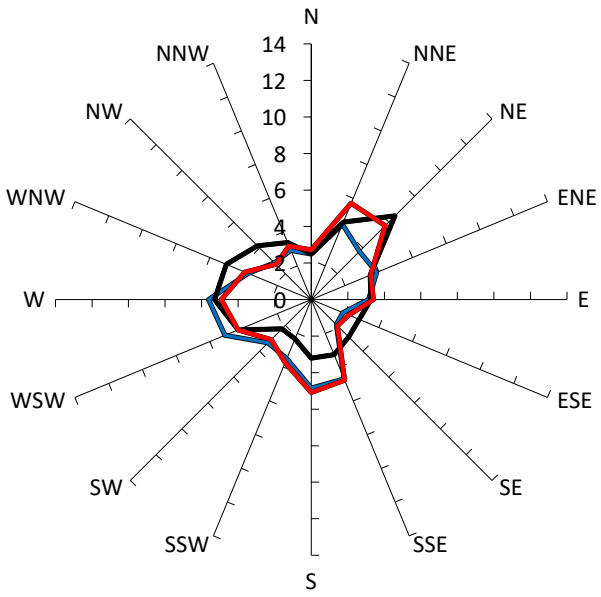
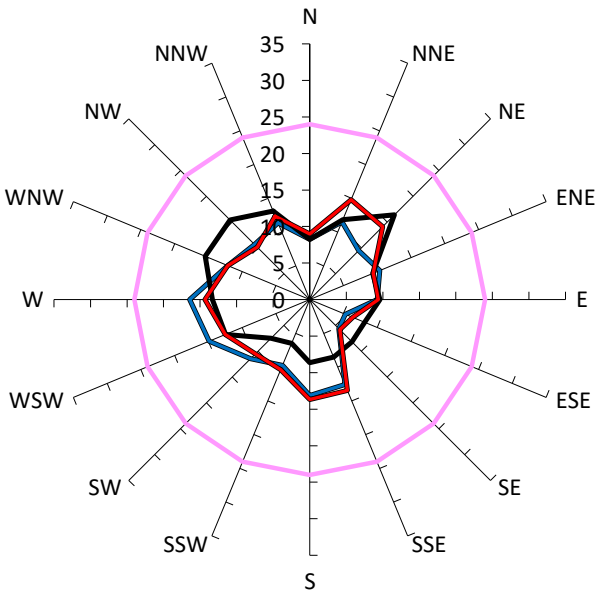
Results for Point 14

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
Existing Site	0%	16
With inclusion of Existing and Retained Trees	4%	20

WD510-10 Waterloo South 7/02/2020

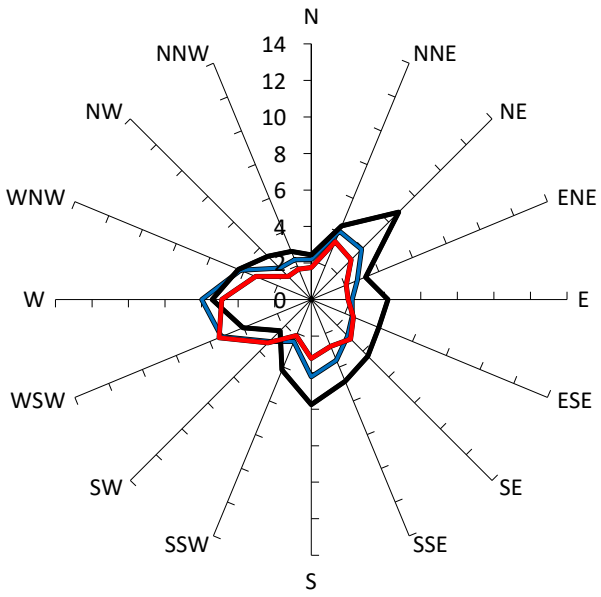
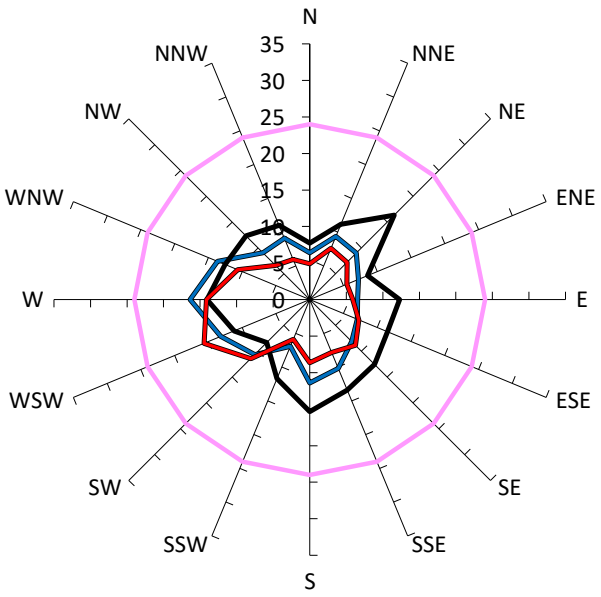
Results for Point 15

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	16
Existing Site	0%	16
With inclusion of Existing and Retained Trees	0%	15

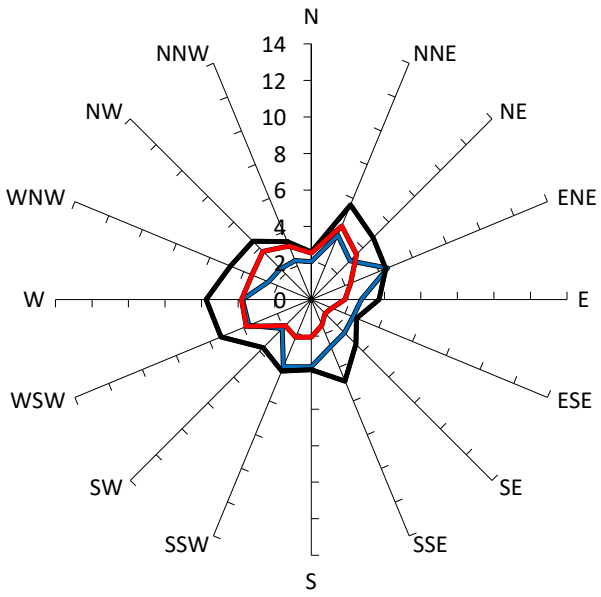
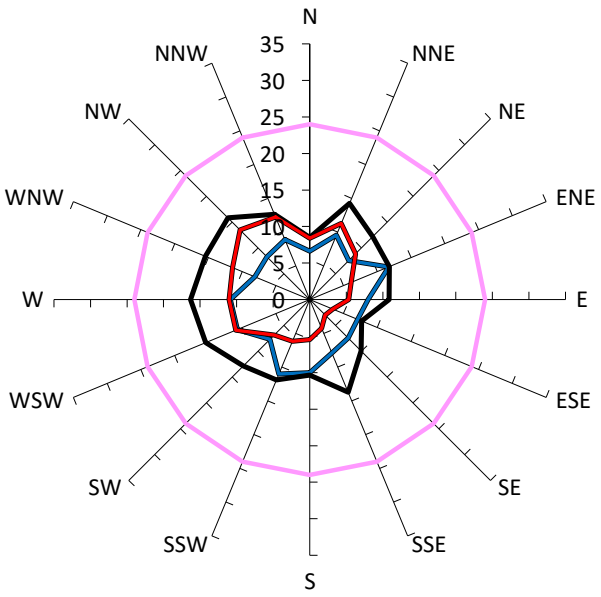
WD510-10 Waterloo South 7/02/2020

Results for Point 16

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

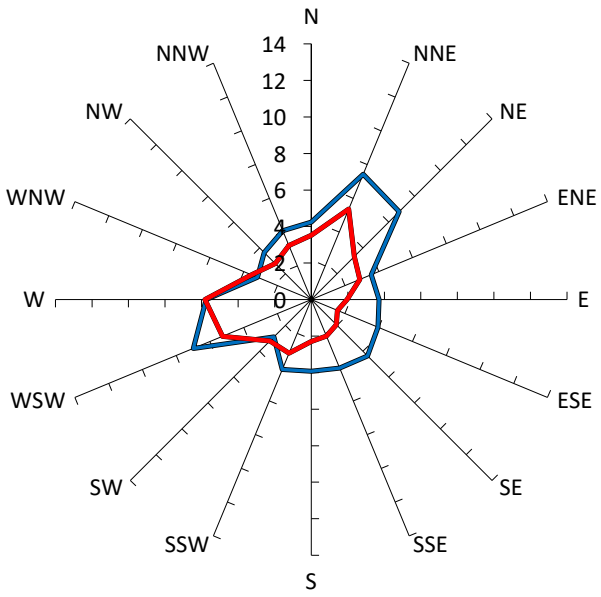
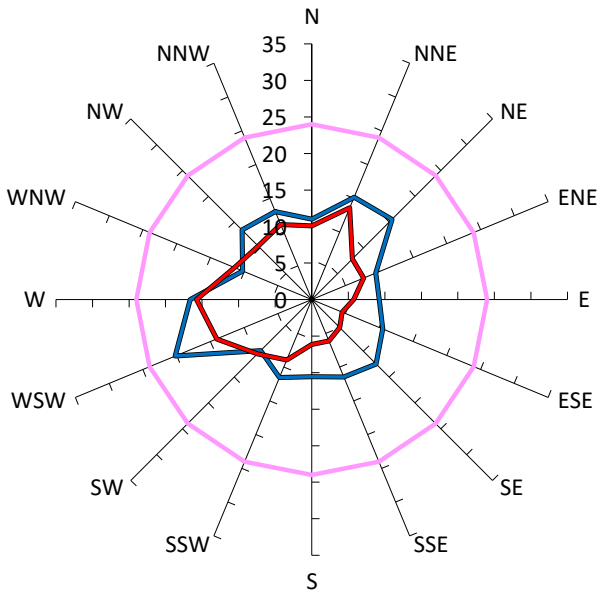
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	16
Existing Site	1%	16
With inclusion of Existing and Retained Trees	0%	16

Results for Point 17

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

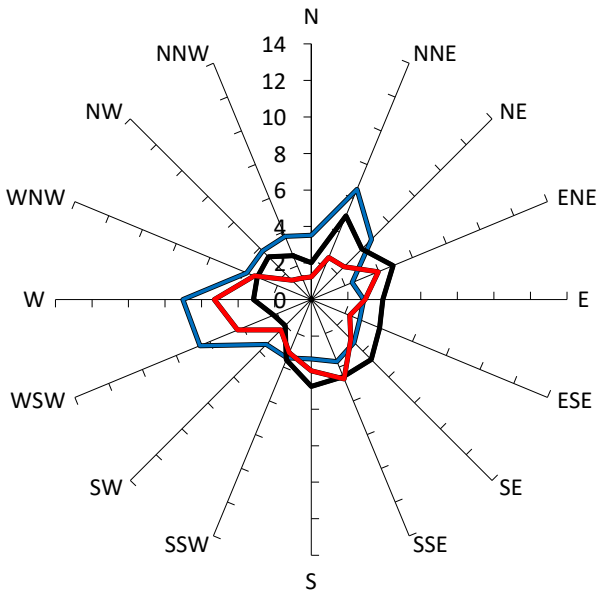
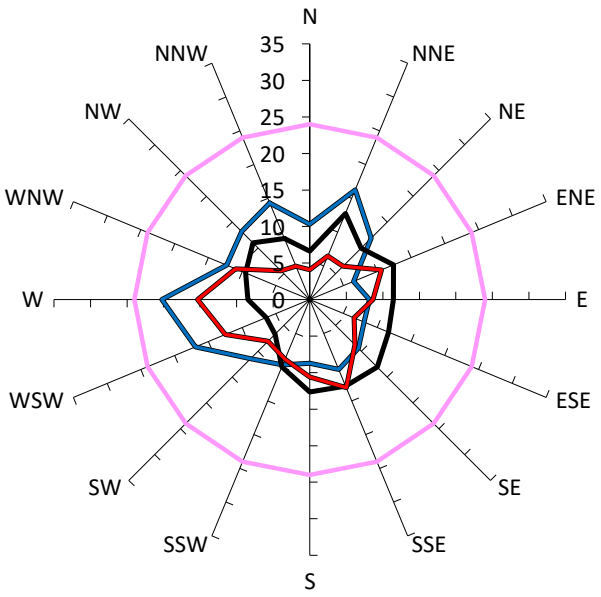
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	12
Existing Site	1%	16
With inclusion of Existing and Retained Trees	0%	13

Results for Point 18

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
With inclusion of Existing and Retained Trees	0%	16

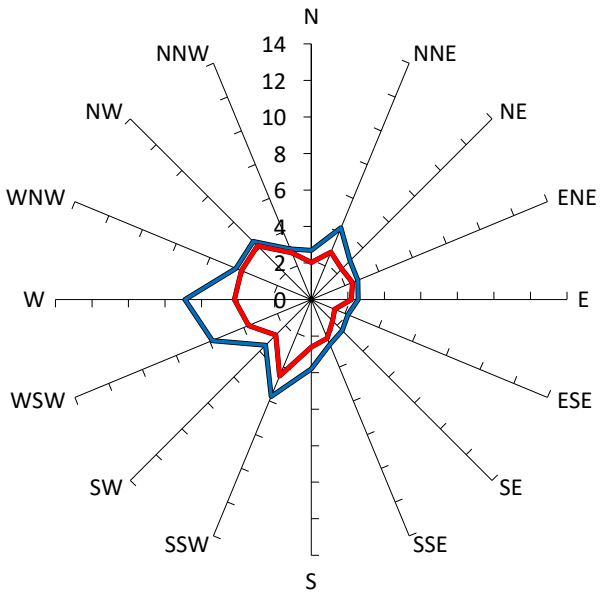
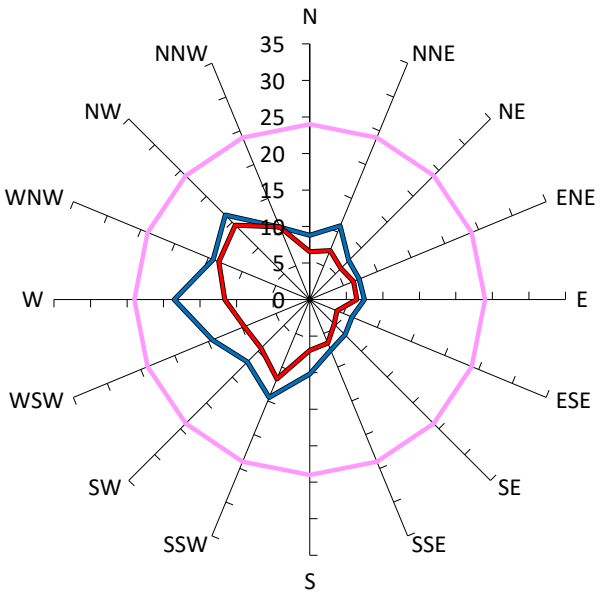
Results for Point 19

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	20
Existing Site	0%	13
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

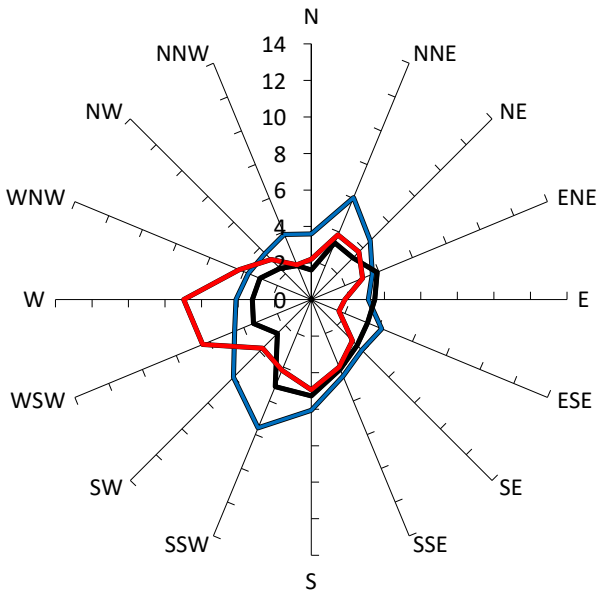
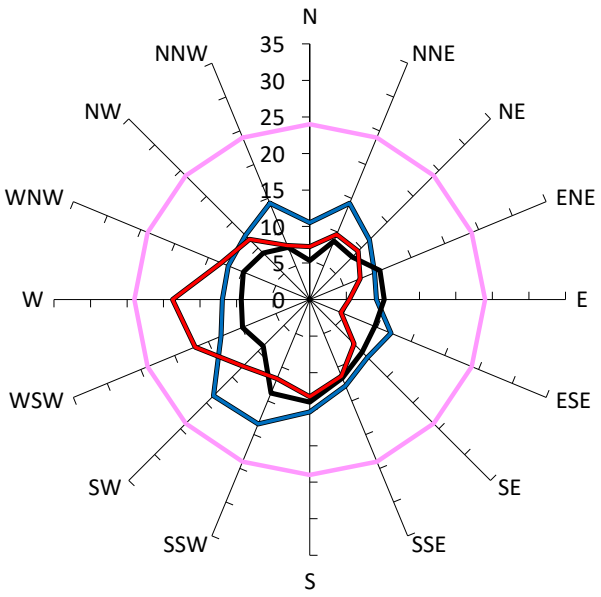
Results for Point 20

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

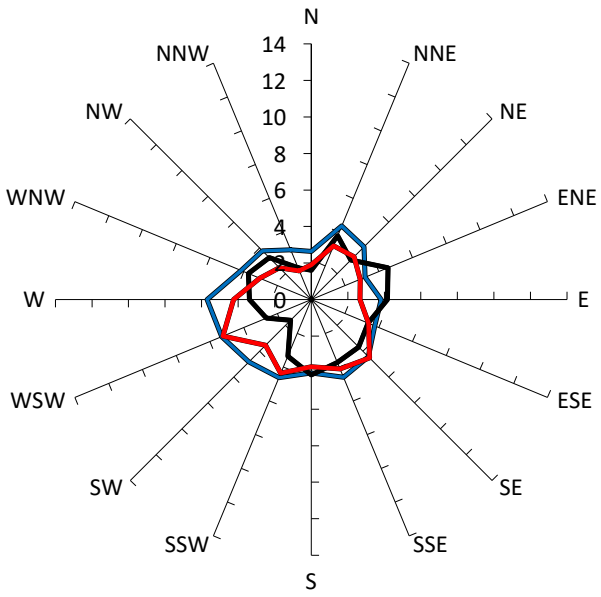
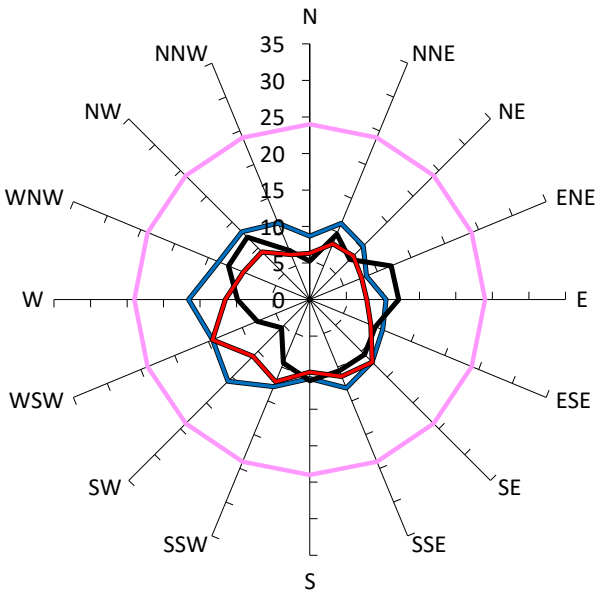
Results for Point 21

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	19
Existing Site	0%	14
With inclusion of Existing and Retained Trees	1%	19

WD510-10 Waterloo South 7/02/2020

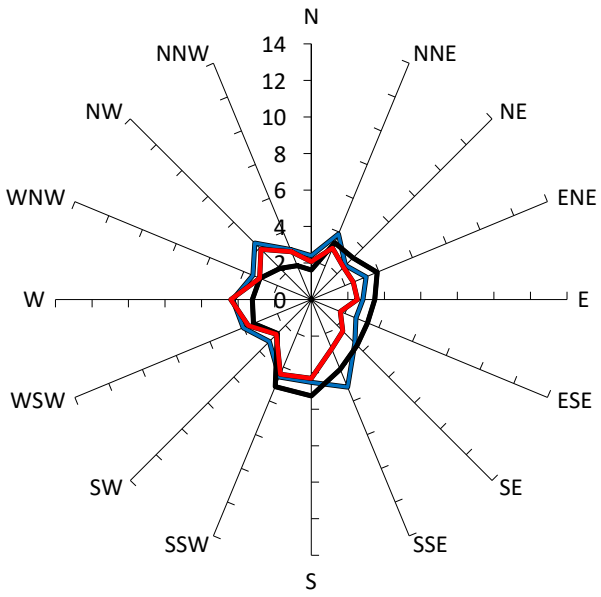
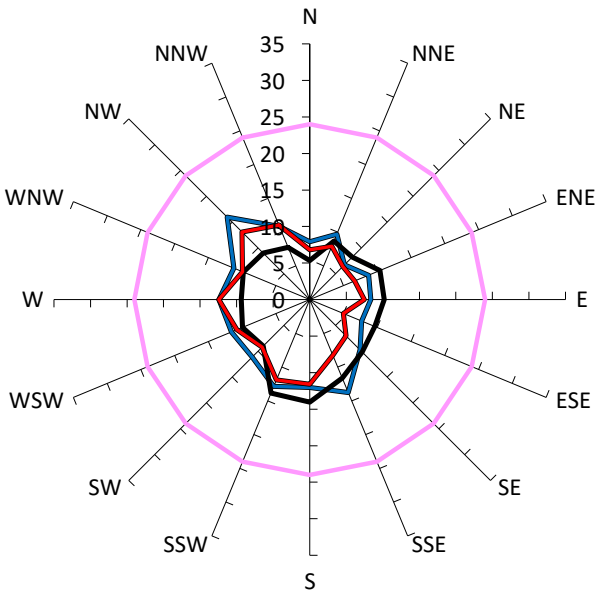
Results for Point 22

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	17
Existing Site	0%	12
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

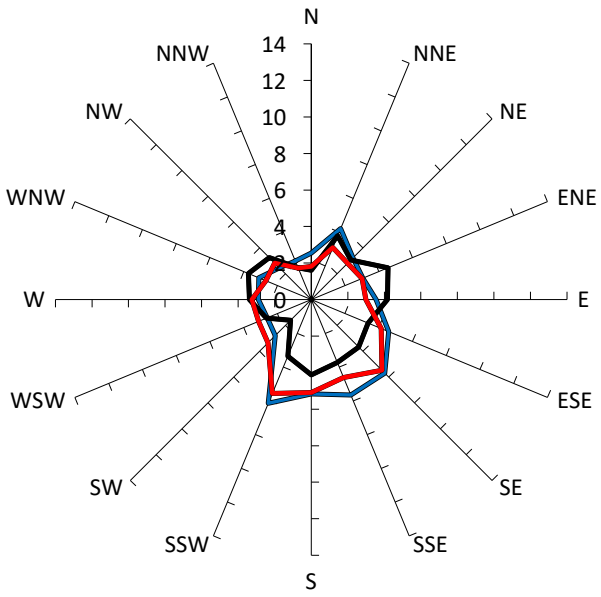
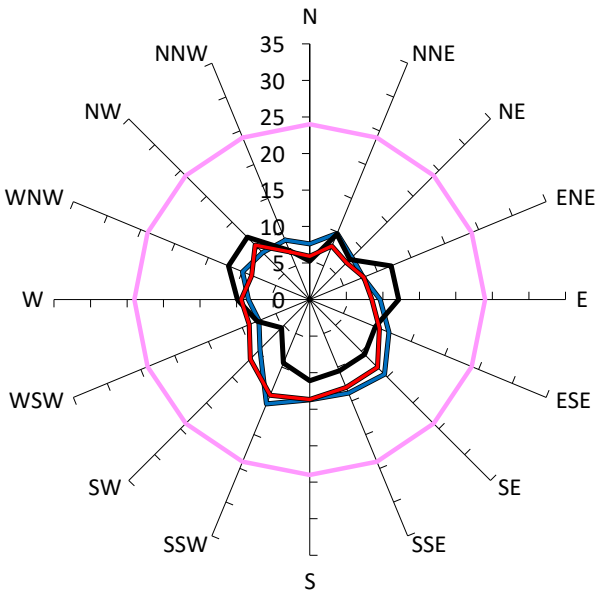
Results for Point 23

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	16
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

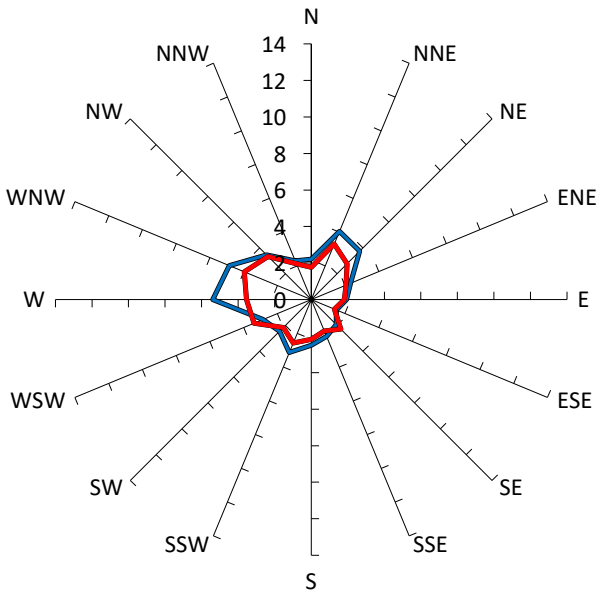
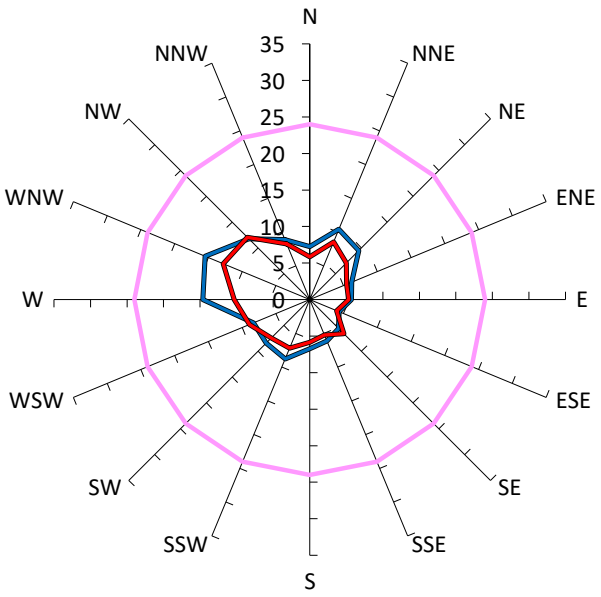
Results for Point 24

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
Existing Site	0%	12
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

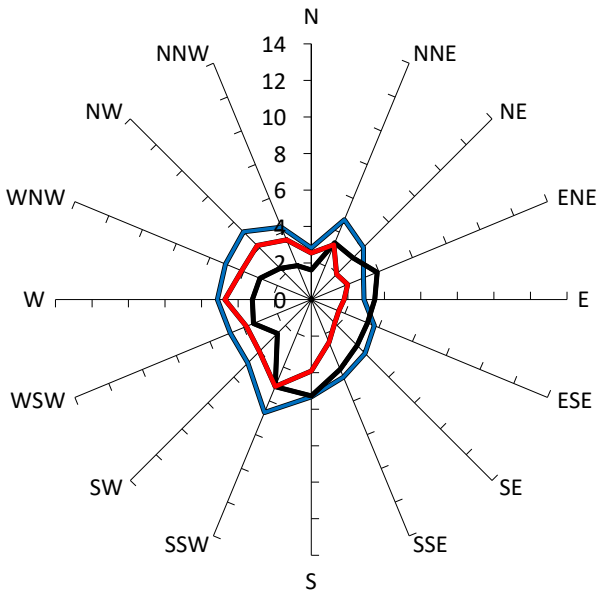
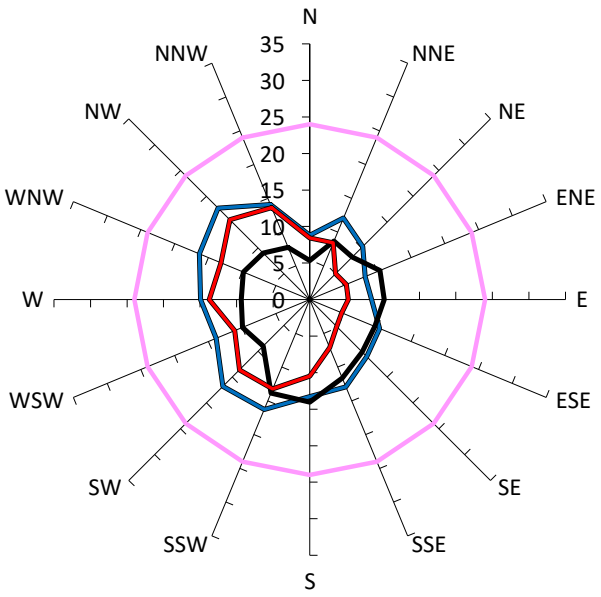
Results for Point 25

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

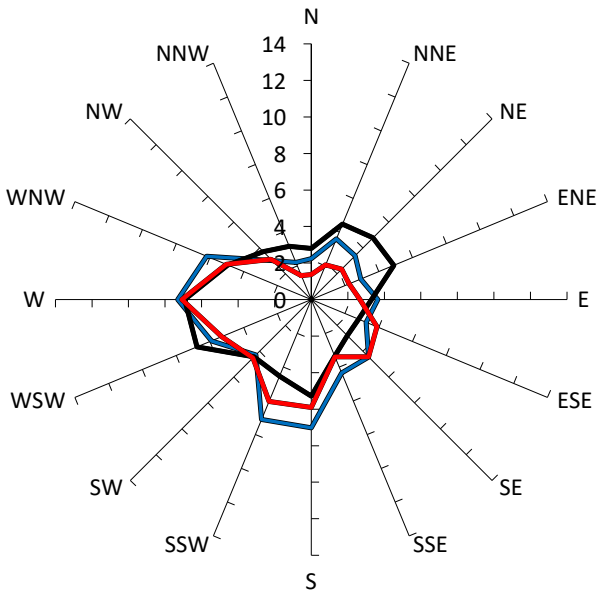
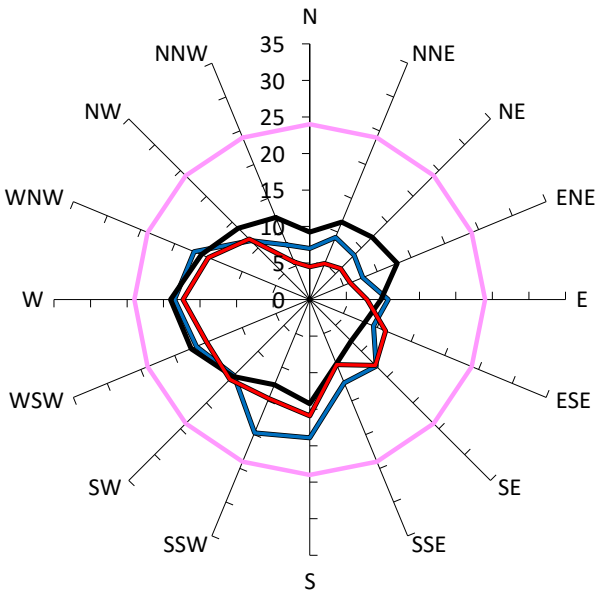
Results for Point 26

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

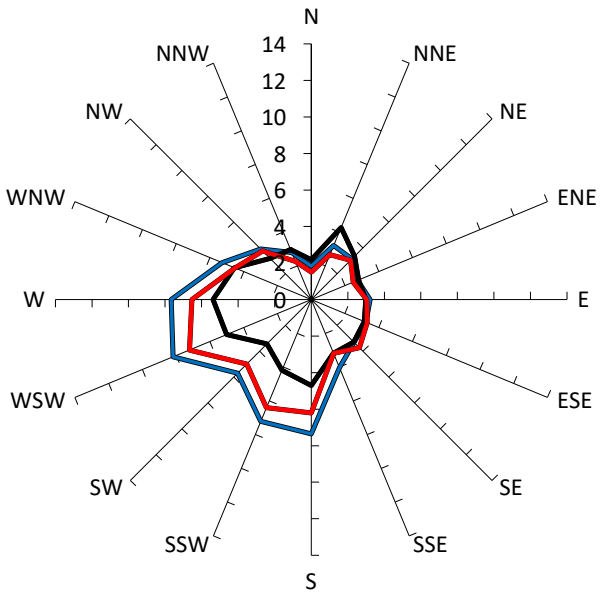
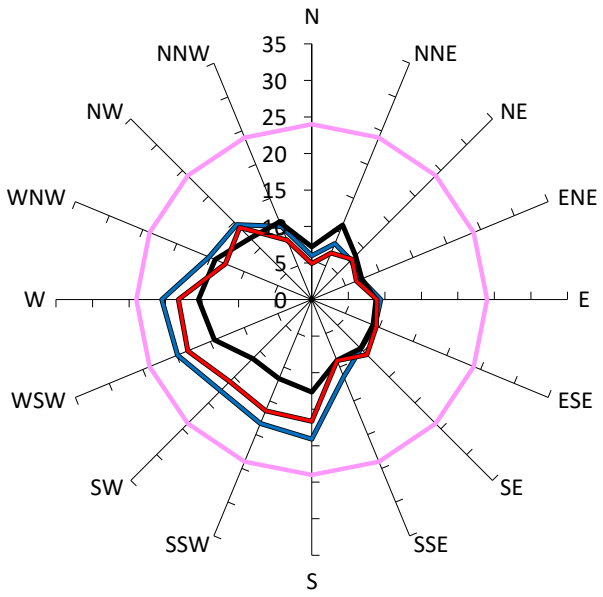
Results for Point 27

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
Existing Site	1%	19
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

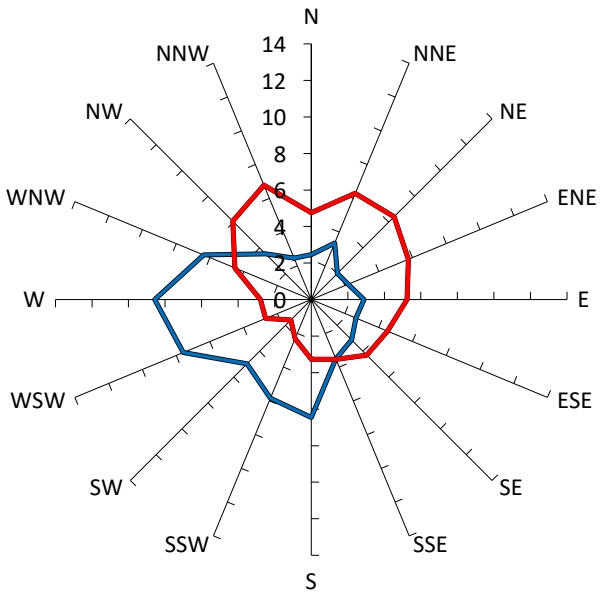
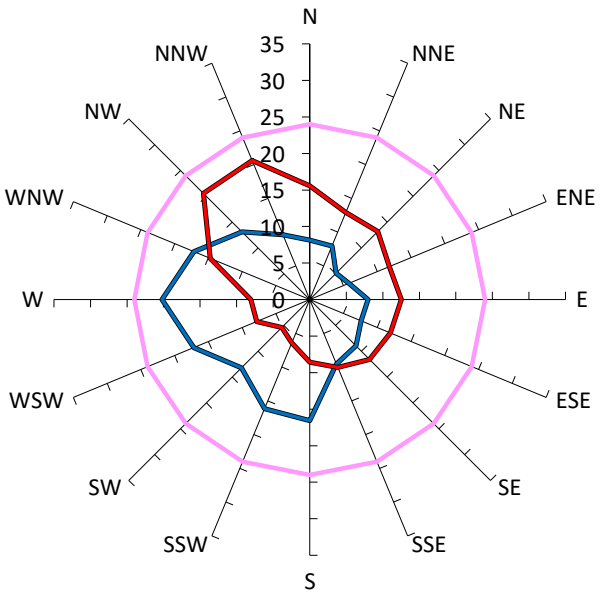
Results for Point 28

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	21
Existing Site	0%	15
With inclusion of Existing and Retained Trees	2%	18

WD510-10 Waterloo South 7/02/2020

Results for Point 29

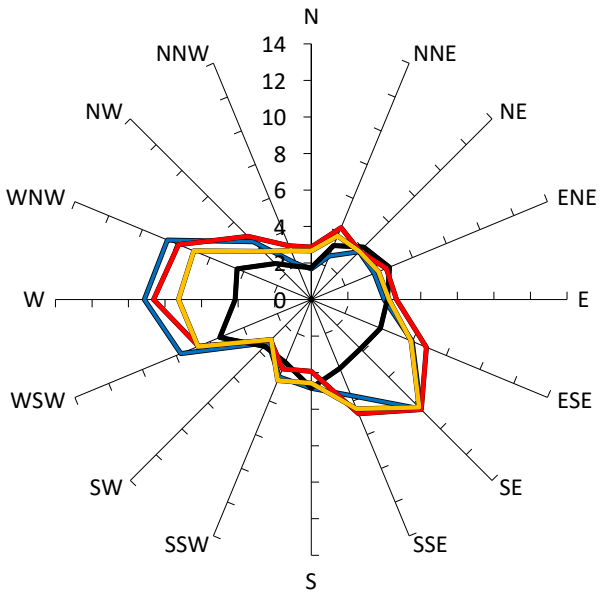
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	20
With inclusion of Existing and Retained Trees	2%	21

WD510-10 Waterloo South 7/02/2020

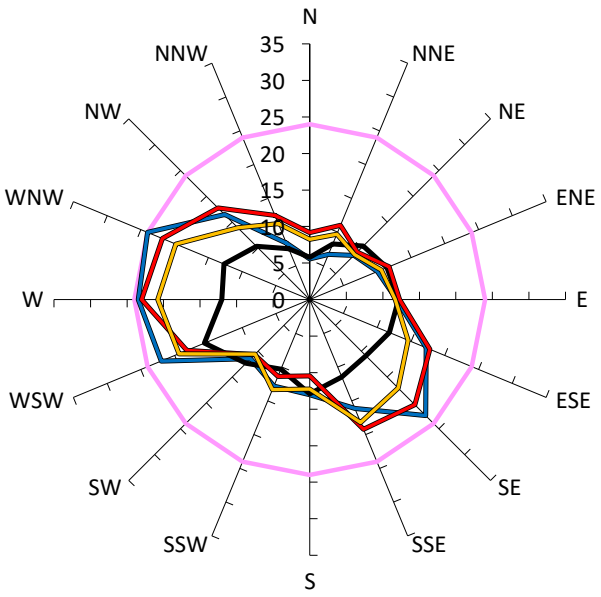
Results for Point 30

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

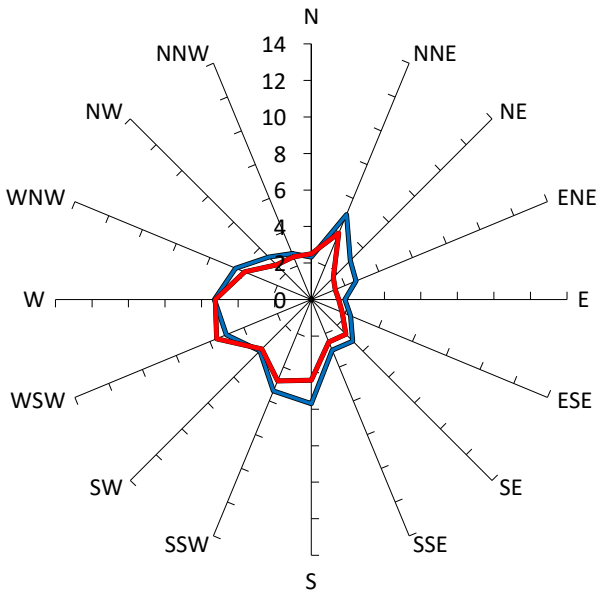
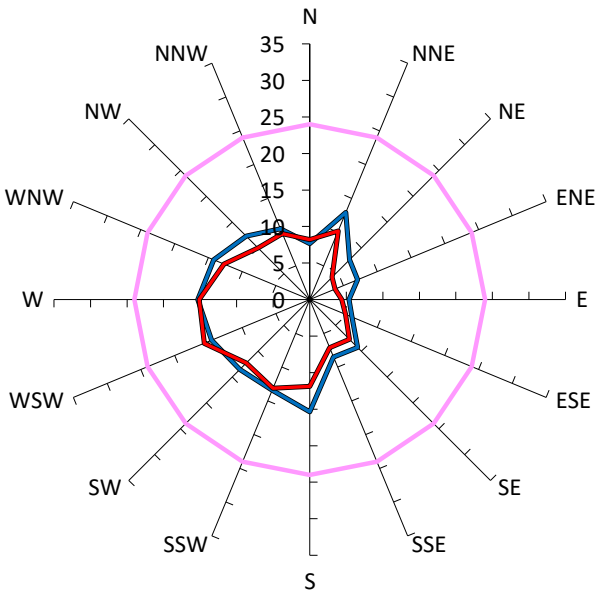
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	6%	24
Existing Site	0%	16
With inclusion of Existing and Retained Trees	6%	23
Awning along Western and Southern façade of LOT Q	4%	21

Results for Point 31

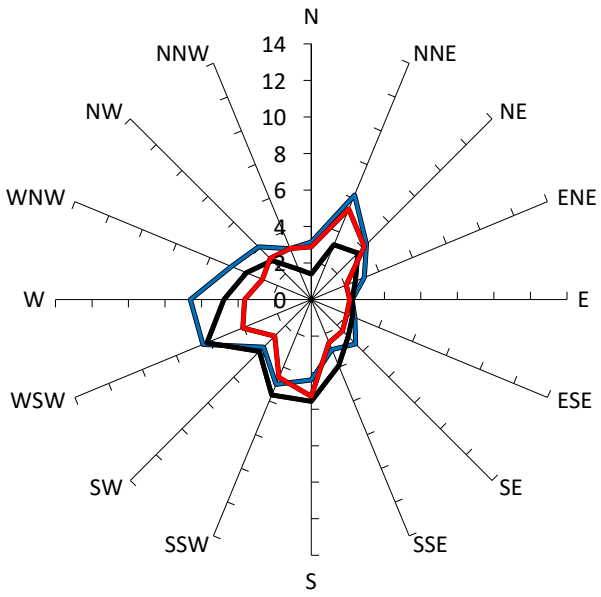
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
With inclusion of Existing and Retained Trees	0%	16

WD510-10 Waterloo South 7/02/2020

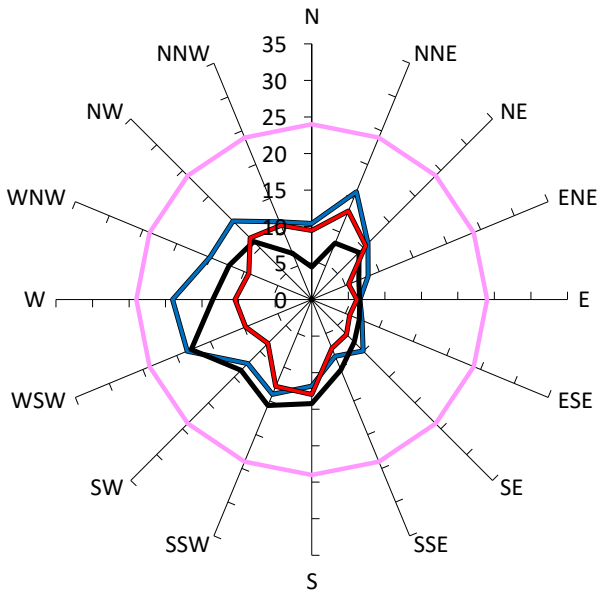
Results for Point 32

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

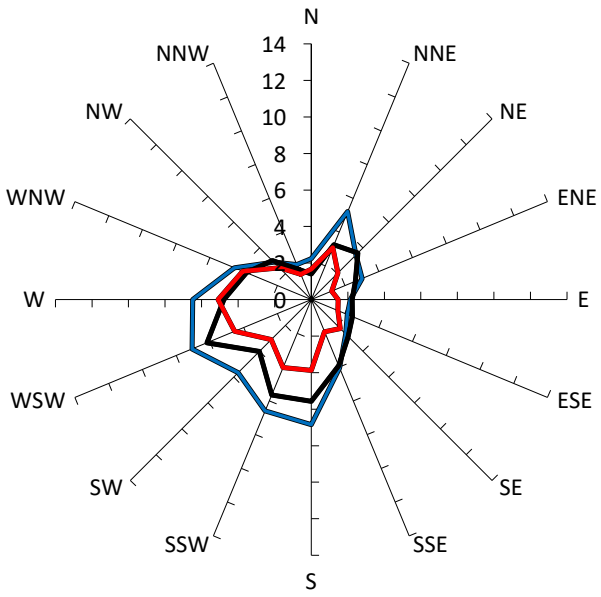
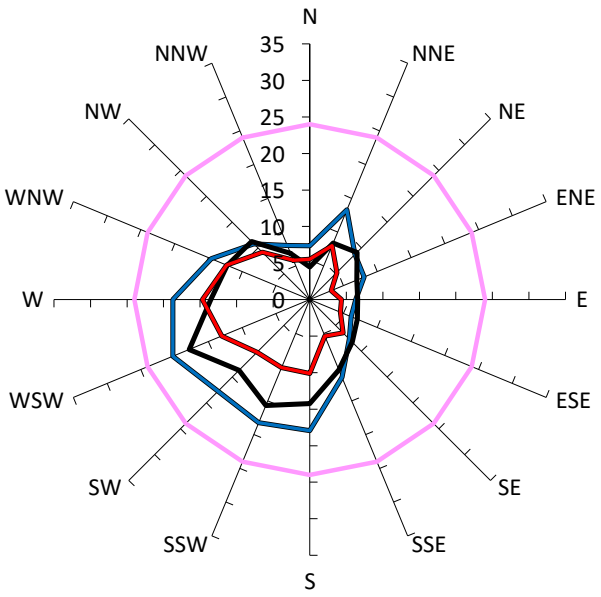
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
Existing Site	0%	18
With inclusion of Existing and Retained Trees	0%	13

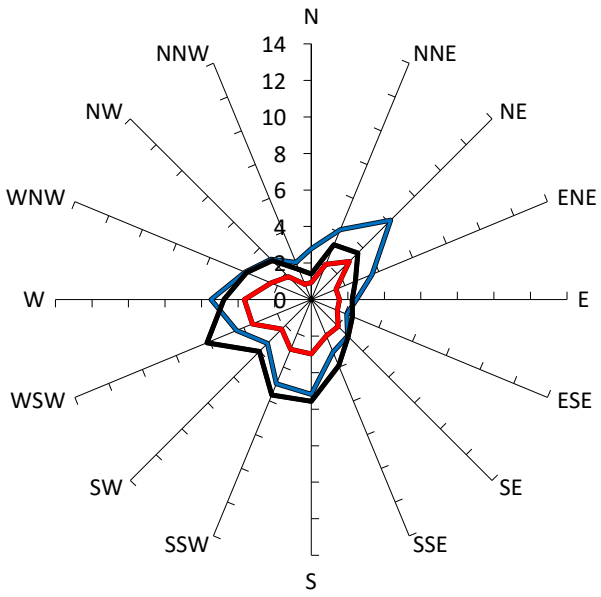
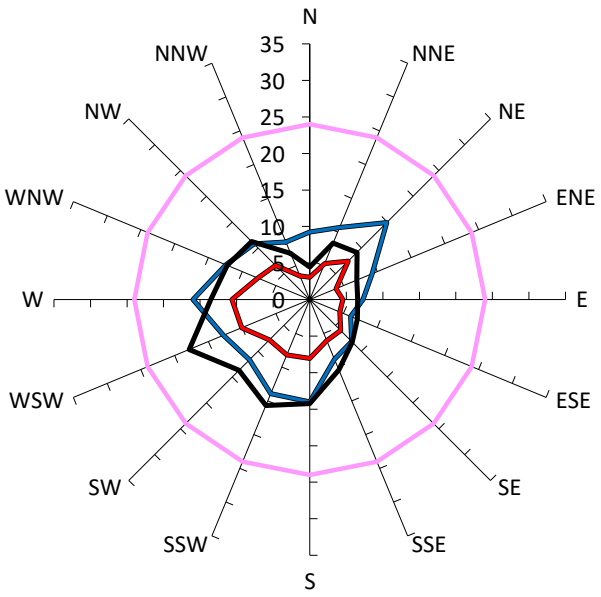
Results for Point 33

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
Existing Site	0%	18
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

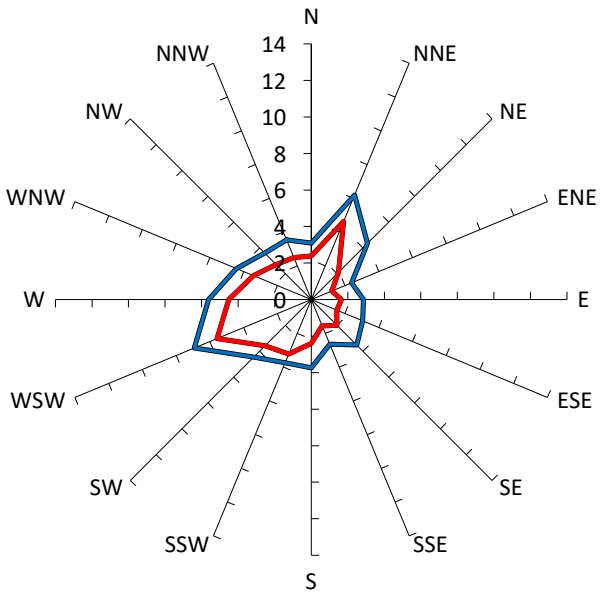
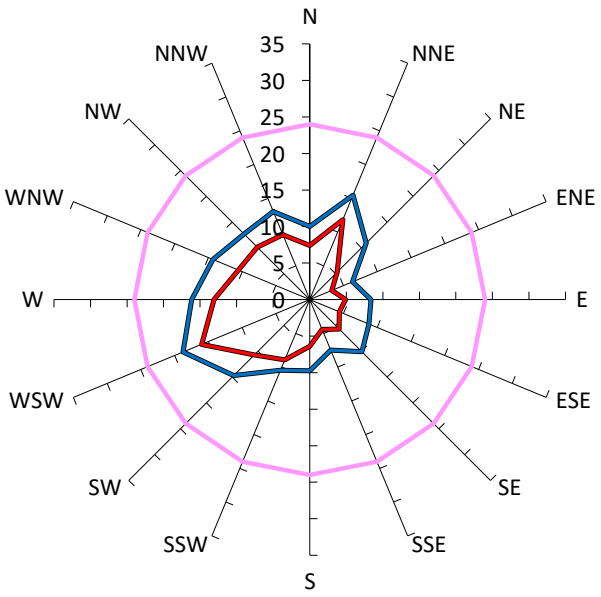
Results for Point 34

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	16
Existing Site	0%	18
With inclusion of Existing and Retained Trees	0%	11

WD510-10 Waterloo South 7/02/2020

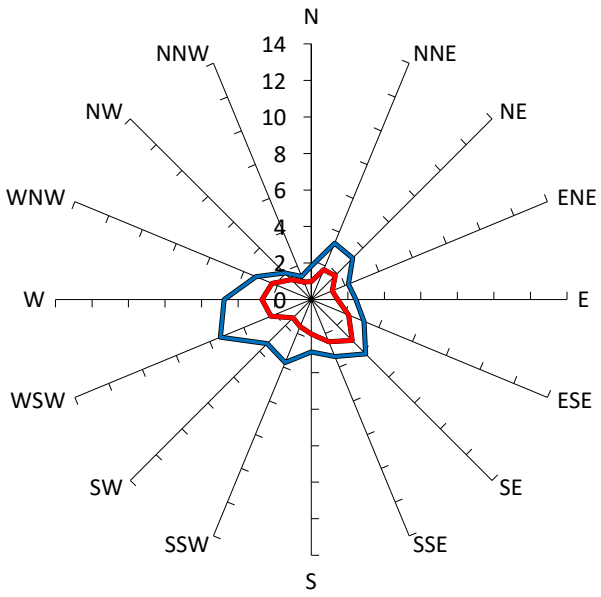
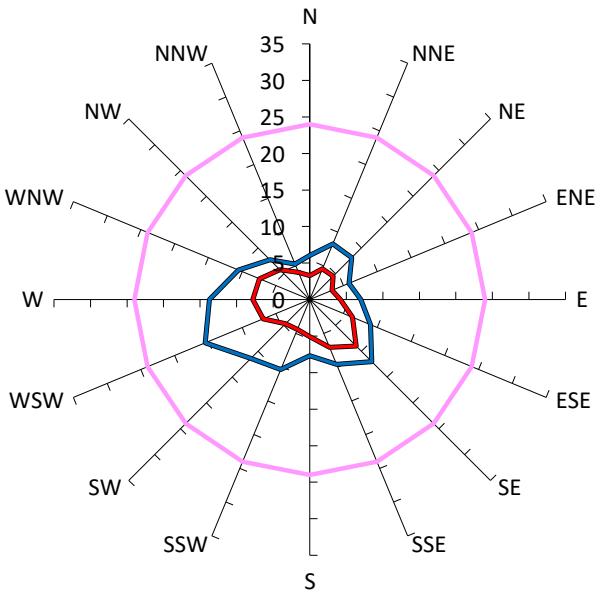
Results for Point 35

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
With inclusion of Existing and Retained Trees	0%	16

WD510-10 Waterloo South 7/02/2020

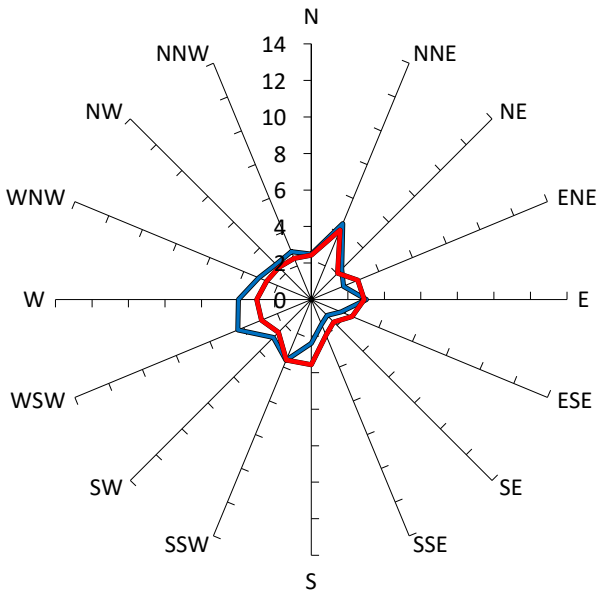
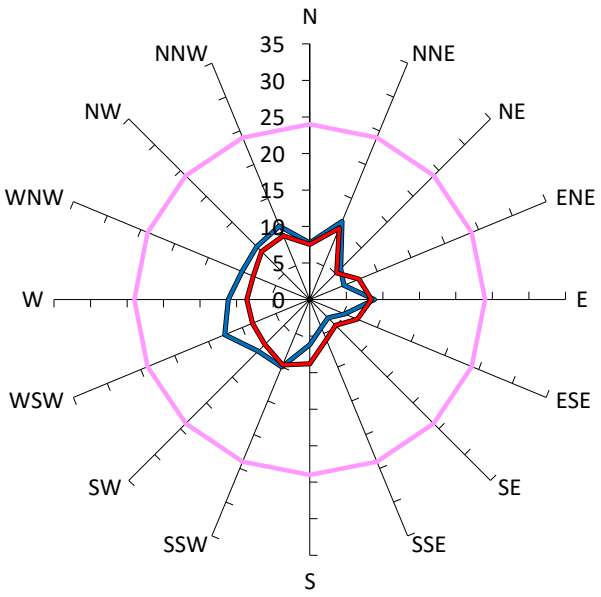
Results for Point 36

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
With inclusion of Existing and Retained Trees	0%	9

WD510-10 Waterloo South 7/02/2020

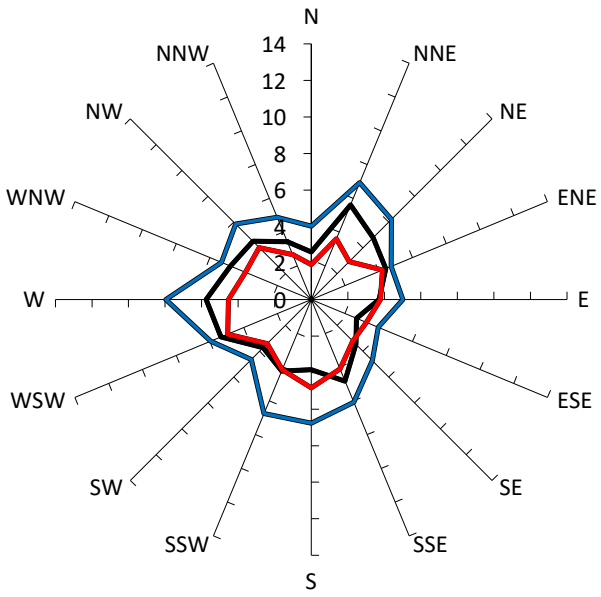
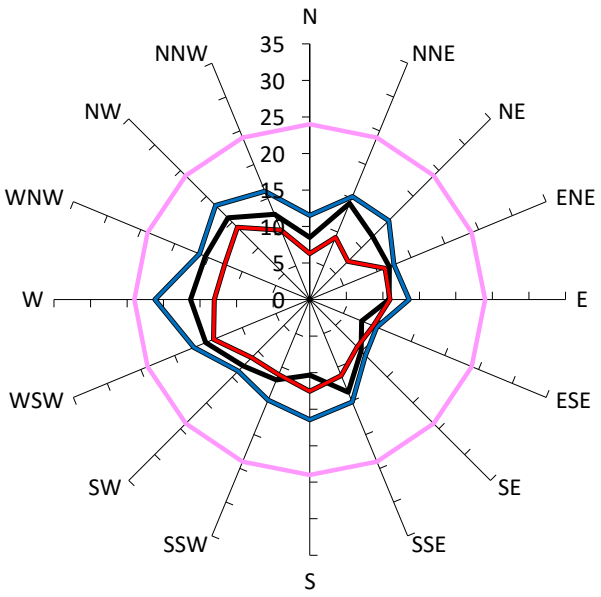
Results for Point 37

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	13
With inclusion of Existing and Retained Trees	0%	11

WD510-10 Waterloo South 7/02/2020

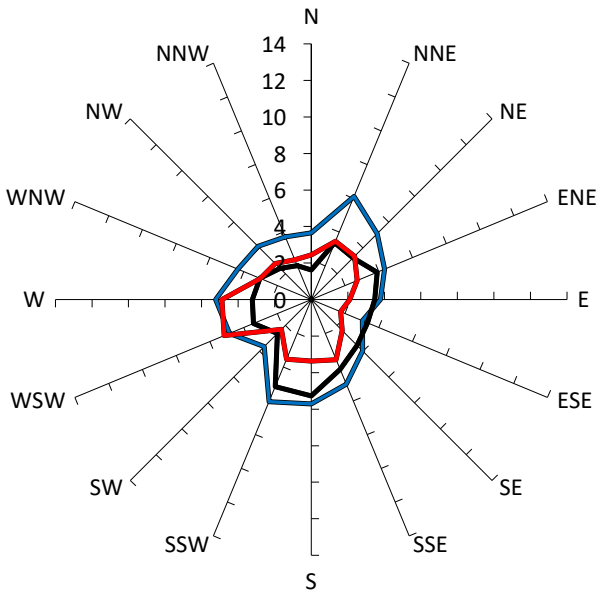
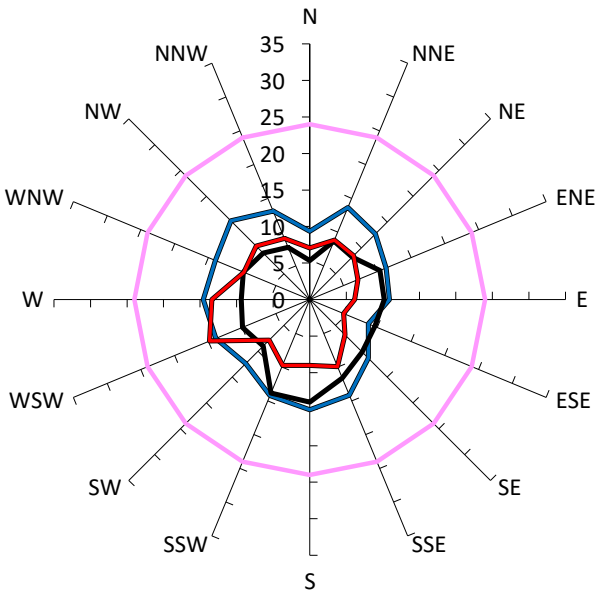
Results for Point 38

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	21
Existing Site	1%	16
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

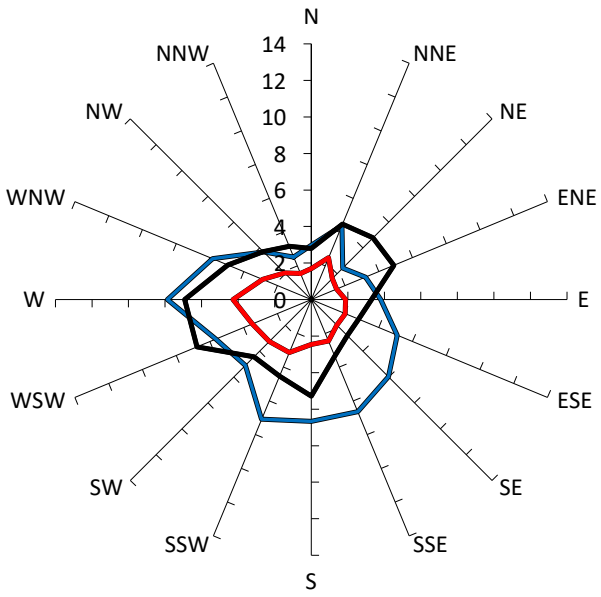
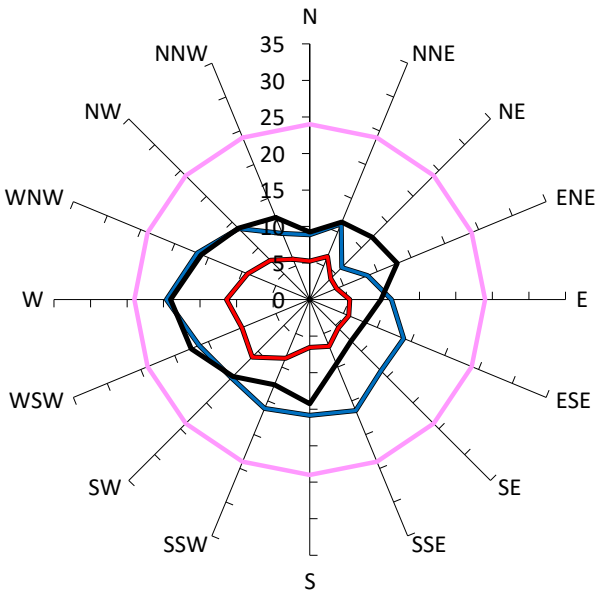
Results for Point 39

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	15
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

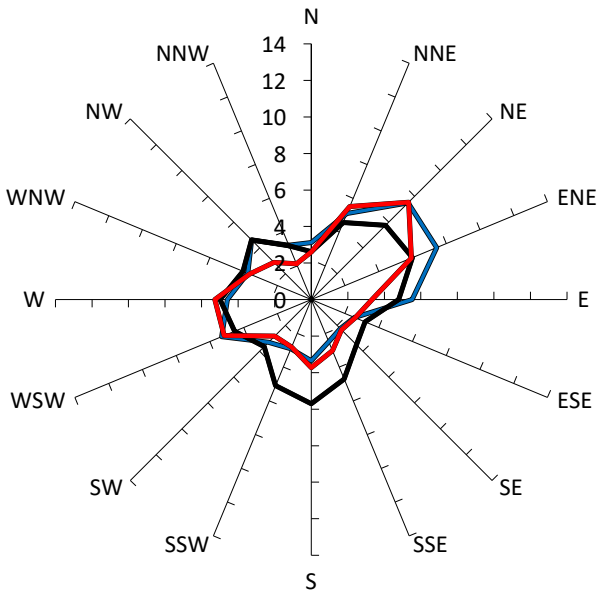
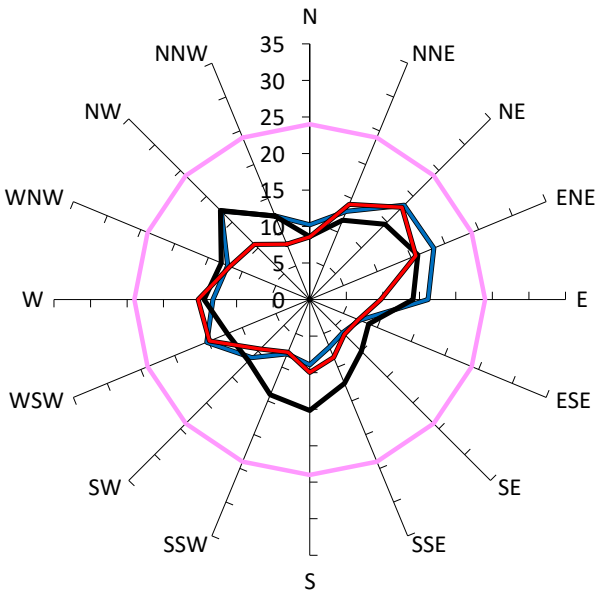
Results for Point 40

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	20
Existing Site	1%	19
With inclusion of Existing and Retained Trees	0%	11

WD510-10 Waterloo South 7/02/2020

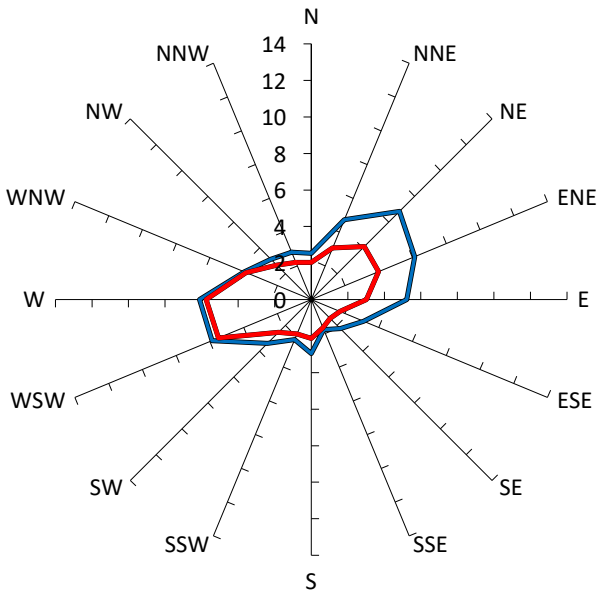
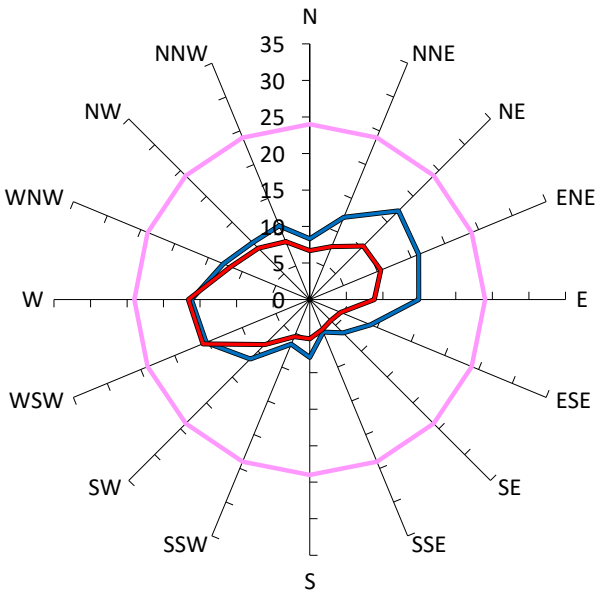
Results for Point 41

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	18
Existing Site	1%	17
With inclusion of Existing and Retained Trees	1%	18

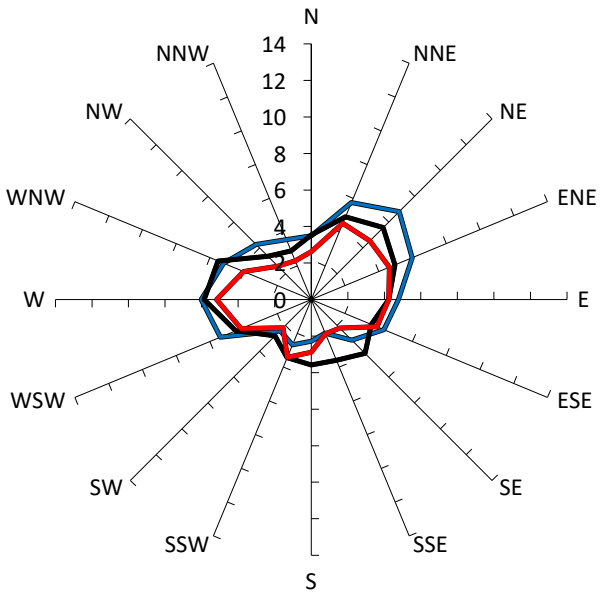
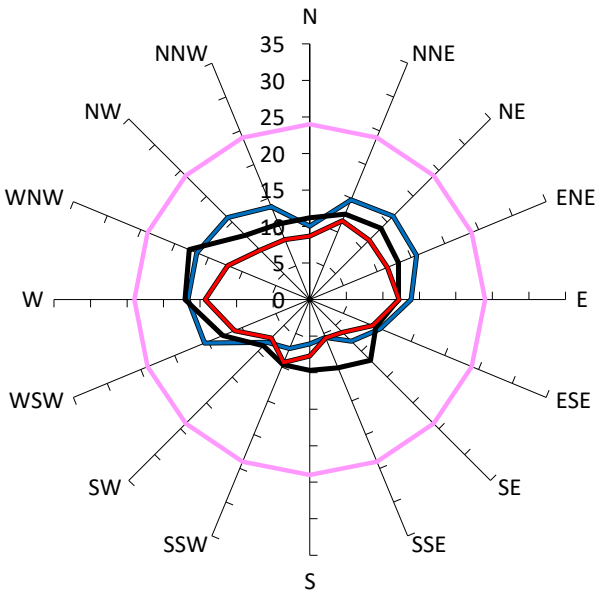
WD510-10 Waterloo South 7/02/2020

Results for Point 42

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	0%	17

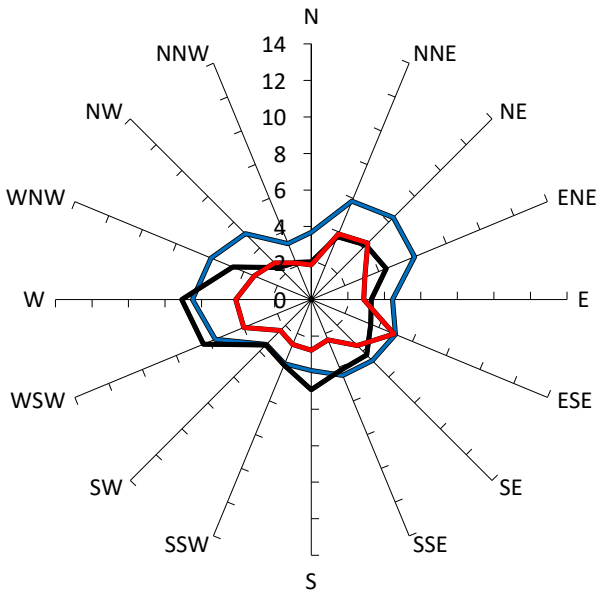
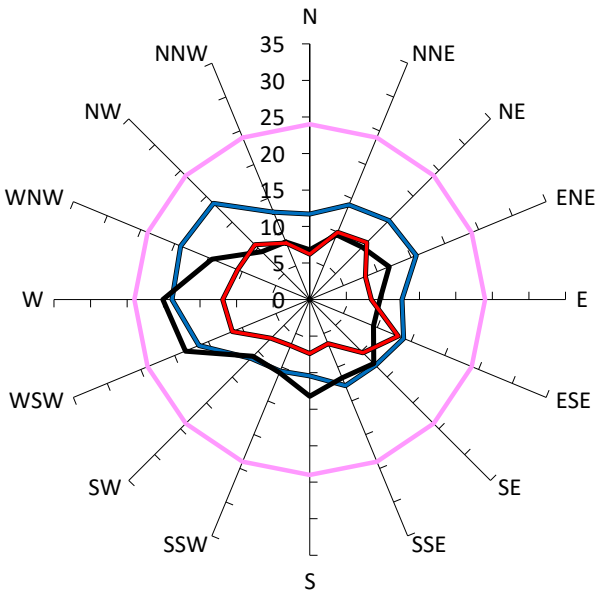
Results for Point 43

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	0%	18
With inclusion of Existing and Retained Trees	0%	14

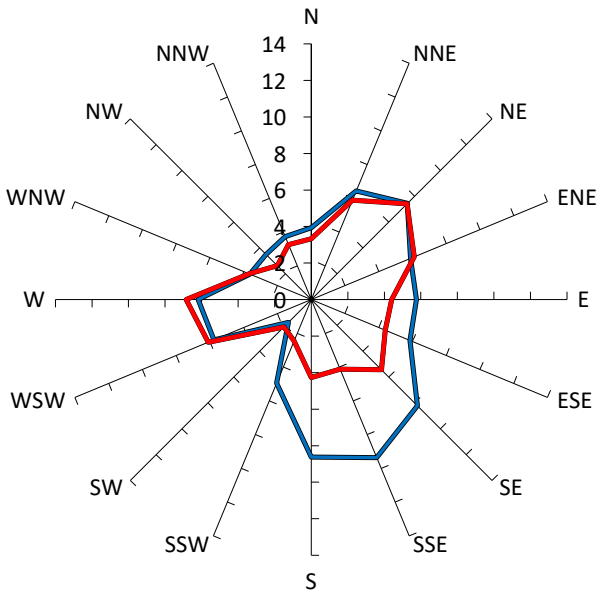
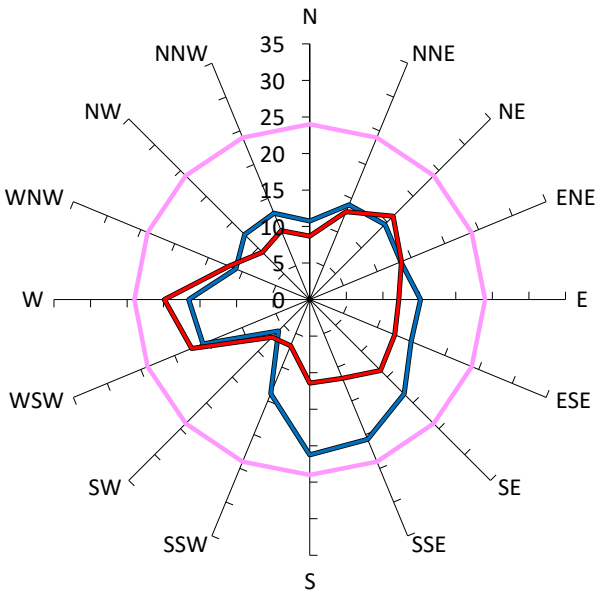
WD510-10 Waterloo South 7/02/2020

Results for Point 44

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

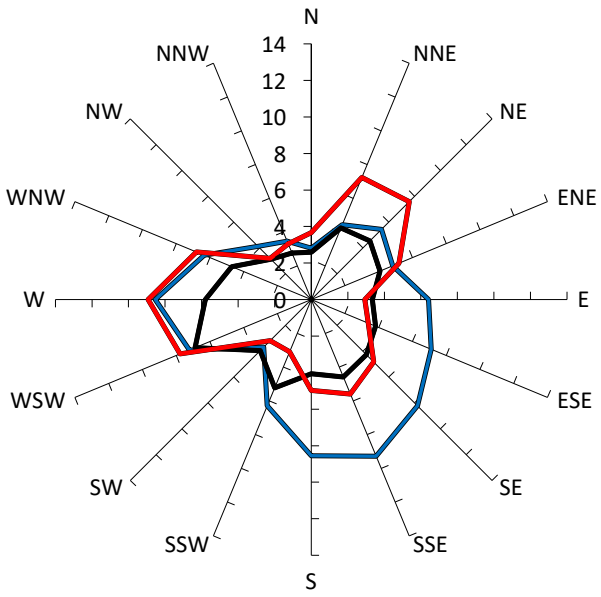
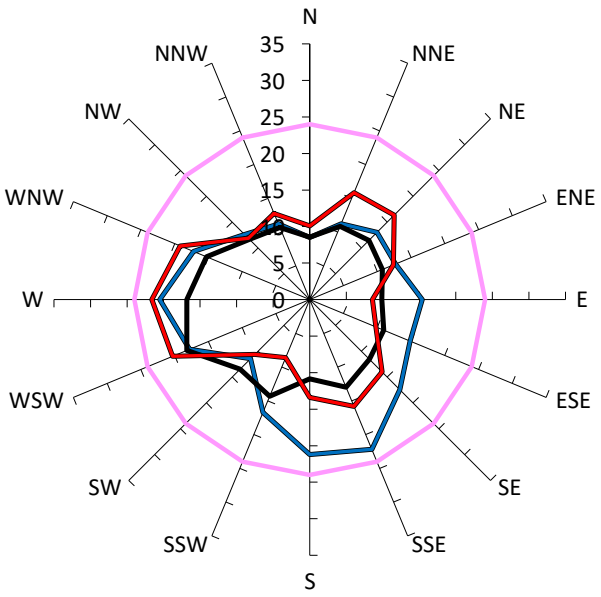
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
Existing Site	1%	20
With inclusion of Existing and Retained Trees	0%	13

Results for Point 45

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	9%	21
With inclusion of Existing and Retained Trees	2%	20

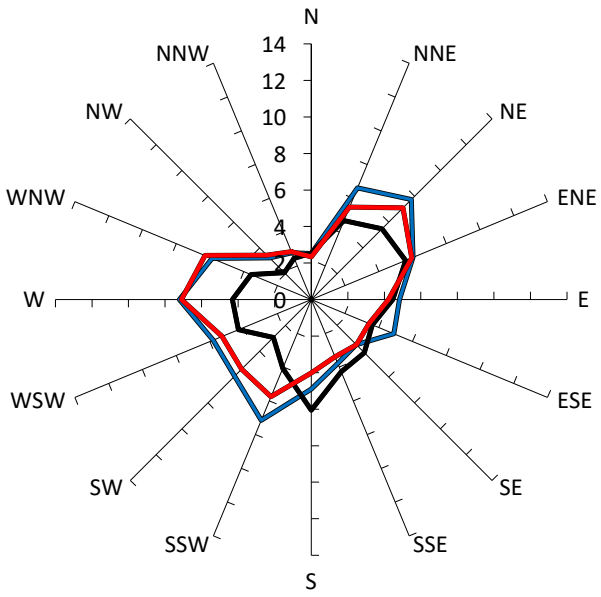
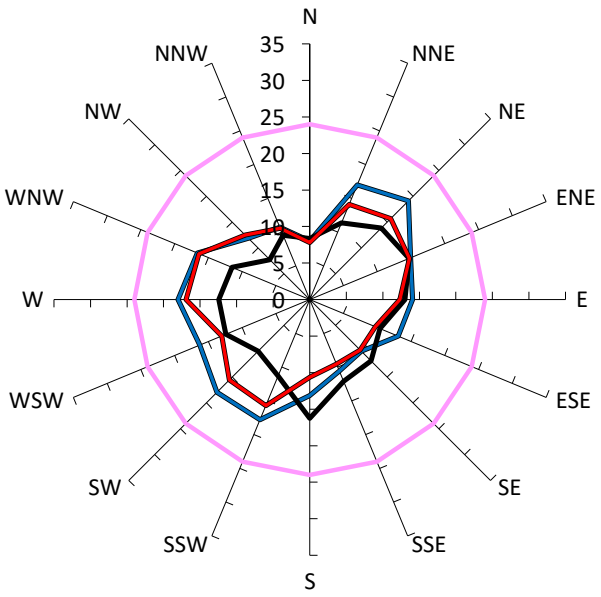
Results for Point 46

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	11%	22
Existing Site	1%	18
With inclusion of Existing and Retained Trees	5%	22

WD510-10 Waterloo South 7/02/2020

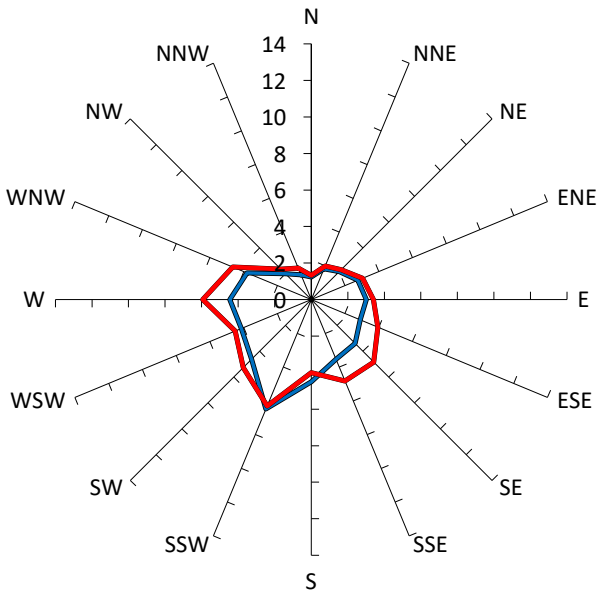
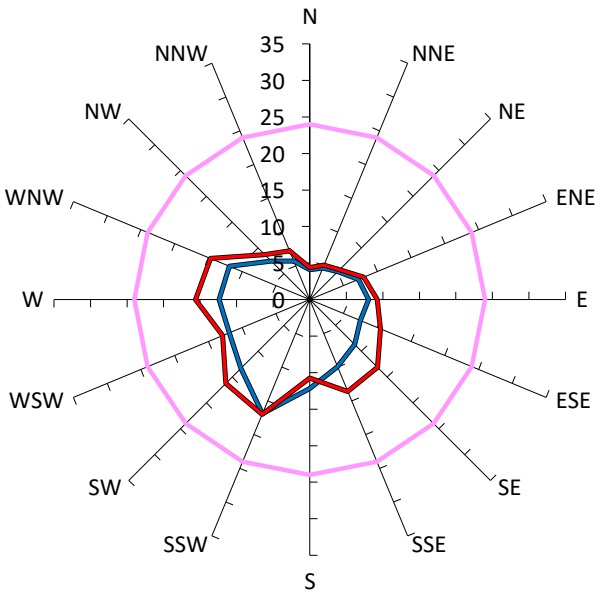
Results for Point 47

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	19
Existing Site	0%	16
With inclusion of Existing and Retained Trees	2%	17

WD510-10 Waterloo South 7/02/2020

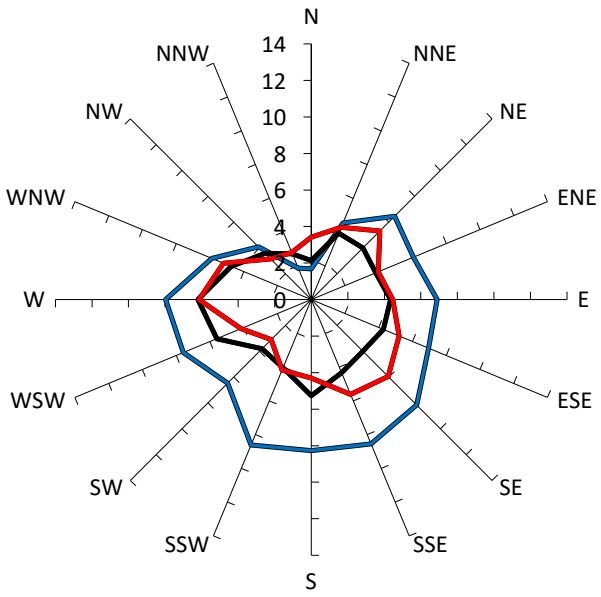
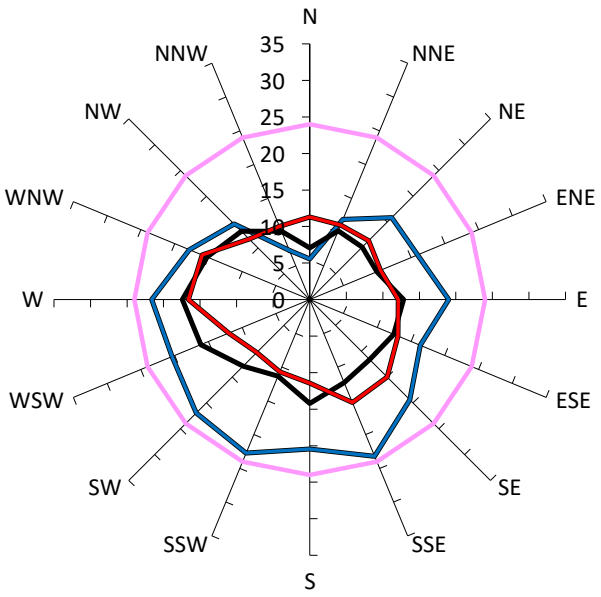
Results for Point 48

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	17
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

Results for Point 49

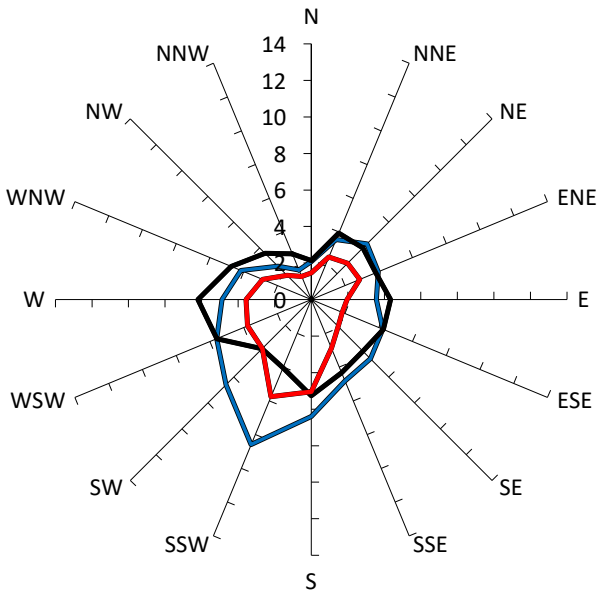
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	11%	23
Existing Site	1%	17
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

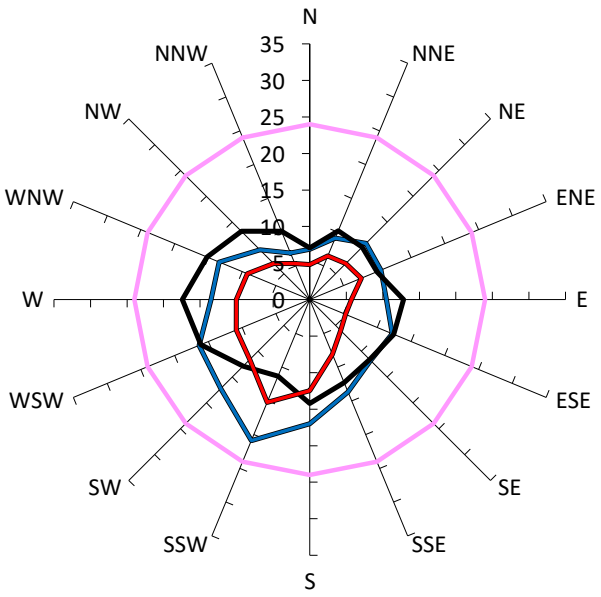
Results for Point 50

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

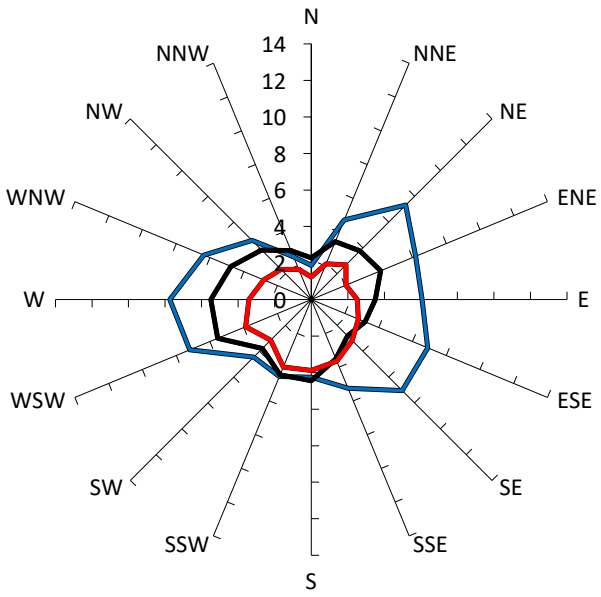
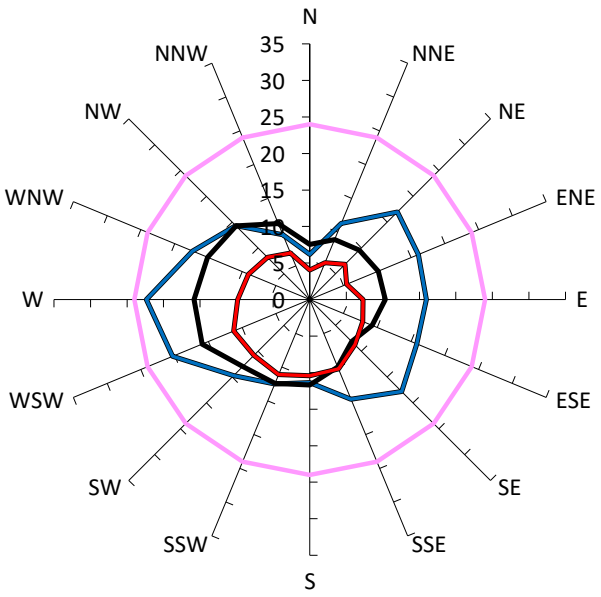
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	21
Existing Site	1%	17
With inclusion of Existing and Retained Trees	0%	15

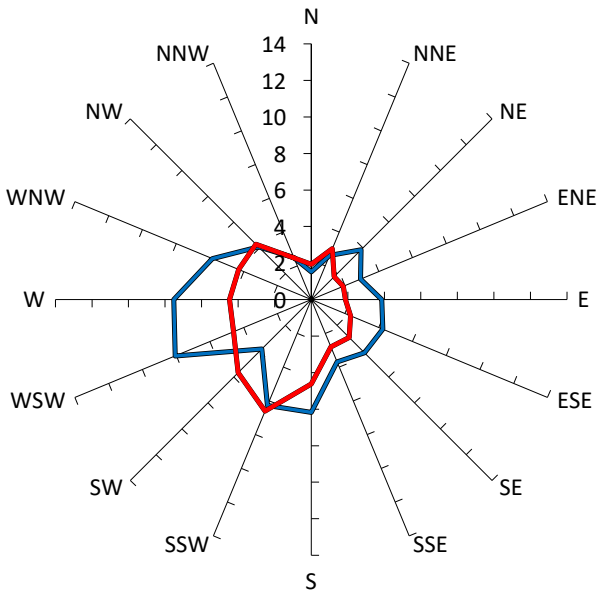
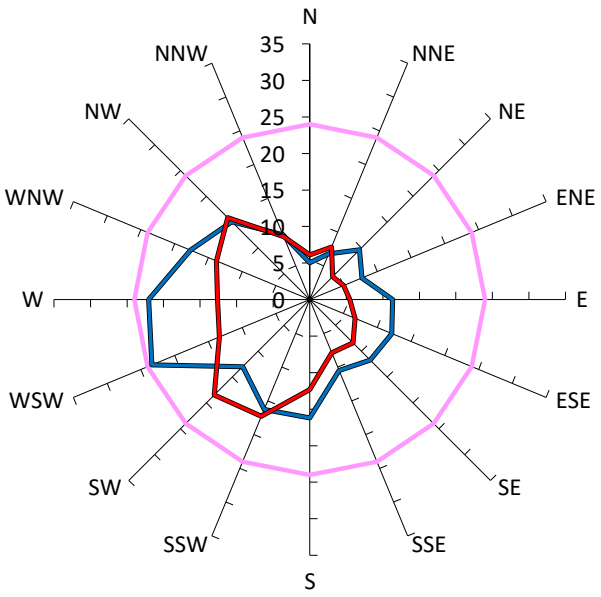
Results for Point 51

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	22
Existing Site	0%	16
With inclusion of Existing and Retained Trees	0%	11

WD510-10 Waterloo South 7/02/2020

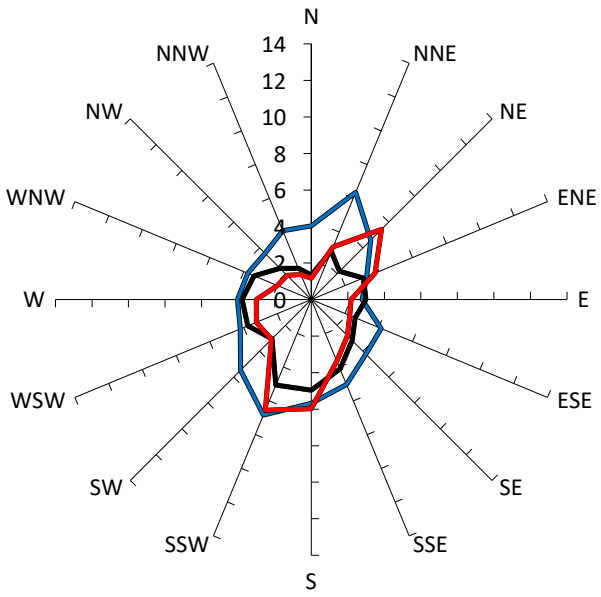
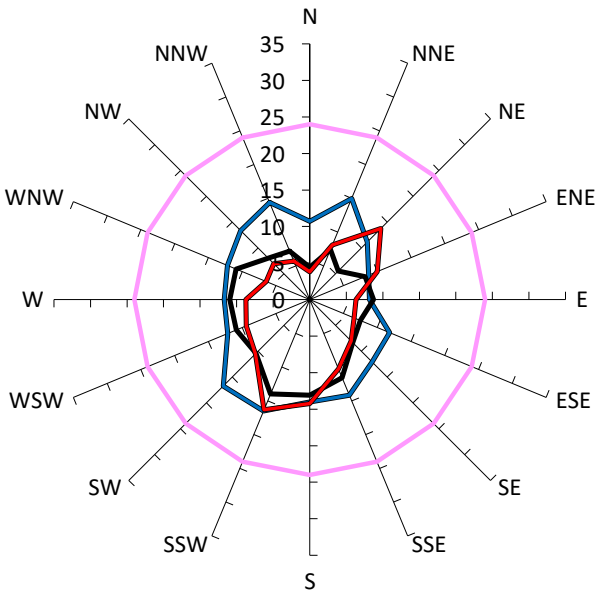
Results for Point 52

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	23
With inclusion of Existing and Retained Trees	1%	18

WD510-10 Waterloo South 7/02/2020

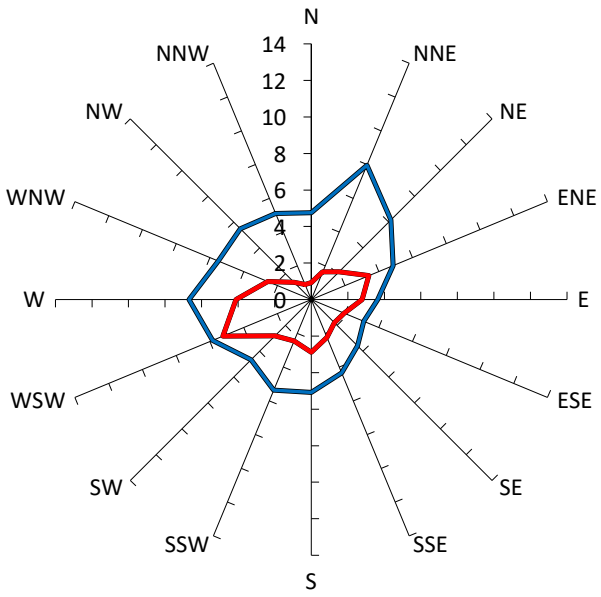
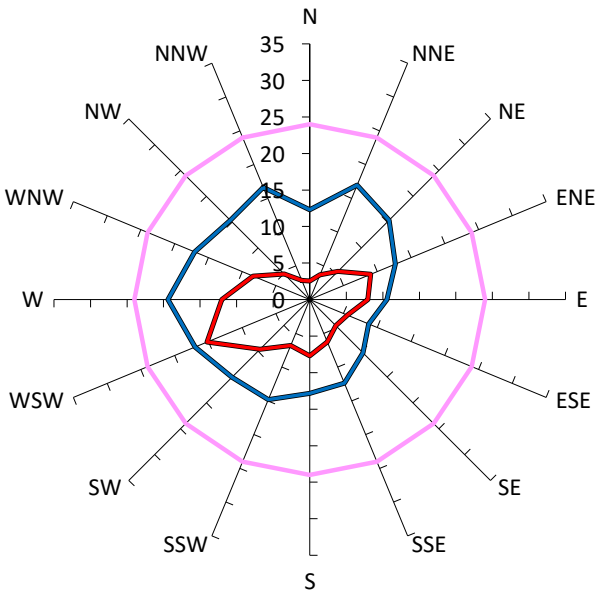
Results for Point 53

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	16

WD510-10 Waterloo South 7/02/2020

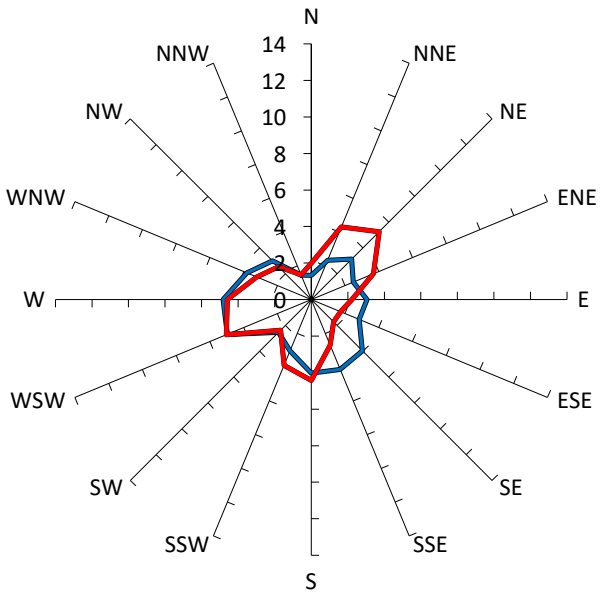
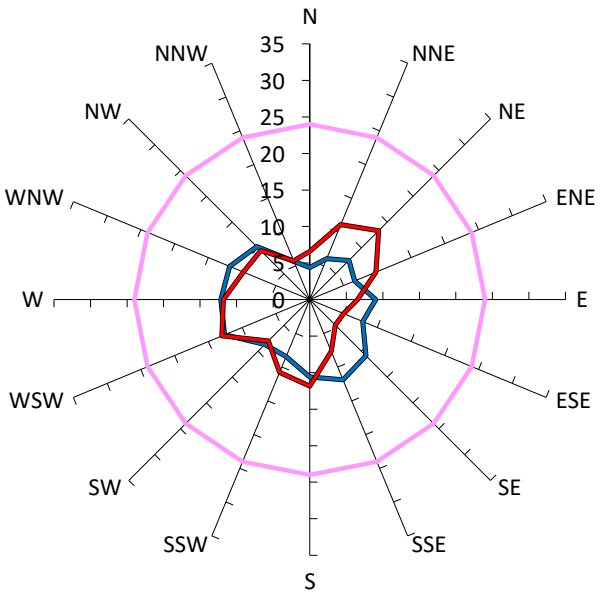
Results for Point 54

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	19
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

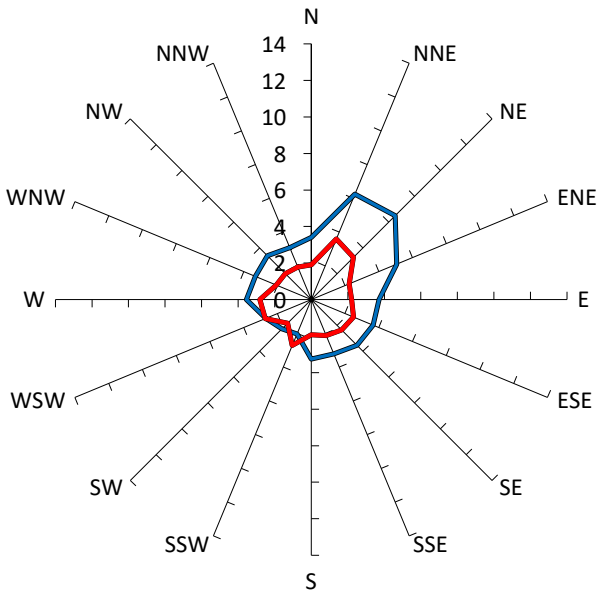
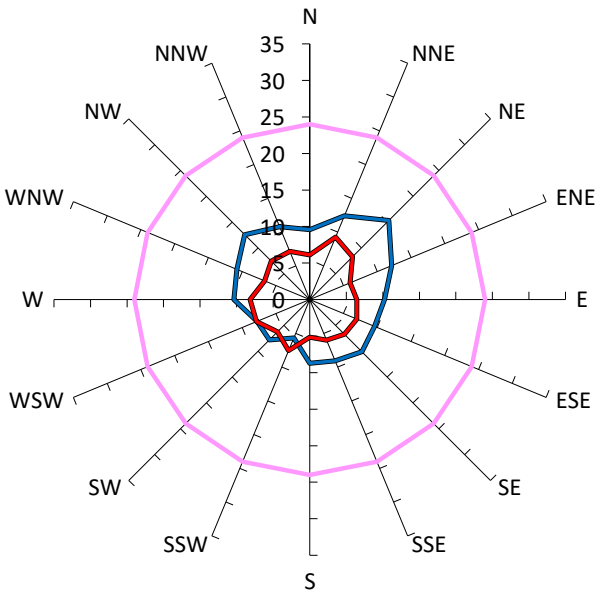
Results for Point 55

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	13
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

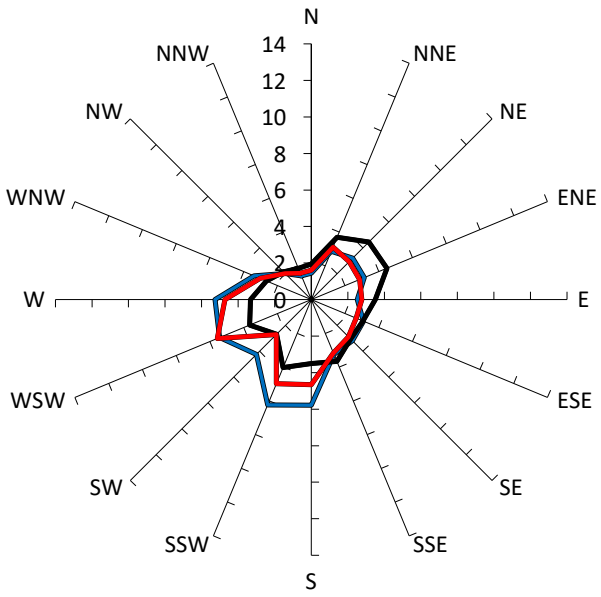
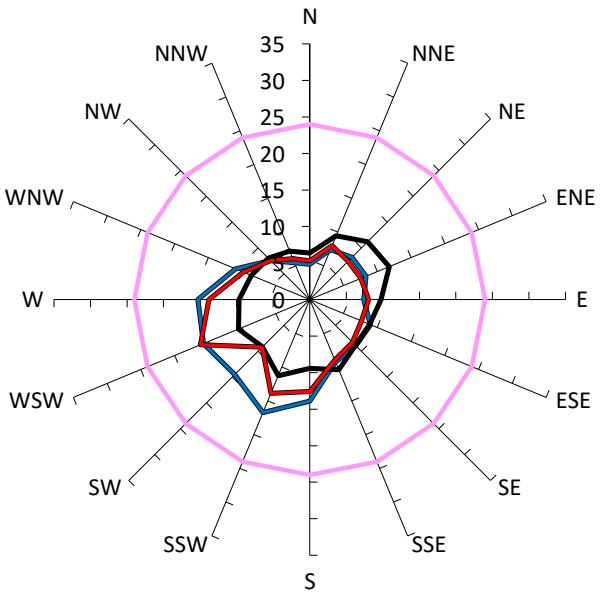
Results for Point 56

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
With inclusion of Existing and Retained Trees	0%	9

WD510-10 Waterloo South 7/02/2020

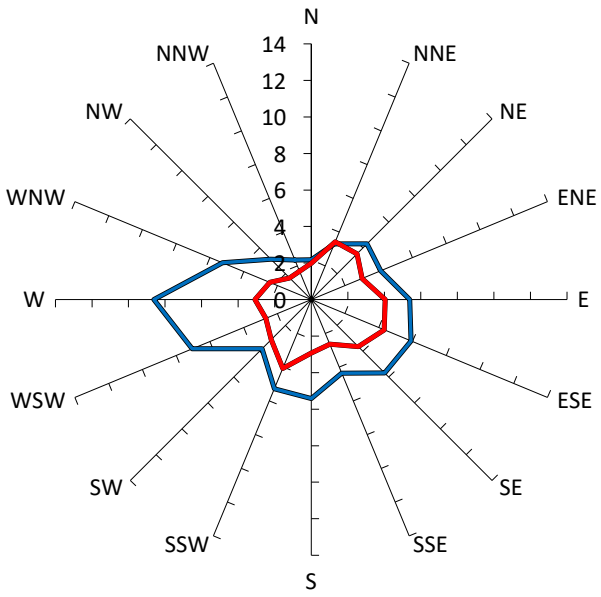
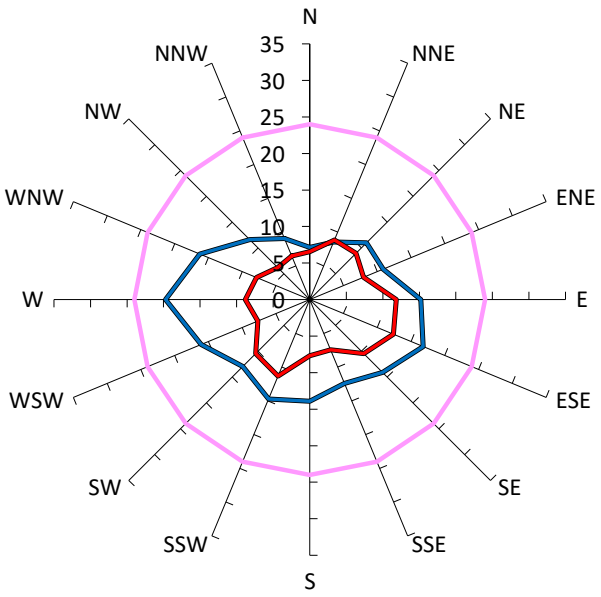
Results for Point 57

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	0%	12
With inclusion of Existing and Retained Trees	0%	16

WD510-10 Waterloo South 7/02/2020

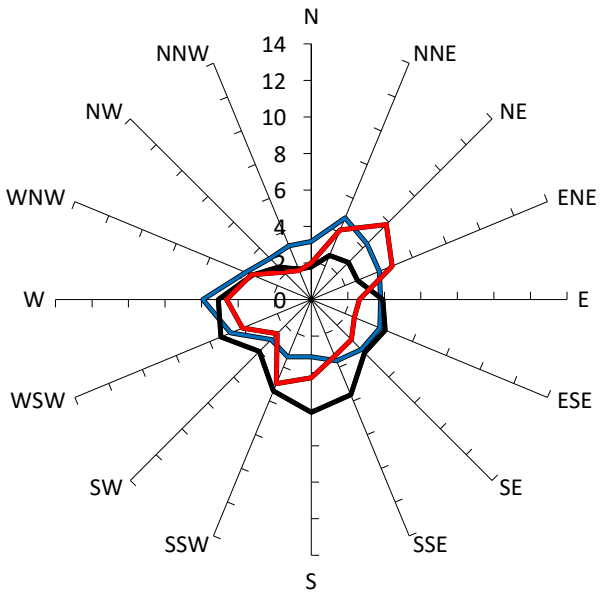
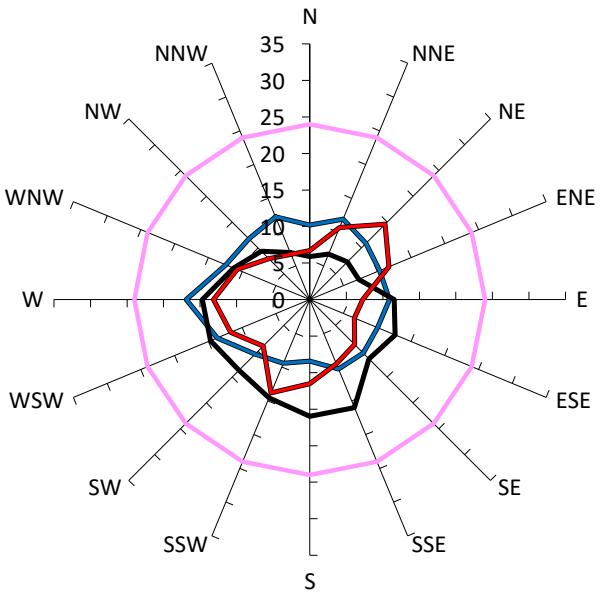
Results for Point 58

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	20
With inclusion of Existing and Retained Trees	0%	12

WD510-10 Waterloo South 7/02/2020

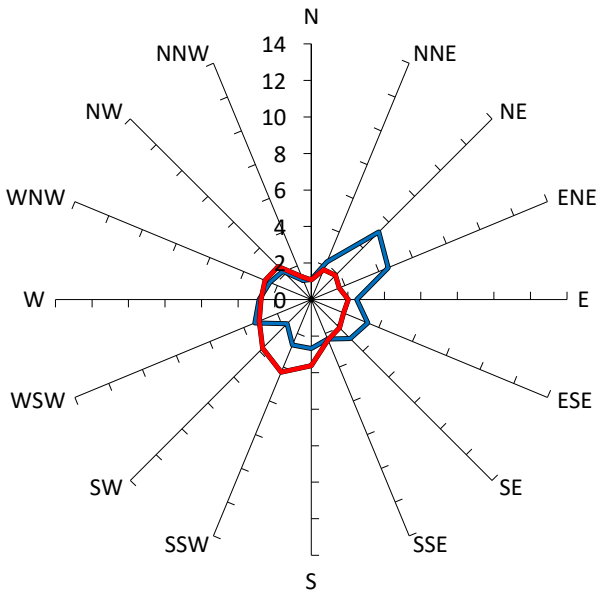
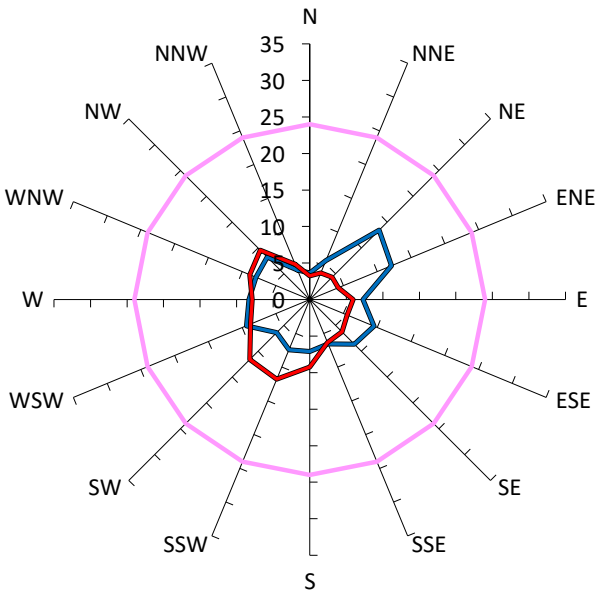
Results for Point 59

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	17
Existing Site	1%	16
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

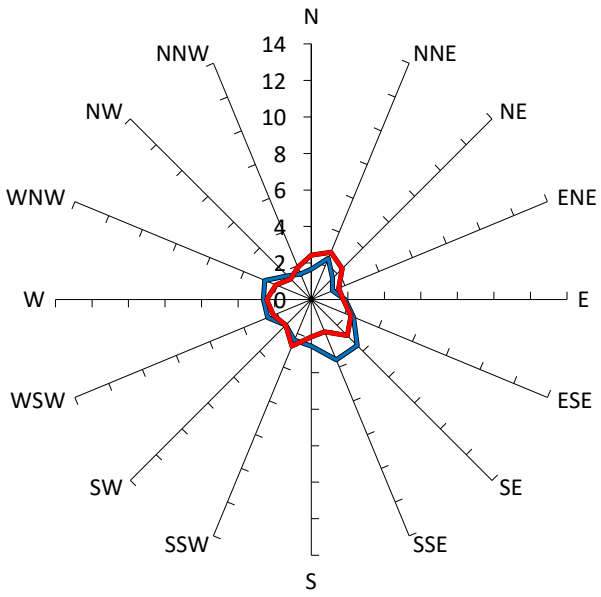
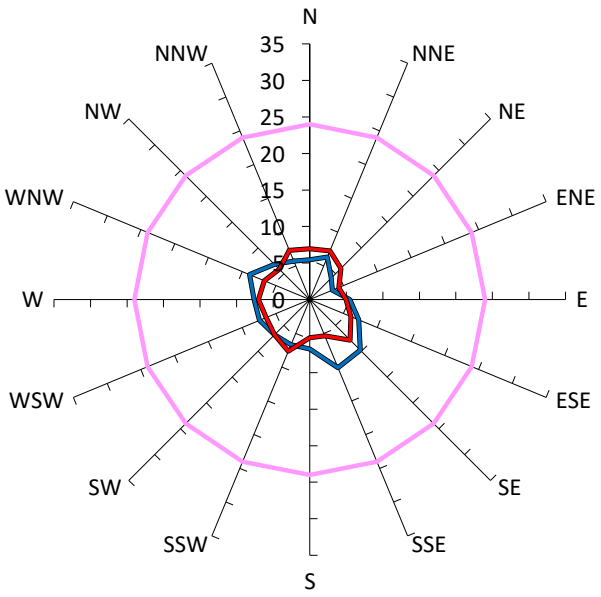
Results for Point 60

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	13
With inclusion of Existing and Retained Trees	0%	12

WD510-10 Waterloo South 7/02/2020

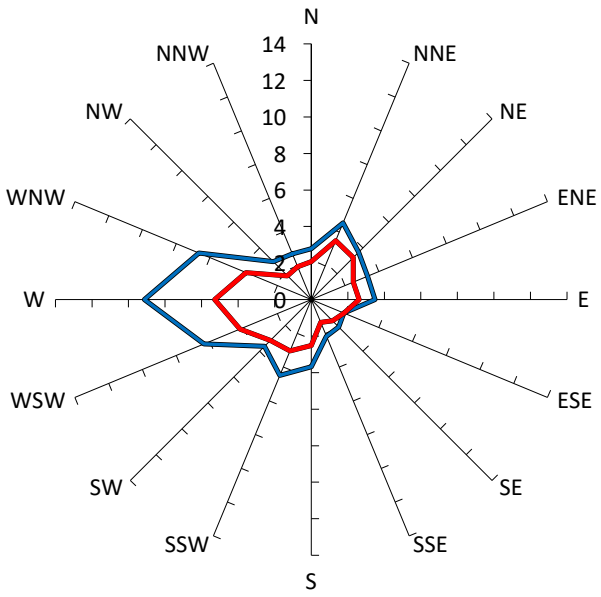
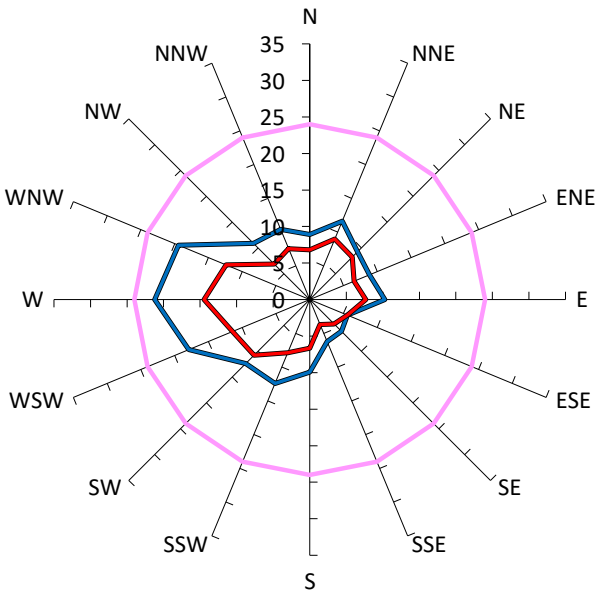
Results for Point 61

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	10
With inclusion of Existing and Retained Trees	0%	8

WD510-10 Waterloo South 7/02/2020

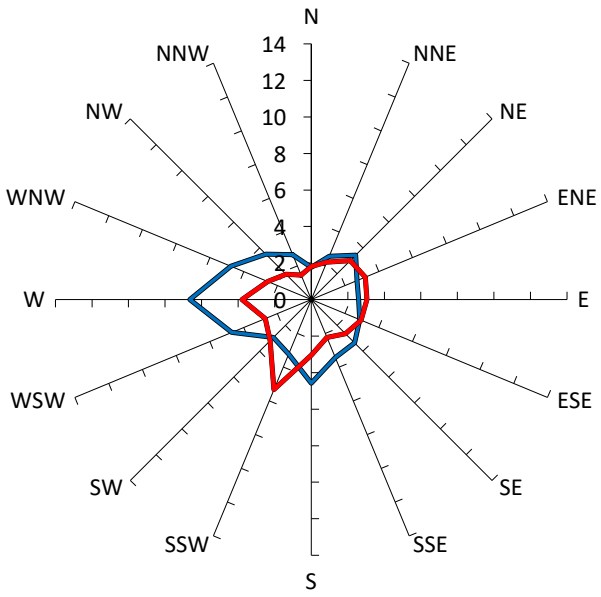
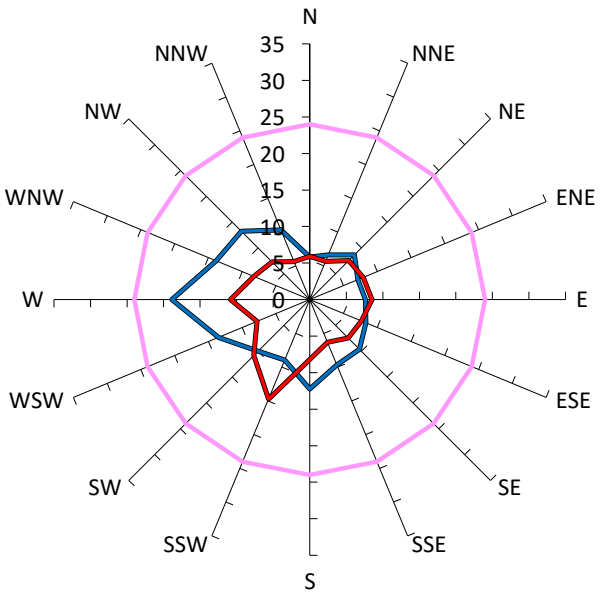
Results for Point 62

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	21
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

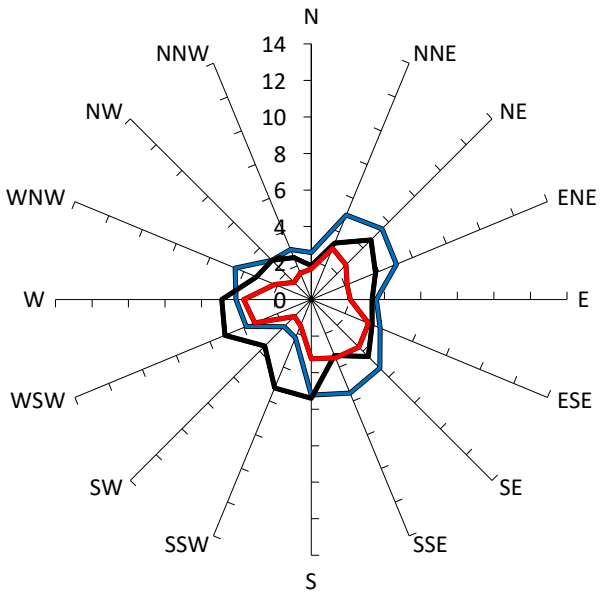
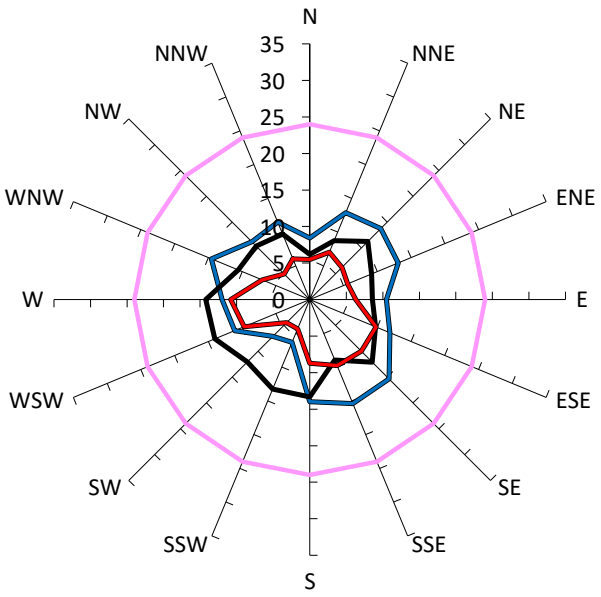
Results for Point 63

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
With inclusion of Existing and Retained Trees	0%	15

WD510-10 Waterloo South 7/02/2020

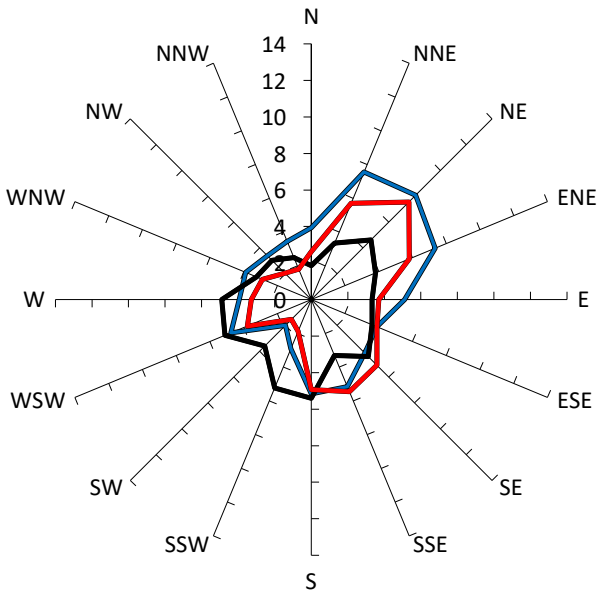
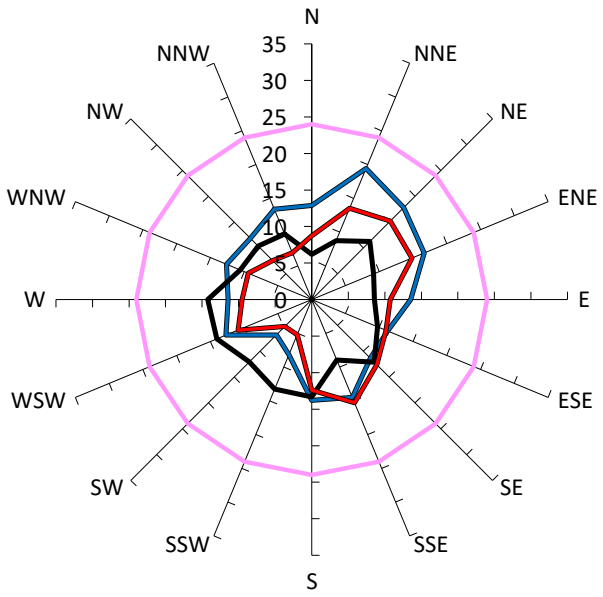
Results for Point 64

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	11

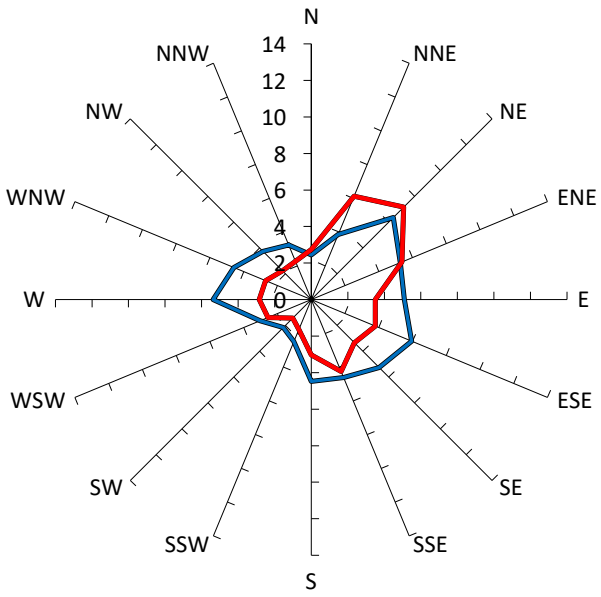
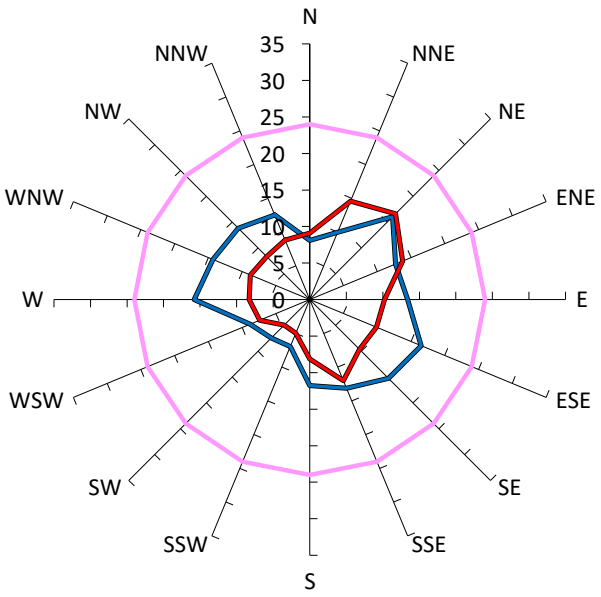
WD510-10 Waterloo South 7/02/2020

Results for Point 65

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	19
Existing Site	0%	14
With inclusion of Existing and Retained Trees	1%	15

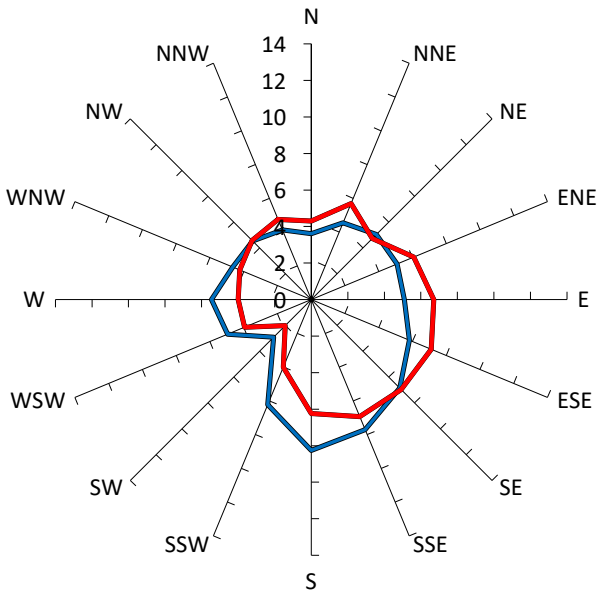
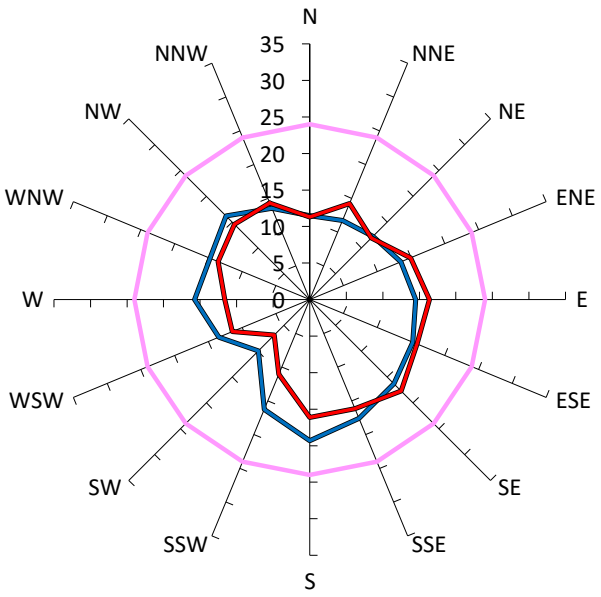
Results for Point 66

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

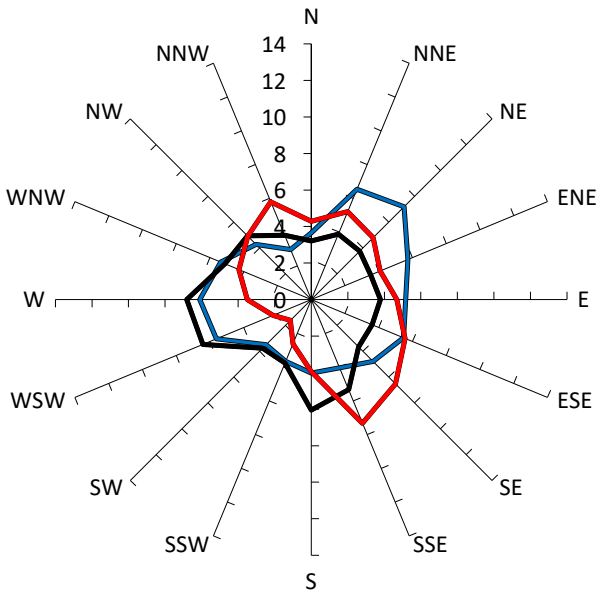
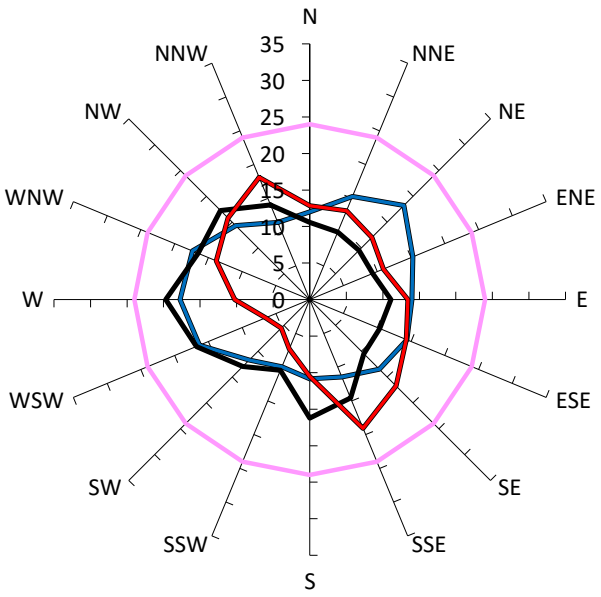
Results for Point 67

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	19
With inclusion of Existing and Retained Trees	3%	18

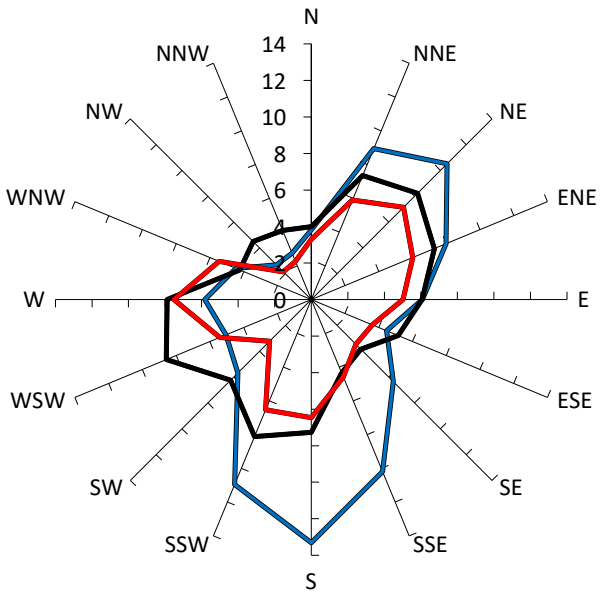
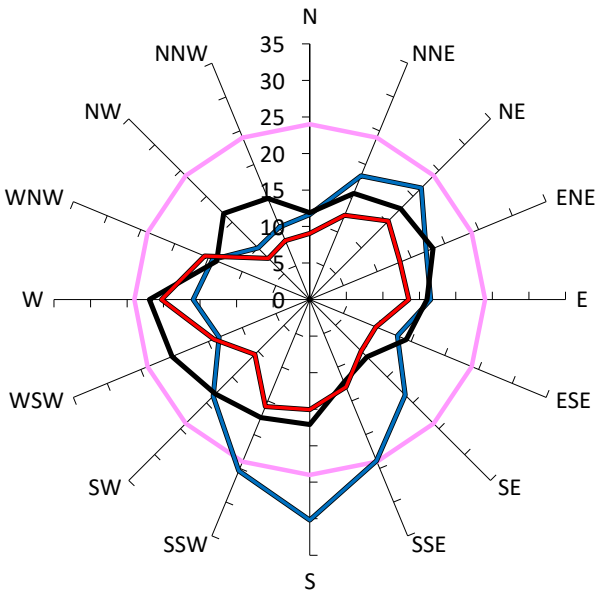
WD510-10 Waterloo South 7/02/2020

Results for Point 68

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

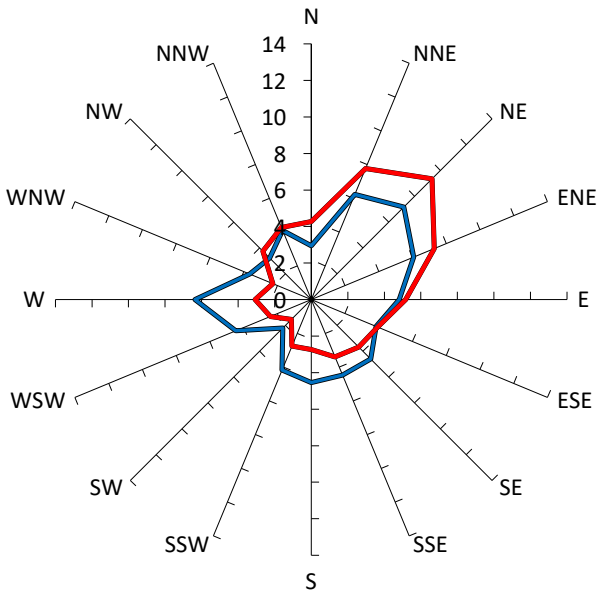
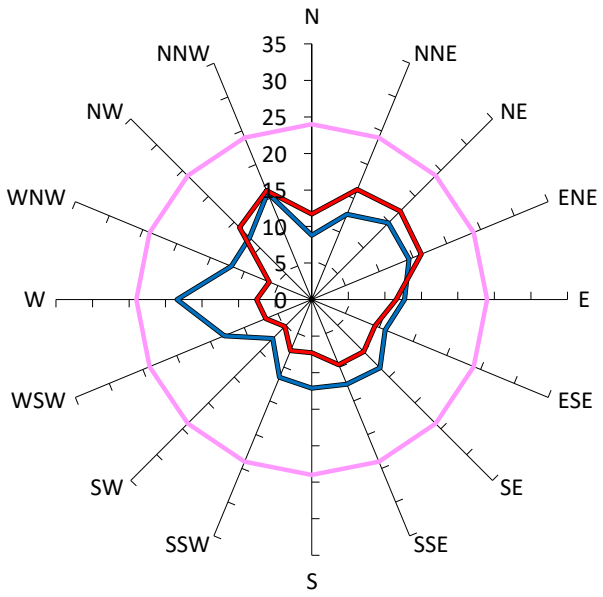
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
Existing Site	1%	20
With inclusion of Existing and Retained Trees	2%	19

Results for Point 69

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	28%	30
Existing Site	8%	22
With inclusion of Existing and Retained Trees	2%	20

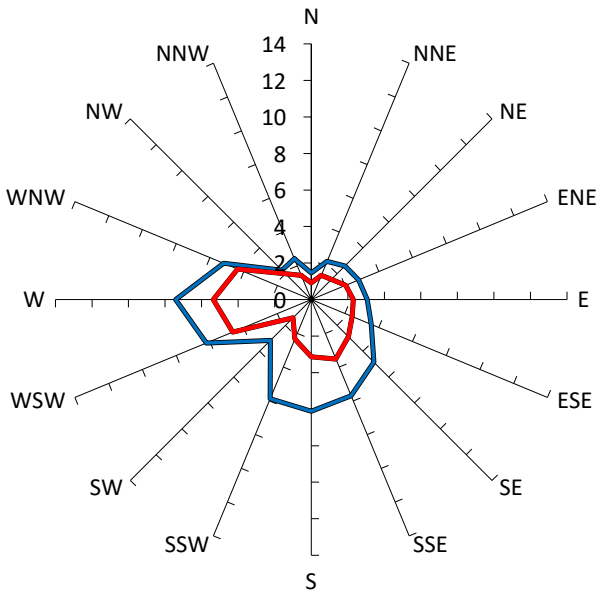
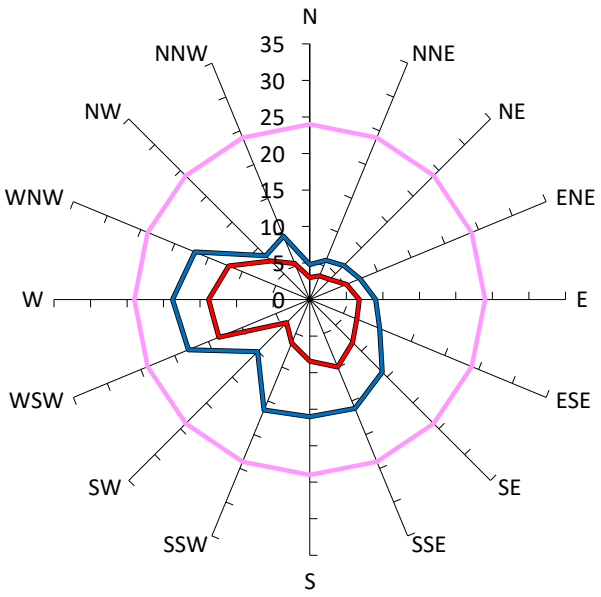
Results for Point 70

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
With inclusion of Existing and Retained Trees	5%	17

WD510-10 Waterloo South 7/02/2020

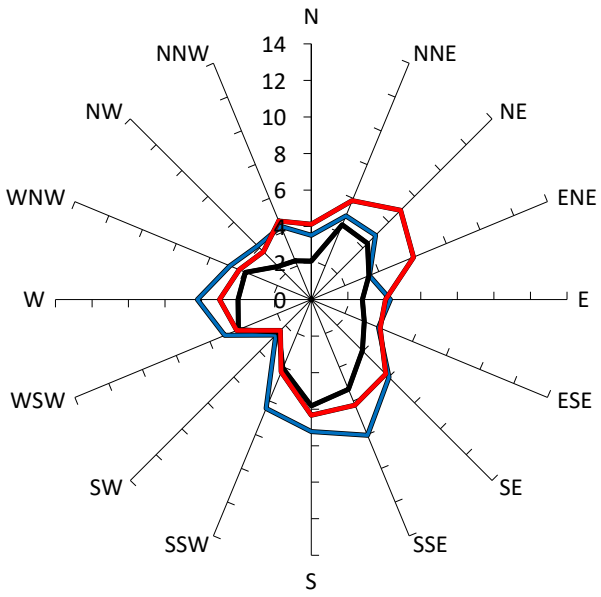
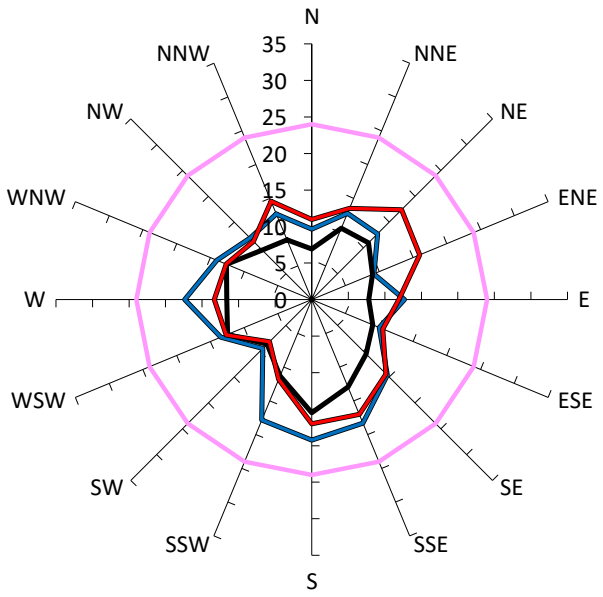
Results for Point 71

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	19
With inclusion of Existing and Retained Trees	0%	14

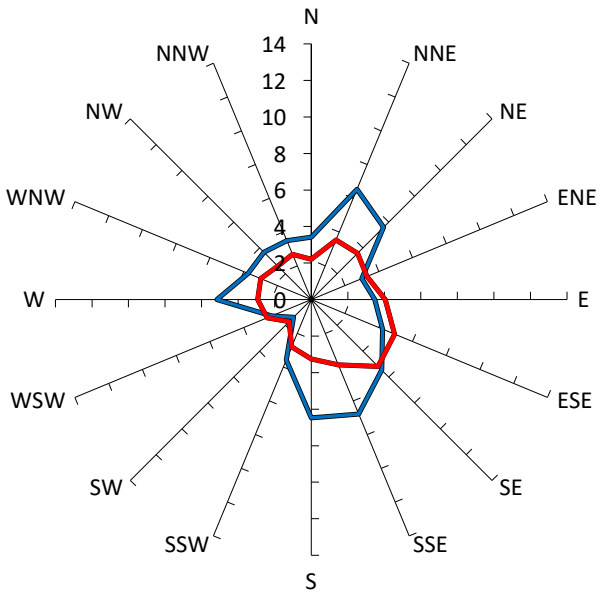
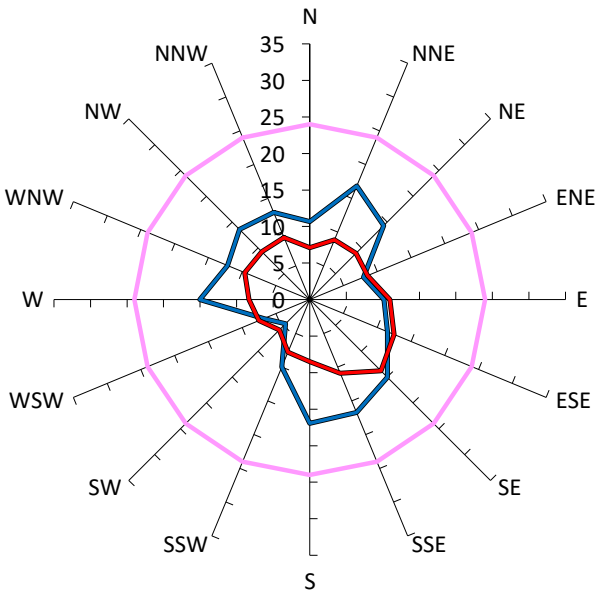
WD510-10 Waterloo South 7/02/2020

Results for Point 72

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	19
Existing Site	0%	15
With inclusion of Existing and Retained Trees	1%	17

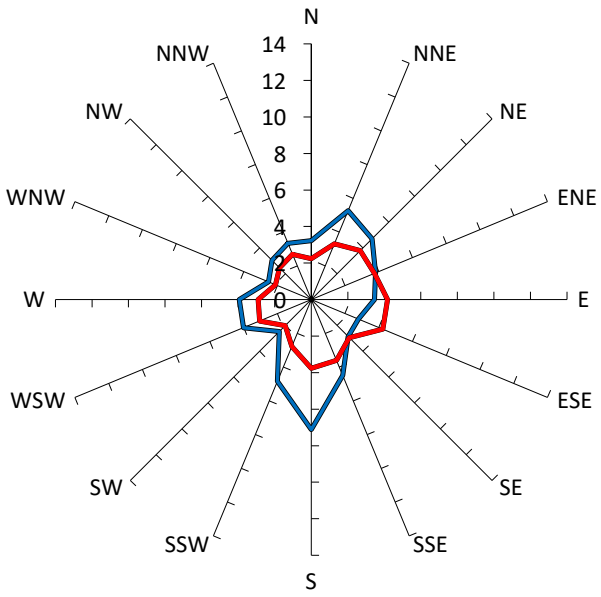
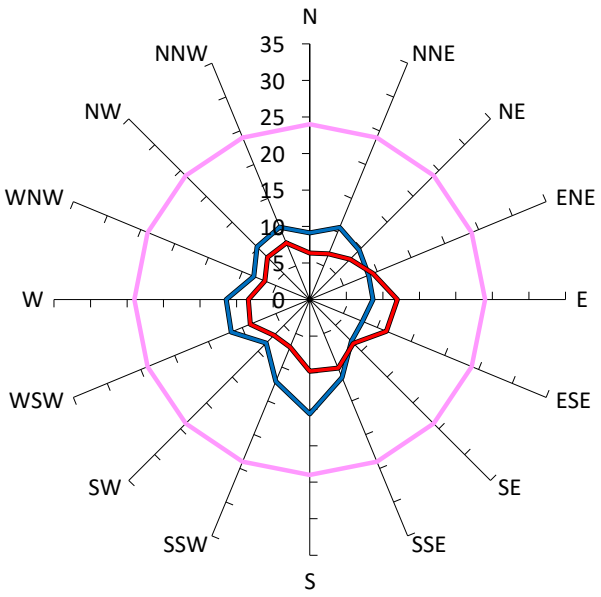
Results for Point 73

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

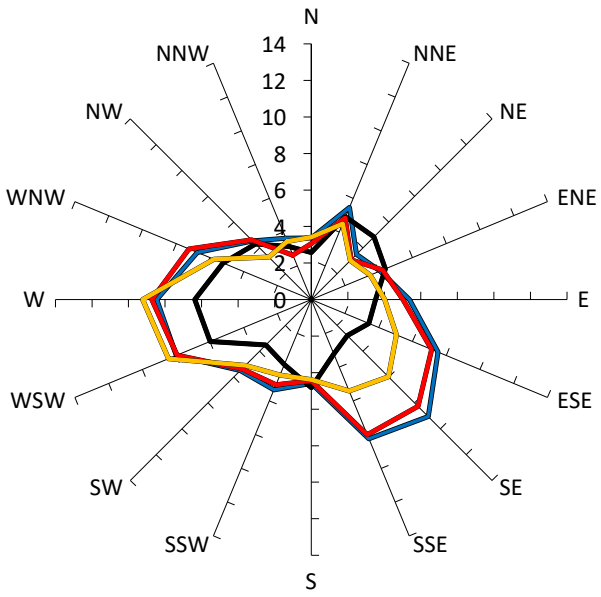
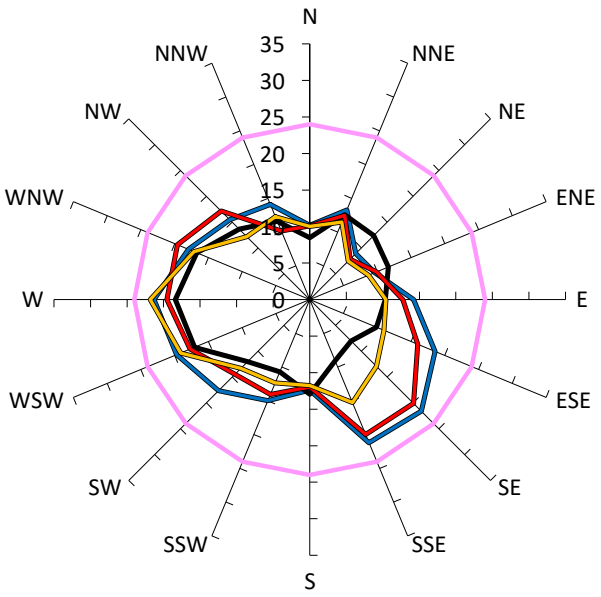
Results for Point 74

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	16
With inclusion of Existing and Retained Trees	0%	12

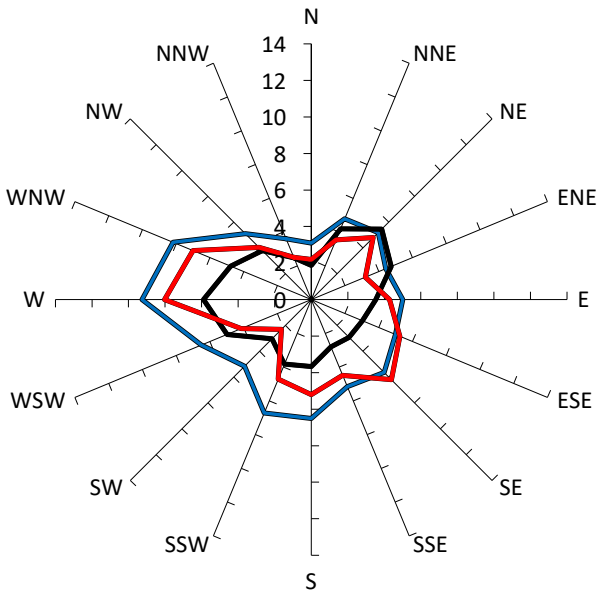
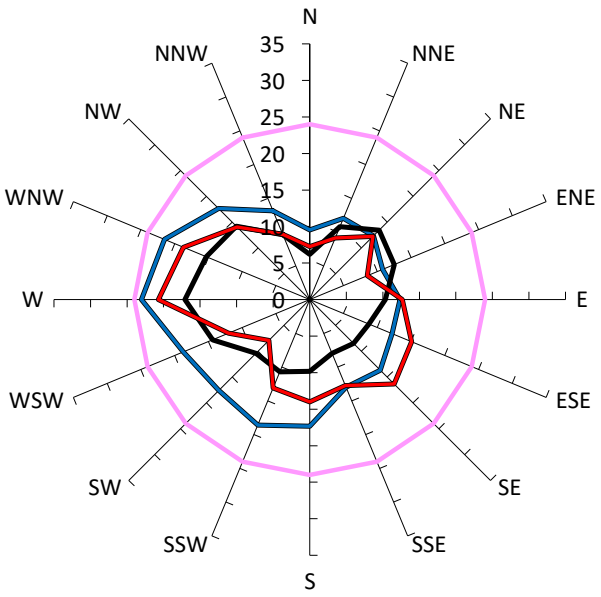
WD510-10 Waterloo South 7/02/2020

Results for Point 75

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	9%	22
Existing Site	1%	18
With inclusion of Existing and Retained Trees	8%	20
Inclusion of porous screen - 5m length x 2m height adjacent Building U4	5%	22

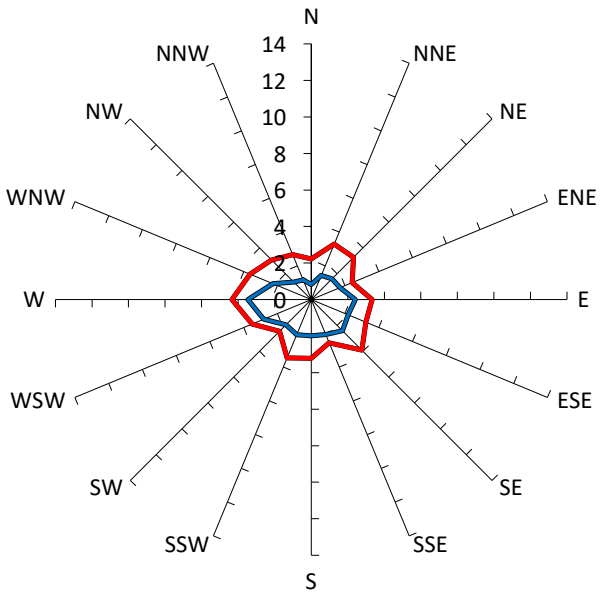
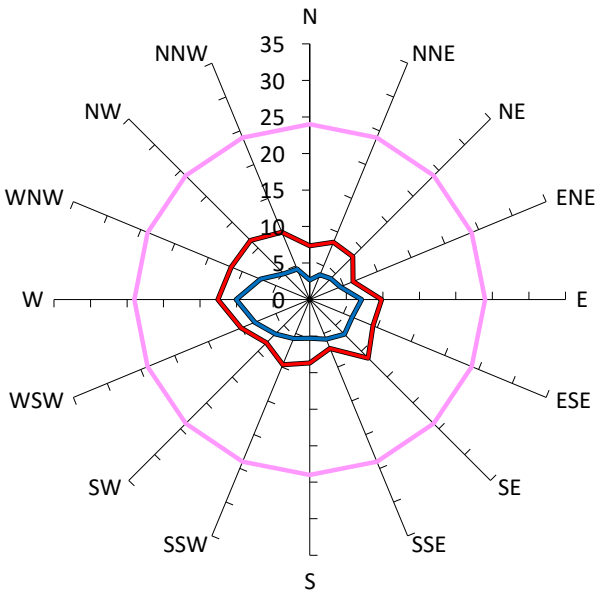
Results for Point 76

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	5%	23
Existing Site	0%	17
With inclusion of Existing and Retained Trees	2%	21

WD510-10 Waterloo South 7/02/2020

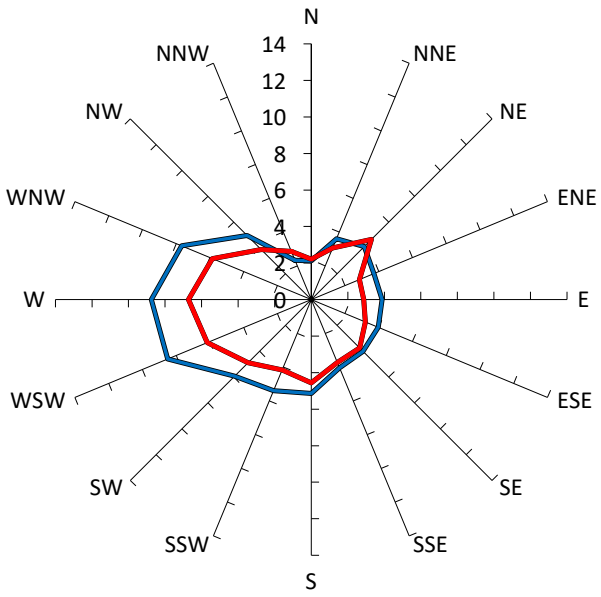
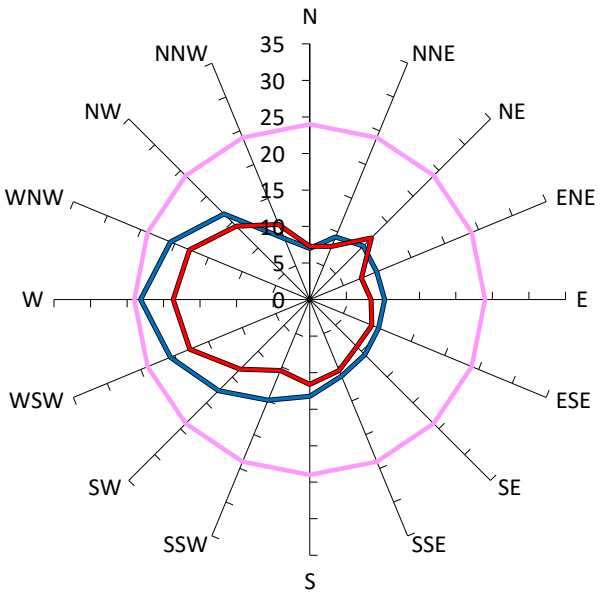
Results for Point 77

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	10
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

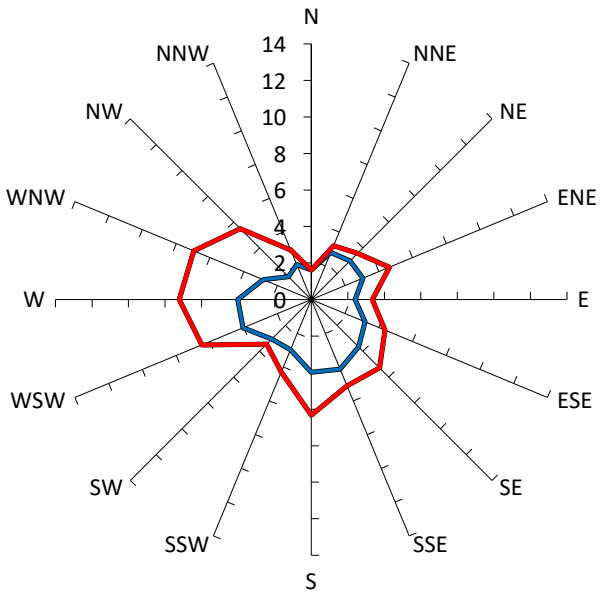
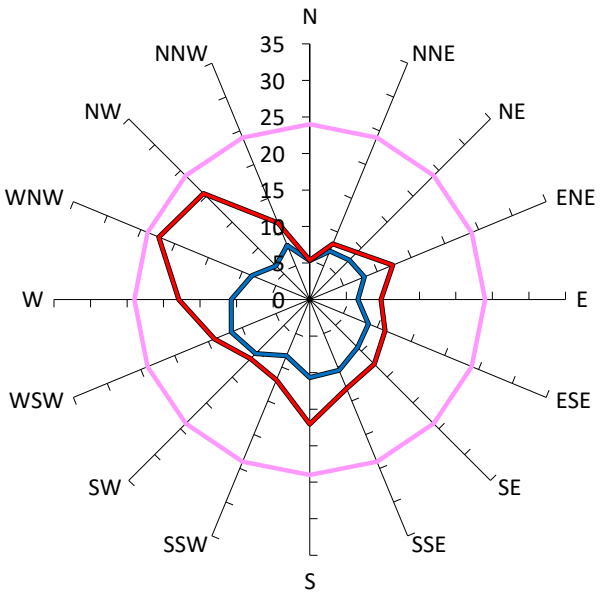
Results for Point 78

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	5%	23
With inclusion of Existing and Retained Trees	1%	19

WD510-10 Waterloo South 7/02/2020

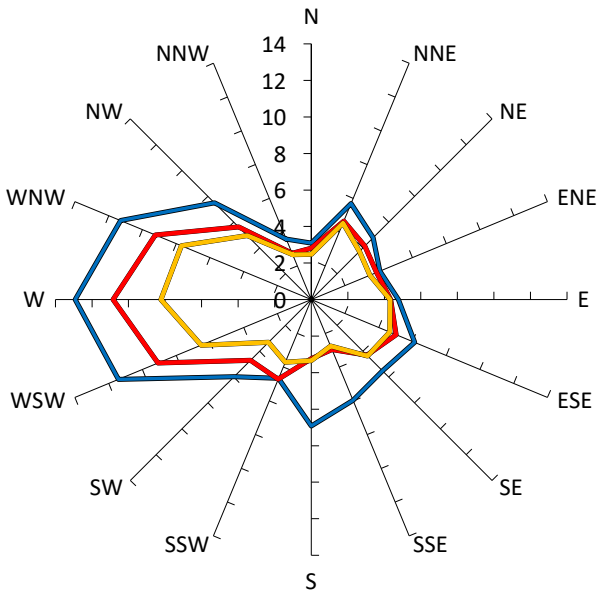
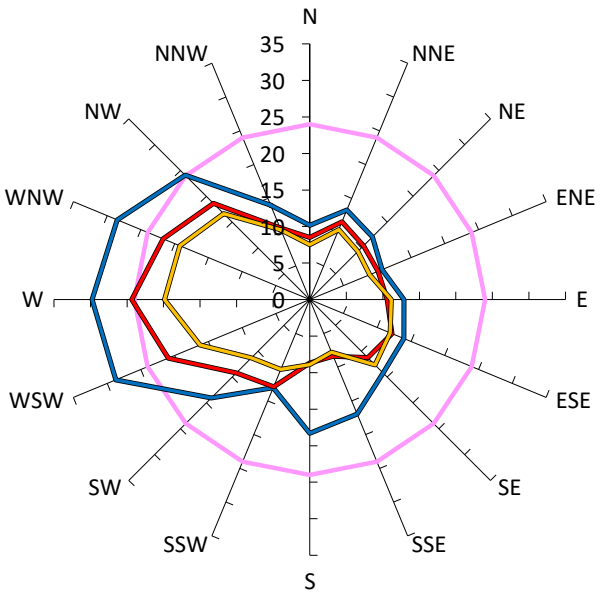
Results for Point 79

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	12
With inclusion of Existing and Retained Trees	2%	22

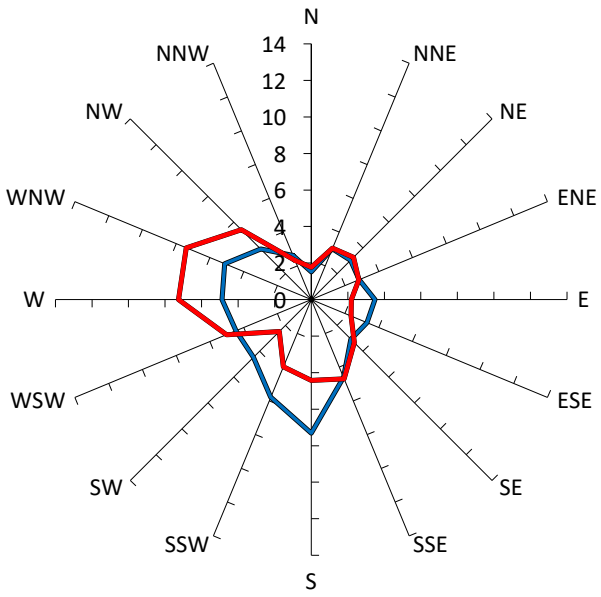
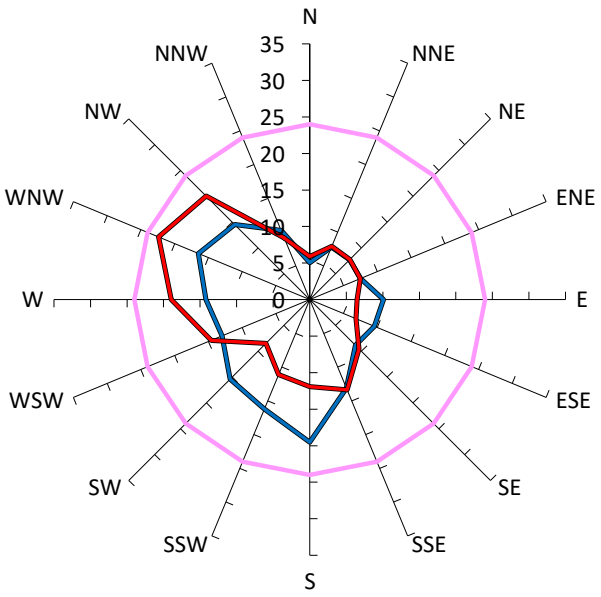
WD510-10 Waterloo South 7/02/2020

Results for Point 80

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	15%	30
Wrap around awning along Western and part of Southern Façade of LOT U	9%	24
Awning along Western and Southern façade of LOT U	3%	20

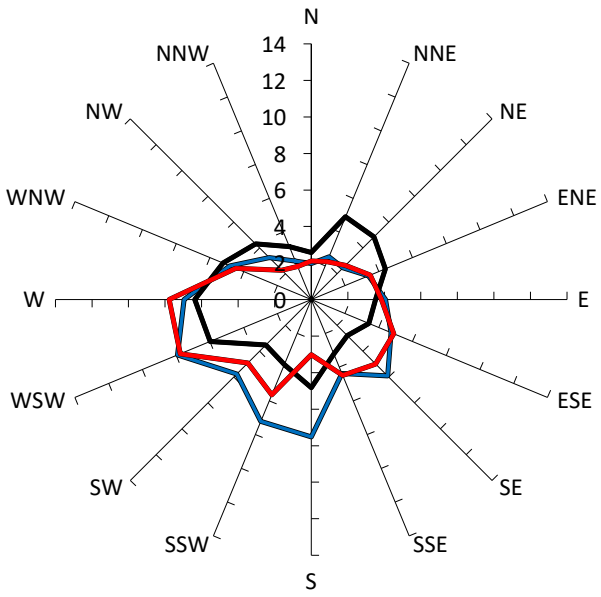
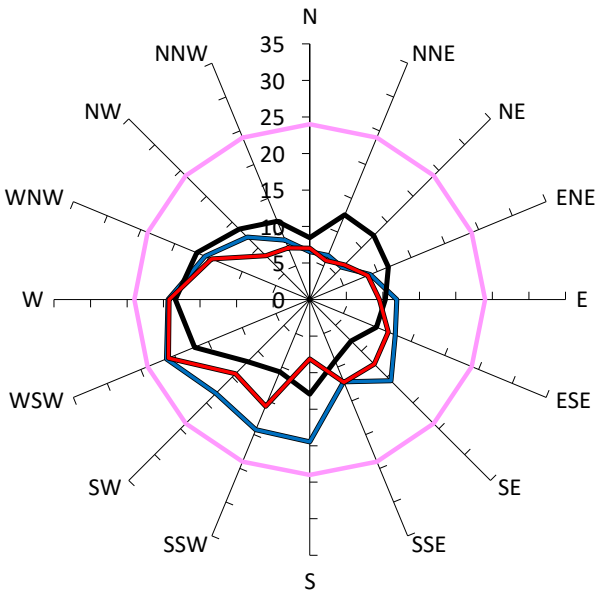
Results for Point 81

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	20
With inclusion of Existing and Retained Trees	2%	22

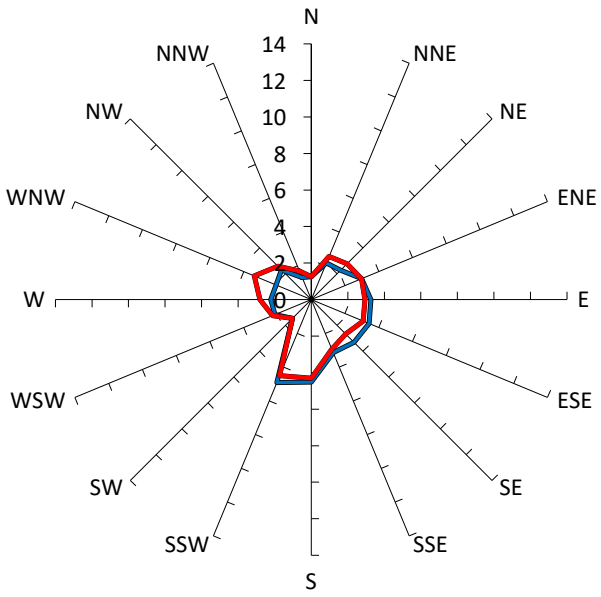
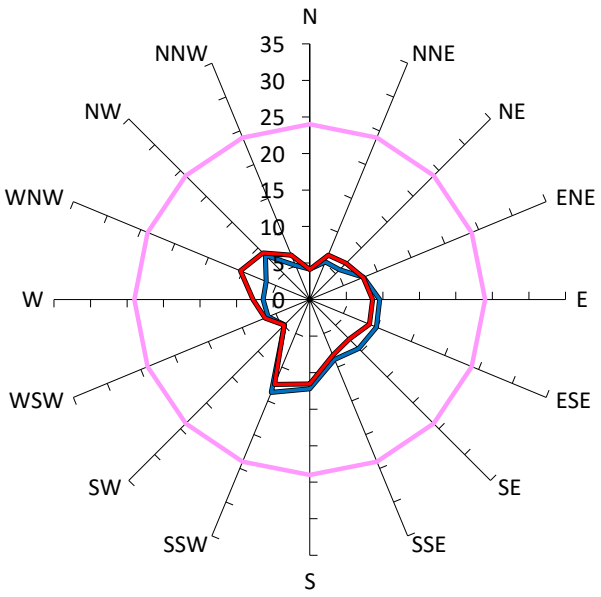
WD510-10 Waterloo South 7/02/2020

Results for Point 82

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	21
Existing Site	1%	18
With inclusion of Existing and Retained Trees	2%	21

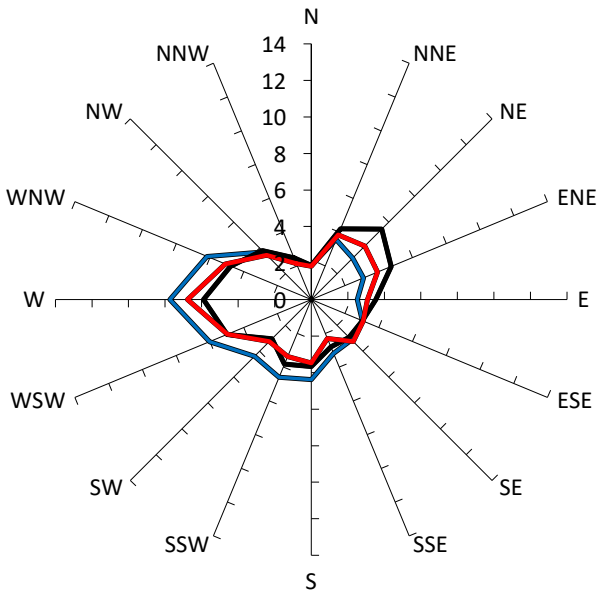
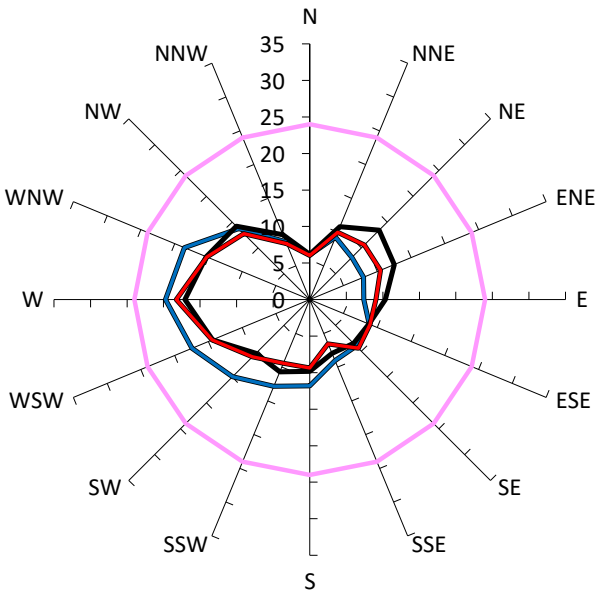
Results for Point 83

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	14
With inclusion of Existing and Retained Trees	0%	13

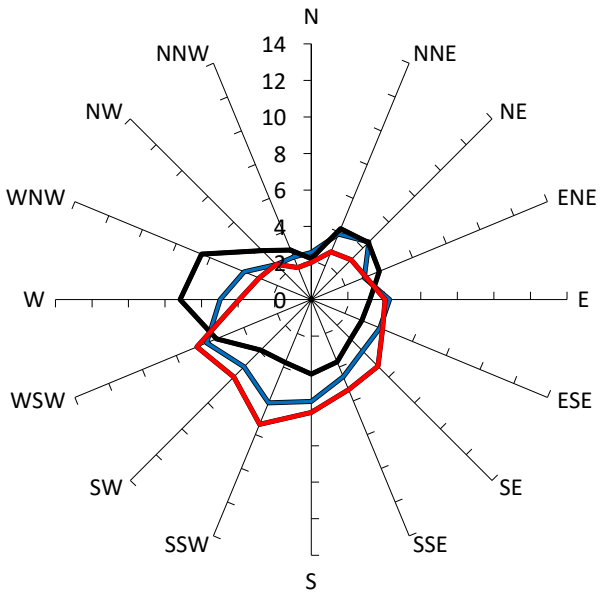
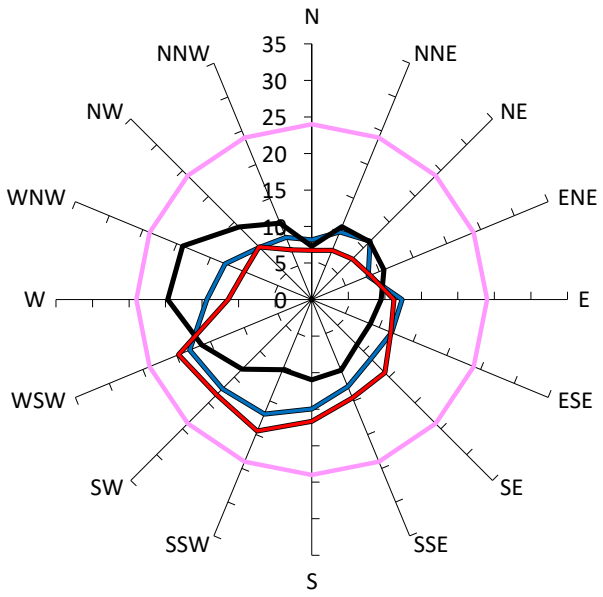
WD510-10 Waterloo South 7/02/2020

Results for Point 84

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
Existing Site	0%	17
With inclusion of Existing and Retained Trees	1%	18

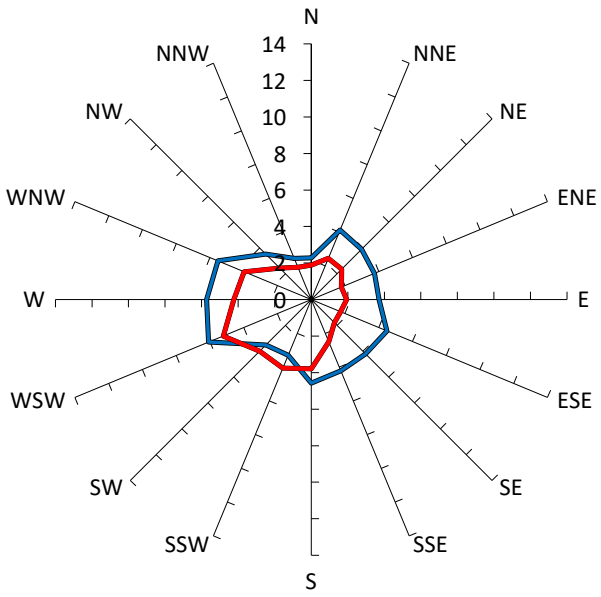
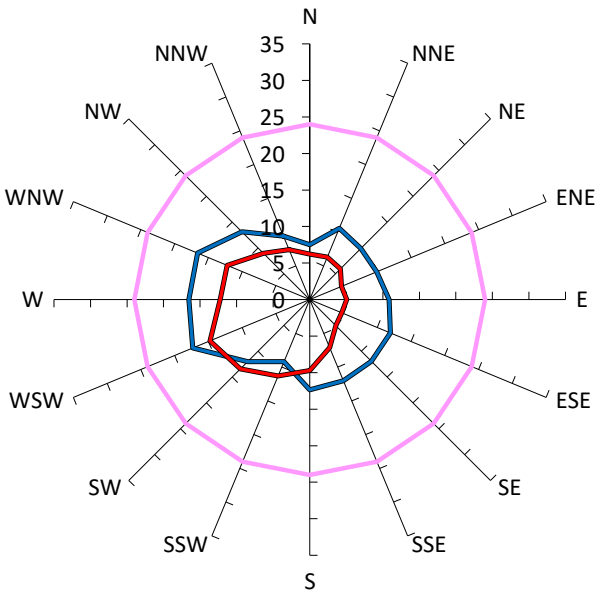
Results for Point 85

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
Existing Site	1%	20
With inclusion of Existing and Retained Trees	2%	20

WD510-10 Waterloo South 7/02/2020

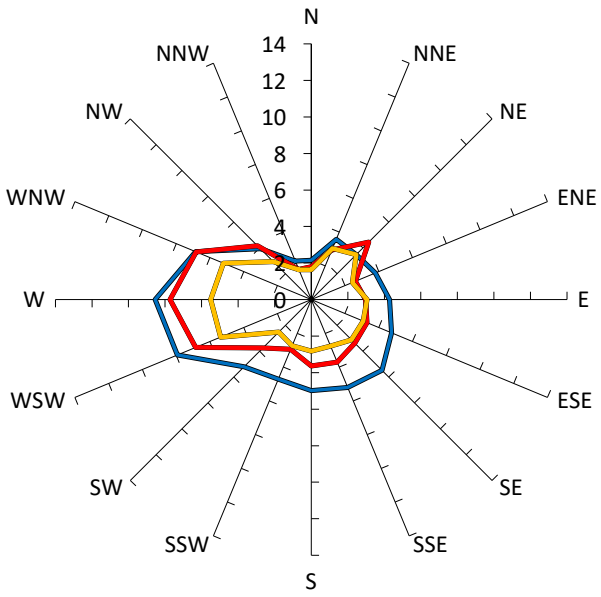
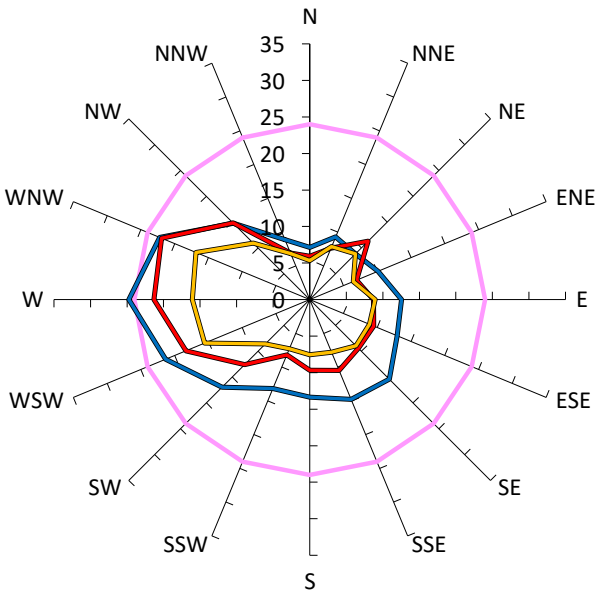
Results for Point 86

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	0%	15

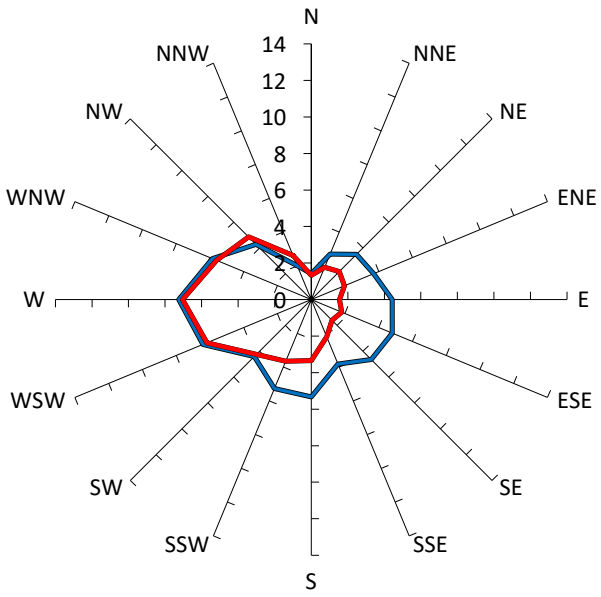
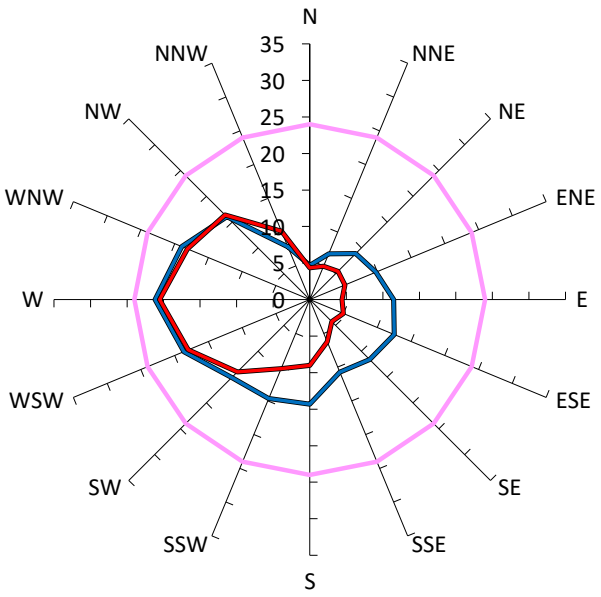
WD510-10 Waterloo South 7/02/2020

Results for Point 87

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

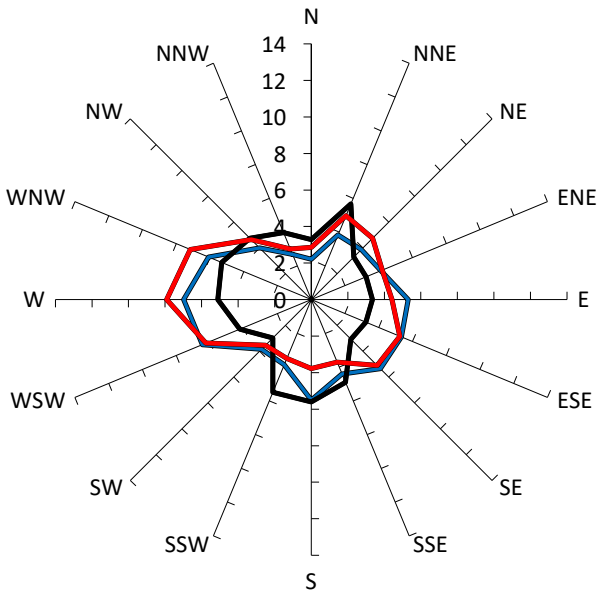
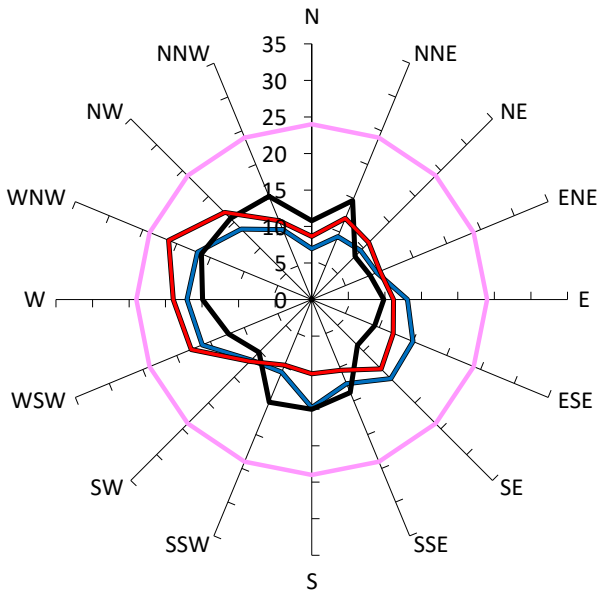
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	25
Wrap around awning along Western and part of Southern Façade of LOT U	2%	22
Awning along Western and Southern façade of LOT U	0%	17

Results for Point 88

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

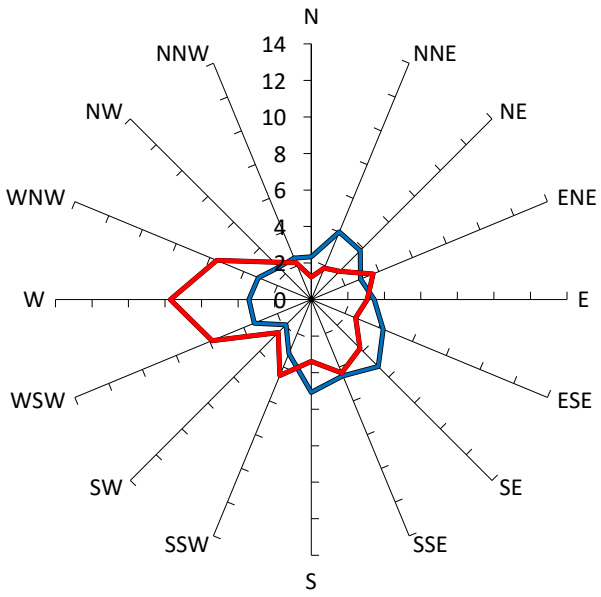
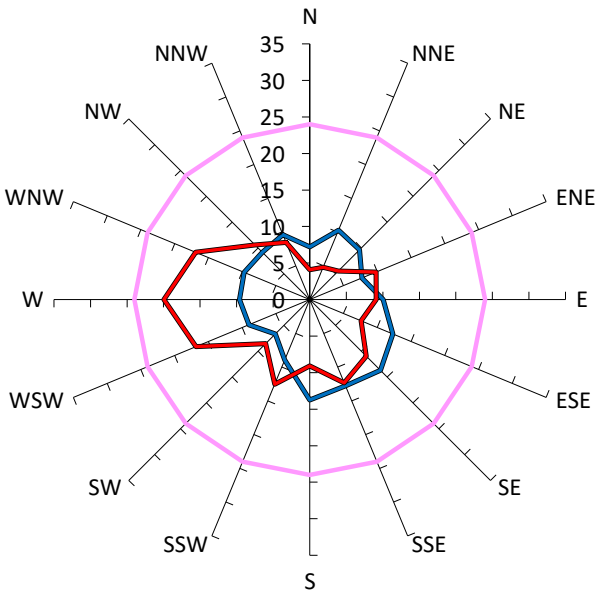
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	21
With inclusion of Existing and Retained Trees	1%	21

Results for Point 89

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	17
Existing Site	1%	16
With inclusion of Existing and Retained Trees	2%	21

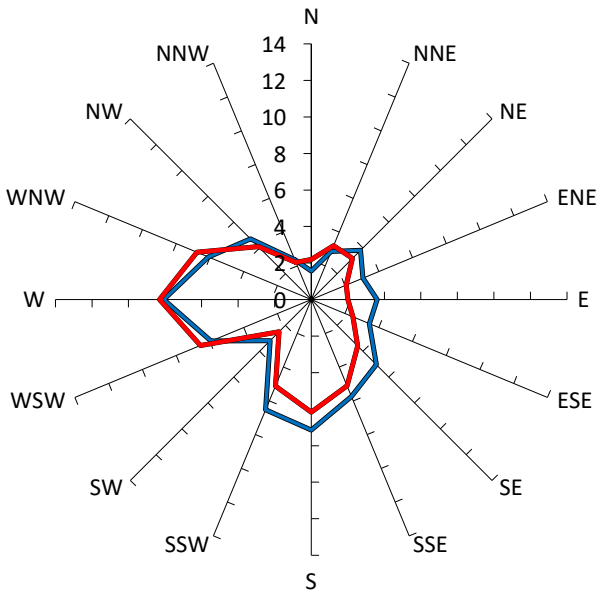
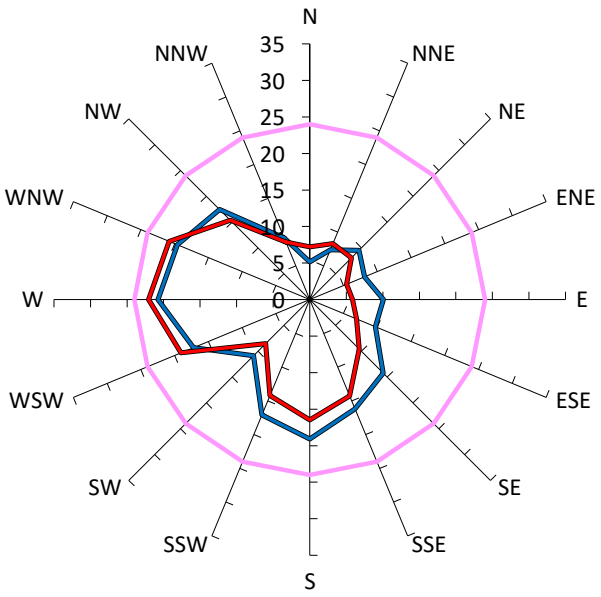
Results for Point 90

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	14
With inclusion of Existing and Retained Trees	1%	20

WD510-10 Waterloo South 7/02/2020

Results for Point 91

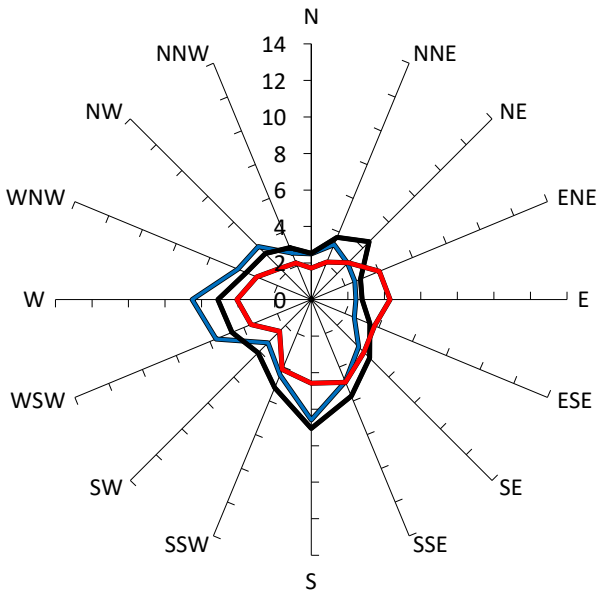
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	21
With inclusion of Existing and Retained Trees	3%	22

WD510-10 Waterloo South 7/02/2020

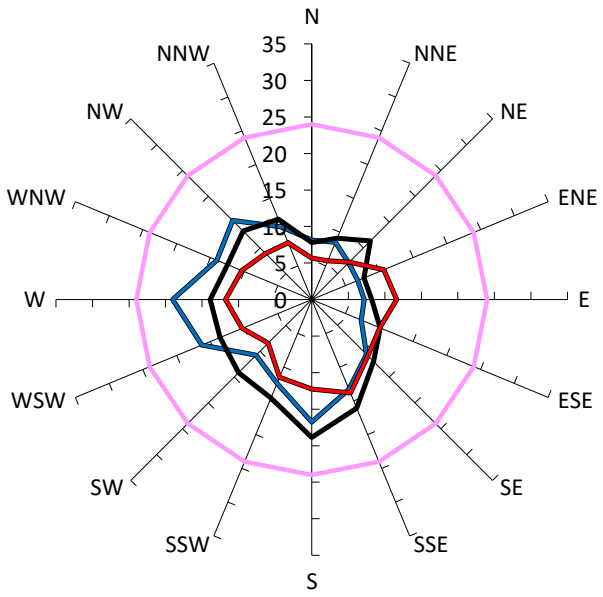
Results for Point 92

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

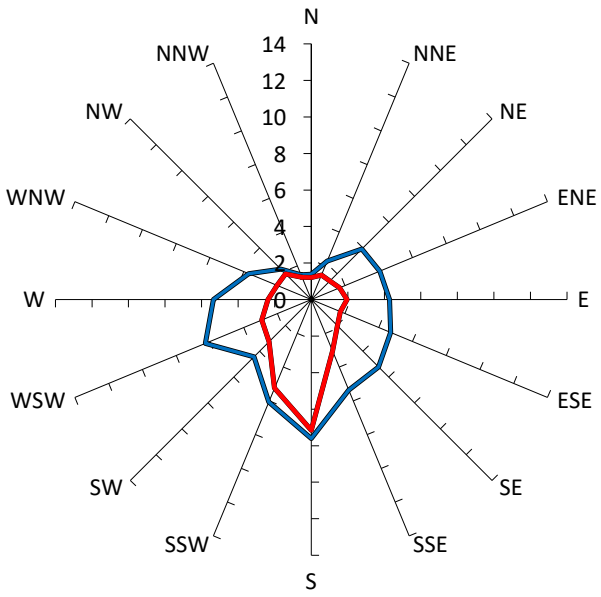
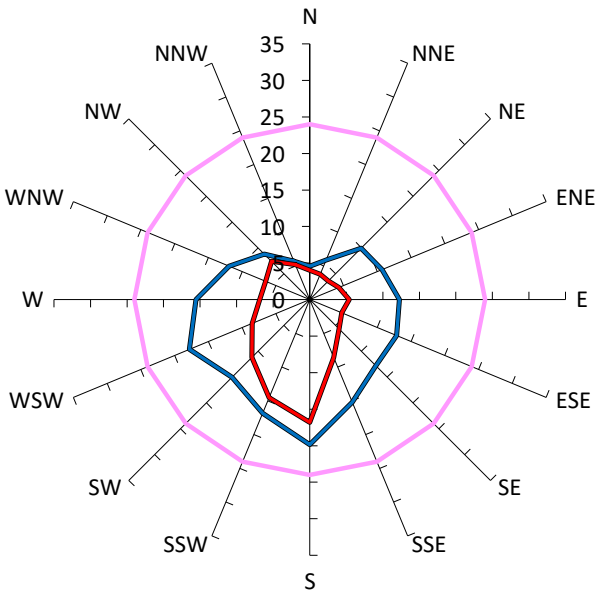
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	19
Existing Site	1%	19
With inclusion of Existing and Retained Trees	0%	14

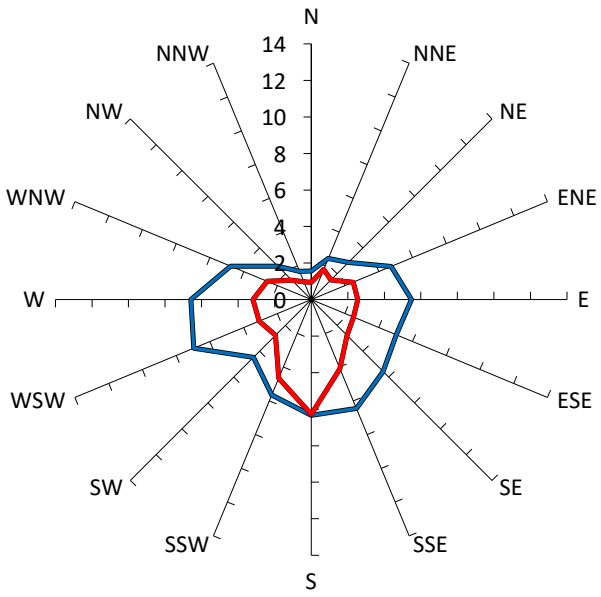
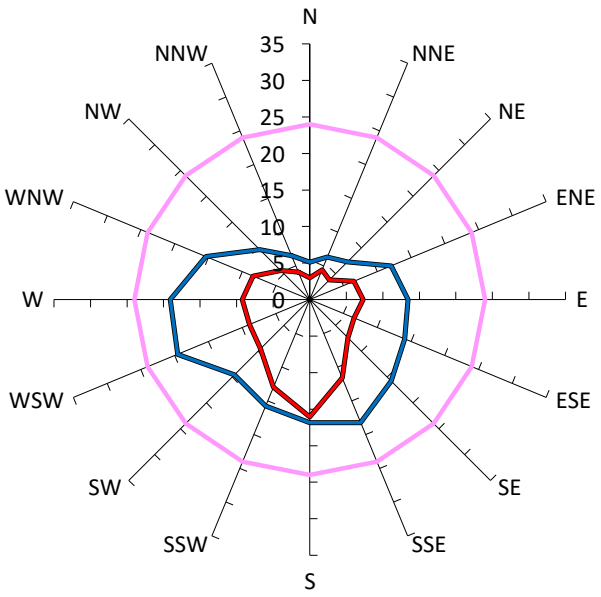
Results for Point 93

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

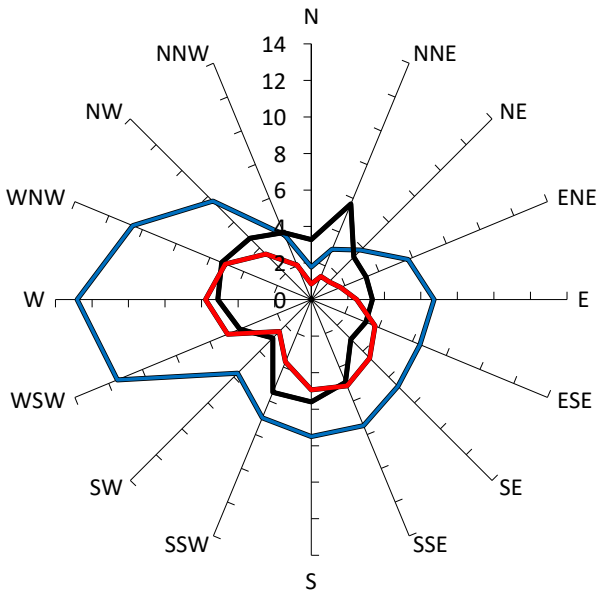
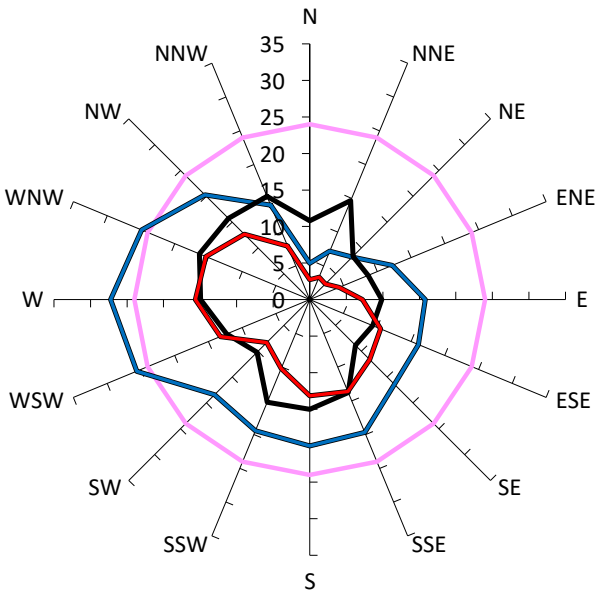
Results for Point 94

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
With inclusion of Existing and Retained Trees	0%	16

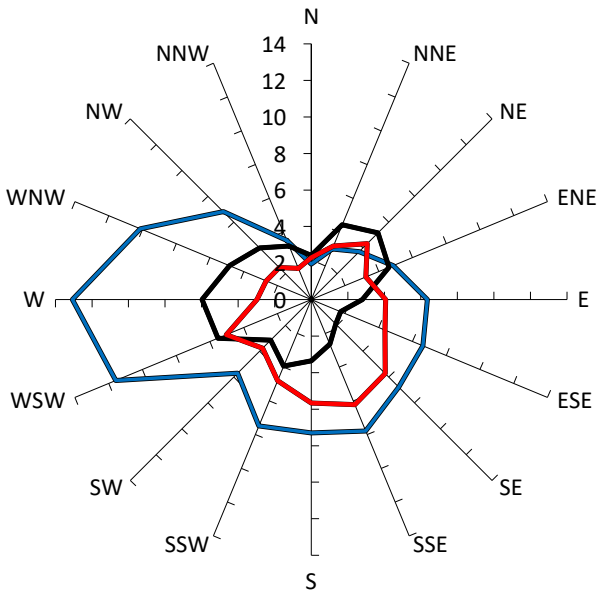
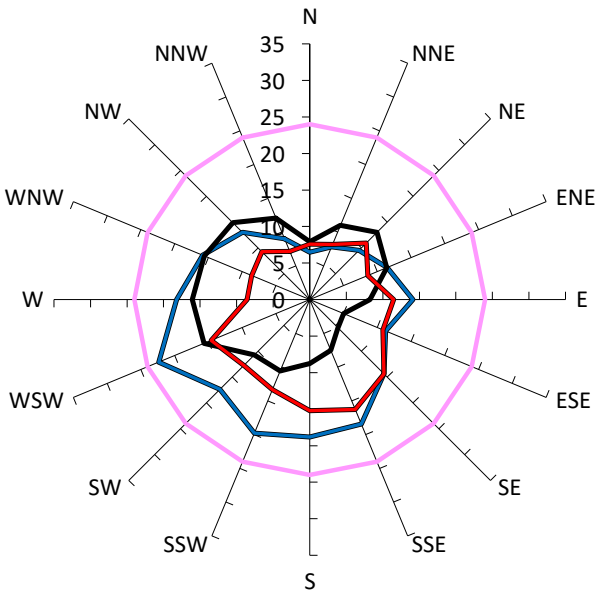
WD510-10 Waterloo South 7/02/2020

Results for Point 95

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

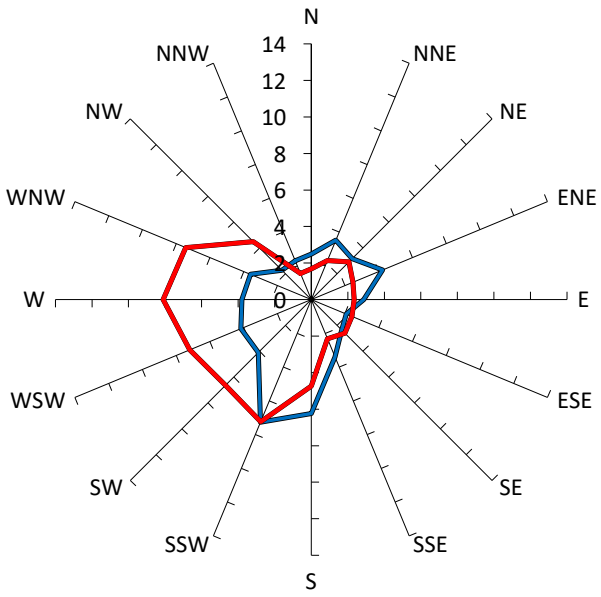
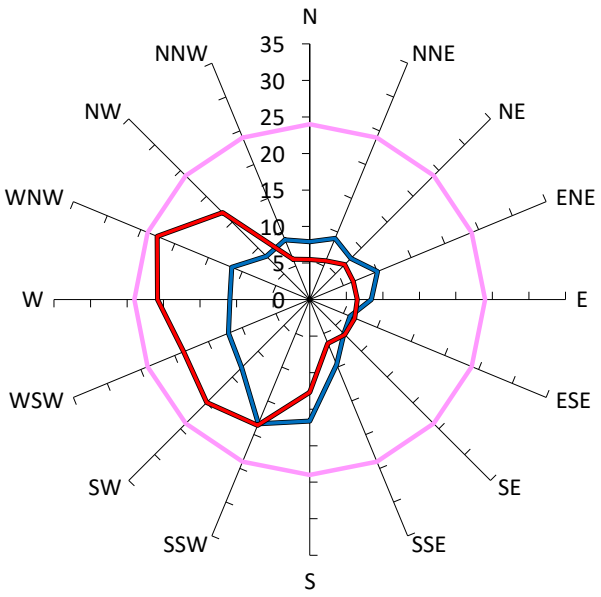
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	16%	27
Existing Site	1%	16
Wrap around awning along Western Façade and part of Southern of Building Y1	0%	16

Results for Point 96

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	16%	22
Existing Site	1%	16
With inclusion of Existing and Retained Trees	1%	16

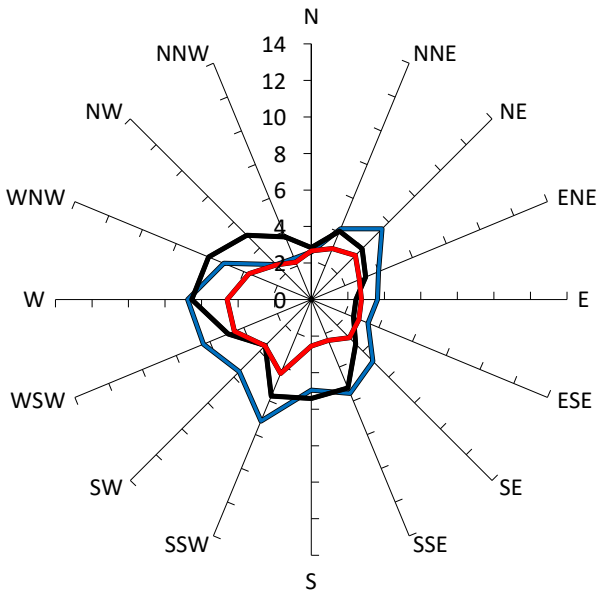
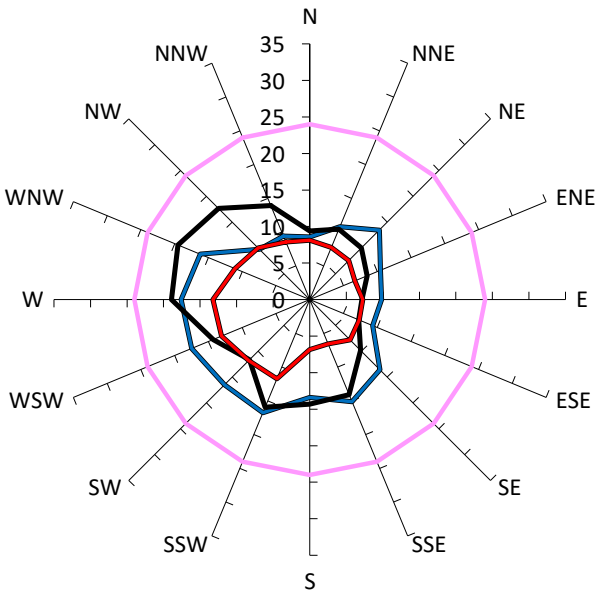
Results for Point 97

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
With inclusion of Existing and Retained Trees	4%	23

WD510-10 Waterloo South 7/02/2020

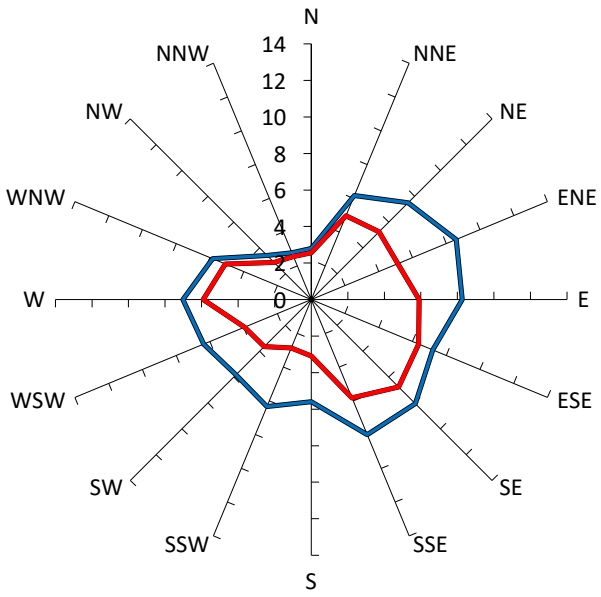
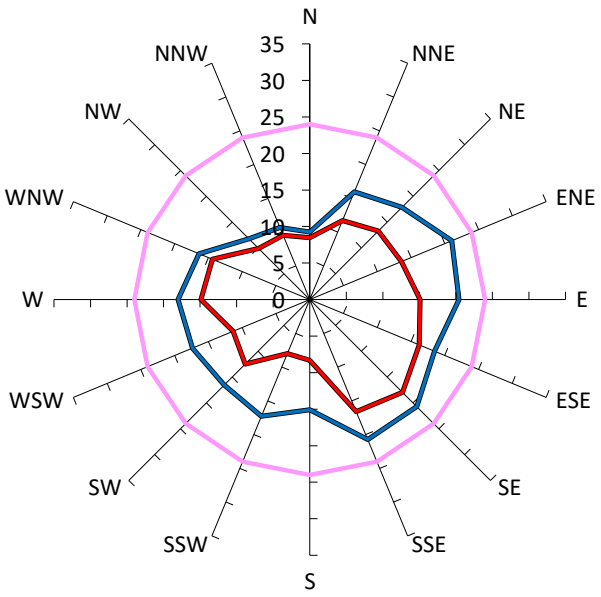
Results for Point 98

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	18
Existing Site	1%	20
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

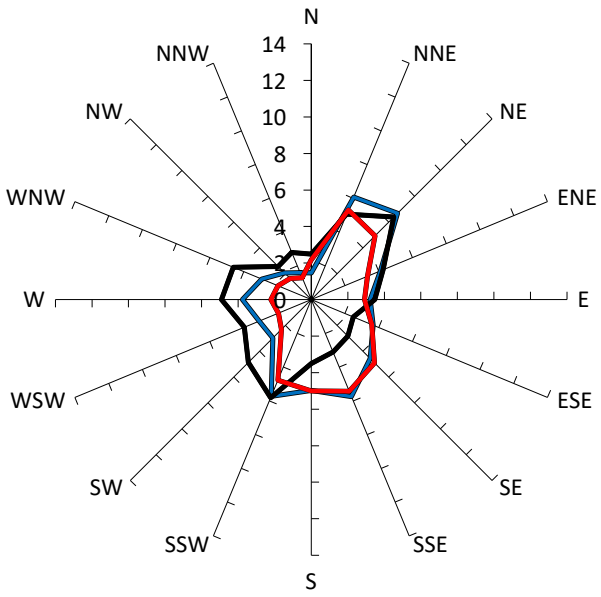
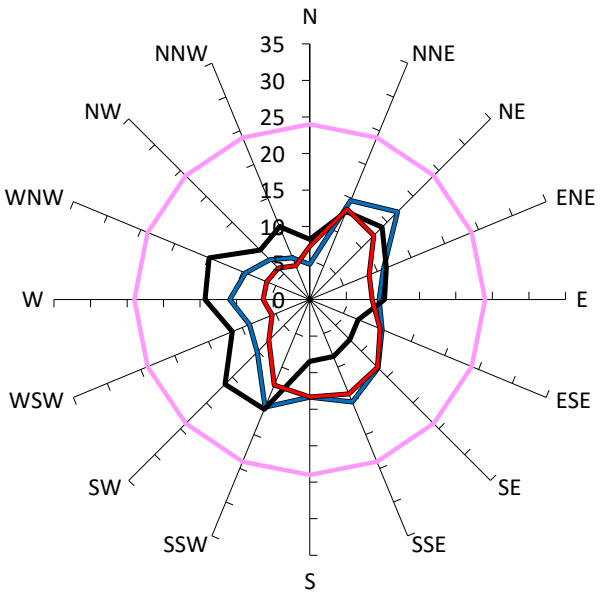
Results for Point 99

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	9%	21
With inclusion of Existing and Retained Trees	1%	18

WD510-10 Waterloo South 7/02/2020

Results for Point 100

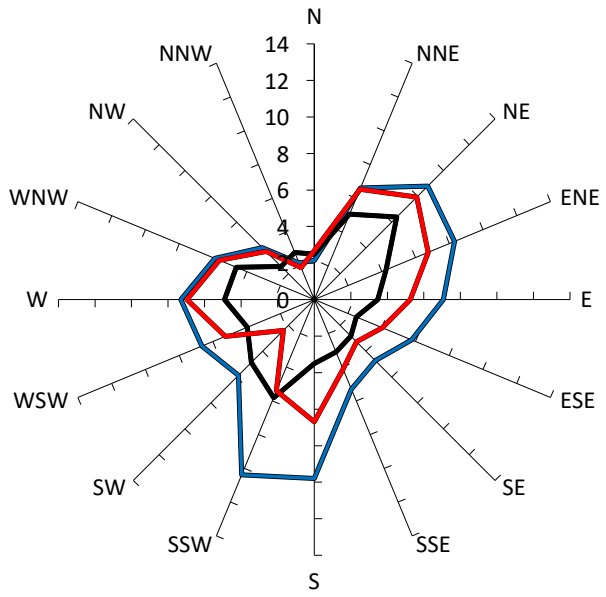
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	1%	16
With inclusion of Existing and Retained Trees	0%	14

WD510-10 Waterloo South 7/02/2020

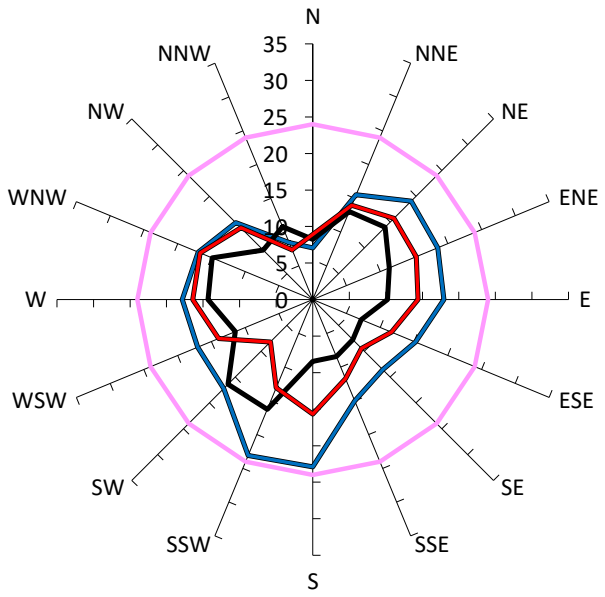
Results for Point 101

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

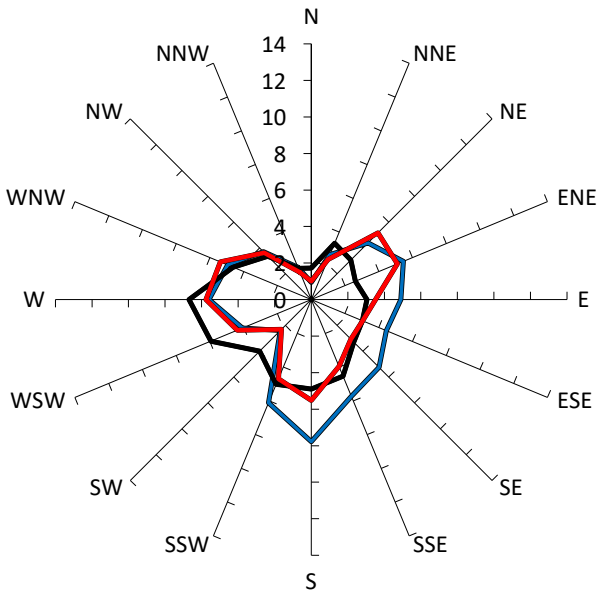
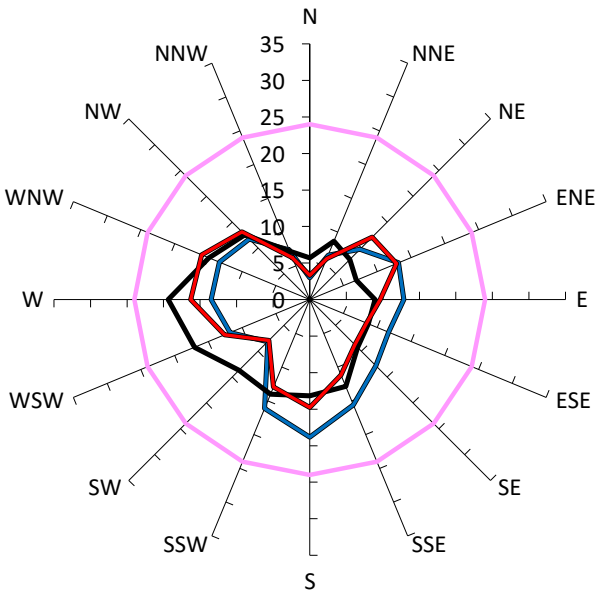
Maximum Gust (m/s)



Safety Limit: 24m/s

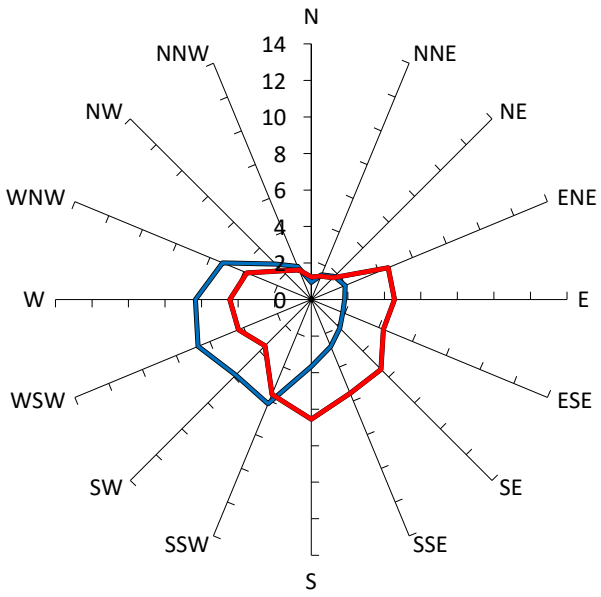
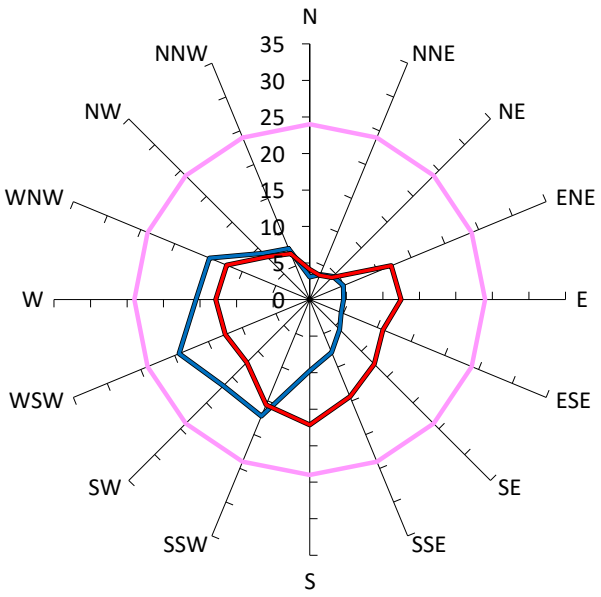
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	14%	23
Existing Site	1%	16
With inclusion of Existing and Retained Trees	3%	17

Results for Point 102

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

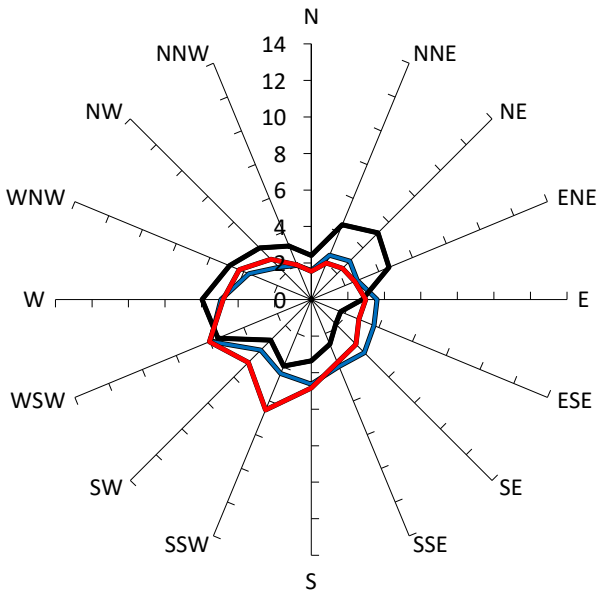
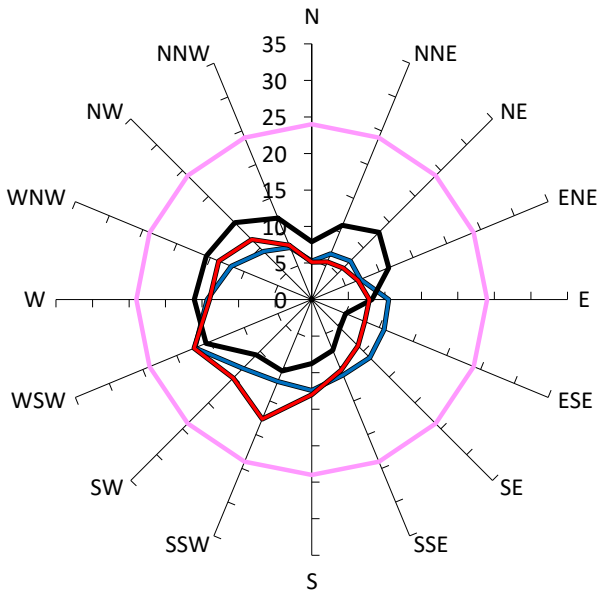
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	19
Existing Site	1%	19
With inclusion of Existing and Retained Trees	0%	16

Results for Point 103

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	19
With inclusion of Existing and Retained Trees	1%	17

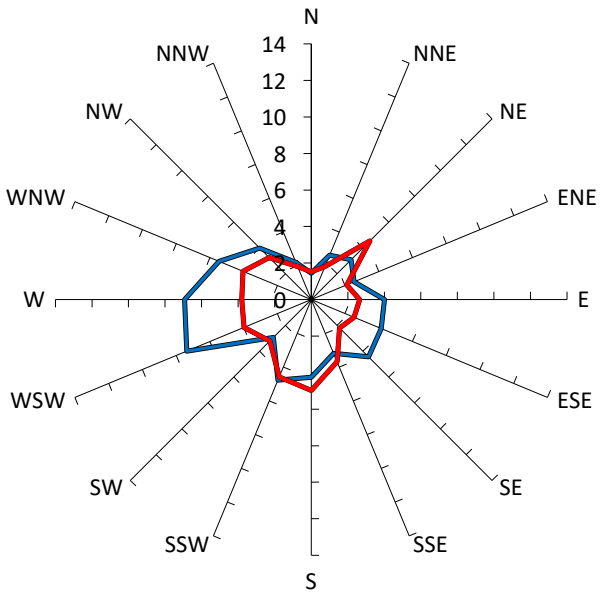
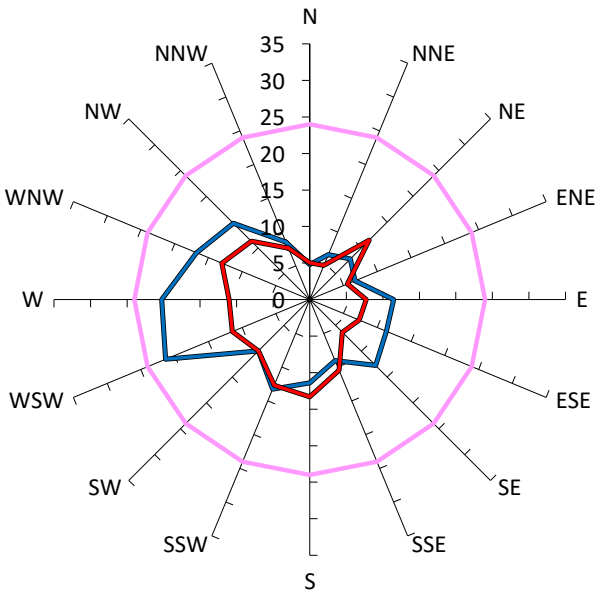
Results for Point 104

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	17
Existing Site	1%	16
With inclusion of Existing and Retained Trees	1%	18

WD510-10 Waterloo South 7/02/2020

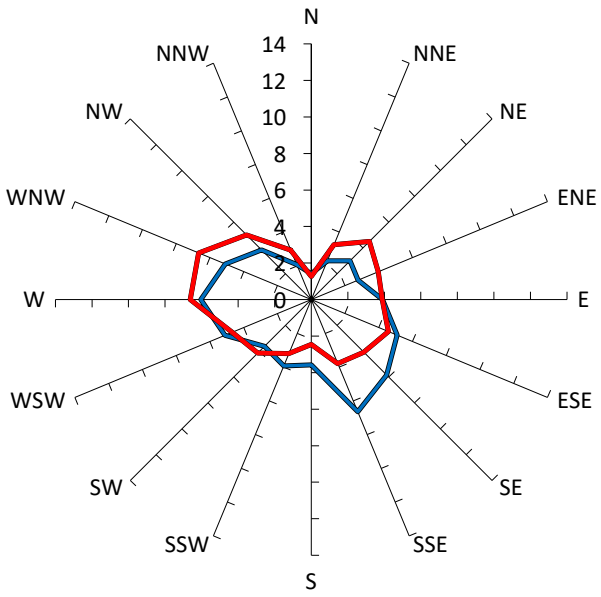
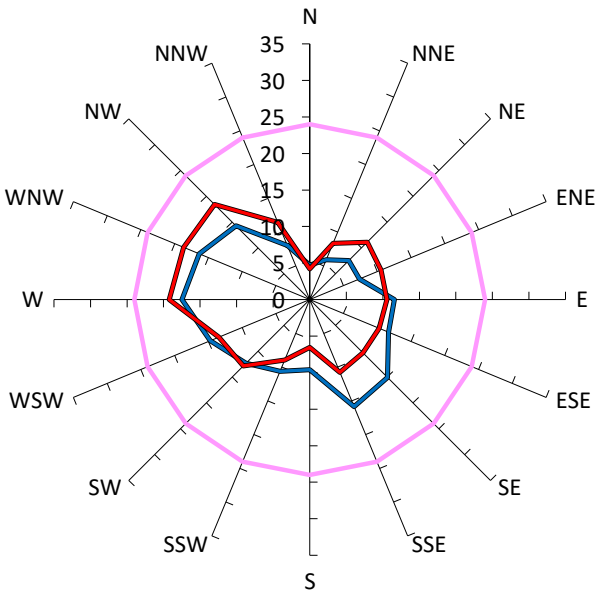
Results for Point 105

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	21
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

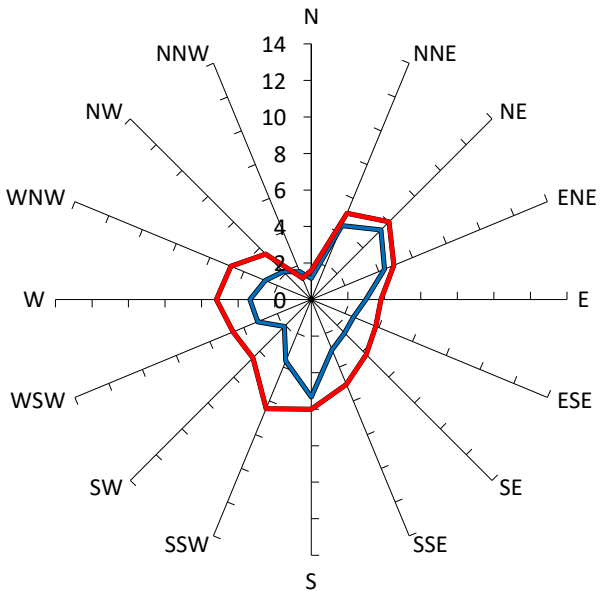
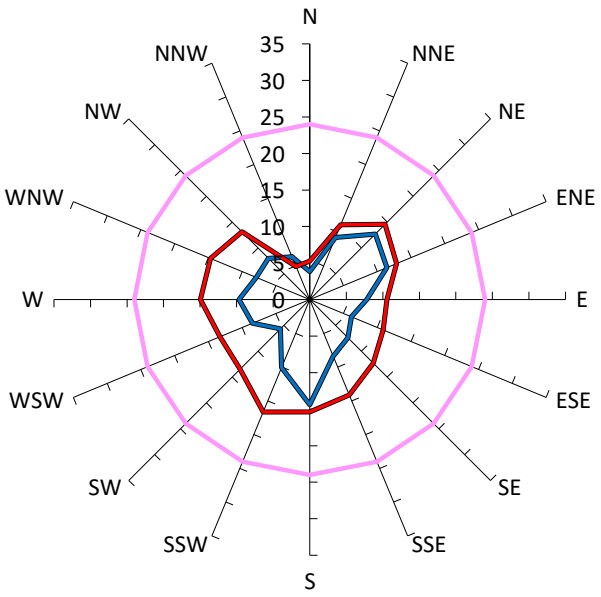
Results for Point 106

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	1%	19

WD510-10 Waterloo South 7/02/2020

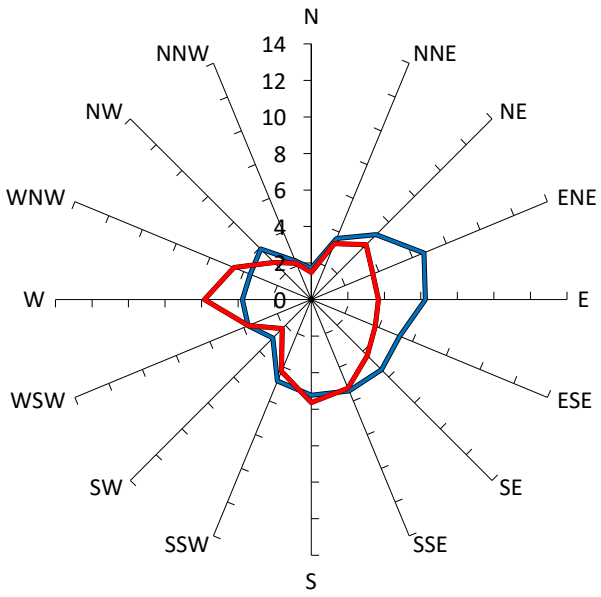
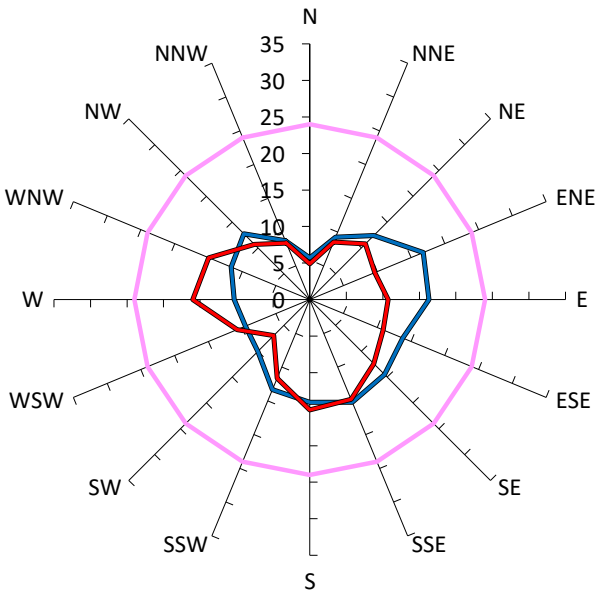
Results for Point 107

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	14
With inclusion of Existing and Retained Trees	1%	17

WD510-10 Waterloo South 7/02/2020

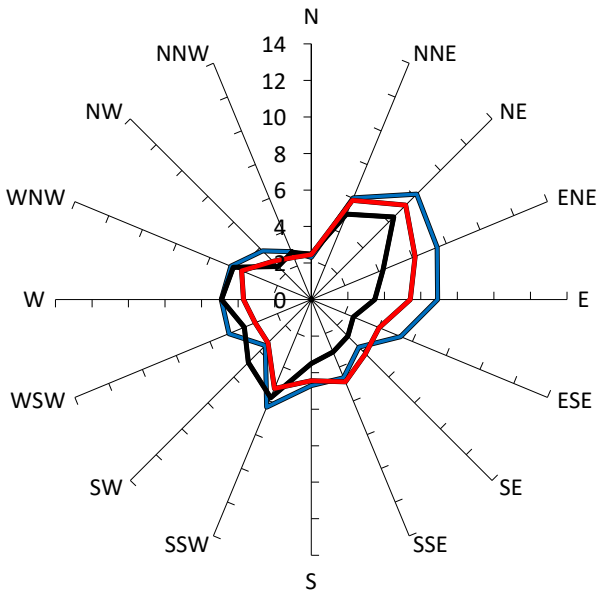
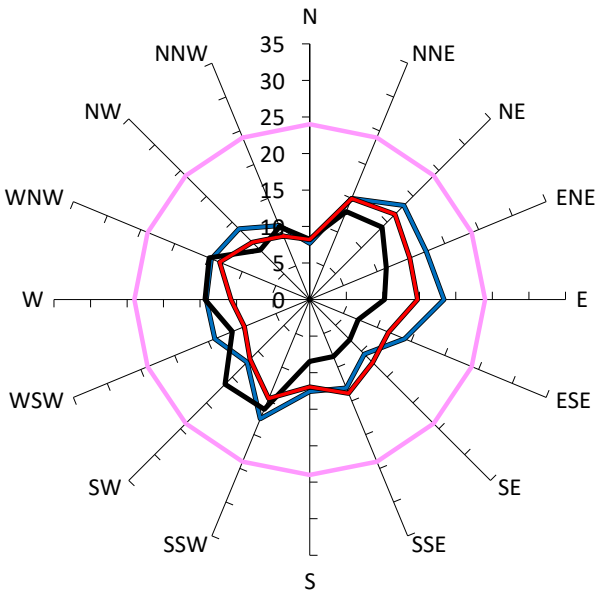
Results for Point 108

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
With inclusion of Existing and Retained Trees	0%	16

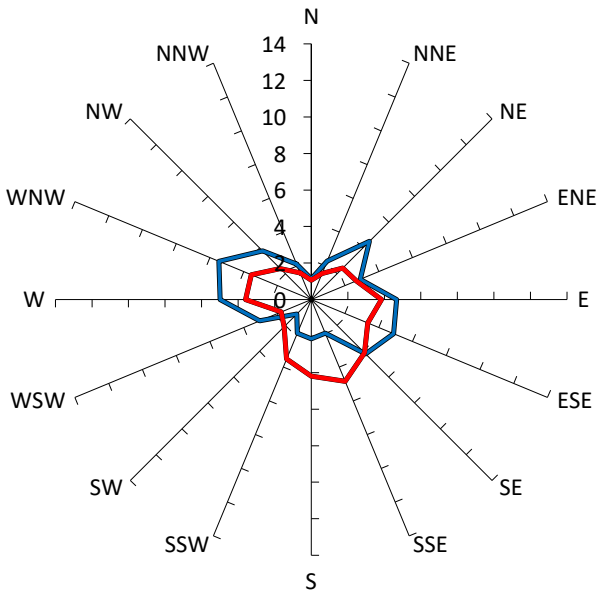
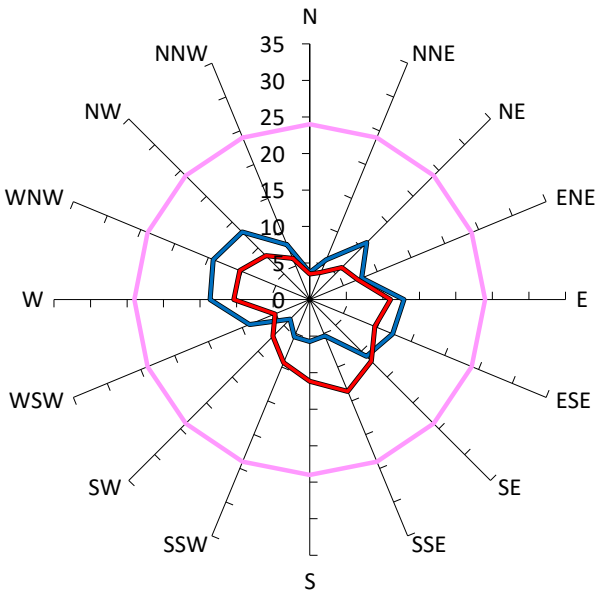
WD510-10 Waterloo South 7/02/2020

Results for Point 109

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	3%	18
Existing Site	1%	16
With inclusion of Existing and Retained Trees	1%	17

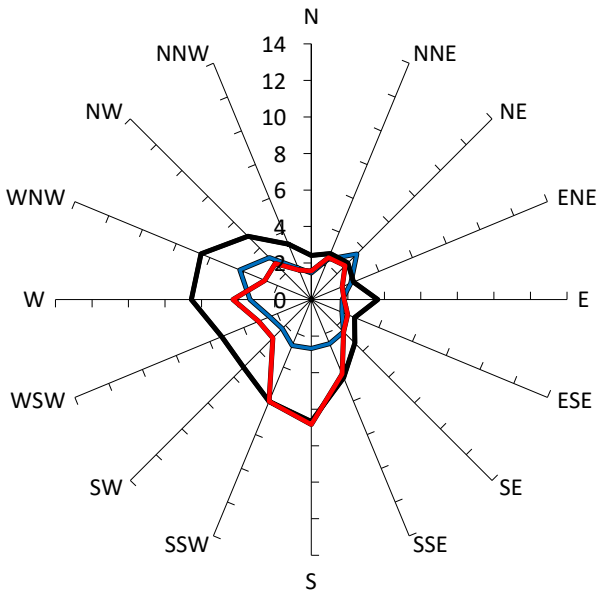
Results for Point 110

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	14
With inclusion of Existing and Retained Trees	0%	14

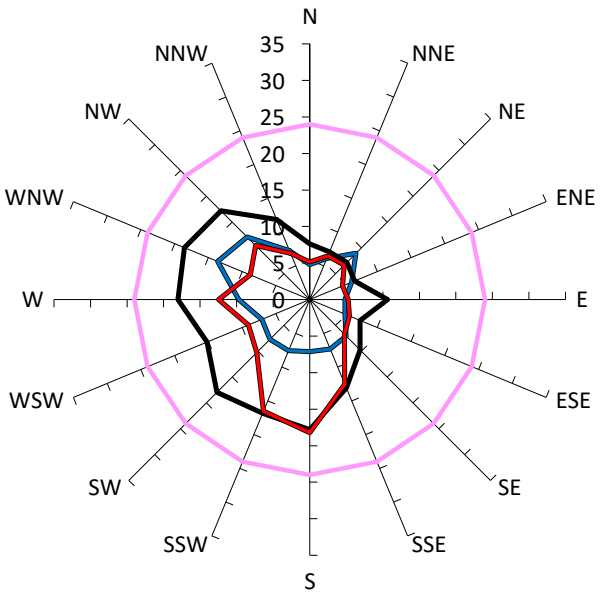
Results for Point 111

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

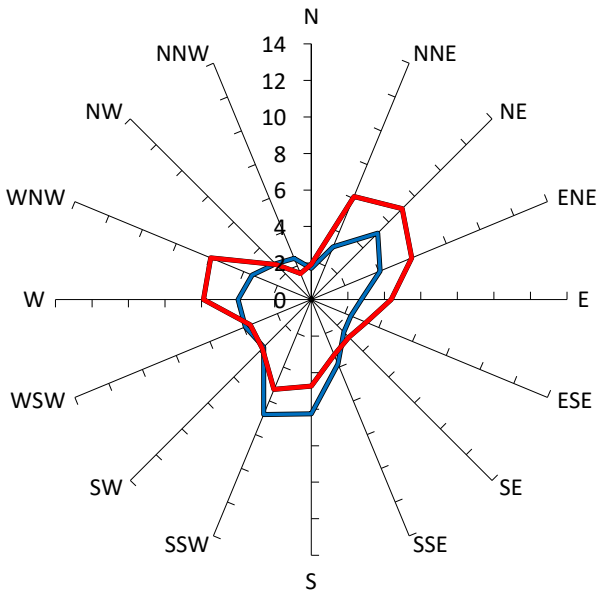
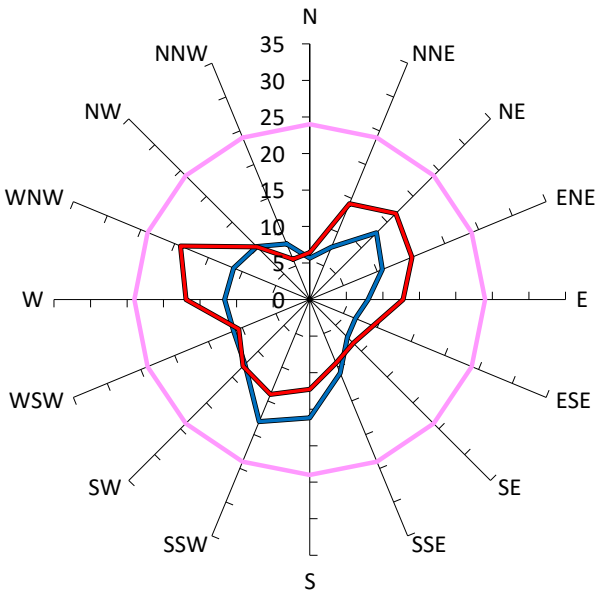
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	14
Existing Site	2%	19
With inclusion of Existing and Retained Trees	1%	18

Results for Point 112

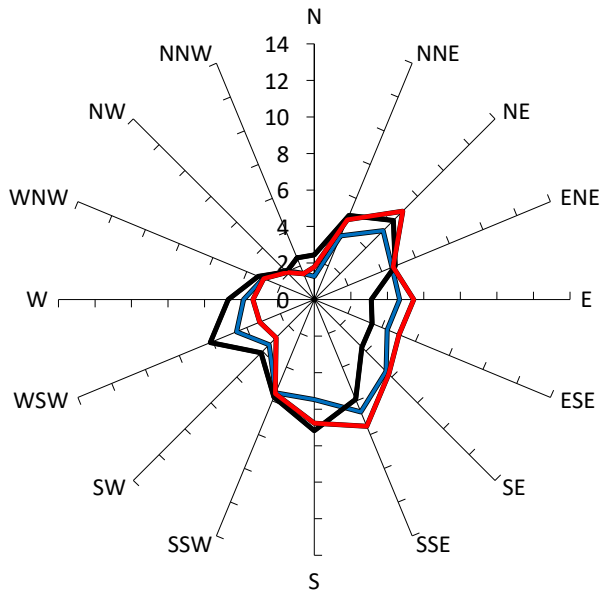
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
With inclusion of Existing and Retained Trees	1%	19

WD510-10 Waterloo South 7/02/2020

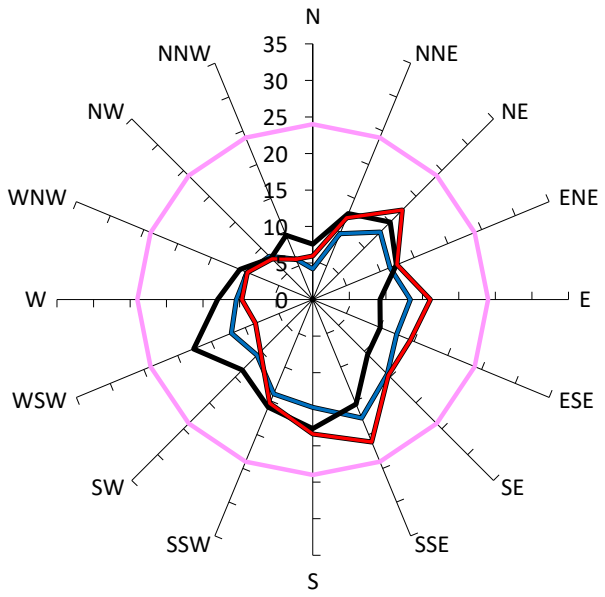
Results for Point 113

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

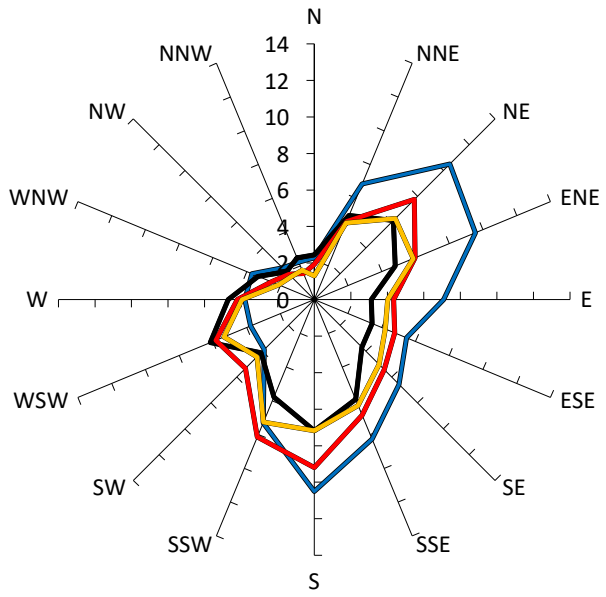


Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	18
Existing Site	1%	18
With inclusion of Existing and Retained Trees	2%	21

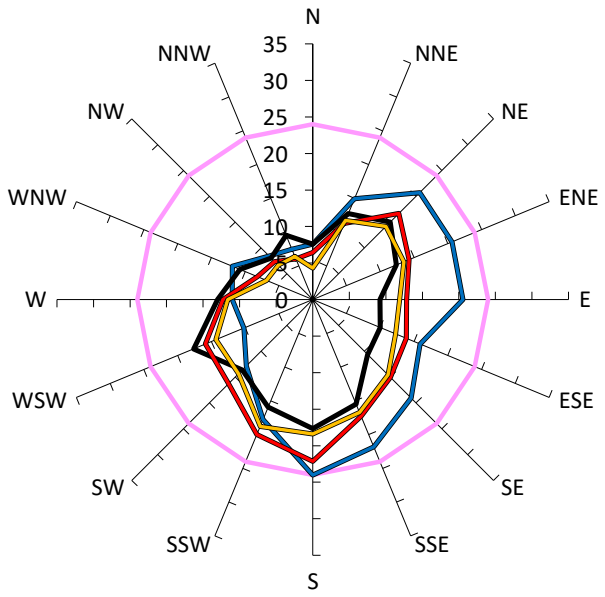
Results for Point 114

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

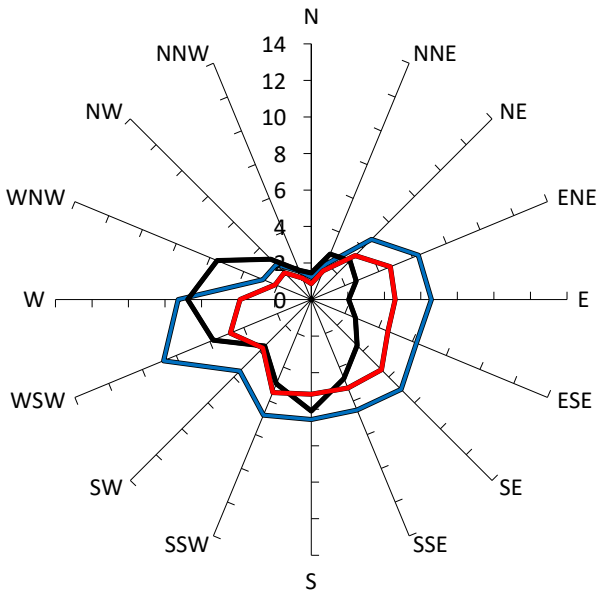
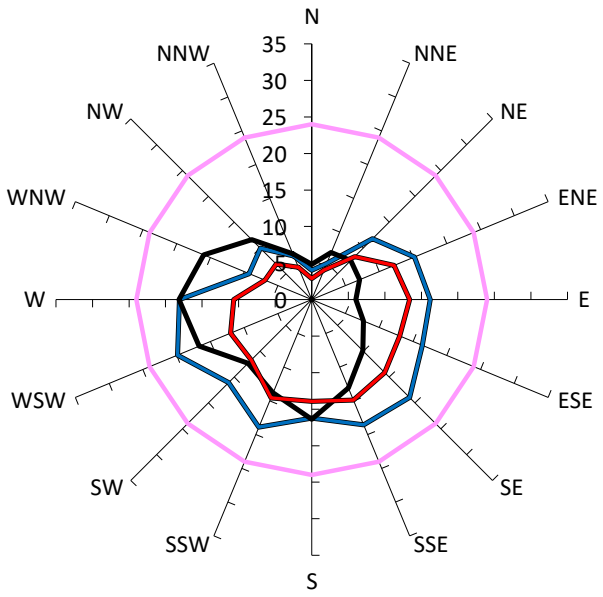
Maximum Gust (m/s)



Safety Limit: 24m/s

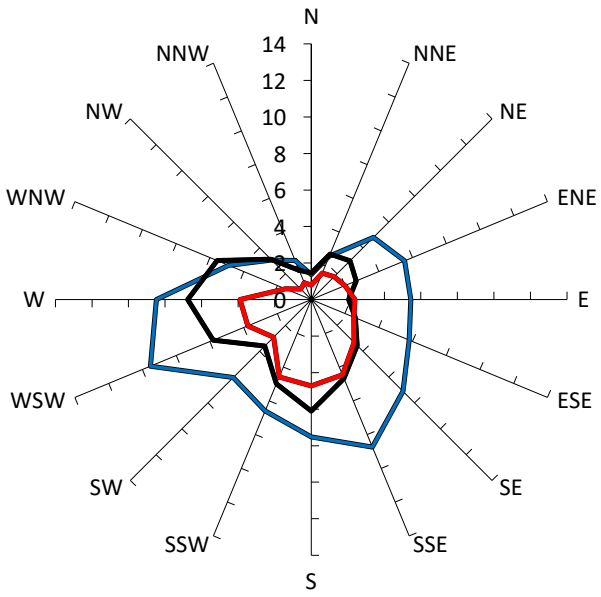
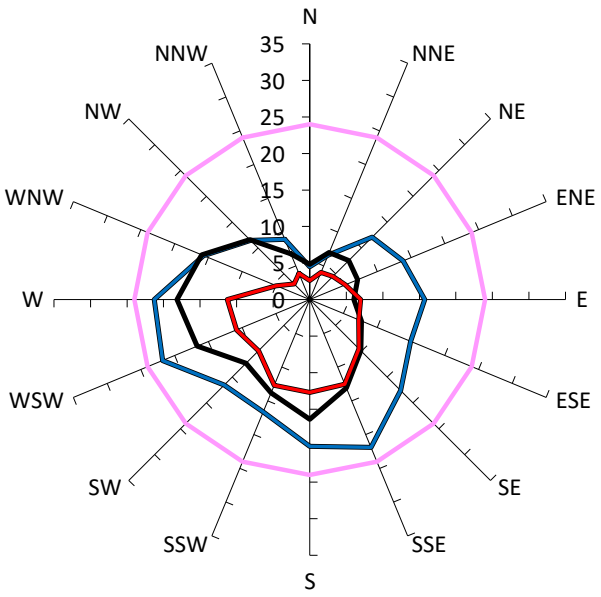
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	19%	24
Existing Site	1%	18
With inclusion of Existing and Retained Trees	6%	22
Awning along Eastern and part of Southern Façade and chamfer of Building Z5	2%	19

Results for Point 115

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

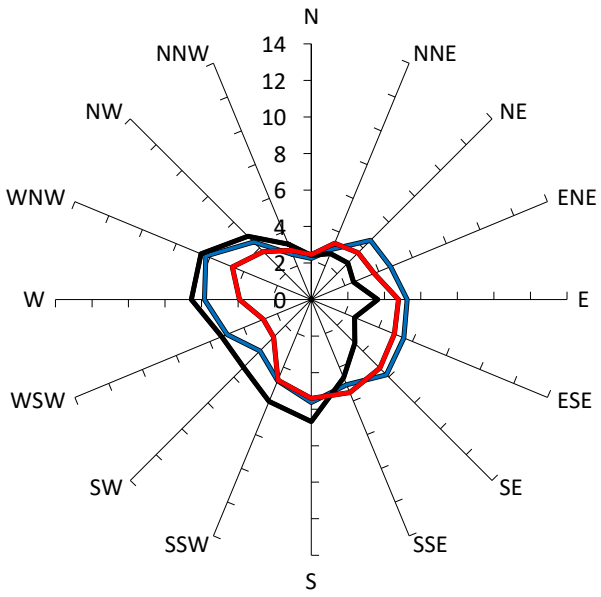
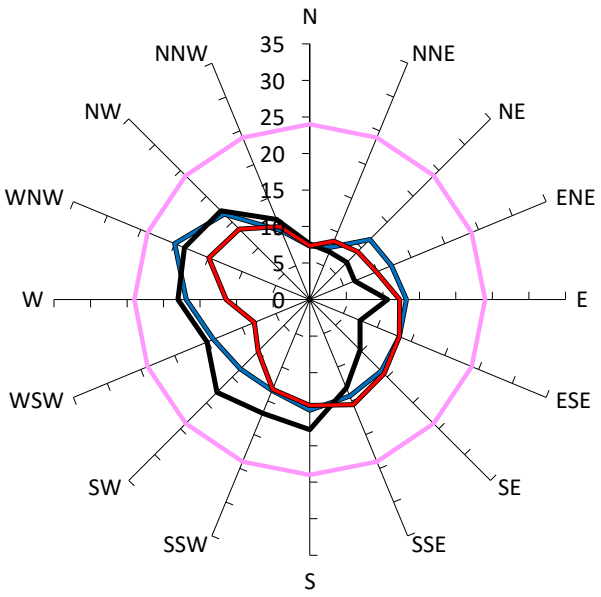
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	5%	20
Existing Site	1%	18
With inclusion of Existing and Retained Trees	0%	15

Results for Point 116

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	9%	22
Existing Site	1%	18
With inclusion of Existing and Retained Trees	0%	13

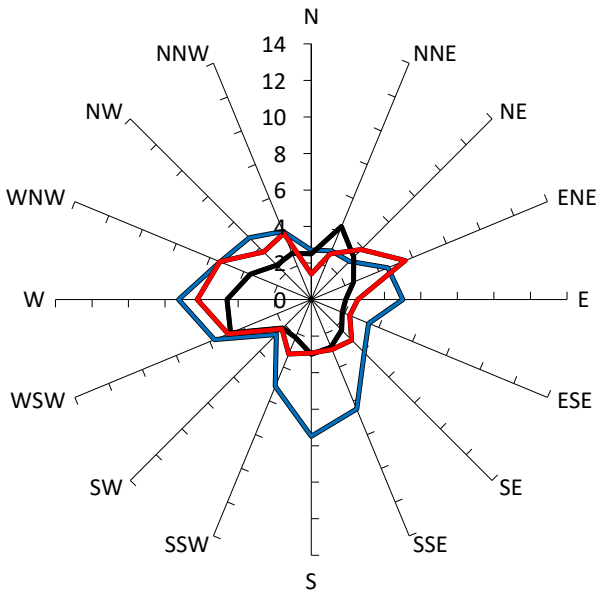
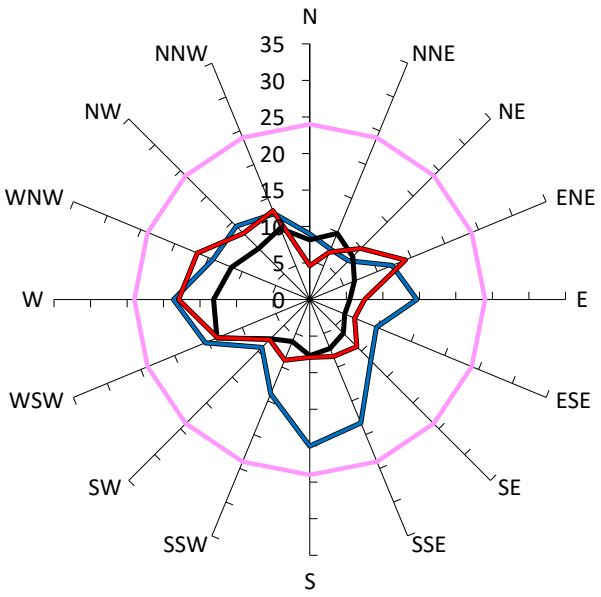
Results for Point 117

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	20
Existing Site	2%	19
With inclusion of Existing and Retained Trees	0%	16

WD510-10 Waterloo South 7/02/2020

Results for Point 118

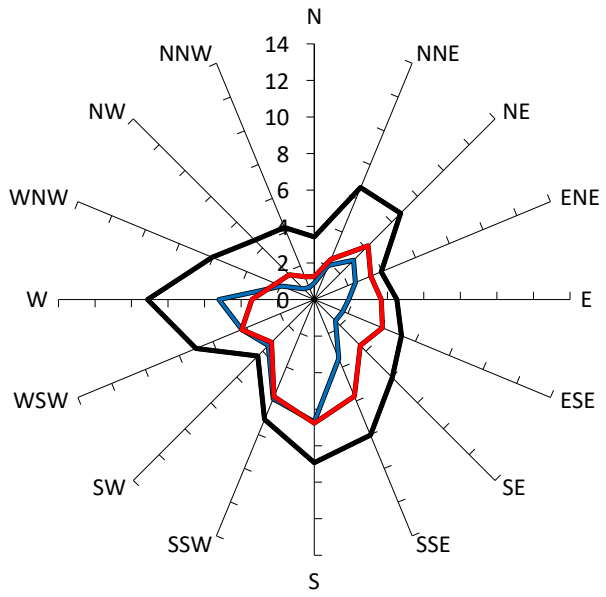
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	20
Existing Site	0%	14
With inclusion of Existing and Retained Trees	1%	18

WD510-10 Waterloo South 7/02/2020

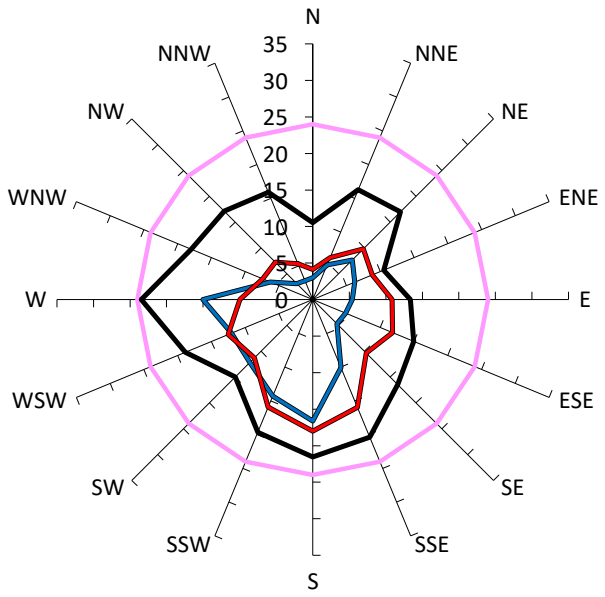
Results for Point 119

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

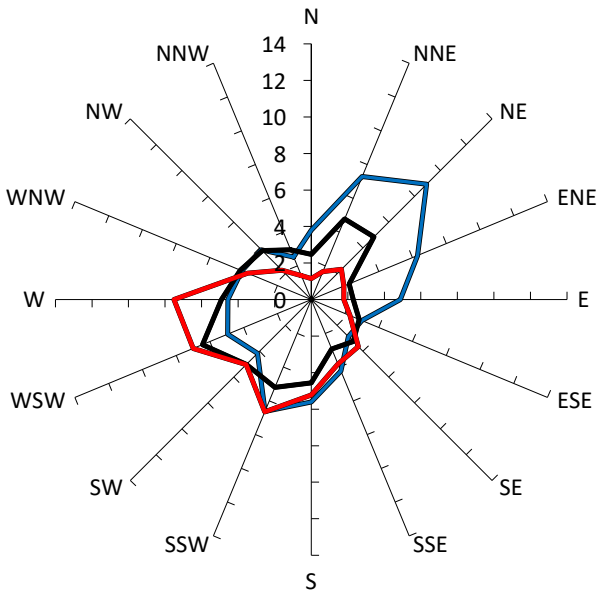
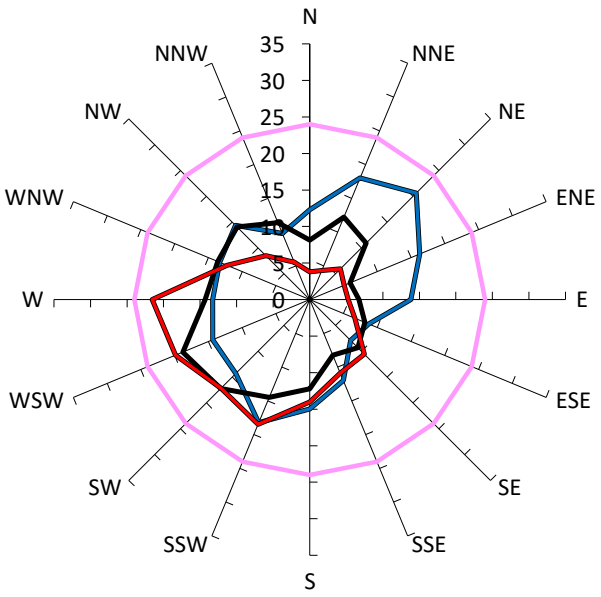
Maximum Gust (m/s)



Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	17
Existing Site	8%	23
With inclusion of Existing and Retained Trees	1%	18

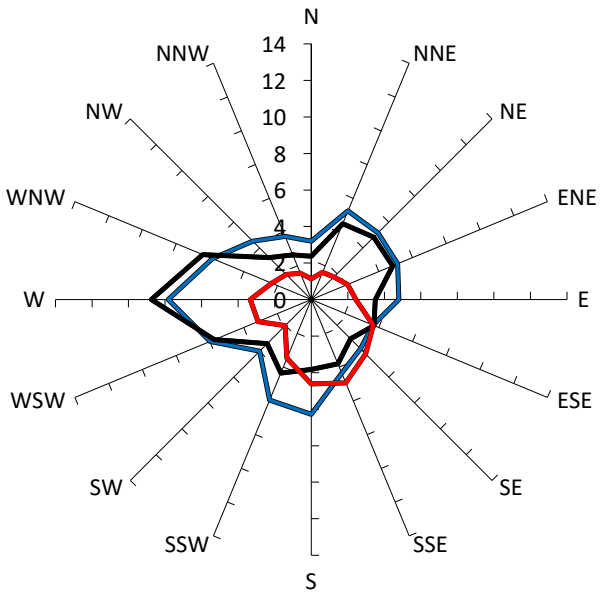
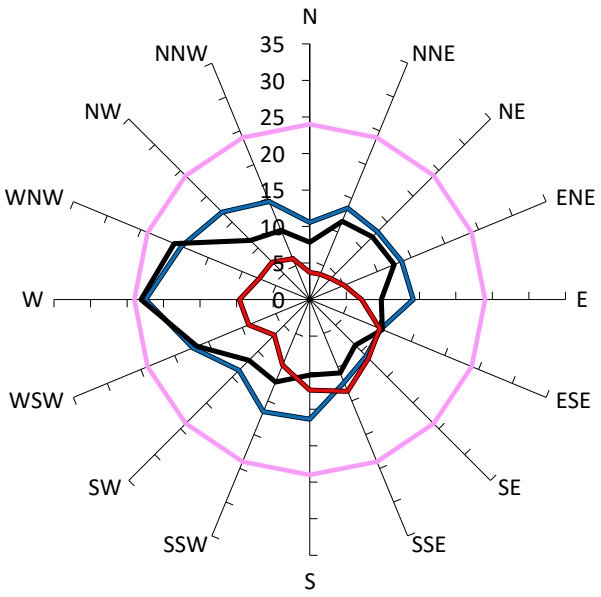
Results for Point 120

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	21
Existing Site	1%	19
With inclusion of Existing and Retained Trees	2%	22

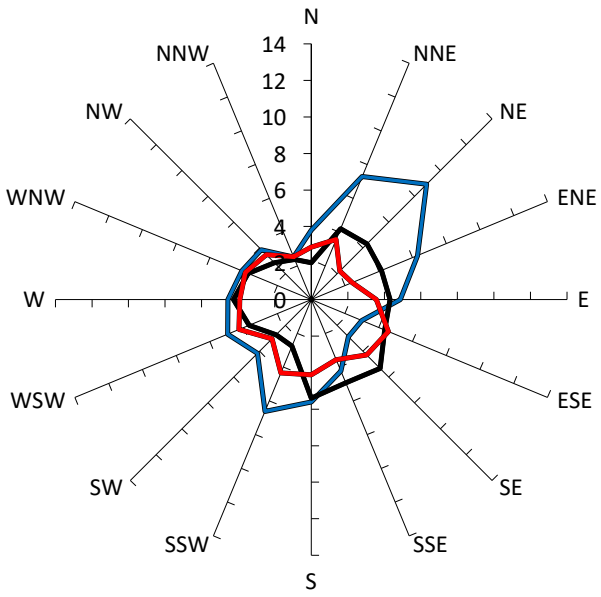
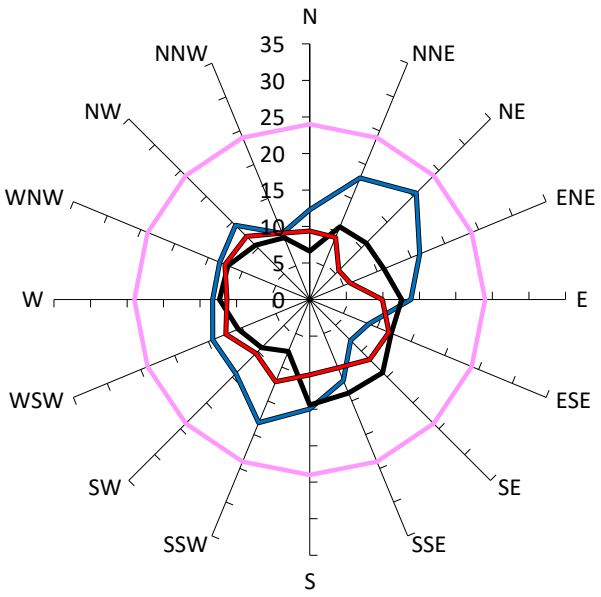
WD510-10 Waterloo South 7/02/2020

Results for Point 121

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	22
Existing Site	3%	23
With inclusion of Existing and Retained Trees	0%	14

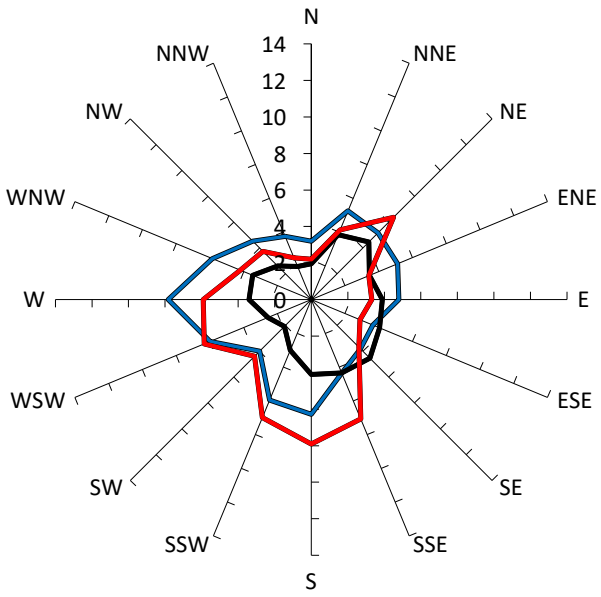
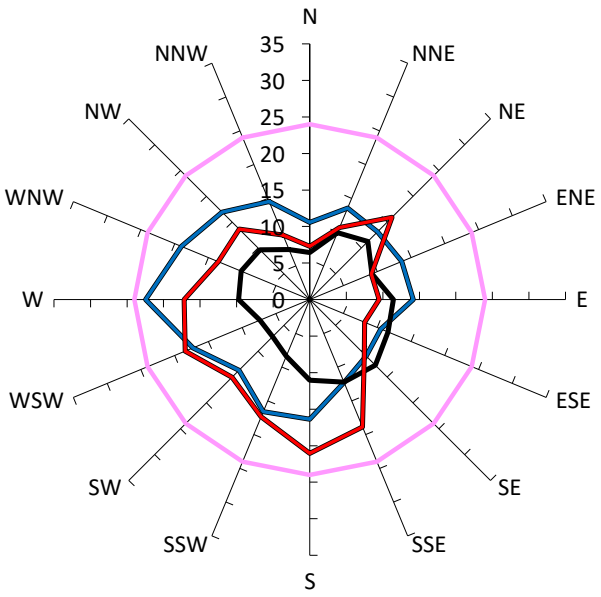
Results for Point 122

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	4%	21
Existing Site	0%	14
With inclusion of Existing and Retained Trees	0%	13

WD510-10 Waterloo South 7/02/2020

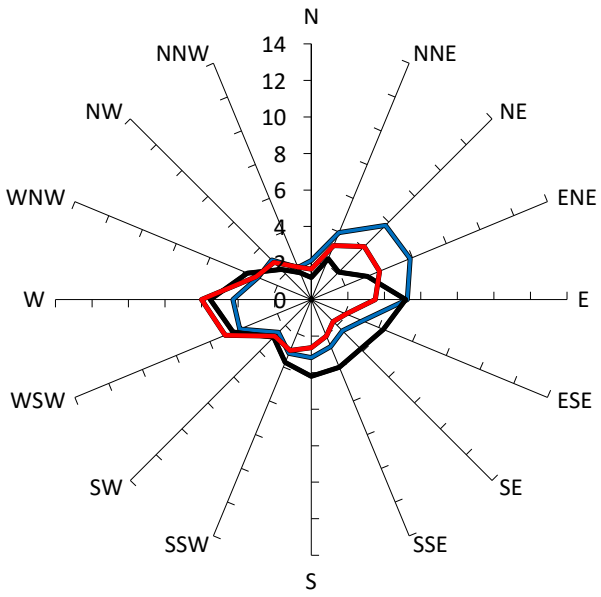
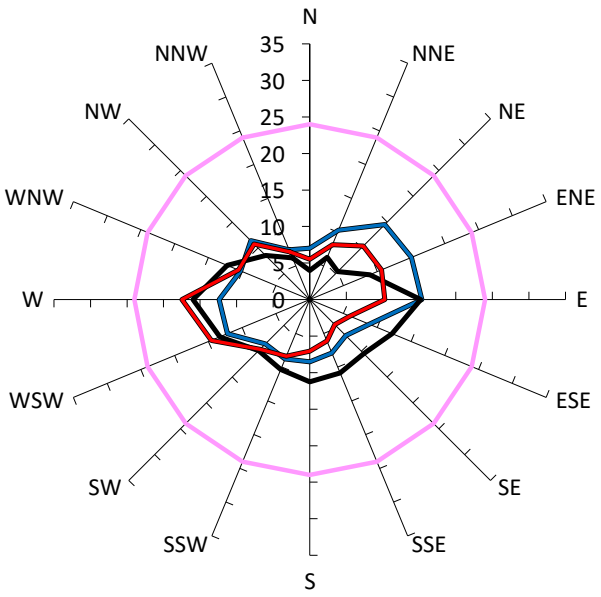
Results for Point 123

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	2%	22
Existing Site	0%	13
With inclusion of Existing and Retained Trees	3%	21

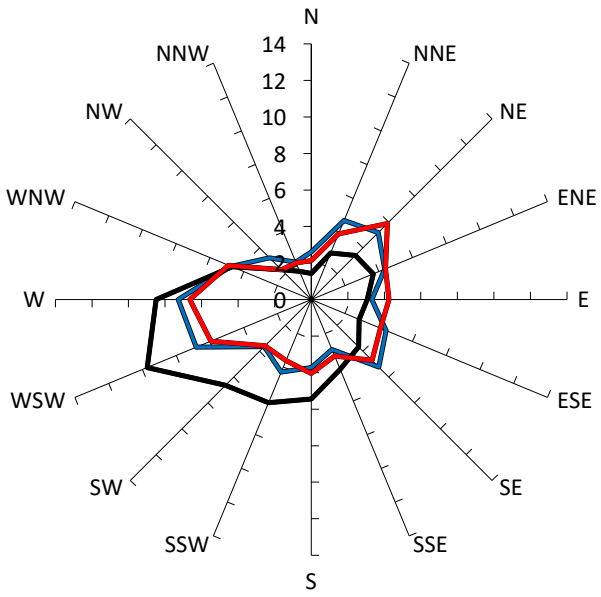
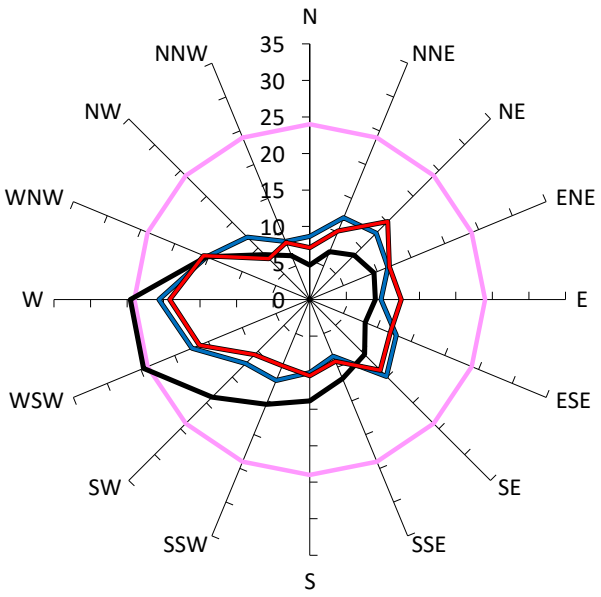
WD510-10 Waterloo South 7/02/2020

Results for Point 124

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	0%	15
Existing Site	0%	16
With inclusion of Existing and Retained Trees	0%	17

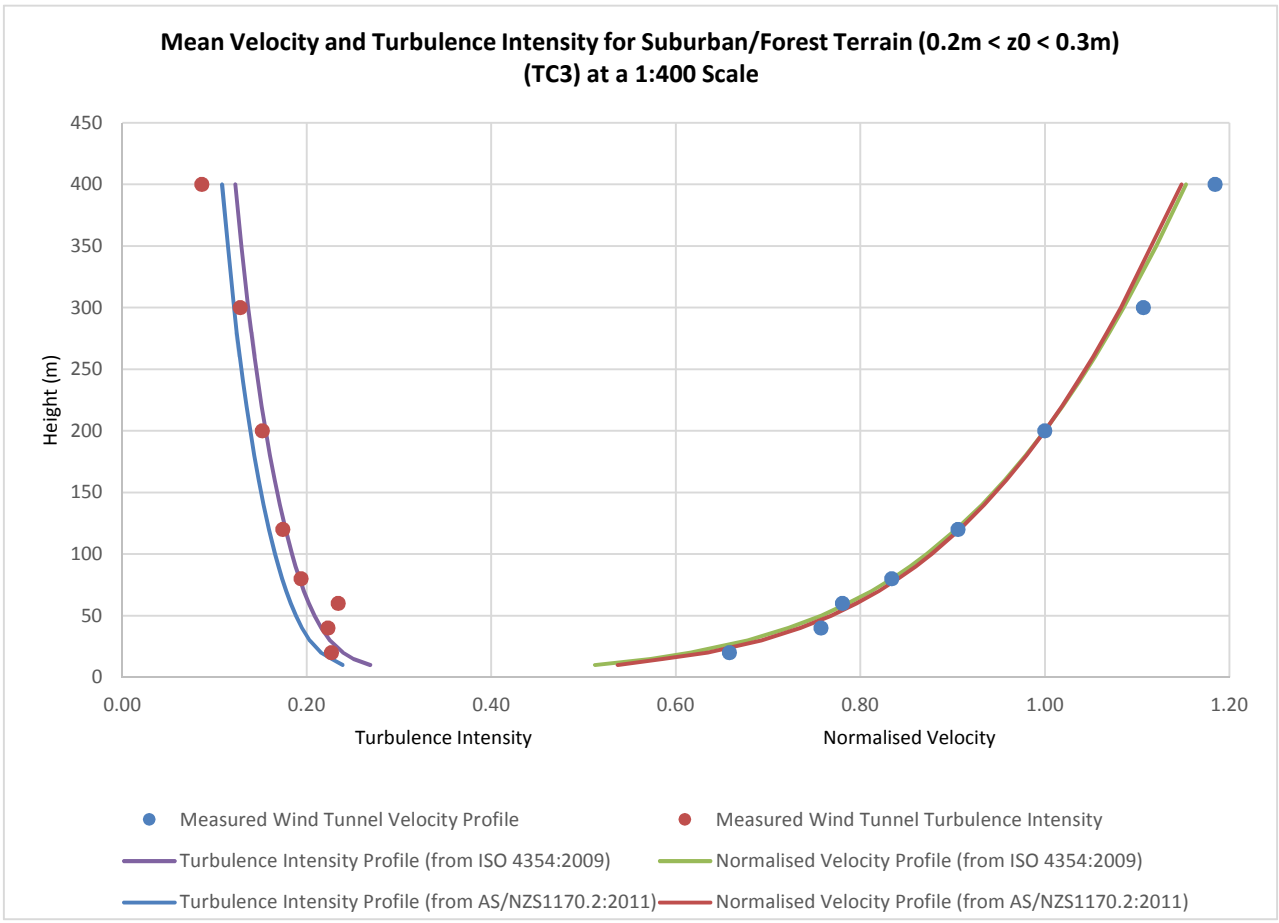
Results for Point 125

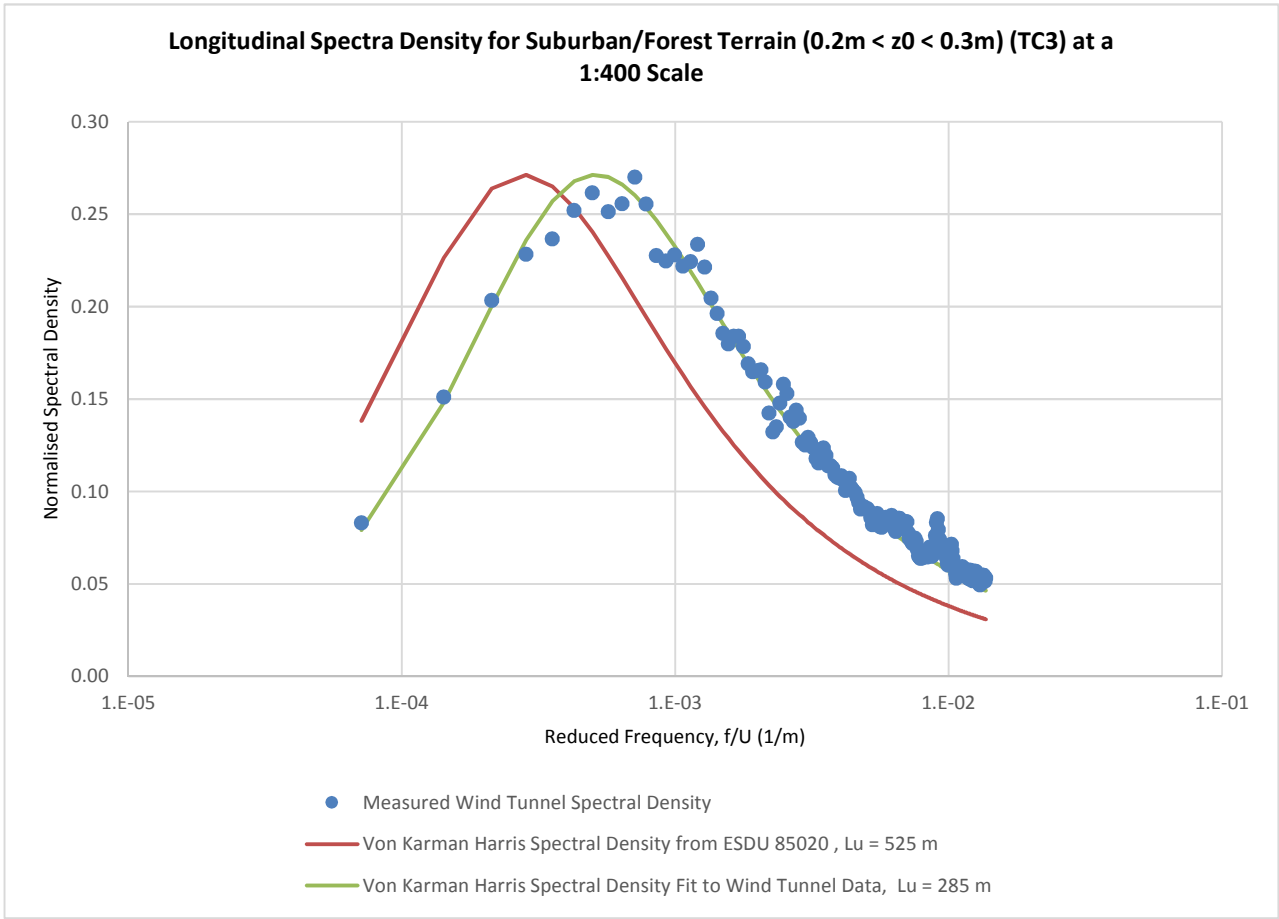
Gust Equivalent Mean (m/s)	Maximum Gust (m/s)
	
Comfort Criteria: 8m/s with 5% probability of exceedence	Safety Limit: 24m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Comfortable Walking Activities (8m/s). Safety Limit (24m/s).	5%	24
With development as proposed, no vegetation	1%	21
Existing Site	6%	25
With inclusion of Existing and Retained Trees	1%	19

WD510-10 Waterloo South 7/02/2020

APPENDIX B - VELOCITY AND TURBULENCE INTENSITY PROFILES


Mean Velocity and Turbulence Intensity for Suburban/Forest Terrain (0.2m < z0 < 0.3m) (TC3) at a 1:400 Scale
Height (m)
450
400
350
300
250
200
150
100
50
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Turbulence Intensity
Normalised Velocity
Measured Wind Tunnel Velocity Profile
Measured Wind Tunnel Turbulence Intensity
Turbulence Intensity Profile (from ISO 4354:2009)
Normalised Velocity Profile (from ISO 4354:2009)
Turbulence Intensity Profile (from AS/NZS1170.2:2011)
Normalised Velocity Profile (from AS/NZS1170.2:2011)


Longitudinal Spectra Density for Suburban/Forest Terrain (0.2m < z0 < 0.3m) (TC3) at a 1:400 Scale
Normalised Spectral Density
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
Reduced Frequency, f/U (1/m)
Measured Wind Tunnel Spectral Density
Von Karman Harris Spectral Density from ESDU 85020 , Lu = 525 m
Von Karman Harris Spectral Density Fit to Wind Tunnel Data, Lu = 285 m

APPENDIX C - PUBLISHED ENVIRONMENTAL CRITERIA

C.1 Wind Effects on People

The acceptability of wind in an area is dependent upon the use of the area. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Quantifying wind comfort has been the subject of much research and many researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, and A.D. Penwarden, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. This section discusses and compares the various published criteria.

C.1.1 A.D. Penwarden (1973) Criteria for Mean Wind Speeds

A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people. Table C.1 presents the modified Beaufort scale. Note that the effects listed in this table refers to wind conditions occurring frequently over the averaging time (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated for rarer events.

Table C.1: Summary of Wind Effects on People (A.D. Penwarden, 1973)

Type of Winds	Beaufort Number	Hourly Mean Wind Speed (m/s)	Effects
Calm	0	0 - 0.25	
Calm, light air	1	0 25 - 1.55	No noticeable wind
Light breeze	2	1.55 - 3.35	Wind felt on face
Gentle breeze	3	3.35 - 5.45	Hair is disturbed, clothing flaps, newspapers difficult to read
Moderate breeze	4	5.45 - 7.95	Raises dust, dry soil and loose paper, hair disarranged
Fresh breeze	5	7.95 – 10.75	Force of wind felt on body, danger of stumbling
Strong breeze	6	10.75 – 13.85	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, wind noise on ears unpleasant
Near gale	7	13.85 – 17.15	Inconvenience felt when walking
Gale	8	17.15 - 20.75	Generally impedes progress, difficulty balancing in gusts
Strong gale	9	20.75 – 24.45	People blown over

C.1.2 A.G. Davenport (1972) Criteria for Mean Wind Speeds

A.G. Davenport (1972) also determined a set of criteria in terms of the Beaufort scale and for various return periods. Table C.2 presents a summary of the criteria based on a probability of exceedance of 5%.

Table C.2: Criteria by A.G. Davenport (1972)

Classification	Activities	5% exceedance Mean Wind Speed (m/s)
Walking Fast	Acceptable for walking, main public accessways.	7.5 - 10.0
Strolling, Skating	Slow walking, etc.	5.5 - 7.5
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	3.5 - 5.5
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	0 - 3.5

C.1.3 T.V. Lawson (1975) Criteria for Mean Wind Speeds

In 1973, T.V. Lawson, while referring to the Beaufort wind speeds of A.D. Penwarden (1973) (as listed in Table C.1), quoted that a Beaufort 4 wind speed would be acceptable if it is not exceeded for more than 4% of the time, and that a Beaufort 6 wind speed would be unacceptable if it is exceeded more than 2% of the time. Later, in 1975, T.V. Lawson presented a set of criteria very similar to those presented in A.G. Davenport (1972) (as listed in Table C.2). These criteria are presented in Table C.3 and Table C.4 for safety and comfort respectively.

Table C.3: Safety Criteria by T.V. Lawson (1975)

Classification	Activities	Annual Mean Wind Speed (m/s)
Safety (all weather areas)	Accessible by the general public.	0 – 15
Safety (fair weather areas)	Private areas, balconies/terraces, etc.	0 – 20

Table C.4: Comfort Criteria by T.V. Lawson (1975)

Classification	Activities	5% exceedance Mean Wind Speed (m/s)
Business Walking	Objective Walking from A to B.	8 - 10
Pedestrian Walking	Slow walking, etc.	6 - 8
Short Exposure Activities	Pedestrian standing or sitting for short times.	4 – 6
Long Exposure Activities	Pedestrian sitting for a long duration.	0 - 4

C.1.4 W.H. Melbourne (1978) Criteria for Gust Wind Speeds

W.H. Melbourne (1978) introduced a set of criteria for the assessment of environmental wind conditions that were developed for a temperature range of 10oC to 30oC and for people suitably dressed for outdoor conditions. These criteria are presented in Table C.5 and are based on maximum gust wind speeds with a probability of exceedance of once per year.

Table C.5: Criteria by W.H. Melbourne (1978)

Classification	Human Activities	Annual Gust Wind Speed (m/s)
Limit for Safety	Completely unacceptable: people likely to get blown over.	23
Marginal	Unacceptable as main public accessways.	16 - 23
Comfortable Walking	Acceptable for walking, main public accessways	13 - 16
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	10 - 13
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	0 - 10

C.2 Comparison of the Published Wind Speed Criteria

W.H. Melbourne (1978) presented a comparison of the criteria of various researchers on a probabilistic basis. Figure C.1 presents the results of this comparison, and indicates that the criteria of W.H. Melbourne (1978) are comparatively quite conservative. This conclusion was also observed by A.W. RoYes (2007) when undertaking on-site remedial studies. The results of A.W. RoYes (2007) concluded that the criteria by W.H. Melbourne (1978) generally overstates the wind effects in a typical urban setting due to the assumption of a fixed 15% turbulence intensity for all areas. It was observed in A.W. RoYes (2007) that this value tends to be at the lower end of the range of turbulence intensities, and in an urban setting the range of the minimum turbulence intensities is typically in the range of 20% to 60%.

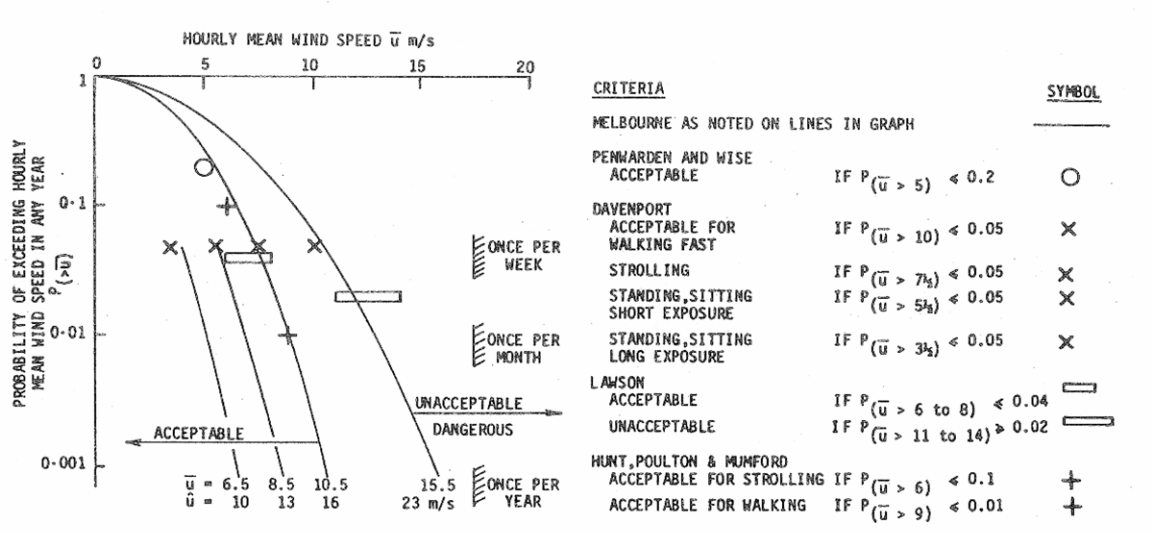


Figure C.1: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (W.H. Melbourne, 1978)

C.3 References relating to Pedestrian Comfort Criteria

Davenport, A.G., 1972, "An approach to human comfort criteria for environmental conditions". Colloquium on Building Climatology, Stockholm.

Davenport, A.G., 1977, "The prediction of risk under wind loading", 2nd International Conference on Structural Safety and Reliability, Munich, Germany, pp511-538.

Lawson, T.V., 1973, "The wind environment of buildings: a logical approach to the establishment of criteria". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, "The determination of the wind environment of a building complex before construction". Bristol University, Department of Aeronautical Engineering.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions". Journal of Wind Engineering and Industrial Aerodynamics, vol. 3, pp241-249.

Penwarden, A.D. (1973). "Acceptable Wind Speeds in Towns", Building Science, vol. 8: pp259–267

Penwarden, A.D., Wise A.F.E., 1975, "Wind Environment Around Buildings". Building Research Establishment Report, London.

RoYes, A.W., 2007, "Comparison of Wind Environment Criteria against Field Observations". 12th International Conference of Wind Engineering, Cairns, Australia.

APPENDIX D - DATA ACQUISITION

The wind tunnel testing procedures for this study were based on the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2017), ASCE 7-10 (Chapter C31), and CTBUH (2013).

The wind speed measurements for the wind tunnel study were acquired as coefficients by Dantec hot-wire anemometers and converted to full-scale wind speeds using details of the regional wind climate obtained from an analysis of directional wind speed recordings from the local meteorological recording station(s).

D.1 Measurement of the Velocity Coefficients

The study model and proximity model were setup within the wind tunnel which was configured to the appropriate boundary layer profile, and the wind velocity measurements were monitored using Dantec hot-wire probe anemometers at selected critical outdoor locations. The anemometers were positioned at each study location at a full-scale height of approximately 1.5m above ground/slab level. The support of the probe was mounted such that the probe wire was vertical as much as possible to ensure that the measured wind speeds are independent of wind direction along the horizontal plane. In addition, care was taken in the alignment of the probe wire and in avoiding wall-heating effects.

Wind speed measurements were made in the wind tunnel for 16 wind directions, at 22.5° increments. The output from the hot-wire probes was obtained using a National Instruments 12-bit data acquisition card. The data was acquired for each wind direction using a sample rate of 1024Hz. The sample length was determined to produce a full-scale sample time that is sufficient for this type of study.

The mean, gust and standard deviation velocity coefficients were measured in the wind tunnel. The gust velocity coefficients were also derived for each wind direction from by the following relation:

$$\hat{C}_V = \bar{C}_V + g \cdot \sigma_{C_V} \qquad \text{D.1}$$

Where:

$\hat{C}_V$ is the gust coefficient.

$\bar{C}_V$ is the mean coefficient.

g is the peak factor, taken as 3.0 for a 3s gust and 3.4 for a 0.5s gust.

σ_{C_V} is the standard deviation of coefficient measurement.

D.2 Calculation of the Full-Scale Results

The full-scale results determine if the wind conditions at a study location satisfy the designated criteria of that location. More specifically, the full-scale results need to determine the probability of exceedance of a given wind speed at a study location. To determine the probability of exceedance, the measured velocity coefficients were combined with a statistical model of the local wind climate that relates wind speed to a probability of exceedance. Details of the wind climate model are outlined in Section 5 of the main report.

The statistical model of the wind climate includes the impact of wind directionality as any local variations in wind speed or frequency with wind direction. This is important as the wind directions that produce the highest wind speed events for a region may not coincide with the most wind exposed direction at the site.

The methodology adopted for the derivation of the full-scale results for the maximum gust and the GEM wind speeds are outlined in the following sub-sections.

Maximum Gust Wind Speeds

The full-scale maximum gust wind speed at each study point location is derived from the measured coefficient using the following relationship:

$$V_{study} = V_{ref,RH}\left(\frac{k_{200m,tr,T=1hr}}{k_{RH,tr,T=1hr}}\right)C_V \qquad \text{D.2}$$

Where:

V_{study} is the full-scale wind speed at the study point location, in m/s.

$V_{ref,RH}$ is the full-scale reference wind speed, measured 3m upstream at the study reference height. This value is determined by combining the directional wind speed data for the region (detailed in Section 5) and the upwind terrain and height multipliers for the site (detailed in Section 4).

$k_{200m,tr,T=1hr}$ is the standard deviation of the wind speed.

$k_{RH,tr,T=1hr}$ is the hourly mean terrain and height multiplier at the study reference height (see Section 4).

C_V is the velocity coefficient measurement obtained from the hot-wire anemometer, which is derived from the following relationship:

$$C_V = \frac{C_{V,study}}{C_{V,200m}} \qquad \text{D.3}$$

Where:

$C_{V,study}$ is the coefficient measurement obtained from the hot-wire anemometer at the study point location.

$C_{V,200m}$ is the coefficient measurement obtained from the hot-wire anemometer at the free-stream reference location at 200m height upwind of the model in the wind tunnel.

The value of $V_{ref,RH}$ varies with each prevailing wind direction. Wind directions where there is a high probability that a strong wind will occur have a higher directional wind speed than other directions. To determine the directional wind speeds, a probability level must be assigned for each wind direction. These probability levels are set following the approach used in AS/NZS1170.2:2011, which assumes that the major contributions to the combined probability of exceedance of a typical load effect comes from only two 45 degree sectors.

Maximum Gust-Equivalent Mean Wind Speeds

The contribution to the probability of exceedance of a specified wind speed (ie: the desired wind speed for pedestrian comfort, as per the criteria) was calculated for each wind direction. These contributions are then combined over all wind directions to calculate the total probability of exceedance of the specified wind speed. To calculate the probability of exceedance for a specified wind speed a statistical wind climate model was used to describe the relationship between directional wind speeds and the probability of exceedance. A detailed description of the methodology is given by T.V. Lawson (1980).

The criteria used in this study is referenced to a probability of exceedance of 5% of a specified wind speed.

D.3 References relating to Data Acquisition

American Society of Civil Engineers (ASCE), ASCE-7-10, 2010, "Minimum Design Loads for Buildings and Other Structures".

Australasian Wind Engineering Society (AWES), QAM-1, 2017, "Quality Assurance Manual".

Council on Tall Buildings and Urban Habitat (CTBUH), 2013, "Wind tunnel testing of high-rise buildings", CTBUH Technical Guides.

Lawson, T.V., 1980, "Wind Effects on Buildings - Volume 1, Design Applications". Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England.

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