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May 17, 2022

Mr. J. Daniel Greenberg
1785 Bloor Holdings Inc.
181 Eglinton Ave East, Suite 204
Toronto, ON
M4P 1J4

Dear Mr. Greenberg,

Re: Microclimatic Analysis - Addendum Letter
1785 Bloor Street
Mississauga, Ontario
Theakston Project No. 22873 (21797)

We reviewed Architectural Drawings for 1785 Bloor Street, prepared by onespace unlimited inc., architecture, dated May 9, 2022, as well as our Pedestrian Level Wind Study dated January 14, 2022, and related files, with regard to the effect of the proposed repurposing of at grade and rooftop areas to outdoor amenity space, and the predicted pedestrian comfort conditions realised at the same.

The proposed Development site occupies a portion of a block of lands bound by Bridgewood Drive to the northeast, Bloor Street to the southeast, Fieldgate Drive to the southwest, and Ponytrail Drive to the northwest, in the City of Mississauga. The original proposal for the Development involved a plan to construct a 14 storey apartment building with a 10 storey wing in an L-shaped configuration to the northwest of the existing 10 storey building on site. A courtyard is proposed at grade along a portion of the northeast extents of the property. Vehicular drop-off along with access to the parking garage is provided via an extension of the existing driveway connecting with Bloor Street. The Main Entrances to the building are proposed along the northwestern and southeastern façades. The ground floor of the Development was assigned to the residential lobby, residences, indoor amenity space, and services.

The summary findings of the pedestrian level wind study indicated that with the introduction of the proposed Development, wind conditions at many locations will improve, with occasional localized areas of higher pedestrian level winds. The overall changes in pedestrian level winds were subtle and comfort conditions were in many cases similar to or better than the existing setting. The proposed Development was predicted to realize wind conditions acceptable to a typical urban context. A mitigation plan was recommended for the Courtyard area in order to achieve conditions that are more suitable for the intended use throughout the year.

Subsequent to the wind study dated May 9, 2022, various changes were made to the proposed Development, however the notable changes include:

- assigning the northeast courtyard and remaining extents of the property along the Ontario Hydro corridor to the existing building, to amenity space, and
- assigning a portion of the 10 storey wing's rooftop to outdoor amenity space, said space adjacent to the 14 storey building's southmost corner.

The at grade amenity space as proposed is an extension of space that was formerly proposed as a Courtyard. The Courtyard and proposed amenity space were instrumented and reported on in the above captioned report and realised pedestrian comfort conditions that are suitable for standing during the summer months. This rating may be appropriate for portions of the repurposed space; however, a rating of sitting is generally preferred for amenity spaces. Recommendations were made for wind mitigation in the above captioned report, they remain valid, and are reiterated for convenience.

The area would benefit from a mitigation plan to improve wind conditions in the area. The plan should be designed with input from the consultant and may include berms, fencing, coniferous trees, porous wind screens, raised planters populated with coarse plantings, trellises, etc. situated around the amenity space as practical. Consideration of an appropriate mitigation plan for the space will result in more comfortable conditions that are appropriate for the intended use throughout the year.

The proposed rooftop amenity space was not assessed, however, given its height and proximity to the 14 storey building's corner, windy conditions can be expected with high ambient winds emanating from predominant directions, and mitigation is recommended. To this end, screen walls 1.8m in height are suggested around the perimeter of the space. Coarse plantings in raised planters, trellises, wind breaks, canopies, and others would further assist in mitigating winds in the area. The space is expected to be subject to seasonal use and as such will be suitable for the intended purpose with appropriate mitigation in place.

In summary, based on our analysis and experience, we submit that the repurposed at grade amenity space area will realise comfort conditions that are like those discussed in the Theakston Report. As such, the site is predicted to remain comfortable and suitable for the intended uses and the original conclusions and recommendations for mitigation remain valid. The rooftop area will similarly require mitigation as described above; the penultimate and ultimate designed in cooperation with the wind consultancy.

Respectfully submitted,

Nicole Murrell M.Eng

Stephen Pollock P. Eng.

THEAKSTON ENVIRONMENTAL

Consulting Engineers • Environmental Control Specialists

REPORT

PEDESTRIAN LEVEL WIND STUDY

1785 Bloor Street

Mississauga, Ontario

1785 Bloor Holdings Inc.

REPORT NO. 21797wind **March 18, 2022**

TABLE OF CONTENTS

1. CONCLUSIONS AND RECOMMENDATIONS

The Residential Development proposed by 1785 Bloor Holdings Inc. for the property municipally known as 1785 Bloor Street in the City of Mississauga, has been assessed for environmental standards with regard to pedestrian level wind relative to comfort and safety. The pedestrian level wind and gust velocities predicted for the locations tested are within the safety criteria and most are within the comfort criteria described within the following report.

The proposed Development site occupies a portion of a block of lands bound by Bridgewood Drive to the northeast, Bloor Street to the southeast, Fieldgate Drive to the southwest, and Ponytrail Drive to the northwest, in the City of Mississauga. The Development involves a proposal to construct a 14 storey apartment building with a 10 storey wing in an L-shaped configuration to the northwest of the existing 10 storey building on site. The Development is, for all intents and purposes, surrounded to prevailing windward directions by a predominantly suburban mix of low through mid-rise residential, commercial, and institutional development and related open areas.

Urban development provides turbulence inducing surface roughness that can be wind friendly, while open settings afford wind the opportunity to accelerate as the wind's boundary layer profile thickens at the pedestrian level, owing to lack of surface roughness. High-rise buildings typically exacerbate wind conditions within their immediate vicinity, to varying degrees, by redirecting wind currents to the ground level and along streets and open areas. Transition zones from open to urban, and to a lesser degree suburban, settings may prove problematic, as winds exacerbated by the relatively more open settings are redirected to flow over, around, and between urban buildings.

These phenomena were observed at the existing site with prevailing winds that have opportunity to accelerate over the relatively open lands associated with the site and adjacent streets. This open setting accounts for the moderately windy conditions observed in the existing setting, on and about the Development site. With inclusion of the proposed Development, winds that formerly flowed over the existing lands are redirected, tending to split with portions flowing over, around and down the proposed building's façades. At the pedestrian level, the winds redirect to travel horizontally along the buildings, around the corners and beyond, creating minor windswept areas at or near the buildings' corners and in the gaps between. These conditions are primarily attributable to the setting, whereby the proposed Development penetrates winds that formerly flowed over the existing lands.

Based upon this analysis the comfort conditions at the site and surrounds are in many cases similar to, or better, than the existing setting, and considered appropriate for the intended uses. Where mitigation was required, it was achieved through the incorporation of the following design features:

- stepped façades
- podium
- modest height
- balconies

- landscaping

and others, that were included in the proposed Development's massing and landscape design. A mitigation plan is recommended for the Courtyard area in order to achieve conditions that are suitable for the intended use throughout the year. The proposed Development will realize wind conditions acceptable to a typical urban context and remains within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in the following.

Respectfully submitted,

Nicole Murrell, M. Eng.

Paul Kankainen, M.A.Sc.

Stephen Pollock, P. Eng.

2. INTRODUCTION

Theakston Environmental Consulting Engineers, Fergus, Ontario, were retained by 1785 Bloor Holdings Inc. to study the pedestrian level wind environment for their proposed Residential Development municipally known as 1785 Bloor Street in the City of Mississauga and depicted on the Aerial Photo in Figure 2a. The Development involves a proposal to construct a 14 storey apartment building with a 10 storey wing in an L-shaped configuration to the northwest of the existing 10 storey building on site in the configuration shown in Figure 2b. Onespace Unlimited provided architectural drawings. The co-operation and interest of the Client and their sponsors in all aspects of this study is gratefully acknowledged.

The specific objective of the study is to determine areas of higher than normal wind velocities induced by the shape and orientation of the proposed building and surroundings. The wind velocities are rated in accordance with the safety and comfort of pedestrians, notably at entrances to the buildings, sidewalks, courtyards on the property, as well as other buildings in the immediate vicinity.

In order to obtain an objective analysis of the wind conditions for the property, the wind environment was tested in two configurations. The existing configuration included existing and proposed buildings in the surrounding area. The proposed configuration included the Development's subject building. Mitigation procedures were assessed during these tests to determine their impact on the various wind conditions.

The laboratory techniques used in this study are established procedures that have been developed specifically for analyses of this kind. The methodology, summarized herein, describes criteria used in the determination of pedestrian level wind conditions. The facilities used by Theakston are ideal for observance of the Development at various stages of testing, and the development of wind mitigation measures, if necessary.

3. OBJECTIVES OF THE STUDY

1. To quantitatively assess, by model analyses, the pedestrian level wind environment under existing conditions and future conditions with the Development in accordance with the City of Mississauga's Terms of Reference.

2. To assess mitigative solutions.

3. To publish a Consultant's report documenting the findings and recommendations.

4. METHOD OF STUDY

4.1 General

The Theakston Environmental wind engineering facility was developed for the study of, among other sciences, the pedestrian level wind environment occurring around buildings, with focus on the safety and comfort of pedestrians. To this end, physical scale models of proposed Development sites, and immediate surroundings, are built, instrumented and tested at the facility with resulting wind speeds measured for different wind directions at various locations likely to be frequented by pedestrians. This quantitative analysis provides predictions of wind speeds for various probabilities of occurrence and for various percentages of time that are ultimately weighted relative to a historical range of wind conditions, and provided to the client.

The techniques applied to wind and other studies carried out at the facility, utilise a boundary layer wind tunnel and/or water flume (Figure 1). The testing facility has been developed for these kinds of environmental studies, and has been adapted with equipment, testing procedures and protocols, in order to provide results comparable to full scale. The Boundary Layer Wind Tunnel lends itself well to the simultaneous acquisition of large data streams while the water flume is excellent for flow visualisation.

The purpose of this Pedestrian Level Wind Study is to evaluate the pedestrian level wind speeds for a full range of wind directions. To accomplish this, the wind's mean speed boundary layer profiles are simulated and applied to a site-specific model under test, instrumented with differential pressure probes at locations of interest. During testing, pressure readings are taken over a one-hour model scale period of time, at a full-scale height of approximately 1.8m and correlated to mean and gust wind speeds, expressed as ratios of the gradient wind speed.

The mean and gust wind speeds at the forty-four (44) points tested were subsequently combined with the design probability distribution of gradient wind speed and direction, (wind statistics) recorded at Airports in the vicinity, to provide predictions of the full-scale pedestrian level wind environment. Predictions of the full-scale pedestrian level wind environment are presented as the wind speed exceeded 20% of the time, based on winter and summer winds in Figures 6a and 6b. Criterion employed by Theakston Environmental was developed by others and us and published in the attached references. The methodology has been applied to over 800 projects on this continent and abroad.

4.2 Meteorological Data

The wind climate for the Mississauga region that was used in the analysis was based on historical records of wind speed and direction measured at Pearson International Airport for the period between 1980 and 2017. The meteorological data includes hourly wind records and annual extremes. The analysis of the hourly wind records provides information to develop the statistical climate model of wind speed and direction. From this model, predicted wind speeds regardless of wind direction for various return periods can be derived. The record of annual extremes was also used to predict wind speeds at various return periods. Based on the analysis of the hourly records, the predicted hourly-mean wind speed measured at 10*m* above grade, corrected for a standard open exposure definition, is 25*m/s* for a return period of 50 years.

4.3 Statistical Wind Climate Model

For the analysis of the data, the wind climate model is converted to a reference height of 500*m* using a standard open exposure wind profile. The mean-hourly wind speed at a 500*m* reference height used for this study is 45.6*m/s* for a return period of 50 years. The corresponding 1-year return period wind speed at the 500*m* height is 36*m/s*.

The design probability distribution of mean-hourly wind speed and wind direction at reference height is shown for Pearson International Airport in Figure 5. Distributions for Winter and Summer are shown. From this it is apparent that winds can occur from any direction, however, historical data indicates the directional characteristics of strong winds during the winter months are north through west to southwest. Through the summer months, the winds are not as strong and are mainly from the same directions as winter winds, with the addition of winds from the southeast more often.

4.4 Wind Simulation

To simulate the correct macroclimate, the upstream flow passes over conditioning features placed upstream of the model, essentially strakes and an appropriately roughened surface, as required to simulate the full-scale mean speed boundary layer approach flow profiles occurring at the site.

4.5 Pedestrian Level Wind Velocity Study

A physical model of the proposed Development and pertinent surroundings, including existing buildings, roadways, pathways, terrain and other features, was constructed to a scale of 1:500. The model is based upon information gathered during a virtual site visit to the proposed Development site, and surrounding area. Onespace Unlimited provided architectural drawings. City of Mississauga aerial photographs were also used in development of the model to ensure the model reasonably represents conditions at the proposed Development. The model is constructed on a circular base so that, by rotation, any range of wind directions can be assessed. Structures and features that are deemed to have an impact on the wind flows are included upwind of the scale model.

In these studies, the effects of wind were analysed using omni-directional wind velocity probes that are placed on the model and located at the usual positions of pedestrian activity. The probes measure both mean and fluctuating wind speeds at a height of approximately 1.8m. During testing, the model sample period is selected to represent 1hr of sampling time at full scale. The velocities measured by the probes are recorded by a computerized data acquisition system and combined with historical meteorological data via a post-processing program.

4.6 Pedestrian Comfort Criteria

The assignment of pedestrian comfort takes into consideration pedestrian safety and comfort attributable to mean and gust wind speeds. Gusts have a significant bearing on safety, as they can affect a person's balance, while winds flowing at or near mean velocities have a greater influence upon comfort.

Figure 6 presents results for the mean wind speed that is exceeded 20% of the time. These speeds are directly related to the pedestrian comfort at a particular point. The overall comfort rating, for existing and proposed, are depicted in Figure 7. Table 1, below, summarizes the comfort criteria used in the presentation of the results depicted in Figures 6 and 7.

Table 1: Comfort Criteria

ACTIVITY	Gust Equivalent Mean Speed Exceeded 20% of the Time		Description
COMFORT	***km/h***	***m/s*** (used in Fig. 6)	
Sitting	0-10	0-2.8	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	0-15	0-4.2	Gentle breezes suitable for main building entrances and bus stops.
Walking	0-20	0-5.6	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	>20	>5.6	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

The activities are described as suitable for Sitting, Standing, Walking, or Uncomfortable, depending on average wind speed exceeded 20% of the time. For a point to be rated as suitable for Sitting, for example, the wind conditions must not exceed 10*km/h* (2.8*m/s*), more than 20% of the time. Thus, in the plots (Figure 6), the upper limit of each bar ends within the range described by the comfort category. For sitting, the rating would include conditions ranging from calm up to wind speeds that would rustle tree leaves or wave flags slightly, as presented in the

Beaufort Scale included in the Appendices. As the name infers, the category is recommended for outdoor space where people might sit for extended periods.

The Standing category is slightly more tolerant of wind, including wind speeds from calm up to 15*km/h* (4.2*m/s*). In this situation, the wind would rustle tree leaves and, on occasion, move smaller branches while flags flap. This category would be suitable for locations where people might sit for short periods or stand in relative comfort. The Walking category includes wind speeds from calm up to 20*km/h* (5.6*m/s*). These winds would set tree limbs in motion, lift leaves, litter and dust, and the locations are suitable for activity areas. The Uncomfortable category covers a broad range of wind conditions that are generally a nuisance for most activities, including wind speeds above 20*km/h* (5.6*m/s*).

In Figure 6, the probe locations are listed along the bottom of the chart; beneath the graphical representation of the Mean Wind Speed exceeded 20% of the time. Along the right edge of the plot the comfort categories are shown. The background of the plot is lightly shaded in colours corresponding to the categories shown in Table 1. Each category represents a 5*km/h* (or more) interval. The location is rated as suitable for Sitting, Standing, Walking, or Uncomfortable, if the bar extends into the corresponding interval.

The charts represent the average person's response to wind force. Effects such as wind chill and humidex (based on perception) are not considered. Also clothing is not considered, since clothing and perceived comfort varies greatly among the population. There are many variables that contribute to a person's perception of the wind environment beyond the seasonal variations presented. While people are generally more tolerant of wind during the summer months, than during the winter, due to the wind cooling effect, people become acclimatized to a particular wind environment. Persons dwelling near the shore of an ocean, large lake or open field are more tolerant of wind than someone residing in a sheltered wind environment.

4.7 Pedestrian Safety Criteria

Safety criteria are also included in the analysis to ensure that strong winds do not cause a loss of balance to individuals occupying the area. The safety criteria are based on wind speeds exceeded nine times per year as shown in Table 2.

Both the Comfort and Safety Criteria are based on those developed at the Allan G. Davenport Wind Engineering Group Boundary Layer Wind Tunnel Laboratory, located on the campus of The University of Western Ontario. The comfort criteria were subsequently revised for the Mississauga Urban Design Terms of Reference for Wind Comfort and Safety Studies, in consultation with RWDI and more closely respects the Lawson criteria.

Table 2: Safety Criteria

ACTIVITY	Mean Wind Speed Exceeded 9 times per year		Description
SAFETY	***km/h***	***m/s*** (used in Fig. 8)	
All-Weather	0-90	0-25	Acceptable gust speeds that will not adversely affect a pedestrian's balance and footing.
Exceeding All-Weather	>90	>25	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

4.8 Pedestrian Comfort Criteria – Seasonal Variation

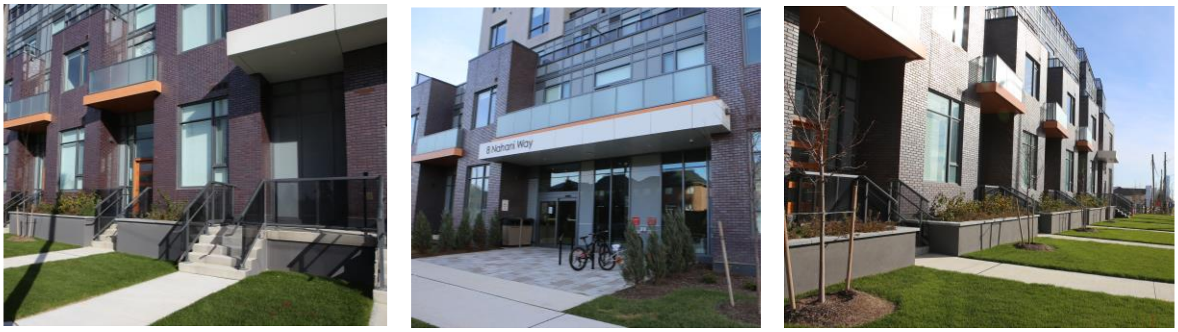
The level of comfort perceived by an individual is highly dependent on seasonal variations of climate. Perceived comfort is also specific to each individual, and depends on the clothing choices. The comfort criterion that is being used averages the results across the general population to remove effects of individuals and clothing choices, however, seasonal effects are important. For instance, a terrace or outdoor amenity space may have limited use during the winter season, but require acceptable comfort during the summer.

The comfort of a site is based on the "winter" or "summer" results of the study, Figures 6a and 6b and 7a through 7d. When compared to the annual average wind speed, winter winds are about 12.5% higher and summer winds are about 16% lower.

4.9 Wind Mitigation Strategies

Wind mitigative features such as podiums, setbacks, stepped façades, balconies, notches, overhangs, canopies, and others, assist in discouraging downwash associated with prevailing winds. These features deflect portions of said winds around buildings at elevations well above the pedestrian level, and moderate upsets to wind conditions with inclusion of new developments. Additional mitigative features may also be applied for localised areas that experience conditions that are inappropriate for the intended use. These features, discussed below, add roughness into wind streamlines and protect exposed areas from high pedestrian level winds.

Entrances to buildings may be mitigated by locating them away from building corners and through recessing the entrances into the façades of the building. Additional mitigative features such as railings, canopies, coarse plantings, porous wind screens, and others, would further assist in mitigating said areas. Examples of these wind mitigation measures are shown below.



Examples of Wind Mitigative Measures at Entrances (recessed entrances, railings, canopies, raised planters, coniferous trees).

Activity areas such as Outdoor Amenity Spaces may similarly be mitigated through implementation of 1.8m – 2.4m high perimeter wind screens, trellises, raised planters, coarse plantings, and others, situated about the spaces as practical. Examples of these wind mitigative measures are shown below.

Examples of Wind Mitigative Measures at Activity Spaces (wind screens, raised planters, trellises)

The model was assessed with selected mitigation strategies during these tests to determine their impact on the various wind conditions. Further testing may be required in order to determine the effectiveness of any additionally proposed wind mitigative features, if desired.

5. RESULTS

5.1 Study Site and Test Conditions

<u>Proposed Development</u>

The Development site municipally known as 1785 Bloor Street occupies a portion of a block of lands bound by Bridgewood Drive to the northeast, Bloor Street to the southeast, Fieldgate Drive to the southwest, and Ponytrail Drive to the northwest, in the City of Mississauga. The Development involves a proposal to construct a 14 storey apartment building with a 10 storey wing in an L-shaped configuration to the northwest of the existing 10 storey building on site. A courtyard is proposed at grade along the northeast extents of the property. Vehicular drop-off along with access to the parking garage is provided via the existing driveway connecting from Bloor Street. The Main Entrances to the building are proposed along the northwestern and southeastern façades.

The configuration of the proposed Development is shown in Figure 2b. The Development, located in the City of Mississauga, is depicted in the Aerial Photo in Figure 2a. Note: Mississauga's street orientation is relative to the Lake Ontario Shoreline resulting in east/west orientated streets in the subject area being offset by approximately 50 degrees north.

View of the 1785 Bloor Street Development Site Looking West from Bloor Street (Google).

Surrounding Area

The Development is, for all intents and purposes, surrounded to prevailing windward directions by a predominantly suburban mix of low through mid-rise residential, commercial, and institutional development and related open areas.

To the immediate southwest of the site are two 9 storey apartment buildings along Bloor Street with surrounding open parking areas and low-rise commercial buildings beyond. To the northwest of the site are two 6 storey apartment buildings and a 10 storey apartment building along Ponytrail Drive with surrounding open parking areas and the low-rise Forest Glen Public School with related open fields. To the northeast of the site are open Ontario Hydro lands with low-rise residential neighbourhoods beyond. To the east through south of the site are further mid-rise apartment buildings fronting Bloor Street with surrounding open parking areas.

Figures 2a and 2b depict the site and its immediate context. The site model, shown in Figure 3, is built to a scale of 1:500. For all intents and purposes, suburban development comprised of low through mid-rise buildings and related open lands surround the site. The surrounding lands present a relatively coarse terrain that will moderate pedestrian level winds approaching the site, whereas more open lands allow winds the opportunity to accelerate as they approach.

Macroclimate

For the proposed Development, the upstream wind flow during testing was conditioned to simulate an atmospheric boundary layer passing over suburban terrain. The terrain within the site's immediate vicinity was incorporated into the proximity model. Historical meteorological data recorded from the Toronto Pearson International Airport was used in this analysis. For studies in the City of Mississauga, the data is presented for two seasons and the resulting wind roses are presented as mean velocity and percent frequency in Figure 5. The mean velocities presented in the wind roses are measured at an elevation of 10*m*. Thus, representative ground level velocities at a height of 2*m*, for an urban macroclimate, are 52% of the mean values indicated on the wind rose, (for suburban and rural macroclimates the values are 63% and 78% respectively).

Winter (November through April) has the highest mean velocities of the seasons with prevailing winds from the north and west, with significant components from north through west to southwest as indicated in Figure 5a. Summer (May through October) has the lowest mean wind velocities of the seasons with prevailing winds from north through west to southerly as indicated in Figure 5b. Reported pedestrian comfort ratings generally pertain to winter conditions, unless stated otherwise.

5.2 Pedestrian Level Wind Velocity Study

On the site model, forty-four (44) wind velocity measurement probes were located around the proposed Development, activity areas, and surrounds, to determine conditions related to comfort and safety. Figure 4 depicts probe locations at which pedestrian level wind velocity measurements were taken in the existing and proposed scenarios. For the existing setting, the subject building as well as proposed mitigation was removed and the "existing" site model retested.

Measurements of pedestrian level mean and gust wind speeds at the various locations shown were taken over a period of time equivalent to one hour of measurements at full-scale. The mean ground level wind velocity measured is presented as a ratio of gradient wind speed, in the plots of Figure B of the Appendices, for each point in the existing and proposed scenarios. These relative wind speeds are presented as polar plots in which the radial distance for a particular wind direction represents the wind speed at the location for that wind direction, expressed as a ratio of the corresponding wind speed at gradient height. They do not assist in assessing wind comfort conditions until the probability distribution gradient wind speed and direction is applied.

The design probability distribution gradient wind speed and direction, taken from historical meteorological data for the area (see Figure 5) was combined with pedestrian level mean and gust wind speeds measured at each point to provide predictions of the percentage of time a point will be comfortable for a given activity. These predictions of mean and maximum or "gust" wind speeds are provided for winter and summer in Figures 6a and 6b, respectively.

The ratings for a given location are conservative by design. When the existing surroundings and proposed building's fine massing details and actual landscaping are taken into consideration, the results tend toward a more comfortable site than quantitative testing alone would indicate.

Venturi action, scour action, downwash and other factors, as discussed in the Appendix on wind flow phenomena, can be associated with large buildings, depending on their orientation and configuration. These serve to increase wind velocities. Open areas within a heavily developed area may also encounter high wind velocities. Consequently, wind force effects are common in heavily built-up areas. The Development site is open to a predominantly suburban setting to prevailing and remaining compass points with winds flowing over and between buildings. As such, the surroundings can be expected to influence wind at the site to varying degrees. It should be noted that the probes are positioned at points typically subject to windy conditions in order to determine the worst-case scenario.

5.3 Review of Probe Results

The probe results, as follows, were clustered into groups comprised of Public Street Conditions, Neighbouring Site Conditions, Internal Site Conditions, Pedestrian Entrance Conditions, and Outdoor Amenity Area Conditions. The measurement locations are depicted in Figure 4 and are listed in Figures 6a and 6b, for winter and summer and for the existing and proposed configurations. The results are also graphically depicted for the existing and proposed configurations in Figures 7a – 7d. The following discusses anticipated wind conditions and suitability for the points' intended use.

5.3.1 Public Street Conditions

Bloor Street

Probes 1 through 17 were located along Bloor Street within the zone of influence of the proposed Development site. These probe locations indicate wind conditions that are mainly suitable for standing throughout the year in the existing setting, with exceptions. Through the winter months probes 11, 16, and 17 were rated suitable for walking, and during the summer months probe 8 was rated suitable for sitting. The relatively comfortable conditions along the street can be attributed to the mid-rise buildings situated along Bloor Street that provide blockage to winds from some directions while allowing winds that approach from over more open terrain to accelerate along the street.

With inclusion of the proposed Development, probes situated along Bloor Street realised fairly subtle changes in winds that were insufficient to change the majority of the seasonal comfort ratings. Many of the probe locations realised an improvement in pedestrian comfort conditions, however, the changes were only sufficient to improve the winter ratings at probes 16 and 17 from walking to standing, and probe 7 from standing to sitting. Similarly, in the summer months, probes 2, 4, 5, 6, 7, and 15 realised improvements sufficient to change from standing to sitting.

The changes along Bloor Street can be attributed to the proposed Development causing a realignment of winds that reduces apparent wind effects at the pedestrian level for several wind directions, but causes an increase to winds for others. However, as indicated in the Appendices Figure B, Ground Level Wind Velocity Plots presented as a ratio of gradient wind velocity, these changes along Bloor Street are relatively subtle. Increased winds from specific directions are attributed to the proposed Development redirecting winds through downwash and other phenomena, to flow along portions of Bloor Street. Conversely, improvements in wind conditions can be attributed to the proposed Development effectively reducing the propensity for specific winds being deflected to flow along the street and over the areas, resulting in the observed leeward effect.

As such, Bloor Street will realise slightly more comfortable conditions throughout the year with inclusion of the proposed Development and will remain suitable for the intended use. Consideration of design and landscape elements that were too fine to include in the massing model will result in more comfortable conditions than reported.

Bloor Street remains within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Bridgewood Drive

Probes 18 through 22 were located along Bridgewood Drive to the northeast of the proposed Development site. In the existing setting, said points are rated suitable for standing throughout the year, with the exception of probes 19, 20, and 21 that are rated suitable for sitting through the summer months. The changes along Bridgewood Drive are subtle in the proposed setting, with only probe 22 realising sufficient blockage to westerly winds to change the summer rating from standing to sitting. As such, Bridgewood Drive will realise fairly similar comfort conditions to the existing setting with inclusion of the proposed Development and will remain suitable for the intended use throughout the year.

Bridgewood Drive remains within the pedestrian level wind velocity safety criteria as an All-Weather Area, as described in Section 4.7 and depicted in Figure 9.

5.3.2 Neighbouring Site Conditions

Probes 23 and 24 were placed adjacent to the Main Entrances to neighbouring apartment buildings to the northwest of the proposed Development site at 3401 and 3395 Ponytrail Drive, respectively. In the existing setting, the neighbouring entrances were rated suitable for sitting year-round. The area realises subtle changes with inclusion of the proposed Development, however the comfort conditions are unchanged throughout the year. As such, the neighbouring entrances to 3401 and 3395 Ponytrail Drive remain comfortable and suitable for the intended uses throughout the year.

Probe 25 was similarly placed adjacent to the Main Entrance to a neighbouring apartment to the west of the Development site at 1759 Bloor Street. The entrance was rated suitable for standing in the winter and sitting in the summer months in the existing setting. With inclusion of the proposed Development, the comfort conditions are unchanged and the neighbouring entrance to 1759 Bloor Street remains suitable for the intended use throughout the year.

Consideration of existing and proposed design elements that were too fine to include in the massing model will result in more comfortable conditions than those predicted at neighbouring sites. The above-mentioned neighbouring entrances remain within the pedestrian level wind velocity safety criteria as All-Weather Areas.

5.3.3 Internal Site Conditions

Probes 26 and 28 through 31 were located along internal walkways near the northern boundaries of the site. The areas are mainly rated for standing throughout the year in the existing setting, with probes 28, 29, and 30 rated suitable for walking through the winter months. With inclusion of the proposed Development the area realises a realignment of winds as winds that formerly flowed over the open site are redirected to flow down and around the proposed building. Improvements were noted at probes 28, 30, and 31 as winds from easterly and westerly directions were redirected to flow away from the area, improving the summer ratings from standing to sitting. In the winter probe 28 improves from walking to standing, probe 30 changes from walking to sitting, and probe 31 improves from standing to standing.

Probes 33 through 35 were similarly located along an internal walkway adjacent to the northeastern façade of the 10 storey wing. The area was rated suitable for standing year-round in the existing setting. With inclusion of the proposed Development, probes 33 and 34 realised significant blockage to dominant westerly winds that was sufficient to change the ratings to sitting, with the exception of the winter months when probe 34 remains suitable for sitting.

Probe 36 was situated along the southeast façade of the building, within the gap between the 10 storey wing and the existing 10 storey building on site. The area is exposed to dominant winds from northerly and westerly directions that are directed to flow around the proposed building and through the gap. As such, the area is rated suitable for walking in the winter and standing through the summer months. The area will be comfortable and suitable for the intended use throughout the year and will realise more comfortable conditions with consideration of fine design and landscape elements.

Probes 37, 39, and 40 were also placed along an internal walkway, adjacent to the driveway area and courtyard. The probes were similarly rated suitable for standing in the existing setting, with the exception of probe 37 that was rated for walking through the winter months. With inclusion of the proposed Development, the area realises blockage to dominant westerly winds that was sufficient to improve the winter rating at probe 37 from walking to standing, and the summer rating from standing to sitting.

Probes 42 and 43 were situated adjacent to the driveway to the southwest of the existing 10 storey building on site. In the existing setting the area is rated suitable for walking through the winter and standing in the summer. With inclusion of the proposed Development the seasonal ratings are unchanged and as such the walkway will be suitable for the intended purpose throughout the year.

With inclusion of the proposed Development the above-mentioned internal walkways realised comfortable conditions that are suitable for the intended uses throughout the year. Consideration of fine design and landscape elements will result in more comfortable conditions than reported along the walkways. The internal site areas fall within the pedestrian level wind velocity safety criteria as All-Weather Areas.

5.3.4 Pedestrian Entrance Conditions

Probe 27 was located adjacent to a Main Residential Entrance to the proposed Development, accessed via a walkway along the northwestern façade of the building. The entrance realises fairly comfortable conditions, suitable for standing in the winter and sitting through the summer months. The entrance will be suitable for the intended use throughout the year and consideration of fine design elements and landscaping will result in more comfortable conditions than reported.

Probe 32 was similarly located adjacent to a Main Residential Entrance to the proposed Development, accessed via the internal driveway along the southern façade of the building. The entrance is protected from large portions of the dominant wind climate by the building and as such realises comfortable conditions, rated for sitting throughout the year. The entrance will be suitable for the intended use throughout the year and consideration of fine design elements and landscaping will result in more comfortable conditions than reported.

Probes 41 and 44 were located adjacent to the Main Entrances to the existing 10 storey building on site. In the existing setting the entrances are rated suitable for sitting throughout the year. With inclusion of the proposed Development, the northwestern entrance is located proximate to the gap between the existing and proposed building, and as such realises increased winds emanating from northern and southern directions that are redirected to flow through the area. As such, the entrance becomes rated suitable for standing throughout the year, but remains suitable for the intended use. The southeastern entrance to the existing building remains suitable for sitting year-round. The entrances to the existing 10 storey building on site will remain suitable for the intended use throughout the year with inclusion of the proposed Development and consideration of fine design elements and landscaping will result in more comfortable conditions than reported.

Wind conditions comfortable for standing are preferable at building entrances while conditions suitable for walking are suitable for sidewalks. The entrances to the proposed and existing buildings, as well as the related adjacent sidewalks, will experience conditions appropriate for the intended uses throughout the year. The proposed Development's Entrances fall within the pedestrian level wind velocity safety criteria as All-Weather Areas.

5.3.5 Outdoor Amenity Area Conditions

A Courtyard area is proposed along the northeastern extents of the property, as represented by probe 38. The area is exposed to northerly winds that are directed to flow down and around the proposed Development and over the area, however it is well protected from large portions of the remaining wind climate by the building and surrounds. As such, the area realises conditions that are suitable for standing throughout the year. The area would benefit from a mitigation plan in order to improve wind conditions in the area. The plan should be designed with input from the consultant and may include berms, fencing, coniferous trees, porous wind screens, raised planters populated with coarse plantings, trellises, etc. situated around the courtyard as practical. Consideration of an appropriate mitigation plan for the space will result in more comfortable conditions that are appropriate for the intended use throughout the year.

The proposed Courtyard falls within the pedestrian level wind velocity safety criteria as an All-Weather Area

5.4 Summary

The observed wind velocity and flow patterns at the Development are largely influenced by approach wind characteristics that are dictated by the predominantly suburban mix of residential and commercial development, and related open areas, mitigating the wind to different degrees on approach. Historical weather data indicates that strong winds of a mean wind speed greater than 30 km/h occur approximately 13 percent of the time during the winter months and 5 percent of the time during the summer. Once the subject site is developed, ground level winds at most locations will improve, with occasional localized areas of higher pedestrian level winds. The consideration of proposed surface roughness will result in conditions more comfortable than those reported herein. The relationship between surface roughness and wind is discussed in the Appendix and shown graphically in Figure A of the same section.

The site and surrounds are predicted comfortable and generally suitable for standing, or better, under normal wind conditions annually; however, under high ambient winter wind conditions with winds emanating from specific directions, a few localized areas adjacent to building corners or gaps between, may be windy from time to time, but the areas remain within safety criteria and appropriate to the intended purpose. Consideration of existing and proposed building features too fine to incorporate into the massing model will improve the predicted comfort ratings beyond those reported.

A mitigation plan is recommended for the Courtyard area in order to achieve comfortable conditions that are suitable for the intended use throughout the year. The proposed Development is predicted to realise wind conditions suitable to the context.

6. FIGURES:

Figure 1: Laboratory Testing Facility

Figure 2a: Site Aerial Photo

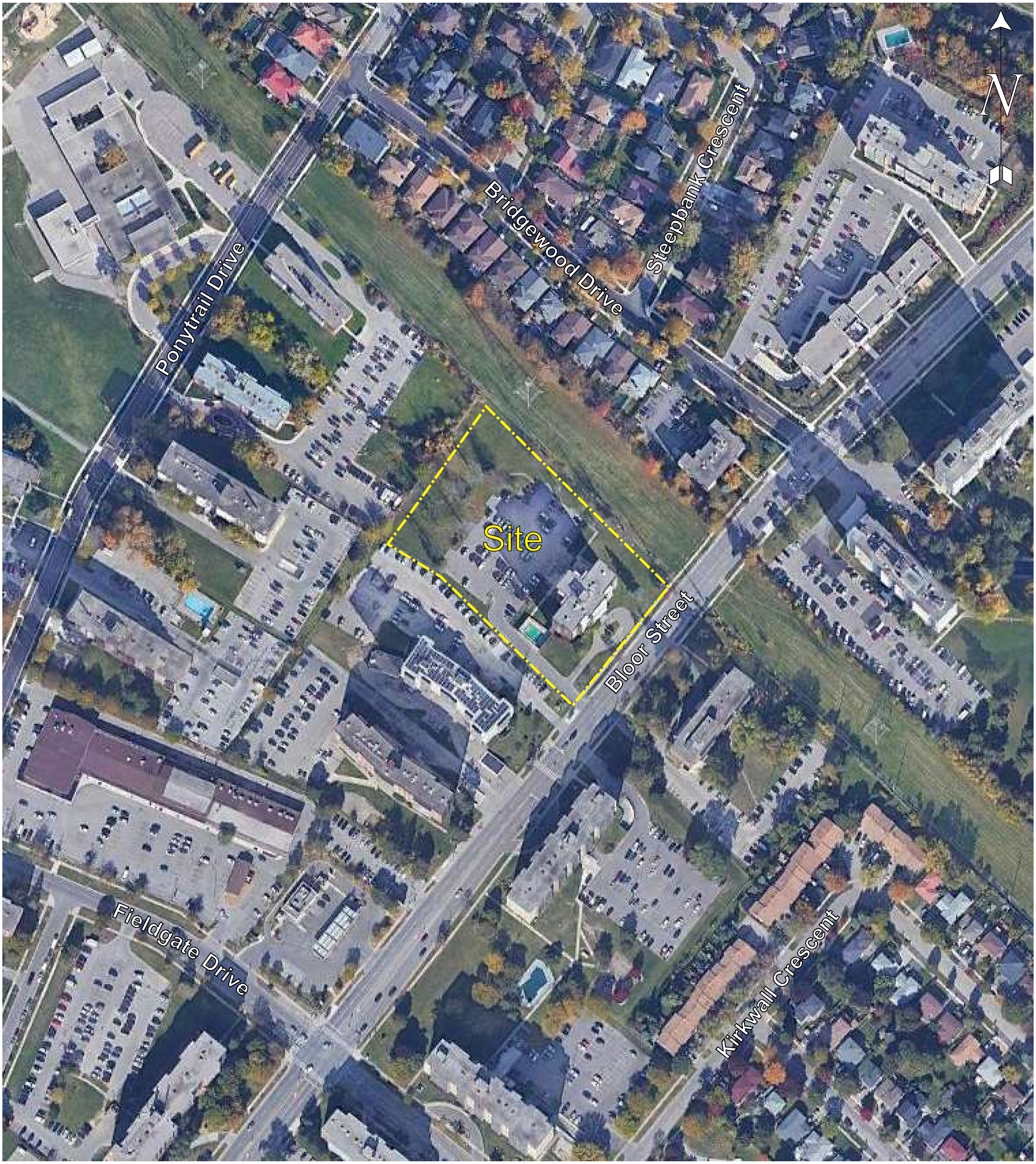


Figure 2b: Site Plan

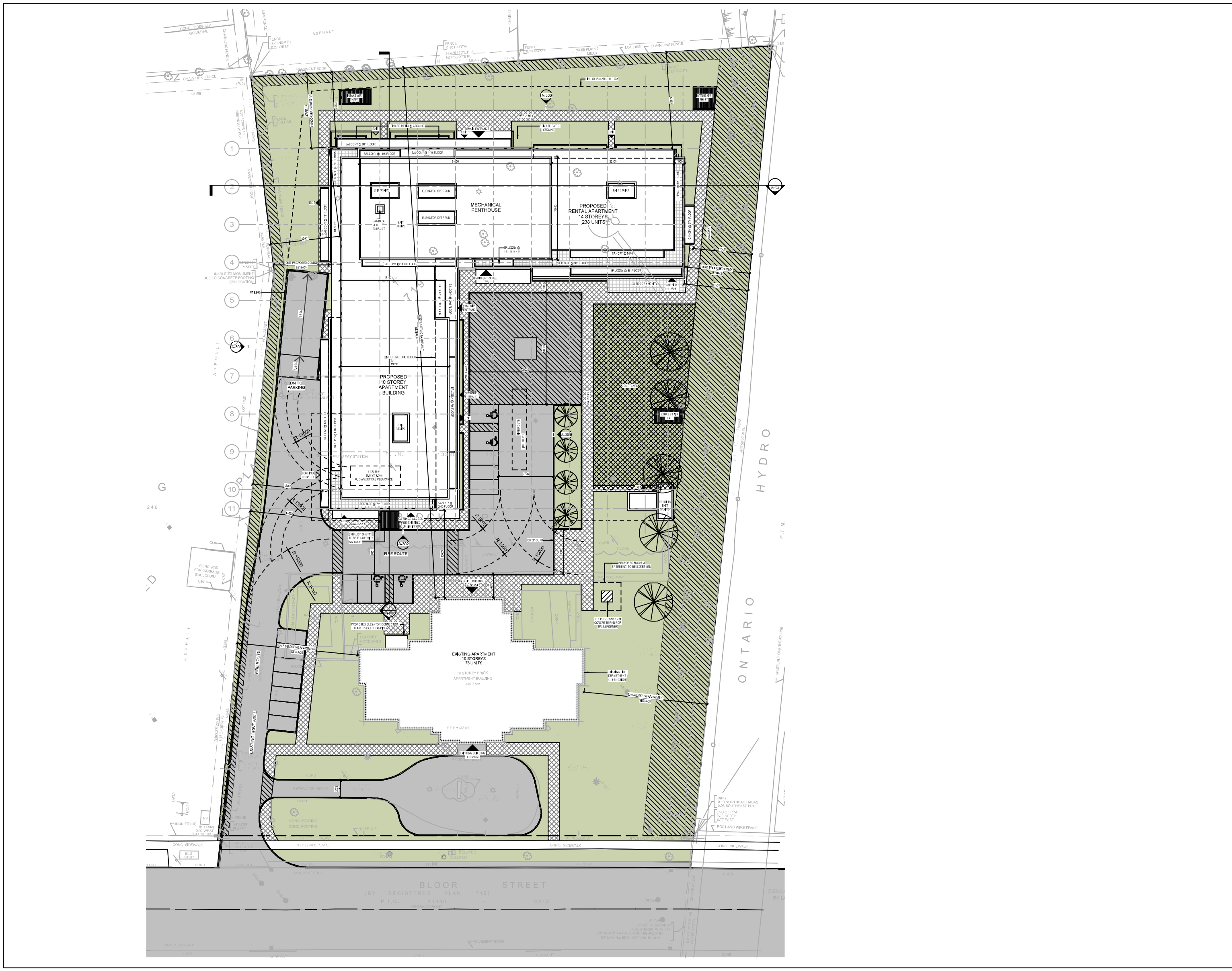
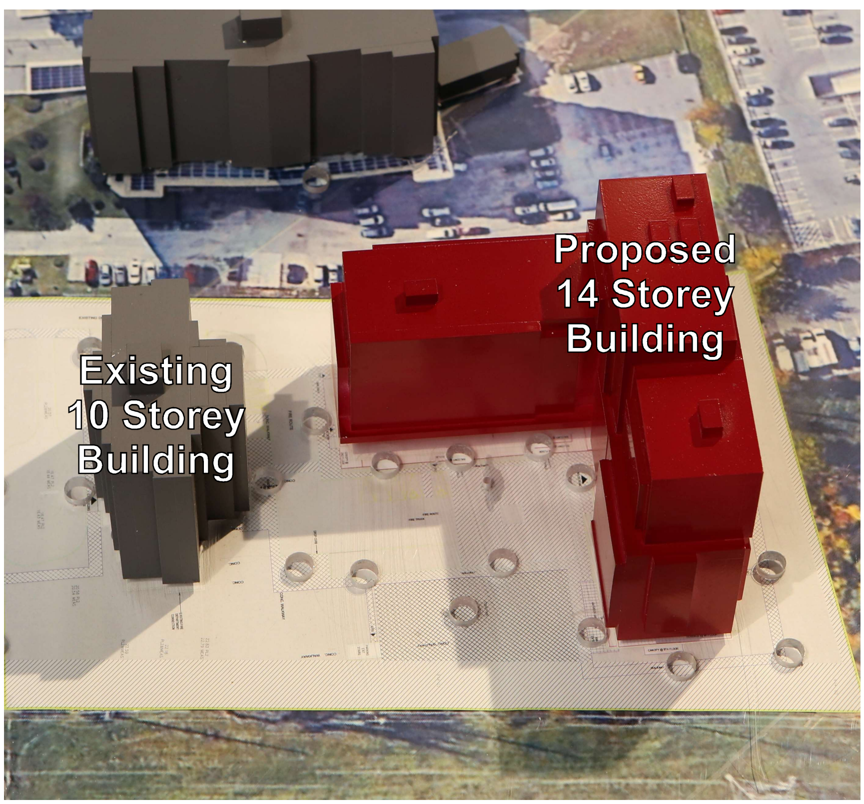


Figure 3: 1:500 Scale model of test site

a) Overall view of model - Proposed Site

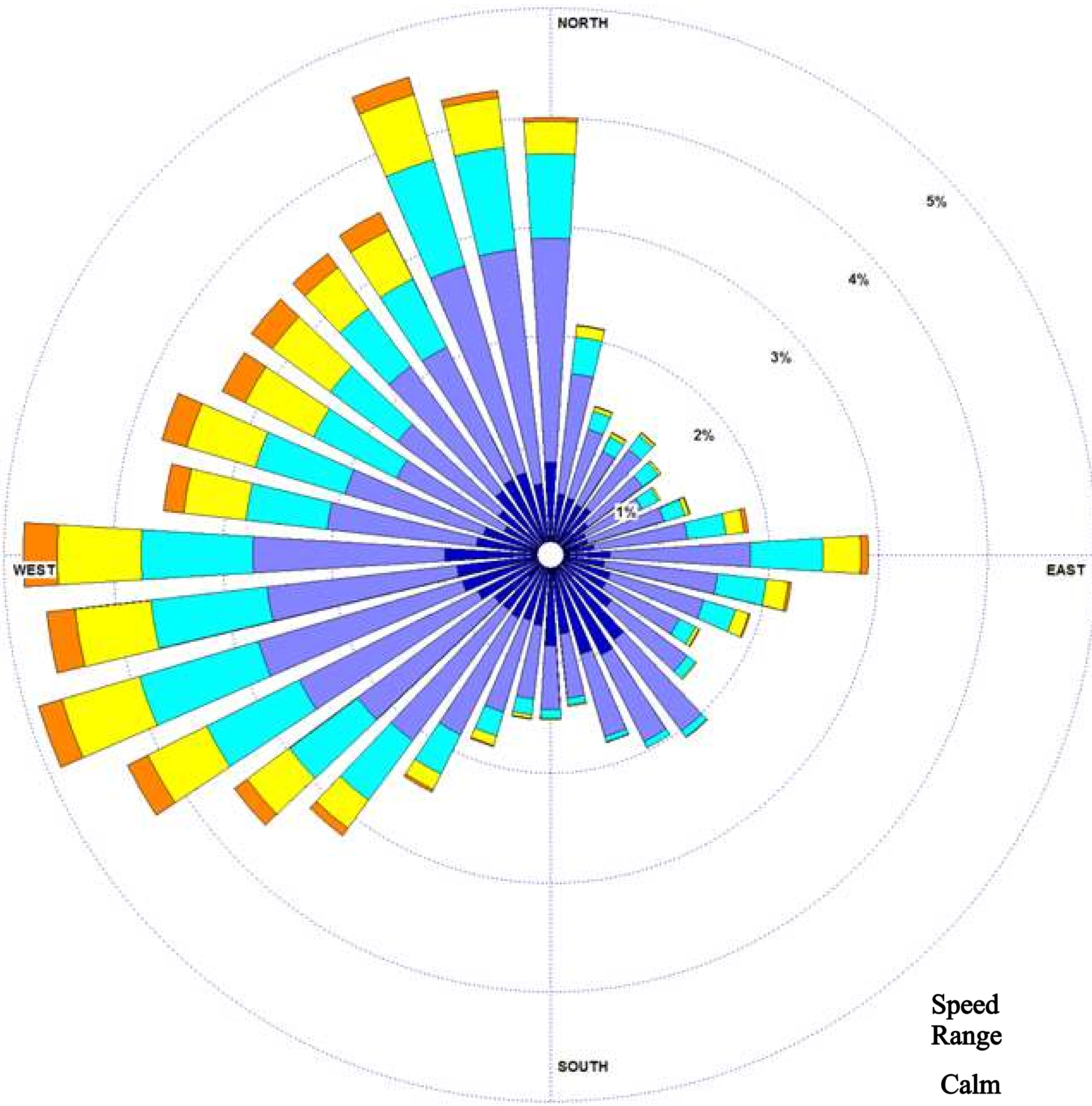


b) Close-up view of model - Proposed Site

Figure 4: Location plan for pedestrian level wind velocity measurements.

Figure 5a: Winter Wind Rose - Pearson International Airport.

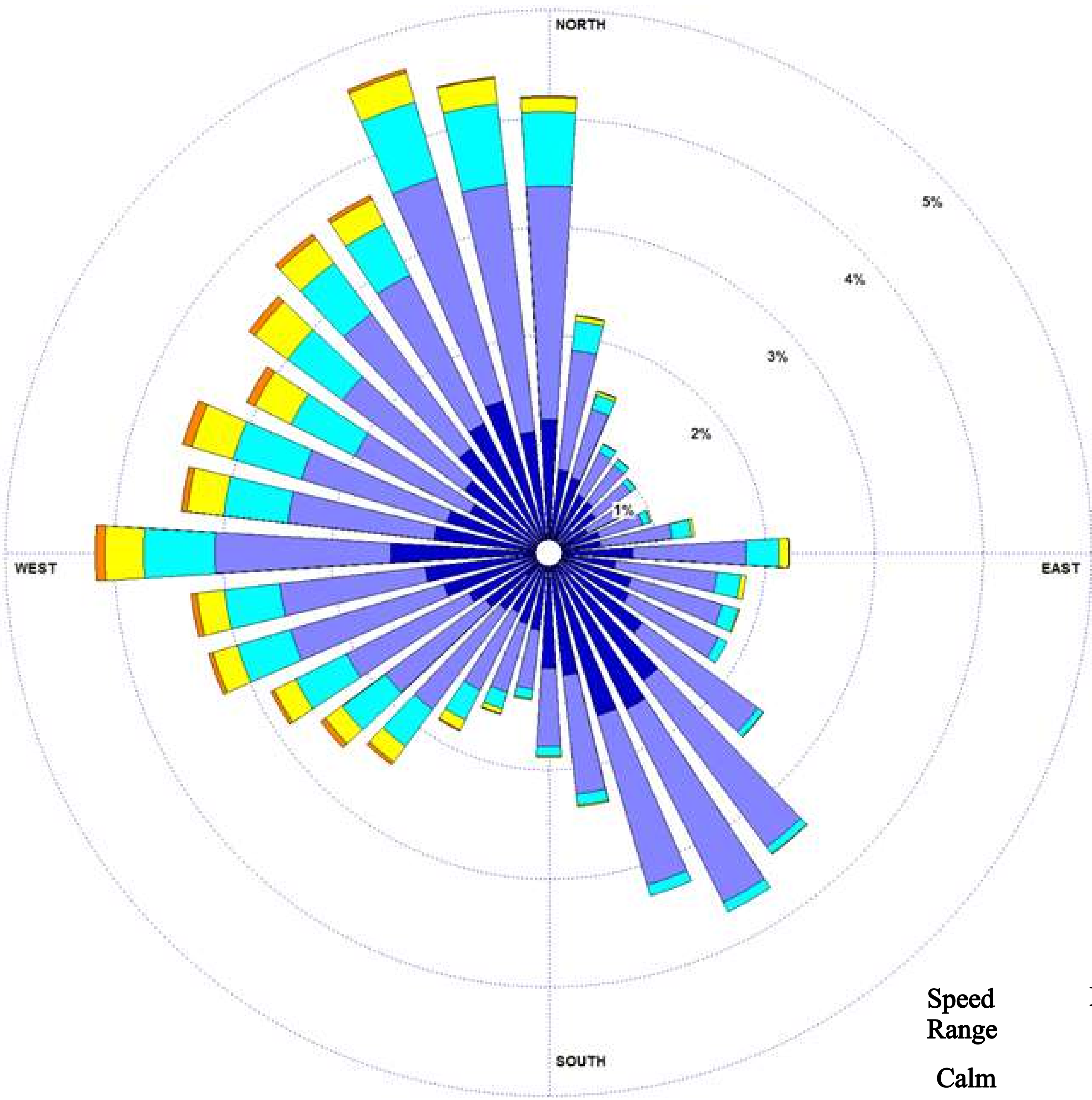
Historical Directional Distribution of Winds (@ 10*m* height)
November through April (1980 - 2017)



Speed Range	Probability (%)
Calm	5%
1 - 10*km/h*	24%
11 - 20*km/h*	41%
21 - 30*km/h*	17%
31 - 40*km/h*	10%
> 40*km/h*	3%

Figure 5b: Summer Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
May through October (1980 - 2017)



Speed Range	Probability (%)
Calm	8%
1 - 10*km/h*	33%
11 - 20*km/h*	42%
21 - 30*km/h*	12%
31 - 40*km/h*	5%
> 40*km/h*	<1%

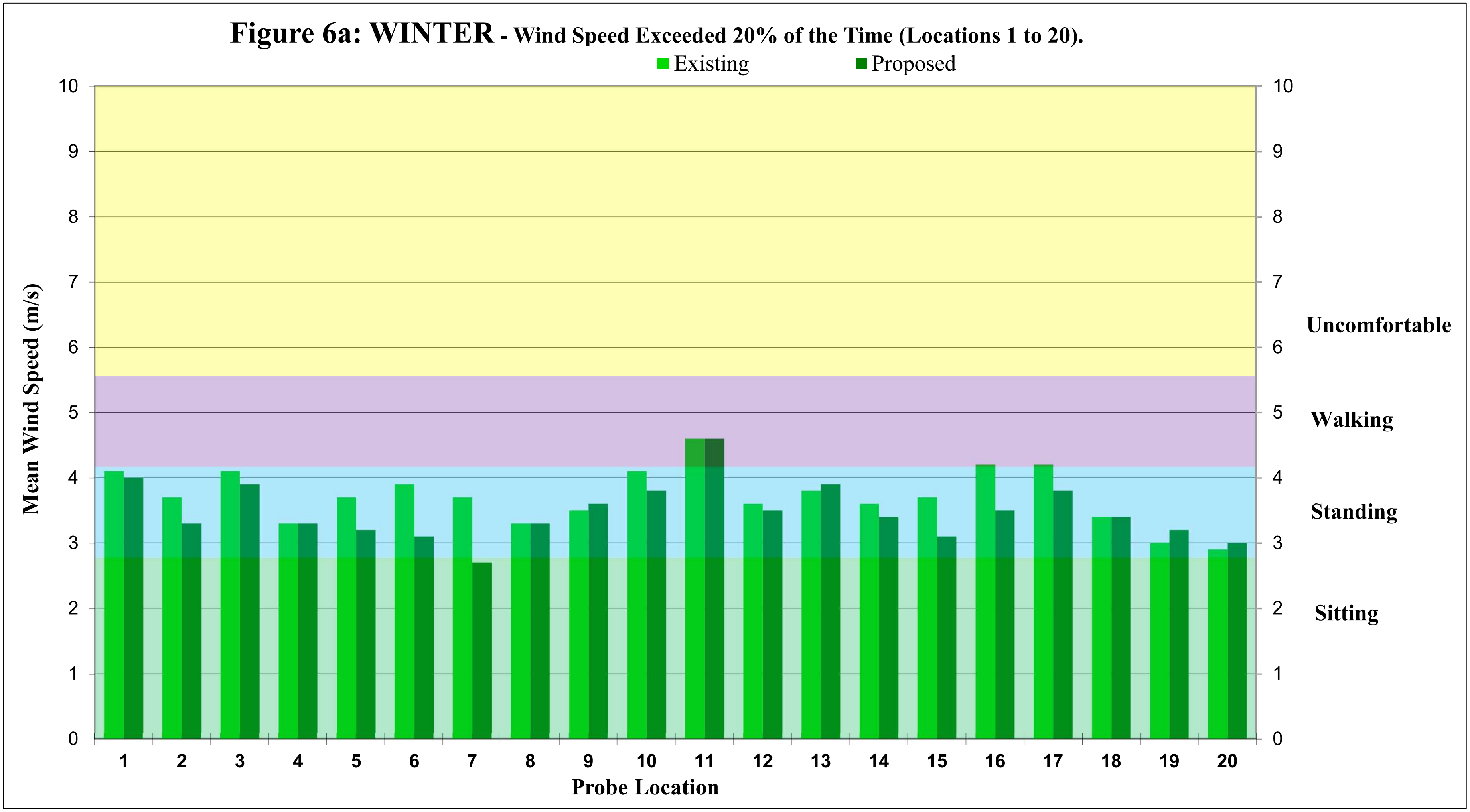


Figure 6a: WINTER - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

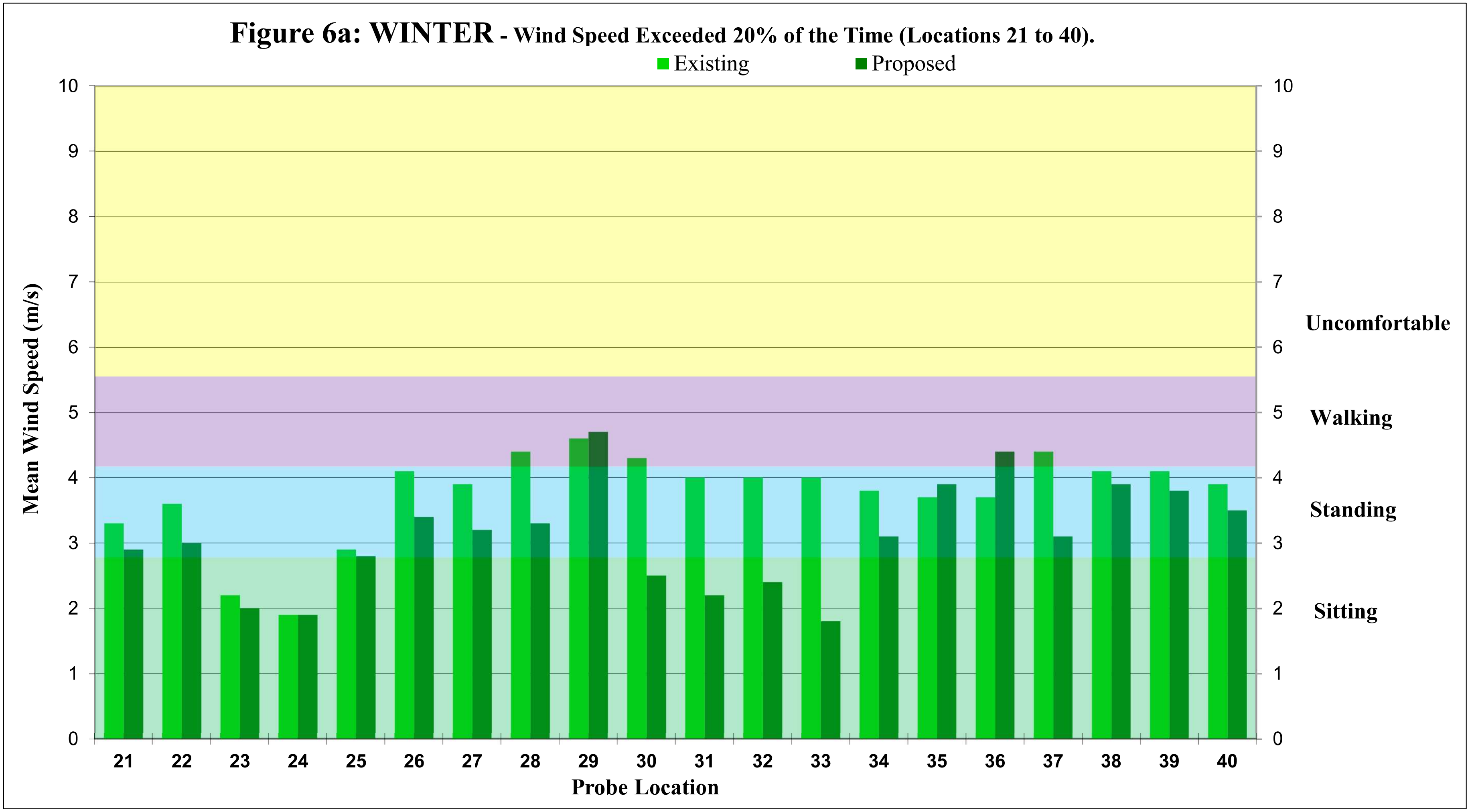


Figure 6a: WINTER - Wind Speed Exceeded 20% of the Time (Locations 21 to 40).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
0
1
2
3
4
5
6
7
8
9
10
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
Uncomfortable
Walking
Standing
Sitting

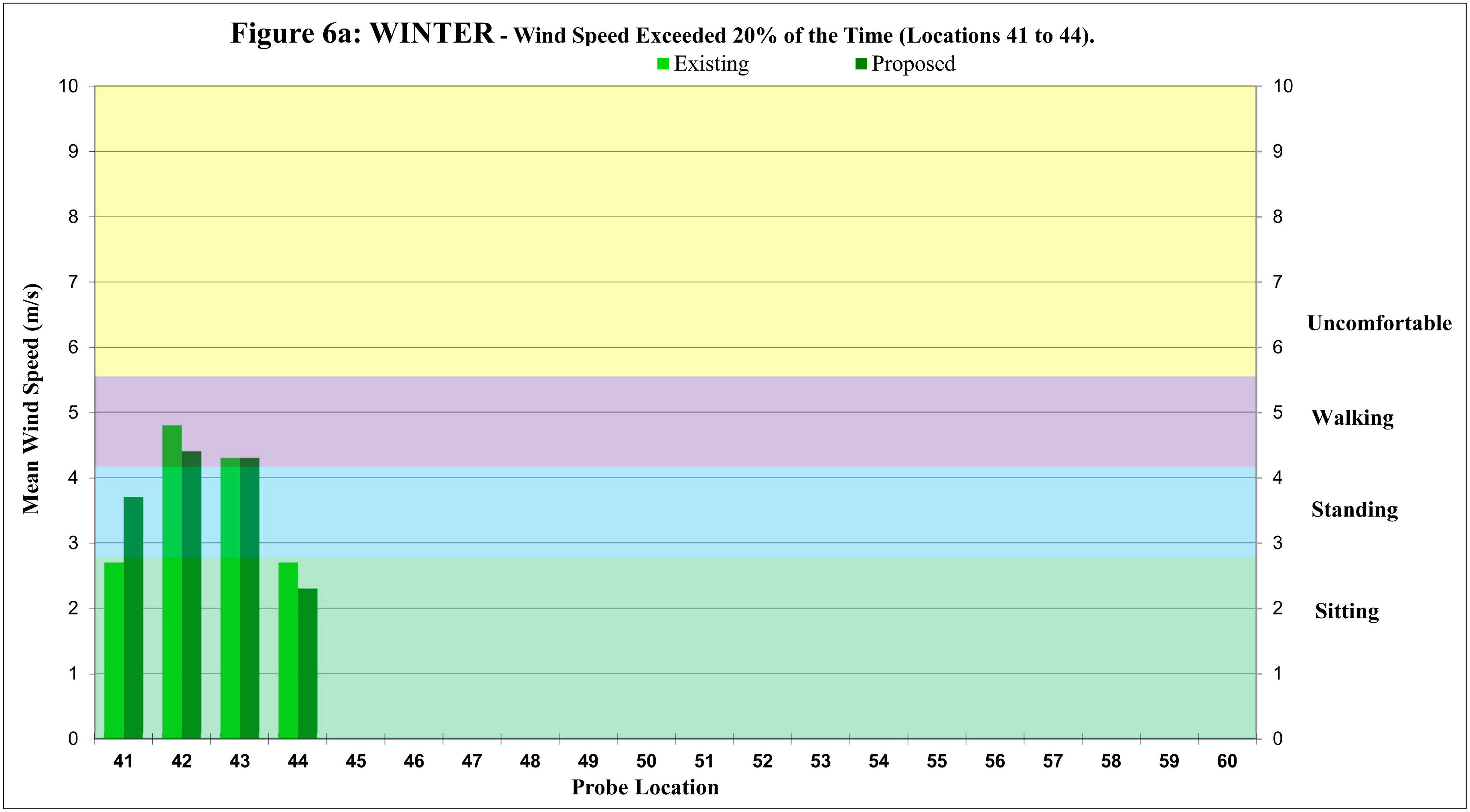
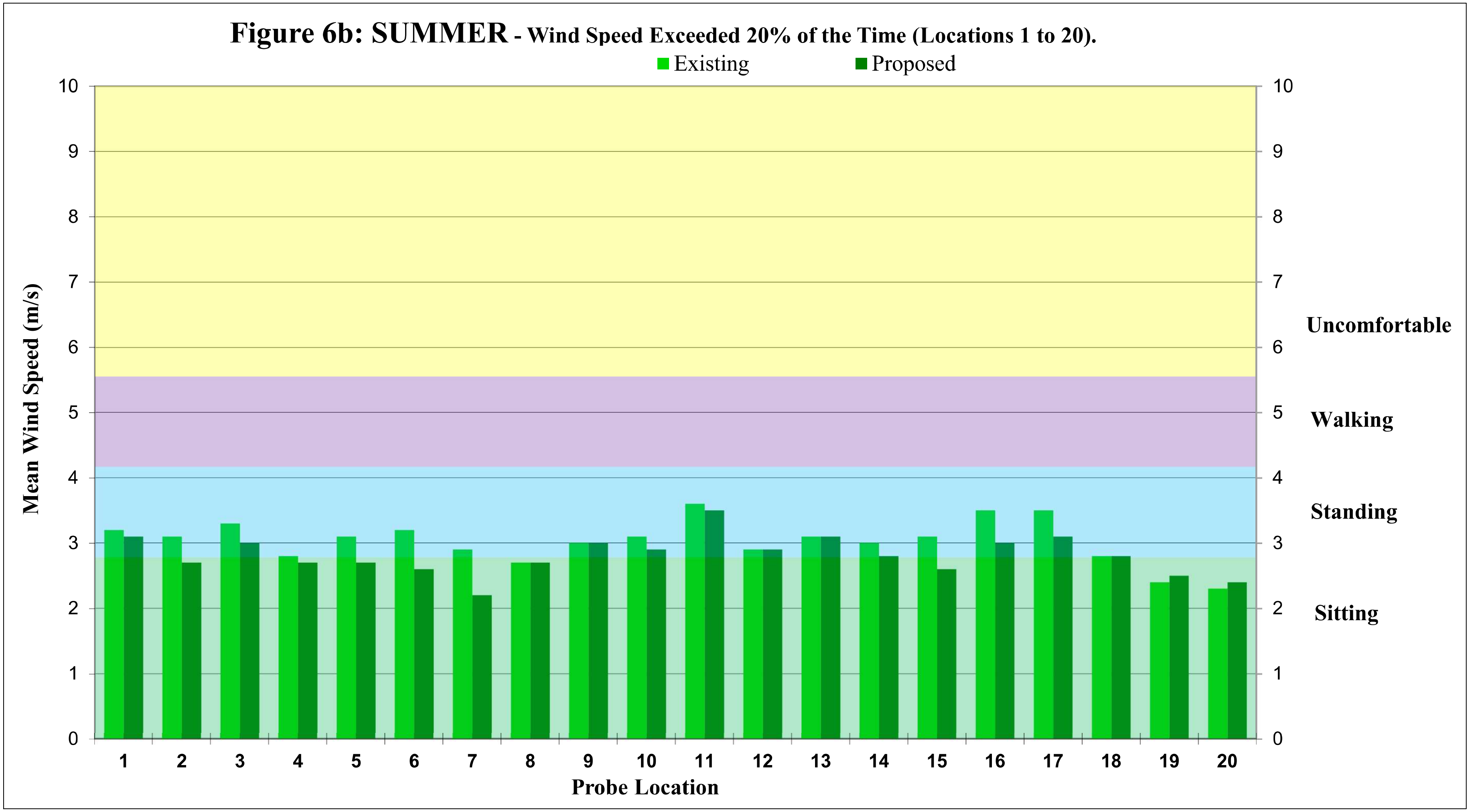


Figure 6a: WINTER - Wind Speed Exceeded 20% of the Time (Locations 41 to 44).
Existing
Proposed
Mean Wind Speed (m/s)
10
9
8
7
6
5
4
3
2
1
0
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
Probe Location
Uncomfortable
Walking
Standing
Sitting



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Environmental

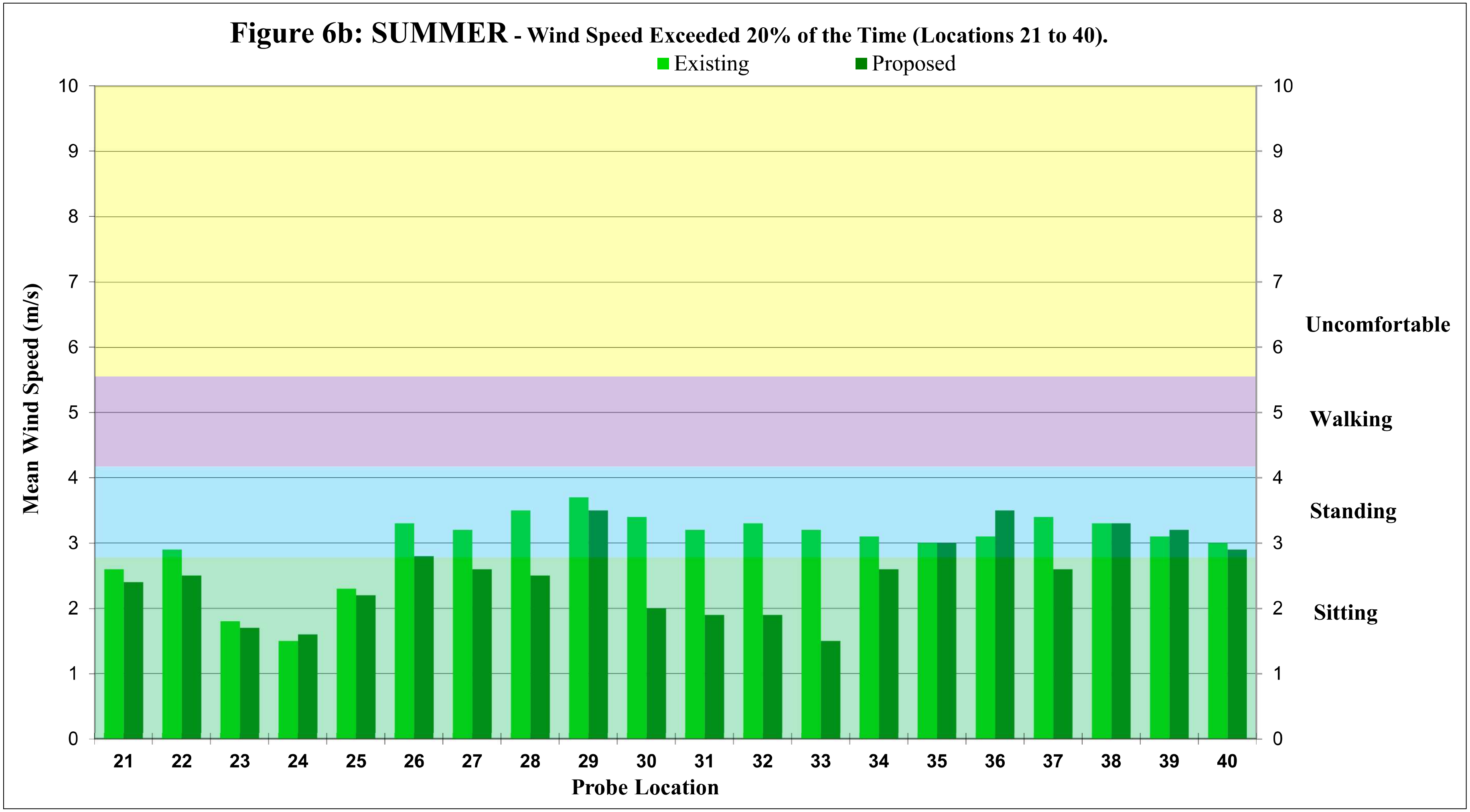

Figure 6b: SUMMER - Wind Speed Exceeded 20% of the Time (Locations 21 to 40).
Existing
Proposed
Mean Wind Speed (m/s)
0
1
2
3
4
5
6
7
8
9
10
Uncomfortable
Walking
Standing
Sitting
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
Probe Location

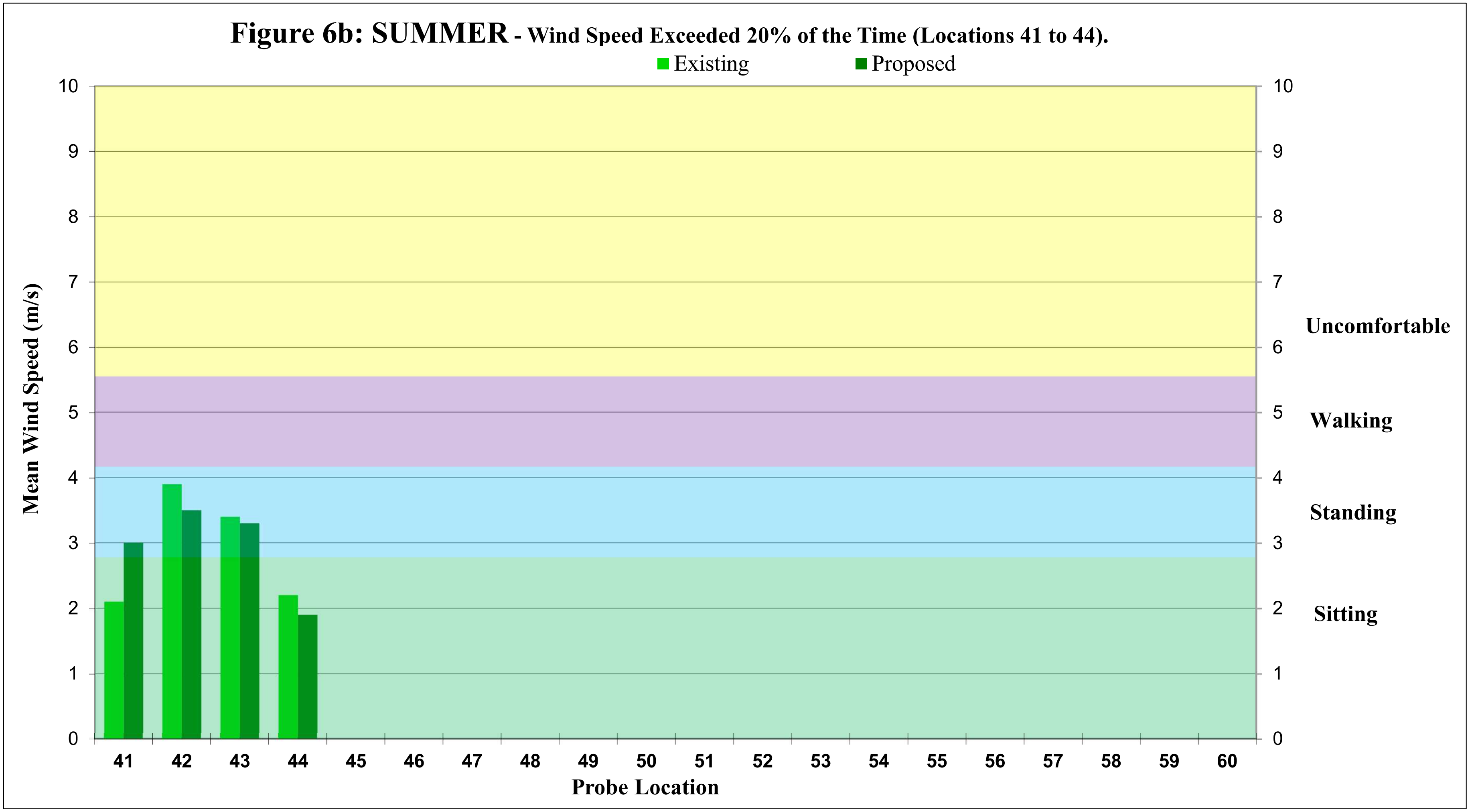
Figure 6b: SUMMER - Wind Speed Exceeded 20% of the Time (Locations 41 to 44).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 7a: Pedestrian level wind velocity comfort categories.

Comfort Categories - Winter - Existing

Sitting Standing Walking Uncomfortable

Figure 7b: Pedestrian level wind velocity comfort categories.

Comfort Categories - Winter - Proposed

Sitting Standing Walking Uncomfortable

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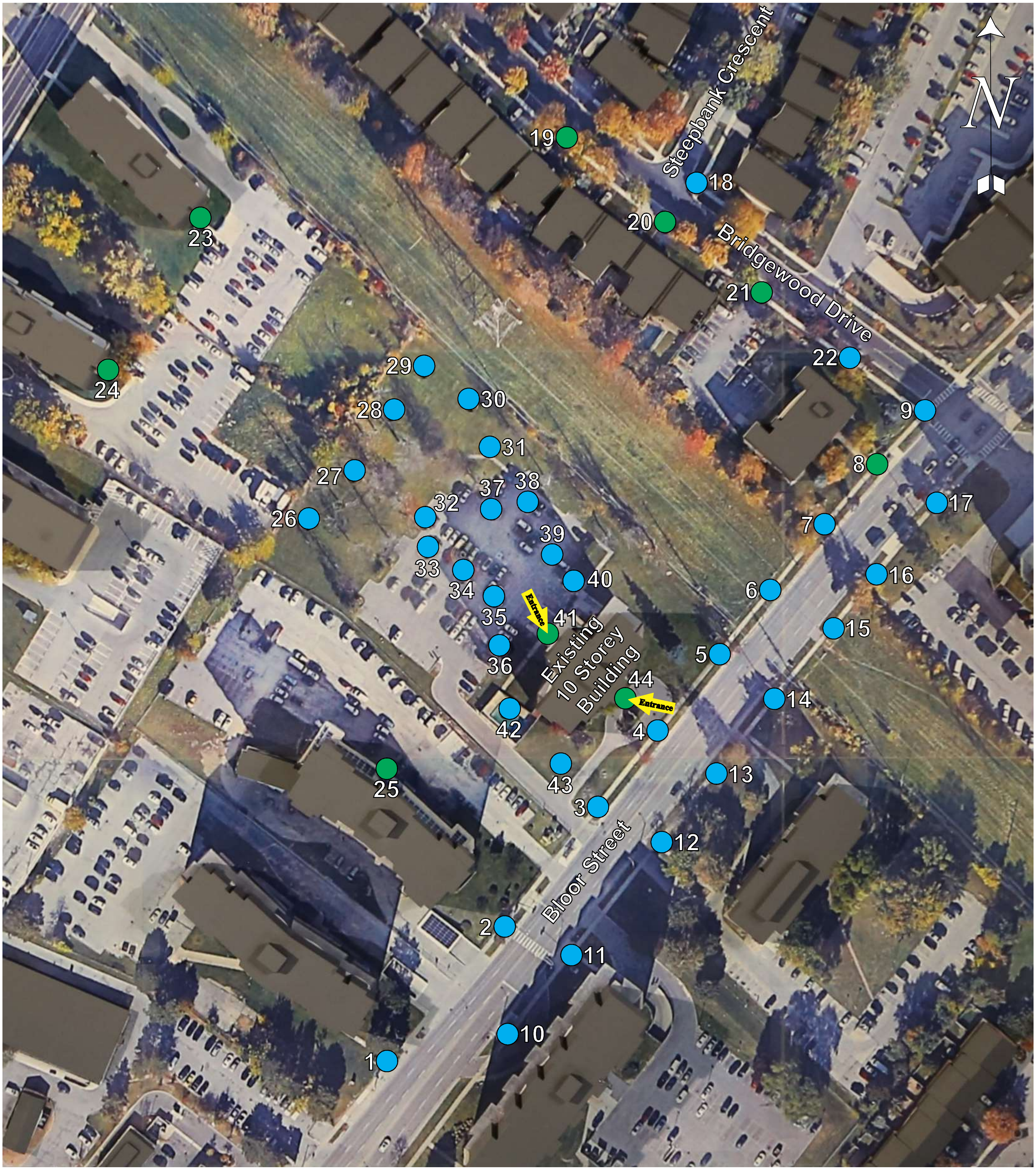
Figure 7c: Pedestrian level wind velocity comfort categories.



Comfort Categories - Summer - Existing

Sitting Standing Walking Uncomfortable

Figure 7d: Pedestrian level wind velocity comfort categories.

Comfort Categories - Summer - Proposed

Sitting Standing Walking Uncomfortable

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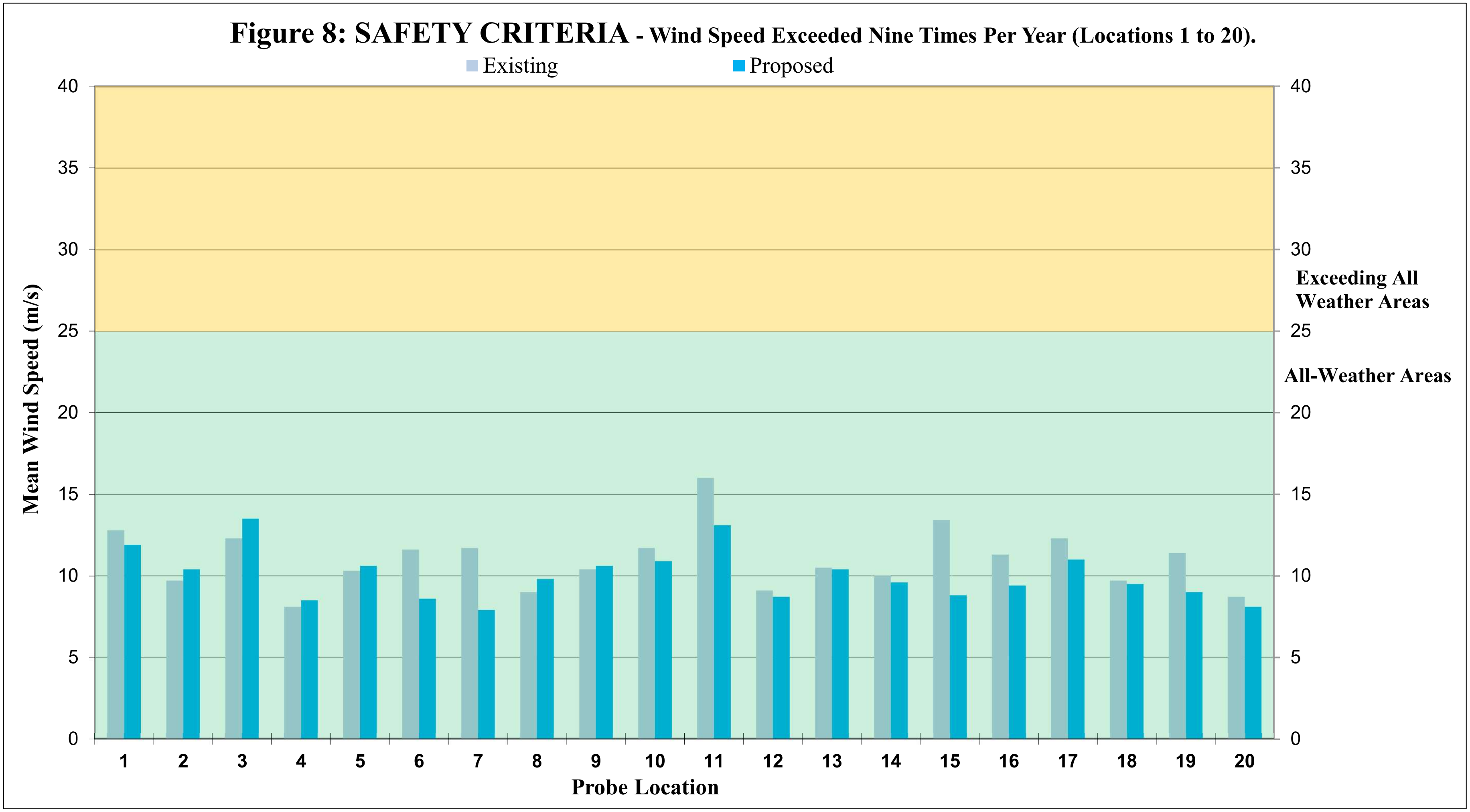


Figure 8: SAFETY CRITERIA - Wind Speed Exceeded Nine Times Per Year (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Exceeding All Weather Areas
All-Weather Areas
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure 8: SAFETY CRITERIA - Wind Speed Exceeded Nine Times Per Year (Locations 21 to 40).

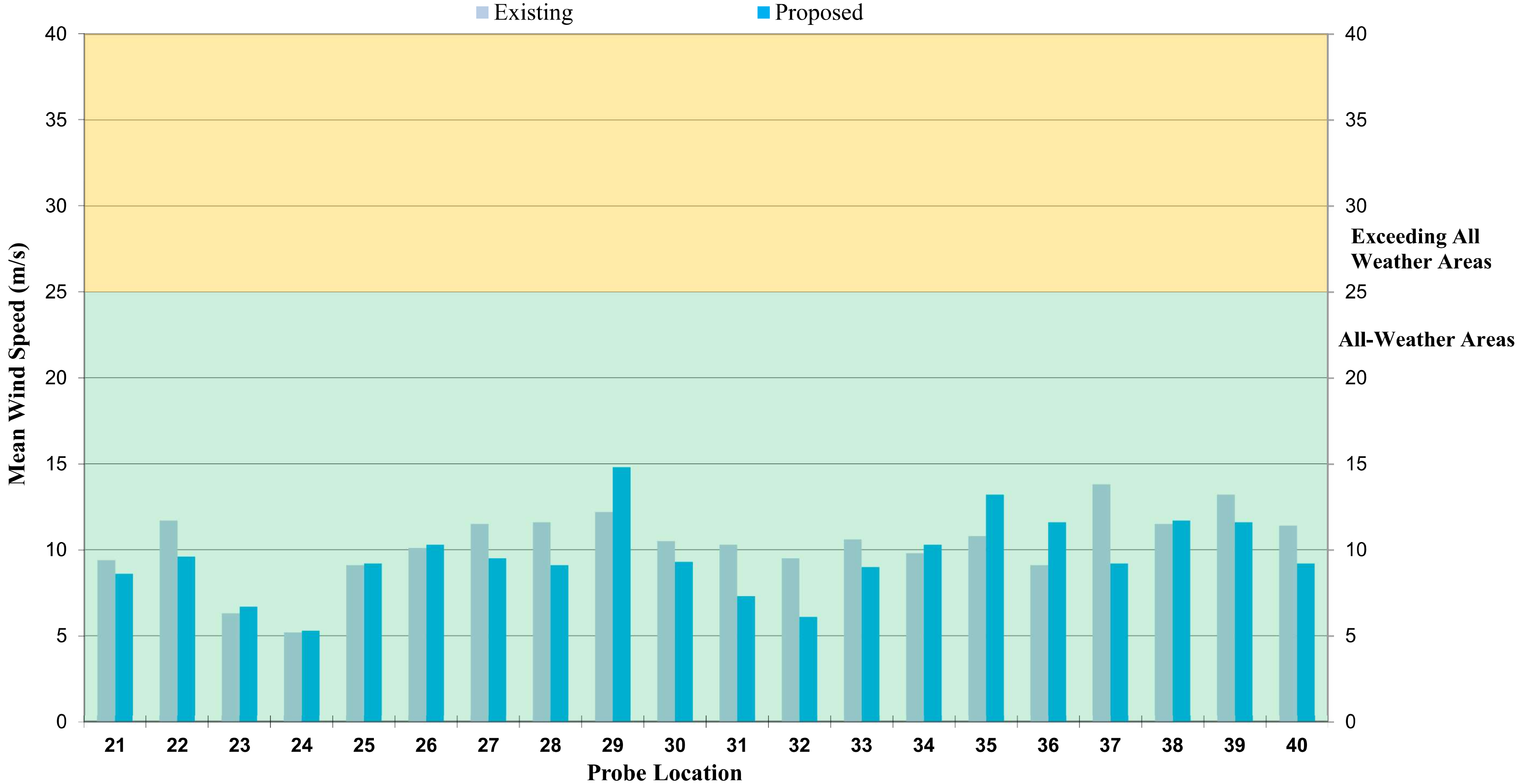


Figure 8: SAFETY CRITERIA - **Wind Speed Exceeded Nine Times Per Year (Locations 41 to 44).**

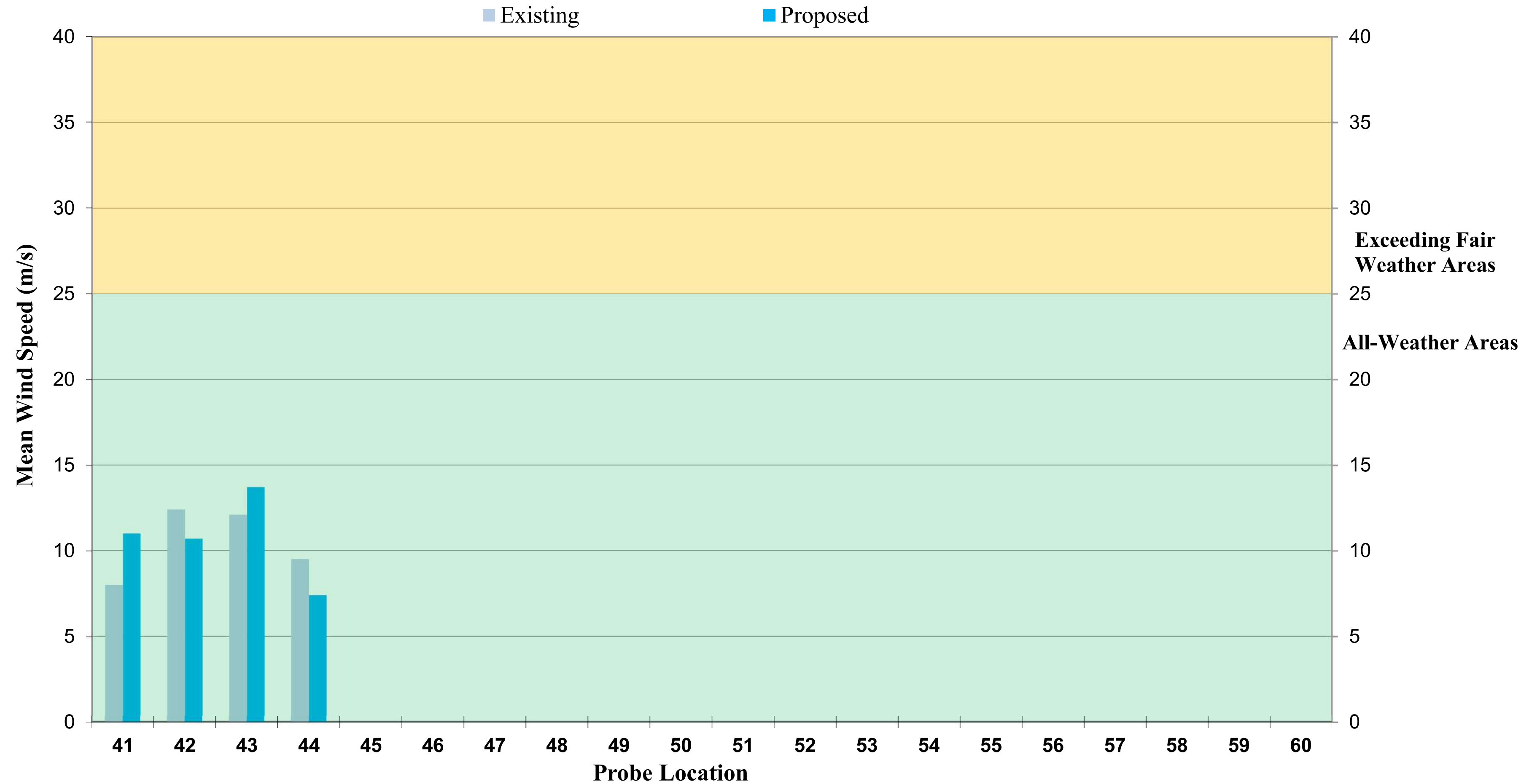


Figure 9a: Pedestrian level wind velocity safety criteria.

Safety Criteria - Existing

All-Weather Areas   Exceeding All-Weather Areas

Figure 9b: Pedestrian level wind velocity safety criteria.

Safety Criteria - Proposed

All-Weather Areas   Exceeding All-Weather Areas

7. APPENDIX

BACKGROUND AND THEORY OF WIND MOVEMENT

During the course of a modular analysis of an existing or proposed site, pertinent wind directions must be analysed with regard to the macroclimate and microclimate. In order for the results of the study to be valid, the effects of both climates must be modelled in test procedures.

Macroclimate

Wind velocity, frequency and directions are used in tests with models to establish part of the macroclimate. These variables are determined from meteorological data collected at the closest weather monitoring station. This information is used in the analysis of the site to establish upstream (approach) wind and weather conditions.

When evaluating approach wind velocities and characteristic profiles in the field it is necessary to evaluate certain boundary conditions. At the earth’s surface, "no slip" conditions require the wind speed to be zero. At an altitude of approximately one kilometre above the earth’s surface, the motion of the wind is governed by pressure distributions associated with large-scale weather systems. Consequently, these winds, known as "geostrophic" or "freestream" winds, are independent of the surface topography. In model simulation, as in the field, the area of concern is the boundary layer between the earth's surface and the geostrophic winds. The term boundary layer is used to describe the velocity profile of wind currents as they increase from zero to the geostrophic velocity.

The approach boundary layer profile is affected by specific surface topography upstream of the test site. Over relatively rough terrain (urban) the boundary layer is thicker and the wind speed increases rather slowly with height. The opposite is true over open terrain (rural). The following power law equation is used to represent the mean velocity profile for any given topographic condition:

$$\frac{U}{U_F} = \left(\frac{z}{z_F}\right)^a$$

where U = wind velocity (m/s) at height z (m)
a = power law exponent
and subscript $_F$ refers to freestream conditions

Typical values for a and z_F are summarized below:

Terrain	a	z_F (m)
Rural	0.14 - 0.17	260 - 300
Suburban	0.20 - 0.28	300 - 420
Urban	0.28 - 0.40	420 - 550

Wind data is recorded at meteorological stations at a height z_{ref} , usually equal to about 10m above grade. This historical mean wind velocity and frequency data is often presented in the form of a wind rose. The mean wind velocity at z_{ref} , along with the appropriate constants based on terrain type, are used to determine the value for U_F , completing the definition of the boundary layer profile specific to the site. The following Figure shows representations of the boundary layer profile for each of the above terrain conditions:

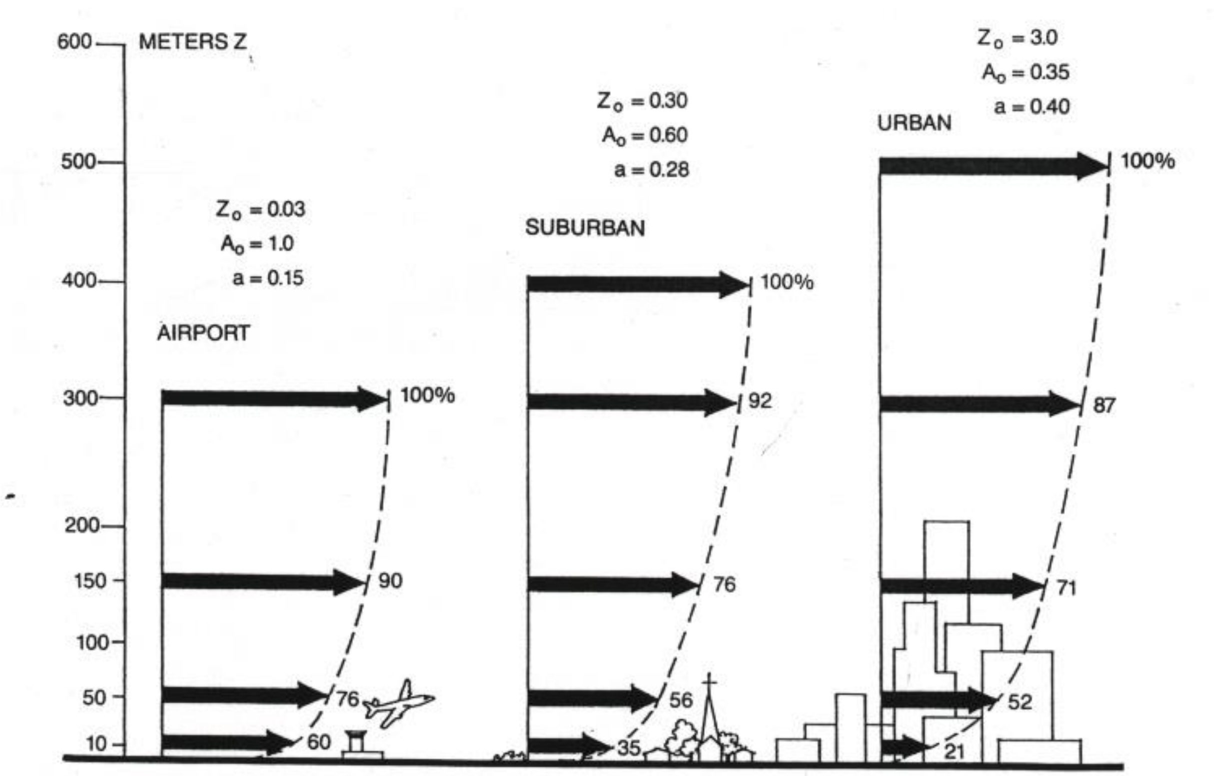


Figure A: Mean wind speed profiles for various terrain (from ASHRAE 1989).

For the above velocity profiles, ground level velocities at a height of $z = 2m$, for an urban macroclimate are approximately 52% of the mean values recorded at the meteorological station at a height equal to $z_{ref} = 10m$. For suburban and rural conditions, the values are 63% and 78% respectively. Thus, for a given wind speed at z_{ref} open terrain or fields (rural) will experience significantly higher ground level wind velocities than suburban or urban areas.

When a boundary layer wind flows over one terrain onto another, the boundary layer profile shape rapidly changes to that dictated by the new terrain. If the preceding wind flow is over rough suburban terrain and an open area is encountered a rapid increase in ground level winds will be realized. A similar effect will occur when large low-density residential areas are demolished to accommodate high-rise developments. The transitional open area will experience significantly higher pedestrian level winds than the previous suburban setting. Once the high-rise development is established, ground level winds will moderate with localized areas of higher pedestrian level winds likely to occur. Pedestrian level wind velocities respond to orientation and shape of the development and if the site is not appropriately engineered or mitigated, pedestrian level wind may be problematic.

Microclimate

The specific wind conditions related to the study site are known as the microclimate, which are dictated mainly by the following factors:

- The orientation and conformation of buildings within the vicinity of the site.
- The surrounding contours and pertinent landscape features.

The microclimate establishes the effect that surrounding buildings or landscape features have on the subject building and the effect the subject building has on the surrounds. For the majority of urban test sites the proper microclimate can be established by modelling an area of 300*m* in radius around the subject building. If extremely tall buildings are present then the study area must be larger, and if the building elevations are on the order of a few floors, smaller areas will suffice to establish the required microclimate.

General Wind Flow Phenomena

Wind flow across undulating terrain contains parallel streamlines with the lowest streamline adjacent to the surface. These conditions continue until the streamlines approach vertical objects. When this occurs there is a general movement of the streamlines upward ("Wind Velocity Gradient") and as they reach the top of the objects turbulence is generated on the lee side. This is one of the reasons for unexpected high wind velocities as this turbulent action moves to the base of the objects on the lee side.

Other fluid action occurs through narrow gaps between buildings (Venturi Action) and at sharp edges of a building or other vertical objects (Scour Action). These conditions are predictable at selected locations but do not conform to a set direction of wind as described by a macroclimate condition. In fact, the orientation and conformation of buildings, streets and landscaping establish a microclimate.

Because of the "Wind Velocity Gradient" phenomena, there is a "downwash" of wind at the face of buildings and this effect is felt at the pedestrian level. It may be experienced as high gusty winds or drifting snow. These effects can be obviated by windbreak devices on the windward side or by canopies over windows and doors on the lee side of the building.

The intersection of two streets or pedestrian walkways have funnelling effects of wind currents from any one of the four directions and is particularly severe at corners if the buildings project to the street line or are close to walkways.

Some high-rise buildings have gust effects as the wind velocities are generated suddenly due to the orientation and conformation of the site. Since wind velocities are the result of energy induced wind currents the solution to most problems is to reduce the wind energy at selected locations by carefully designed windbreak devices, often landscaping, to blend with the surrounds.

The Beaufort Scale is often used as a numerical relationship to wind speed based upon an observation of the effects of wind. Rear-Admiral Sir Francis Beaufort, commander of the Royal Navy, developed the wind force scale in 1805, and by 1838 the Beaufort wind force scale was made mandatory for log entries in ships of the Royal Navy. The original scale was an association of integers from 0 to 12, with a description of the effect of wind on the behaviour of a full-rigged man-of-war. The lower Beaufort numbers described wind in terms of ship speed, mid-range numbers were related to her sail carrying ability and upper numbers were in terms of survival. The Beaufort Scale was adopted in 1874 by the International Meteorological Committee for international use in weather telegraphy and, with the advent of anemometers, the scale was eventually adopted for meteorological purposes. Eventually, a uniform set of equivalents that non-mariners could relate to was developed, and by 1955, wind velocities in knots had replaced Beaufort numbers on weather maps. While the Beaufort Scale lost ground to technology, there remains the need to relate wind speed to observable wind effects and the Beaufort Scale remains a useful tool.

Abbreviated Beaufort Scale

Beaufort Number	Description	Wind Speed			Observations
		km/h	*m/s*	h=2*m* for Urban *m/s*	
2	Slight Breeze	6-11	1.6-3.3	< ~2	Tree leaves rustle; flags wave slightly; vanes show wind direction; small wavelets or scale waves.
3	Gentle Breeze	12-19	3.4-5.4	< ~3	Leaves and twigs in constant motion; small flags extended; long unbreaking waves.
4	Moderate Breeze	20-28	5.5-7.9	< ~4	Small branches move; flags flap; waves with whitecaps.
5	Fresh Breeze	29-38	8.0-10.7	< ~6	Small trees sway; flags flap and ripple; moderate waves with many whitecaps.
6	Strong Breeze	39-49	10.8-13.8	< ~8	Large branches sway; umbrellas used with difficulty; flags beat and pop; larger waves with regular whitecaps.
7	Moderate Gale	50-61	13.9-17.1	< ~10	Sea heaps up, white foam streaks; whole trees sway; difficult to walk; large waves.
8	Fresh Gale	62-74	17.2-20.7	> ~10	Twigs break off trees; moderately high sea with blowing foam.
9	Strong Gale	75-88	20.8-24.4		Branches break off trees; tiles blown from roofs; high crested waves.

Wind speeds indicated above, in *km/h* and *m/s*, are at a reference height of 10 metres, as are the wind speeds indicated on the Figure 5 wind roses. The mean wind speeds at pedestrian level, for an urban climate, would be approximately 56% of these values. The 3rd column for wind speed is shown for reference, at a height of 2*m*, in an urban setting. The approximate Comfort Category Colours are shown above. The relationship between wind speed and height relative to terrain is discussed in the appendices.

Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

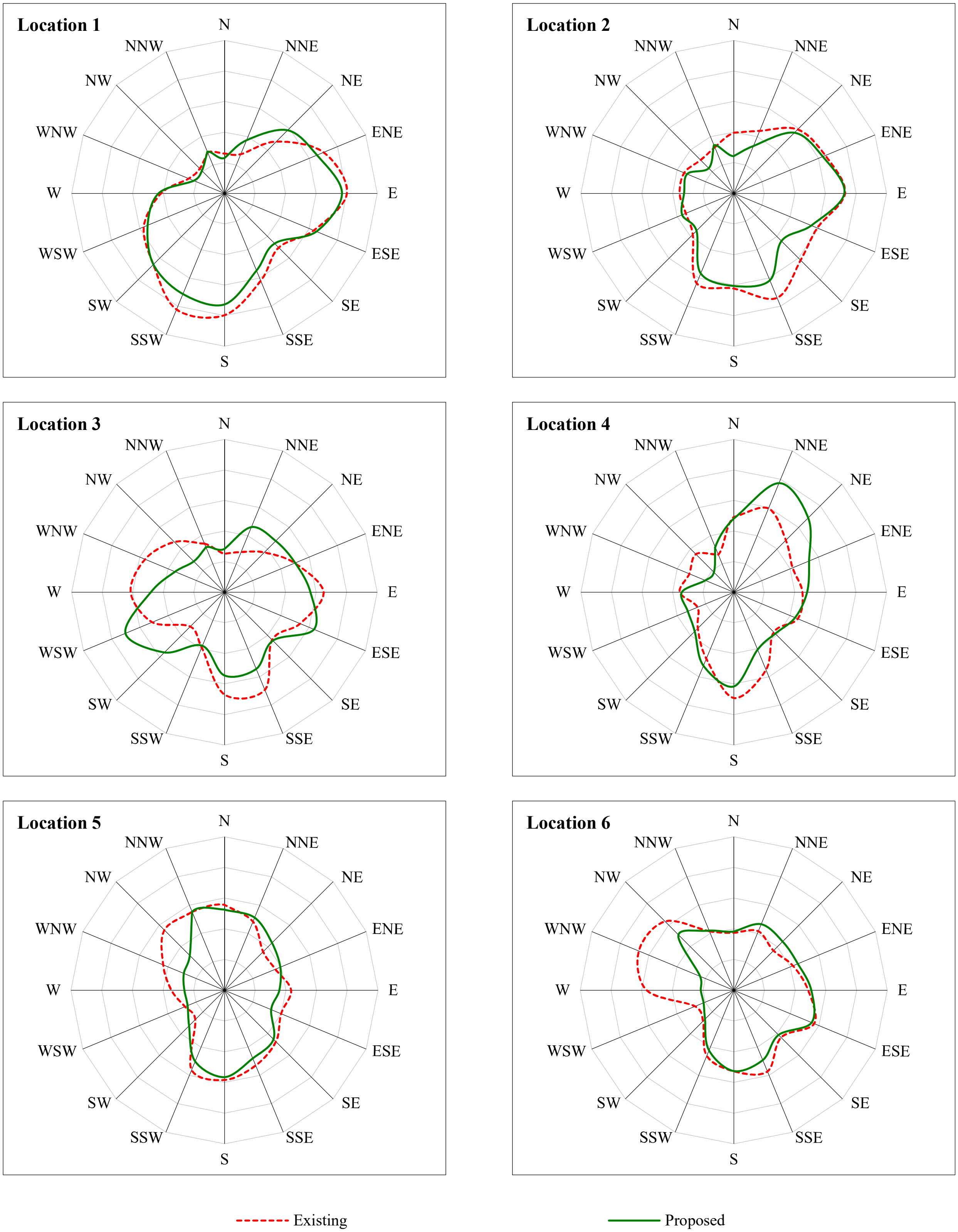
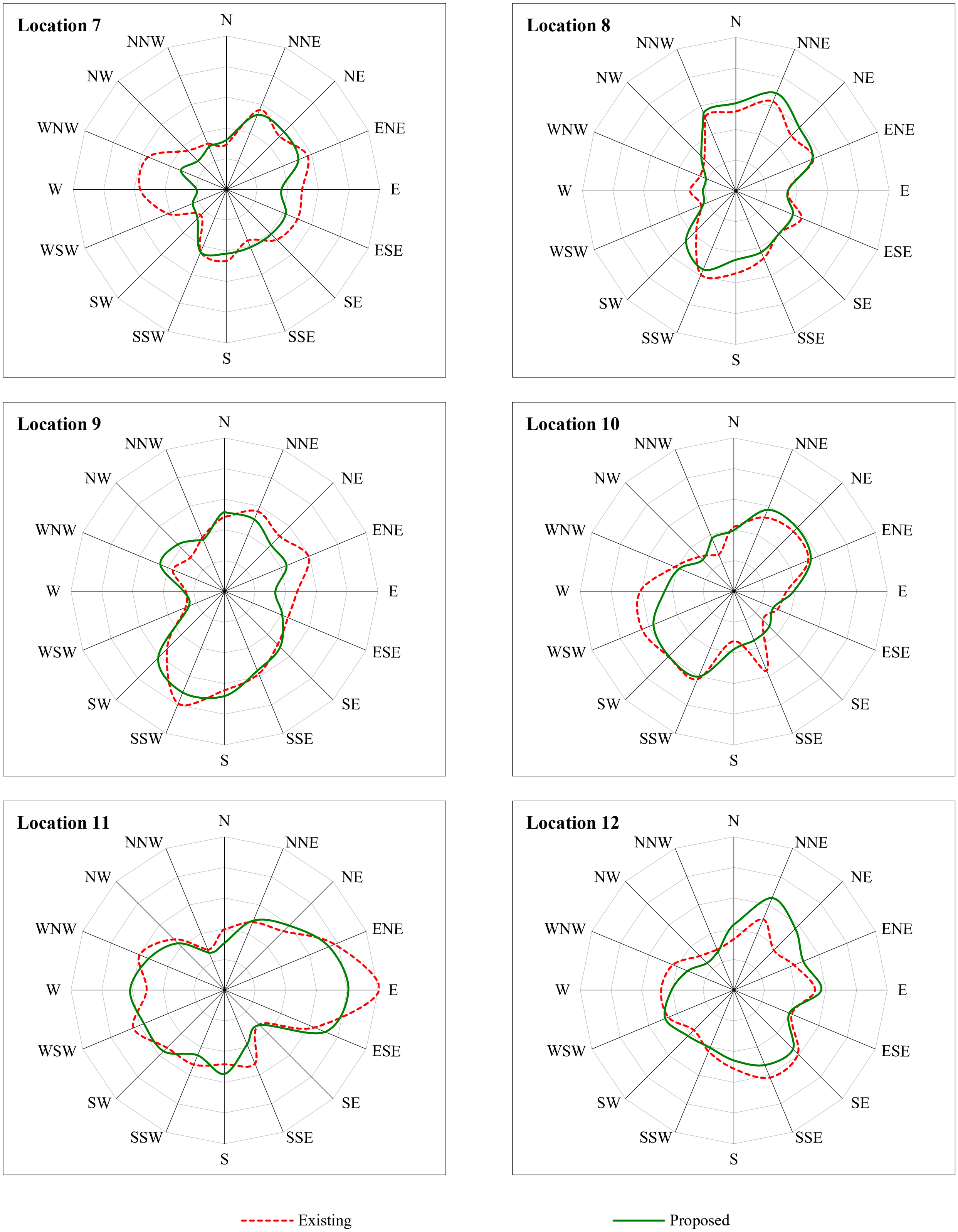


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.



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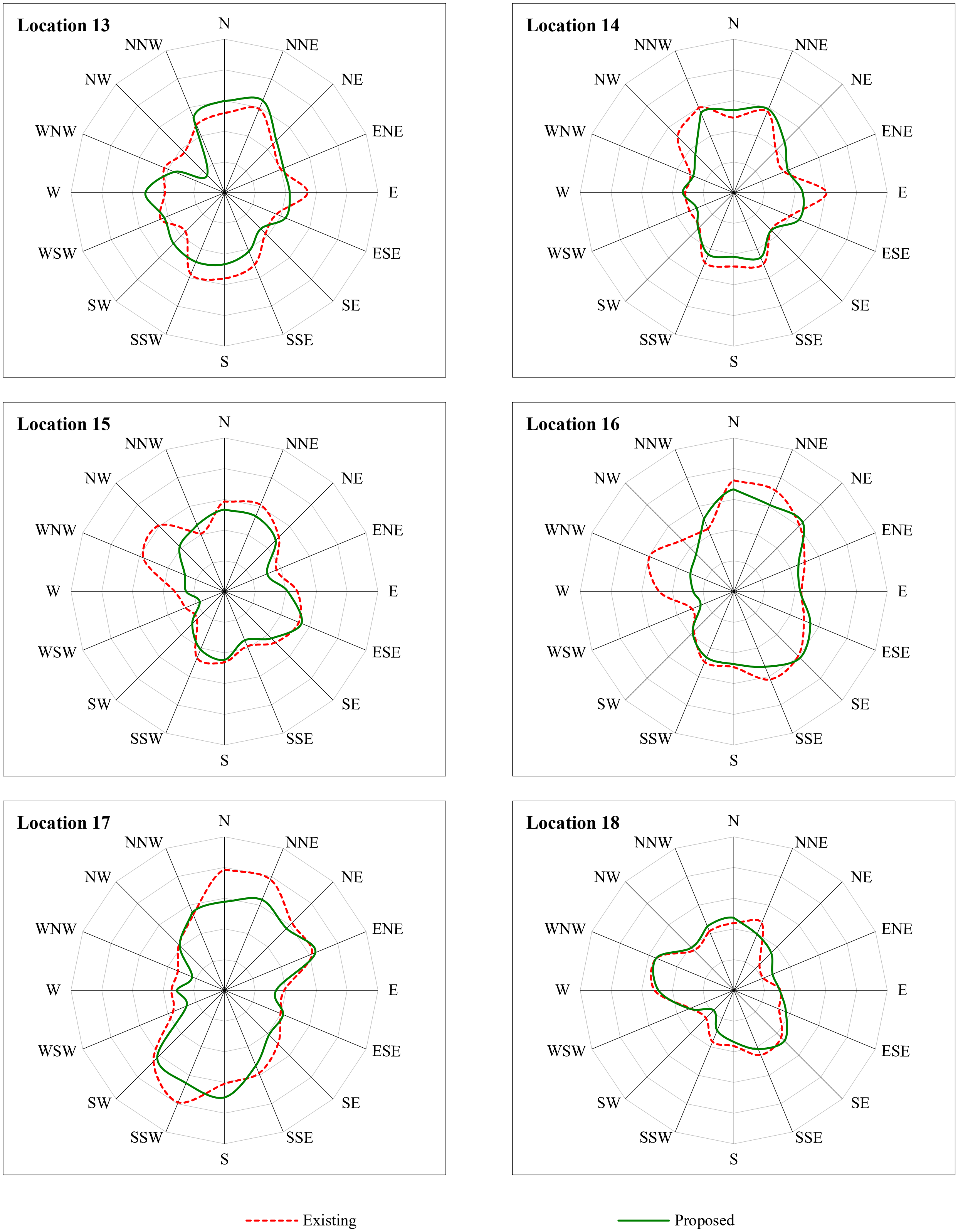

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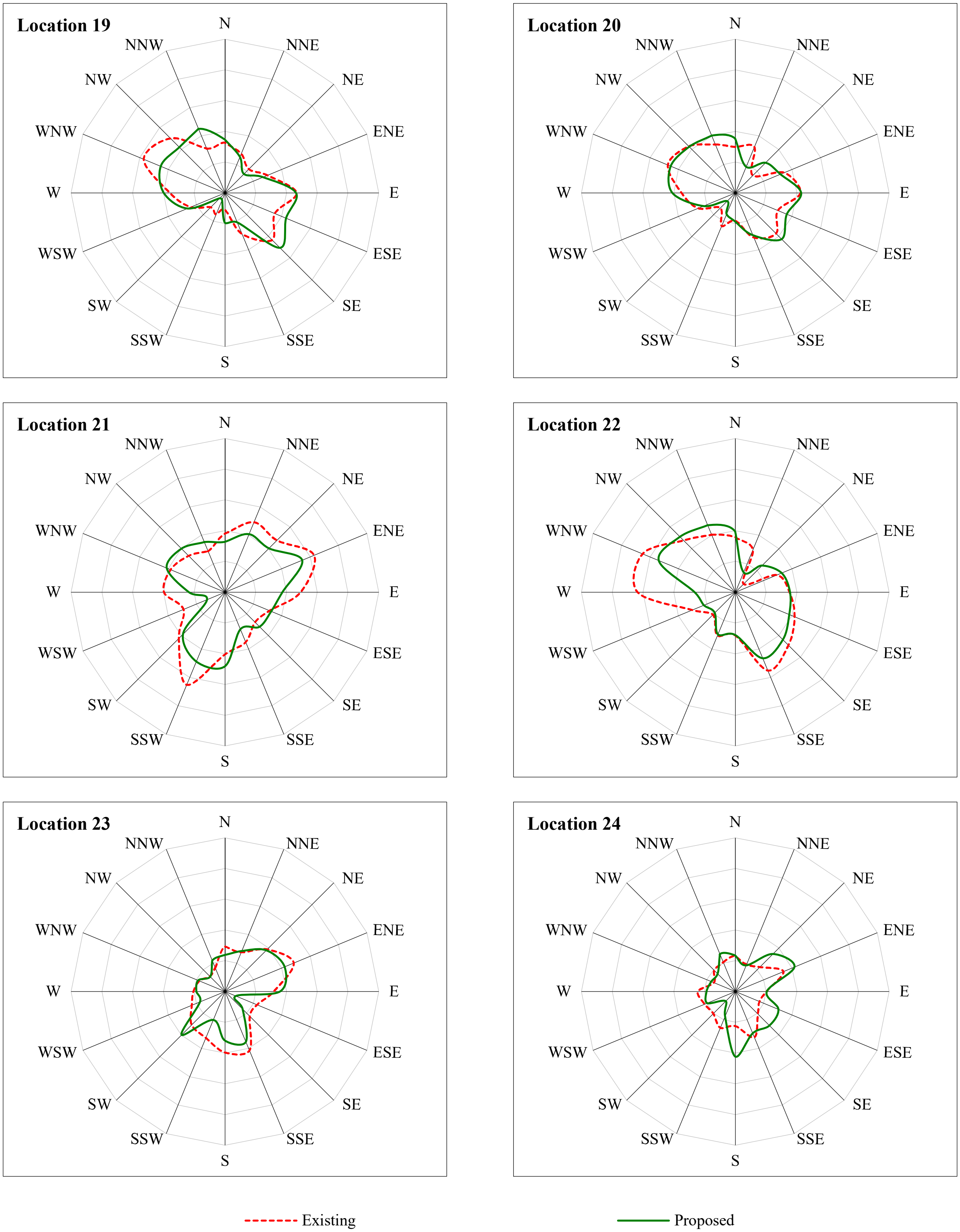
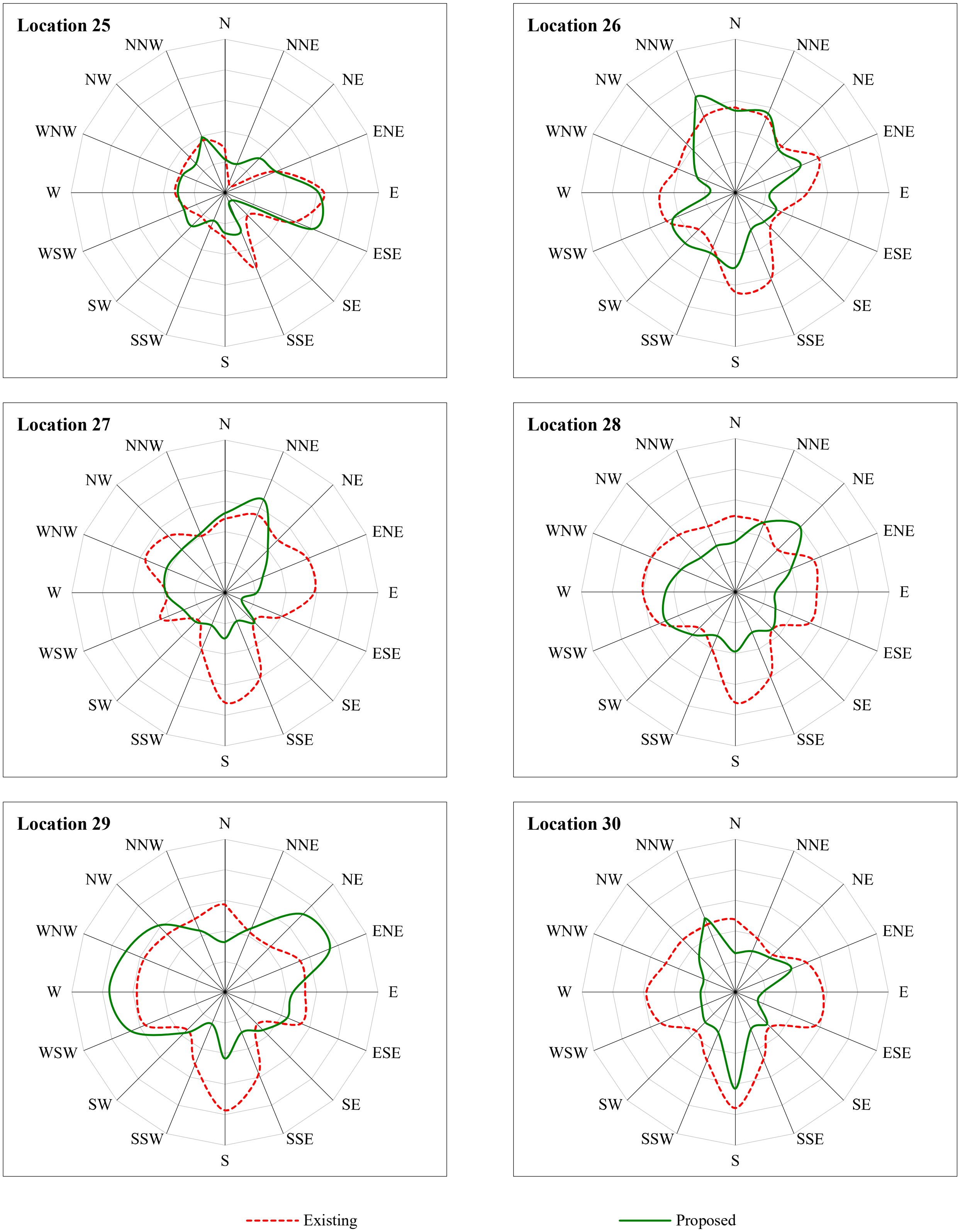


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.



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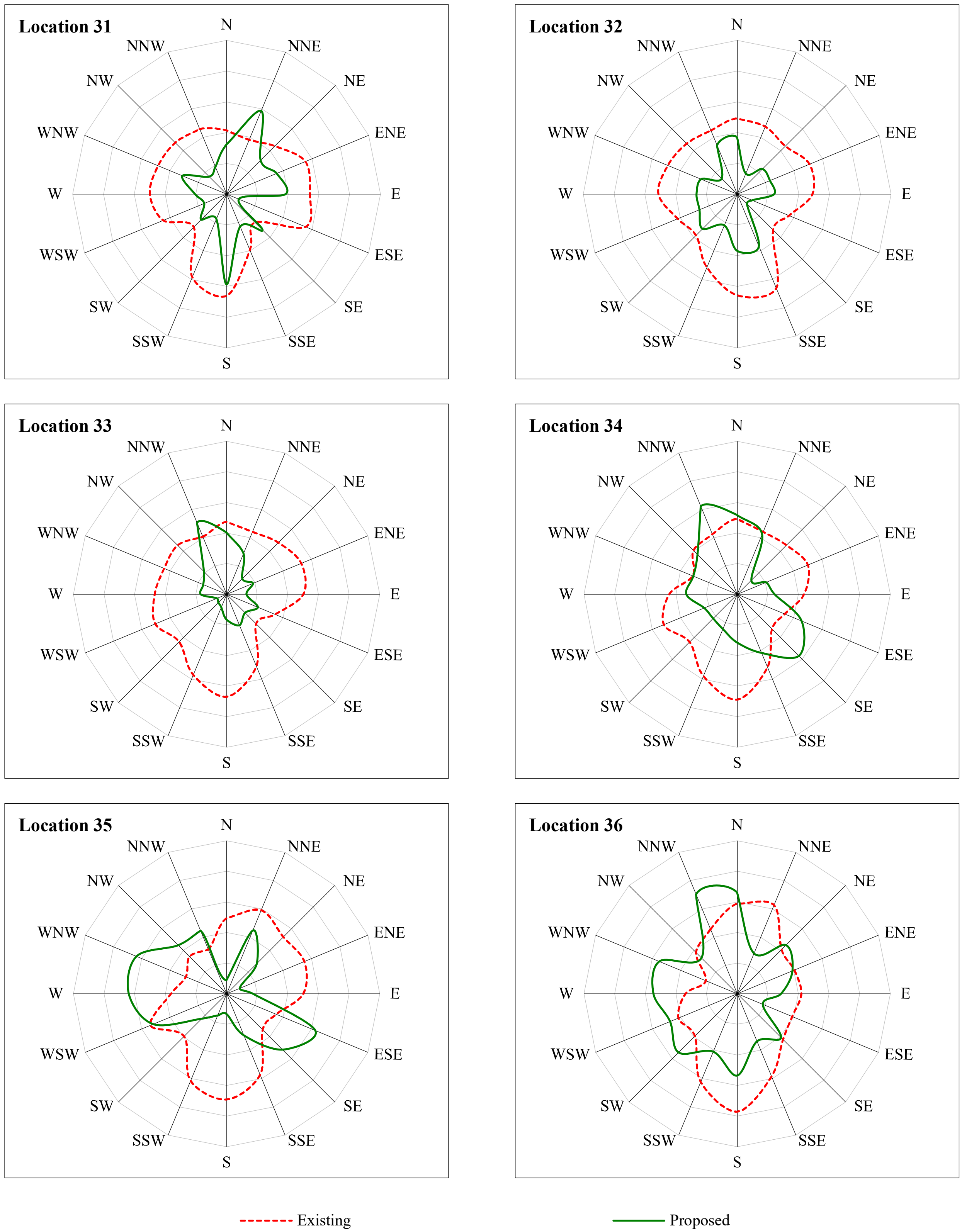
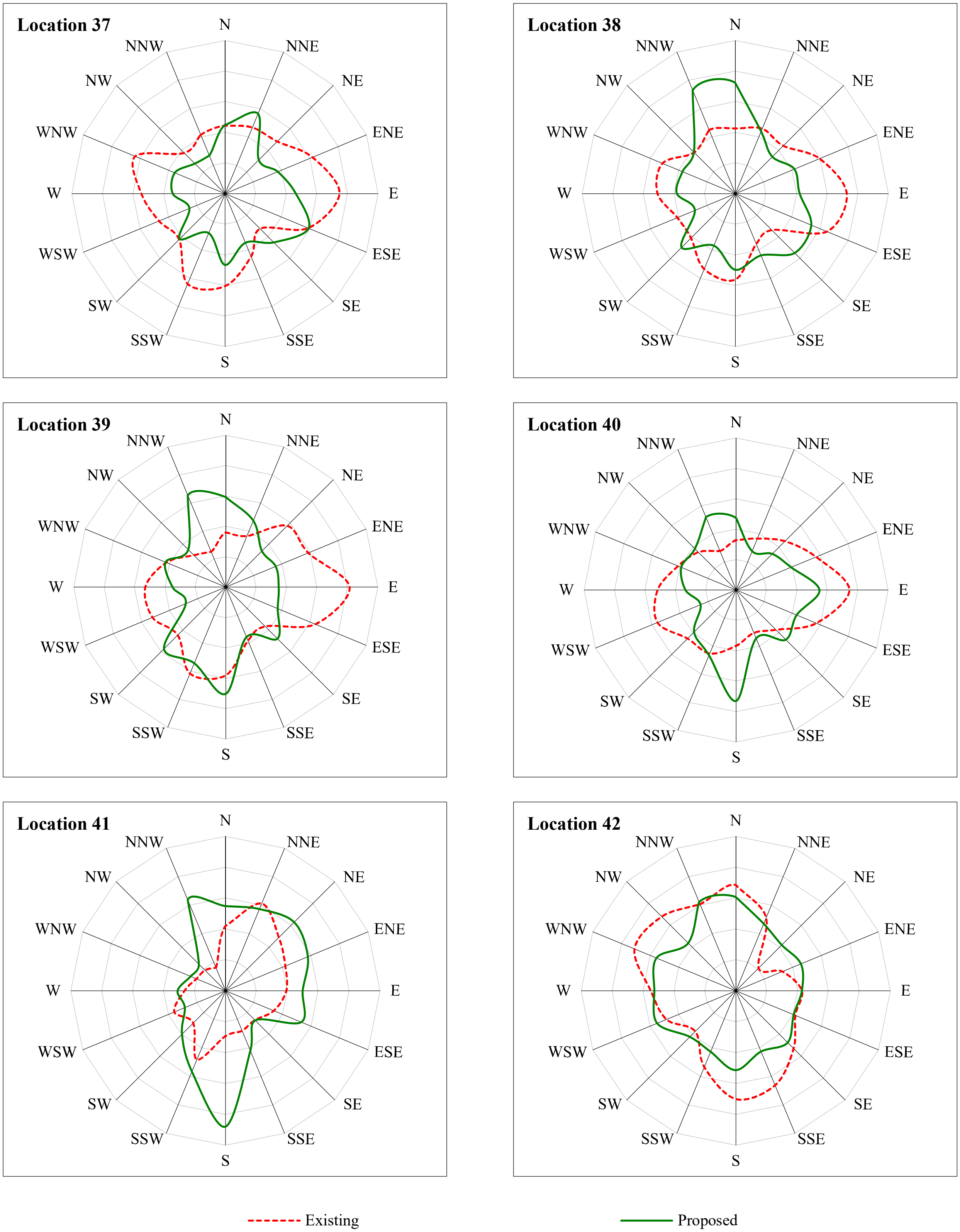


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.



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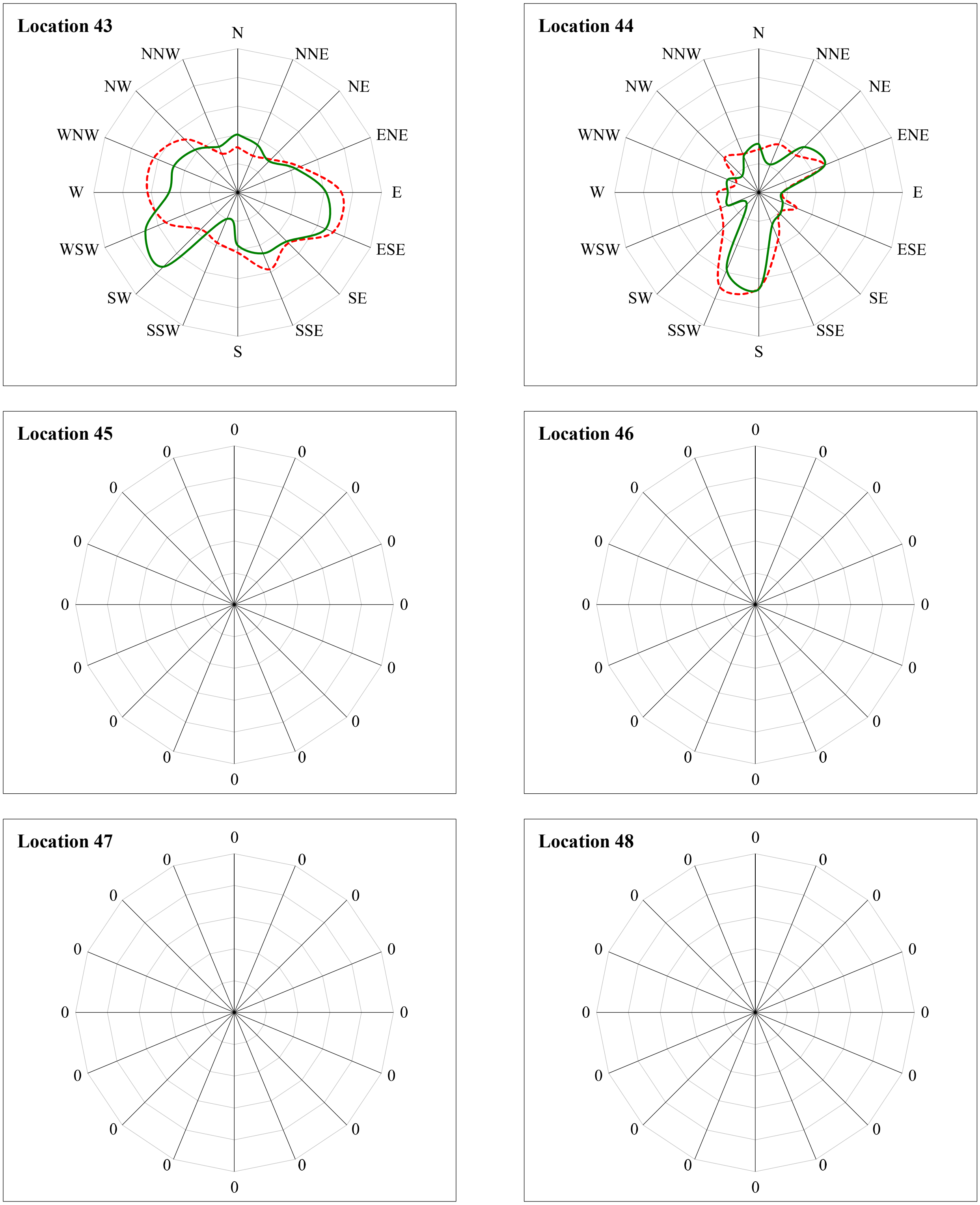

Existing

Proposed

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