THEAKSTON ENVIRONMENTAL

Consulting Engineers • Environmental Control Specialists

REPORT

PRELIMINARY PEDESTRIAN LEVEL WIND STUDY

91 Eglinton Avenue East

Mississauga, Ontario

91 Eglinton Limited Partnership

REPORT NO. 18416wind **September 7, 2018**

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1. CONCLUSIONS AND RECOMMENDATIONS

The Residential Development proposed by 91 Eglinton Limited Partnership for the property municipally known as 91 Eglinton Avenue East, 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 Development involves a proposal to construct 45, 40, 1, 33, 40, 35, and 30 storey buildings denoted Tower A, Tower B, Building C, Tower D, Tower E, Tower F and Tower G, respectively. The proposed towers include connective 2 storey podiums and/or stepped wings of various heights with outdoor Amenity spaces atop the podiums and at grade to the south of the Public Park. The proposed Development's residential entrances and vehicular drop-offs are accessed via Eglinton Avenue East and future extensions of Armdale Road and Thornwood Drive, as well as private driveways dissecting the Proposed Development site.

The Development is, for all intents and purposes, surrounded to prevailing windward directions by an urban/suburban mix of institutional, residential and commercial development, related open areas, and mature vegetation. These buildings and related open areas have a sympathetic relationship with the pending wind climate.

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 site with prevailing winds that have opportunity to accelerate over the relatively open lands associated with Eglinton Avenue East, Hurontario Street, and green fields. This open setting, along with the rural, open setting of the site and relatively open lands accommodating large single storey retail buildings, and related parking, cumulatively account 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 rural lands are redirected, tending to split with portions flowing over, around and down the proposed buildings' façades. At the pedestrian level, the winds redirect to travel horizontally along the buildings, around the corners and beyond, creating minor windswept areas and, on occasion, uncomfortable conditions at or near the buildings' corners and in the gaps between the buildings, and these conditions are primarily attributable to the setting, whereby the Proposed Development penetrates winds that formerly flowed over the existing lands.

Winds emanating from remaining compass points are more effectively mitigated, though to varying degrees, by the local surrounds, and as such, upon impact with the proposed, tend to split, flowing over, and to a lesser extent around and down the buildings' faces. At the pedestrian level, the winds redirect to travel horizontally along the ground, around the corners and beyond, with less significant influence upon pedestrian comfort conditions.

These phenomena result in:

- localised improvements to wind conditions along **Eglinton Avenue East**, although the windiest point is uncomfortable on the occasion of high ambient winds, the area remains suitable for the intended purpose upon consideration of massing features that were too fine to incorporate into the model, and a mitigative landscape design,
- localised uncomfortable conditions along the **future extensions of Armdale Road and Thornwood Drive** on occasion during the winter months. The ratings are near the transition point to comfortable conditions and with consideration of fine massing features, and landscaping, will be suitable for the intended purpose,
- pedestrian comfort conditions in the **Public Park**, that are appropriate to the intended purpose,
- pedestrian comfort conditions at the **Main Entrances,** that are appropriate to the intended purpose, most of the time,
- seasonally appropriate comfort conditions at the proposed **Amenity Spaces**, with incorporation of wind mitigation design features, as discussed in the following.

Comfort conditions expected at the proposed Development site are considered acceptable to the urban context. Where mitigation was recommended, it was achieved through: parapet walls, stepped façades, overhangs, canopies, balconies, porous fencing, screen walls landscaping, plantings, and others, that were incorporated into the proposed Development's massing and landscape design.

Respectfully submitted,

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2. INTRODUCTION

Theakston Environmental Consulting Engineers, Fergus, Ontario, were retained by 91 Eglinton Limited Partnership to study the pedestrian level wind environment for their proposed Residential Development occupying a portion of a block of lands situated to the southeast of the future Armdale Road, northwest of Eglinton Avenue East, and northeast of Hurontario Street. The Development will be located in the City of Mississauga, with the site as depicted on the Aerial Photo in Figure 2a. The Development involves a proposal to construct 6 towers, 4 including 2 storey connective podiums, and 2 with stepped wings at various heights, and a 1 storey building, and in the configuration shown in Figure 2b.

Mark Liddy, P. Eng., 91 Eglinton Limited Partnership, initiated the request, and Dialog Design provided 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 buildings 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 buildings. 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.

2. To assess mitigative solutions.

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

4. METHOD OF STUDY

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. Predictions of wind speeds for various probabilities of occurrence and for various percentages of time are then 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 open channel water flume, the ultimate known as the "Snow and Wind Simulator", in which flowing water is conditioned to represent wind movement (Figure 1). This procedure is based on the fact that air (wind) is a fluid and obeys all the principles and laws contained in Fluid Mechanics and Hydraulics disciplines. The open channel water flume and boundary layer wind tunnel have been developed for these kinds of environmental studies, and have been adapted with equipment, testing procedures and protocols, in order to provide results comparable to full scale. The water flume test is a particularly useful tool where visual examination and qualitative analysis are advantageous in decision making, whereas the Boundary Layer Wind Tunnel lends itself well to the simultaneous acquisition of large data streams.

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 2m 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 Toronto Pearson International Airport, to provide predictions of the full-scale pedestrian level wind environment. The statistical wind data graphically depicted in Figure 5 indicates the mean wind speed and directionality of winds analysed for annual, winter, spring, summer and fall seasons. Historical weather data presented as mean wind speeds in Figure 5 wind roses indicate that winds exceeding 30km/h occur approximately 13 percent of the time during the winter months and 4 percent of the time during the summer. Winds can occur from any direction, however, historical data indicates wind from the northerly and westerly quadrants dominate the winter, with westerly directions most significant, and winds from the north through west to southwesterly are predominant during the summer months with northerly and westerly directions most significant. Spring winds are mainly from the north to southwest sector and fall winds approach predominately from north through west to southerly directions.

Predictions of the full-scale pedestrian level wind environment are presented as a percentage of time that is comfortable for a given activity, based on wind annually and for the seasons in Figures 6a through 6e. Criterion employed by Theakston Environmental was developed by others and us and published in the attached references. The methodology has been applied to projects on this continent and abroad.

Wind Simulation

To simulate the correct macroclimate, the upstream flow is conditioned and passes over a roughened surface that develops the full-scale mean speed boundary layer approach flow profiles occurring at the site. Conditioning features placed upstream of the modelled site simulate full-scale wind conditions, thus creating the appropriate macroclimate.

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 site visit to the proposed Development site, and surrounding area. Dialog Design provided architectural drawings. City of Mississauga context drawings and 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 full-scale height of 2*m* above the local grade. During testing, the model sample period is selected to represent 1*hr* 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.

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. The effects of mean and gust wind conditions are weighted, combined and are plotted in Figures 6a through 6e for predicted comfort conditions.

Figures 7a – 7j are a representation of the percentage of time that a given point is comfortable for a given activity. The activities are described as suitable for Sitting or Standing or Walking over 80% of the time. In order for a point to be rated as suitable for <u>Sitting</u>, for example, the wind conditions must be less than 10 km/h. 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 <u>Standing</u> category is slightly more tolerant of wind, including wind speeds from calm up to 14km/h. In this situation, the wind would rustle tree leaves and, on occasion, move smaller branches while flags would be partially extended. This category would be suitable for locations where people might sit for short periods or stand in relative comfort. The <u>Walking</u> category includes wind speeds from calm up to 19km/h. These winds would set tree limbs in motion, lift leaves, litter and dust, and the locations are suitable for activity areas. The <u>Uncomfortable</u> category covers a broad range of wind conditions, including wind speeds above 19km/h.

In the Figures, the probe locations and test configuration are listed along the bottom of the chart, beneath the graphical representation of the percentage of time that the winds are expected to fall within each category. The location is rated as suitable for sitting, standing or walking if the appropriate bar extends above the 80% level and is Uncomfortable if the bar for the category extends above 20%. Activities other than those indicated by the rating can take place at the points of interest, however, the time period will be less, as indicated in the percentage of time in the chart's abscissa axis. For example, a point that is rated as uncomfortable may be suitable for walking 75% of the time, standing 60% of the time and sitting 45% of the time.

The charts represent the average person's response to wind for the seasons. 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.

5. RESULTS

Study Site and Test Conditions

Proposed Development

The Development occupies a portion of a block lands situated to the north of the intersection of Hurontario Street with Eglinton Avenue East in the City of Mississauga. The subject site was occupied by a one storey residential dwelling and several farming related structures that are in the process of being removed. The development is phased, however, the analysis is based upon the ultimate configuration. The first phase occupies the southeast portion of the Development site, along Eglinton Avenue East, and involves construction of Lot 1, which is comprised of 45 and 40 storey towers, denoted Towers A and B. The buildings step down from 8 storeys to a 2 storey connective podium with amenity space on the second level roof. A 33 storey tower, denoted Tower D, is proposed for Lot 2, proximate to the centre of the development site, with a multi-level wing including 9th Level Amenity space, extending towards the north along the future extensions of Armdale Road and Thornwood Drive. The west portion of the Development involves 40 and 35 storey towers on Lot 3, denoted Towers E and F, that are connected via a 2 storey podium with Amenity space at the 3rd level. A 30 storey tower, denoted Tower G, is proposed for Lot 4 at the east corner of the Development, stepping down to a multi-level podium, including 9th Level Amenity space, that extends north along the future extension of Thornwood Drive. Finally, a 1 storey building providing access to an underground Amenity space, denoted Building C, is located in the centre of the site, south of the Public Park space. The configuration of the proposed buildings and associated amenity spaces 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.

Surrounding Area

The most noteworthy urban buildings in the immediate surroundings, by proximity, are the Pinnacle Development comprised of 8 buildings ranging in height from 30 to 50 storeys, occupying lands to the west of the intersection of Eglinton Avenue West and Hurontario Street. Earlier phases of the Pinnacle Development are complete, subsequent phases are under construction, approved, or seeking approval. To the west of the site the Hurontario Street & Nahani Way development site is proposed to include a 33 storey residential tower with 2 storey townhomes planned along the northeasterly side of the site, fronting the balance of Nahani Way and the future Belbin Street. To the southeast and east of the above-mentioned Pinnacle Development, also proposed along Hurontario Street, Summit Eglinton Inc. proposes to build Townhouses and Semi Detached Units on lands along the northwest and northeast extremities of the site, removed from Hurontario Street, with high-rise to the southeast and southwest with the latter fronting Hurontario Street. To the southeast of Eglinton Avenue West, and southwest of Hurontario Street lay several large residential buildings that are well spaced with parking, green space and Cooksville Creek related lands with townhomes and lower density residential farther to the southwest along Eglinton Avenue West.

Macroclimate

For the proposed Development, the upstream wind flow during testing was conditioned to simulate an atmospheric boundary layer passing over urban/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 annually and for four 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). The macroclimate for this area is dependent upon wind direction and varies with direction between suburban and urban.

Winter (November 16 to March 31) 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 5b. Summer (June 16 to September 15) has the lowest mean wind velocities of the seasons with prevailing winds from north through west to southerly as indicated in Figure 5d. Spring and Fall winds tend to be more moderate and emanate from the north through west to southwest. Reported pedestrian comfort ratings generally pertain to annual conditions, unless stated otherwise.

Pedestrian Level Wind Velocity Study

Pedestrian level wind velocity measurement probes were located on the site model. The instrumented areas include the street frontages adjacent to the proposed Development, placed at approximately 10m spacing, as well as other buildings and activity areas, and the test data was used 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 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 on an annual and seasonal basis in Figures 6a-6e.

The ratings for a given location are conservative by design, and those ratings that are Uncomfortable, when close to a transition between Walking and Uncomfortable, will not pose a problem from a pedestrian comfort point of view. When the existing surroundings and proposed buildings' 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 an urban/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 an urban environment in order to determine the worst-case scenario.

Review of Probe Results

The probe results, as follows, were clustered into groups comprised of Public Street Conditions, Public Park and Central Amenity Area Conditions, Pedestrian Entrance Conditions, and Rooftop Outdoor Amenity Areas. The measurement locations are depicted in Figure 4 and are listed in Figures 6a through 6e, annually and for the seasons, for the existing and proposed configurations. The results are also graphically depicted for the existing and proposed configurations in Figures 7a – 7j. The following discusses anticipated wind conditions and suitability for the points' intended use.

Public Street Conditions

Eglinton Avenue East

Probes 1 to 10 and 18 were located along the above-named street within the zone of influence of the proposed Development. Of these probe locations all indicate annual wind conditions that are suitable for walking in the existing setting with exception; locations 1, 6, 9, and 18 were rated as suitable for standing. The ratings are partially attributable to westerly through northwesterly winds that are exacerbated upon approach by the currently open development site, the lack of turbulence inducing roughness affording winds opportunity to accelerate on approach. The ratings can also be partially attributed to winds approaching in approximate alignment with the street, the open approach of the street, related boulevards, and low-rise commercial buildings, affording winds approaching from the southwesterly portion of the prevailing wind climate opportunity to accelerate on approach.

With inclusion of the proposed Development, probe locations 2, 3, and 4 realised sufficient improvement to change annual comfort categories from walking to standing. The improvements realised can be attributed to the proposed development presenting increased blockage to winds, resulting in the observed leeward effect, however, the realignment of winds associated with insertion of tall buildings into a suburban/urban setting invariably causes a realignment of winds that can result in localised windier conditions. Points 1, 9, and 18 realised increased wind effects sufficient to change annual comfort ratings from standing to walking, but the areas remain suitable for the intended purpose.

From the mean ground level wind velocity presented as a ratio of gradient wind speed, in the plots of Figure B in the Appendix, it is apparent that many of these points realise either no change or an improvement to the existing setting with inclusion of the Proposed Development for specific wind directions, however, there are directions from which the wind is exacerbated. Should that direction coincide with dominant wind directions, as indicated in Figure 5's wind roses, relatively more windy conditions can be expected. As such, the uncomfortable conditions predicted at probe location 5, situated at the east corner of the Development, result from winds that formerly flowed over the open lands of the existing site being redirected to flow along Lot 4's 30 storey Tower G, and related wing, the combined massing, which steps down in a northwesterly direction from 16 storeys at the tower to 4 storeys, deflecting winds from specific directions to the pedestrian level and over the point, resulting in an occasionally uncomfortable rating.

The above-mentioned, considered in concert with massing features and landscaping that were too fine to be incorporated into the site and surroundings, and urban intensification will result in further improvement, likely sufficient to bring the annual uncomfortable rating to walking. During the winter months, the occasionally uncomfortable winds predicted at probe locations 5, 7, and 18 are an acceptable pedestrian comfort condition. All points are suitable for activities requiring longer exposure times during the summer.

Townhouse Development to the Northeast
Probes 11 and 12 were placed along the Driveway serving a townhouse development to the northeast of the proposed Development. The area is effectively sheltered by the residential dwellings, and as such rated suitable for standing in the existing setting on an annual basis. With inclusion of the Proposed Development there is a slight realignment of winds, however, the annual ratings remain the same and the change to wind flow patterns with inclusion of the Proposed Development will be imperceptible.

Kencourt Drive
Probes 15 and 16 were placed along Kencourt Drive, to the northwest of the proposed Development, and were rated suitable for standing and walking in the existing setting on an annual basis, respectively. With inclusion of the proposed Development, the street realises a slight realignment of winds, however, the change will not likely be perceptible, the annual ratings along Kencourt Drive are unchanged, and therefore the street remains suitable for the intended purpose.

Future Thornwood Drive Extension
Probes 13, 14, 20, 21, 29, 30, 38, 39, 40 and 41 were located along Thornwood Drive and the future extension of the same name. In the existing setting said points display an annual rating as suitable for walking, with the exception of point 13, situated adjacent to the townhomes along the street to the north, and points 29 and 41 which are situated within the Proposed Development site, and were rated as suitable for standing. The comfortable conditions at probe 13, adjacent to the townhouses, is attributed to the homes deflecting much of the prevailing wind climate to flow up and over the street at the selected test location. The relatively windier conditions realised on the Proposed Development site can

be attributed to the more open setting allowing the wind's boundary layer profile to thicken and approach the ground.

With inclusion of the Proposed Development a realignment of winds will occur, resulting in windier conditions being realised at most of the points, with winds emanating from specific directions, and more comfortable conditions with winds from others, however, the net result of the altered wind flow patterns does not change the annual comfort ratings for the points along the future Thornwood Drive extension.

During the winter months there is a greater propensity for stronger winds from specific directions, and should thas direction coincide with an area sensitive to wind from a particular direction, windier, less comfortable conditions will prevail. As a result, point 14 will be uncomfortable on the occasion of strong winter winds emanating from westerly and southeasterly directions, however, lands to the west are currently open, contributing to the windy conditions, and as indicated in Figure 5's winter wind rose, southeasterly winds seldom occur. Urban intensification of lands to the west of point 14 can reasonably be expected to moderate westerly winds upon approach, resulting in more comfortable conditions, suitable for walking during the winter months. Similarly probe 39 will be uncomfortable on occasion during the winter months, on the occasion of high ambient northwesterly winds. This point can also be expected to realise an improvement with development of surrounding lands and upon consideration of the Proposed Development's fine design features and landscaping that was too fine to incorporate into the model under test. Conversely, probe 40 was rated as uncomfortable in the existing setting, however, with inclusion of the Proposed Development, Building D obstructs enough of the westerly wind climate to improve conditions in the represented area to suitable for walking.

Future Armdale Road Extension

Probes 17, 27, 34 and 35 were placed along the future extension of Armdale Road, in addition to the above discussed probes 14, 16, 30, and 41, that were placed at the intersections with Kencourt Drive and Thornwood Drive Extension. Probes 17, 27, 34 and 35 realised moderately windy conditions in the existing setting, suitable for walking on an annual basis. With inclusion of the Proposed Development points 17 and 27 realised sufficient improvement to wind conditions to change the annual comfort ratings from walking to standing. Conversely, an increase in windiness was realised at point 34 that was sufficient to change the comfort rating to uncomfortable annually and in the spring and fall, and at points 34 and 35 to uncomfortable during the winter, on the occasion of high ambient northerly and westerly winds, respectively. However, these points are near the transition between walking and uncomfortable, and will be suitable for walking or better during the winter months approximately 72% to 78% of the time, 80% being the transition from uncomfortable to walking.

Mitigation of downwash conditions is well understood and was applied through design whereby canopies, balconies and overhangs, porous fencing, as well as other design features, were employed, as discussed in the Conclusions and Recommendations Section of this report. These, considered in concert with massing features that were too fine to be incorporated into the surroundings, as well as urban intensification of the street indicate that the future Armdale Road extension will likely remain suitable for its intended purpose, within acceptable pedestrian comfort criteria for the winter months, and suitable for activities requiring longer exposure times during the summer.

Private Driveway Conditions

Probe 32, among others discussed in preceding and following sections, was placed along the sidewalk adjacent to the Private Driveway proximate to the south corner of the Development Tower E. The analysis indicates conditions that are suitable for walking annually, in the proposed setting. During the winter and shoulder seasons probe 32 retains a rating as suitable for walking and is suitable for standing during the summer months. As such the area remains appropriate to its intended purpose.

Public Park and Central Amenity Area Conditions

Probes 24 through 26 were placed in the above-mentioned areas. The analysis indicates conditions that are respectively suitable for standing, standing, and walking, annually, in the existing setting. With inclusion of the Proposed Development, probe 24 realised a slight increase in windiness, relative to the existing, probes 25 and 26 realising a slight, likely imperceptible improvement. During the summer months, the points are suitable for standing and during the shoulder seasons the ratings vary from walking to standing depending upon the wind directionality and velocity. The results as tested represent comfort conditions that can reasonably be expected improved to levels suitable to the respective areas' intended purpose through development of an appropriate Public Park and Central Amenity Area landscape plan.

Pedestrian Entrance Conditions

Probes 19 and 22 were placed along the sidewalks leading to the residential lobby entrances to Lot 1's Tower A and Tower B, respectively fronting Eglinton Avenue East and the Private Driveway. With inclusion of the proposed Development, point 19 realised similar annual comfort ratings, suitable for standing in the existing and proposed settings. Point 22 realised an increase in windiness that was sufficient to change its annual rating from standing to walking. During the summer and fall the point is suitable for standing, during the winter and spring, for walking, however, the point is near the transition to standing and as such, with consideration of the buildings' fine design aliments and landscaping that was too fine to incorporate into the model, will be suitable for standing most of the time, and appropriate to the area's intended purpose.

Probes 28 and 29, placed adjacent to the residential lobby entrances of Lot 2's Tower D, were rated as annually suitable for walking and standing, respectively, in the existing setting. With inclusion of the proposed Development, wind is deflected over, and/or around the building podium resulting in the entrances being in the building's aerodynamic shade regions, for most wind directions and as such will realise improved comfort conditions, suitable for standing through the seasons, with exception; location 28 was predicted suitable for sitting through spring, summer and fall.

Probes 33 and 36 were similarly placed proximate to the residential lobby entrances to Lot 3's Tower E and Tower F. In the existing setting, probe location 33 was sheltered by a farm building, and as a result, was rated as suitable for standing throughout the seasons with the exception of summer when it was rated as suitable for sitting. Probe location 36 was more exposed, and realised windier conditions in the existing setting. As such it was rated as suitable for walking through winter and spring and standing through the summer and fall seasons. With the inclusion of the proposed Development, point 33 was unchanged, suitable for standing, while point 36 realised an improvement to wind conditions that was sufficient to change comfort ratings at the entrance to standing, or better, throughout the seasons.

Probes 39 and 43, placed at the principal entrances to Lot 4's Tower G, were annually rated as suitable for walking and standing, respectively, in the existing setting. With inclusion of the proposed Development, portions of the wind climate that formerly flowed over the open area were obstructed, causing point 43 to improve comfort ratings to sitting throughout the seasons. Conversely, point 39 is exposed to winds deflected to flow along the extension of Thornwood Drive, and the Private Driveway, resulting in wind conditions that will be uncomfortable on occasion during the winter months. With consideration of the Development's and neighbouring buildings' fine design features, and landscaping, and incorporation of entrance vestibules, the entrance will be comfortable and suitable to the intended purpose, most of the time.

Wind conditions comfortable for standing are preferable at building entrances, while conditions suitable for walking are suitable for sidewalks. Conditions at the proposed main residential entrances and related walkways are considered comfortable, with the above noted exception, and suitable to the intended purpose. Consideration of existing and proposed surface roughness features too fine to incorporate into the massing model will further improve the comfort ratings. It is recommended that the main entrances to the Towers be recessed into the façade of the buildings such that winds deflected to flow along the sidewalks adjacent to the buildings will not act upon the door leafs.

Rooftop Outdoor Amenity Areas

Outdoor amenity areas are proposed situated atop the podiums and/or between the towers at probe locations 23, 31, 37 and 44, as indicated in Figures 2b and 4. The spaces will be susceptible to winds from specific directions being deflected to flow down, around and where applicable, through the gap between the towers, resulting in windy, though not inordinate wind conditions. Probes 31 and 44, situated on the podium amenity spaces for Tower D and Tower G, respectively, are predicted suitable for standing during the summer months and are expected to realise seasonally appropriate conditions much of the time. Probe location 23, situated on podium amenity space between Tower A and Tower B, and probe 37, similarly on the podium between Tower E and Tower F, will realise uncomfortable conditions throughout the seasons. Windy conditions are not an unreasonable expectation for amenity spaces atop 8 storey roofs and near towers, and uncomfortable wind conditions are a reasonable expectation for narrow gaps between towers, and as such, the rooftop amenity areas will not realise pedestrian comfort conditions that are appropriate for the intended purpose without implementation of effective wind mitigation plans.

The analysis was conducted without the subject and neighbouring buildings' fine design features or existing and proposed hard and soft landscape features in place. As such, we reasonably expect prevailing pedestrian comfort conditions will be better than those predicted. A mitigation plan is required for the amenity spaces, if activities requiring longer exposure times are desired. This might be accomplished with a landscaping plan for the rooftop amenity spaces that includes appropriately engineered windscreens, railings, trellises, coarse vegetation, recessed seating, and others, which considered cumulatively, will further improve wind conditions in the residential amenity area, making them suitable to the intended purpose.

Summary

The observed wind velocity and flow patterns at the Development are largely influenced by approach wind characteristics that are dictated by the urban/suburban mix of residential and commercial development, related open areas, and mature vegetation 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 4 percent of the time during the summer. Once the subject site is developed, ground level winds at several locations will improve, with occasional localized areas of higher pedestrian level winds. The relationship between surface roughness and wind is discussed in the Appendix and shown graphically in Figure A of the same section.

Consideration of existing and proposed building features too fine to incorporate into the massing model, along with recommended mitigation through the implementation of the landscape plan, will improve the predicted comfort ratings beyond those reported herein, resulting in conditions suitable for the intended use.

6. FIGURES:

Figure 1: Laboratory Testing Facility

Figure 2a: Site Aerial Photo

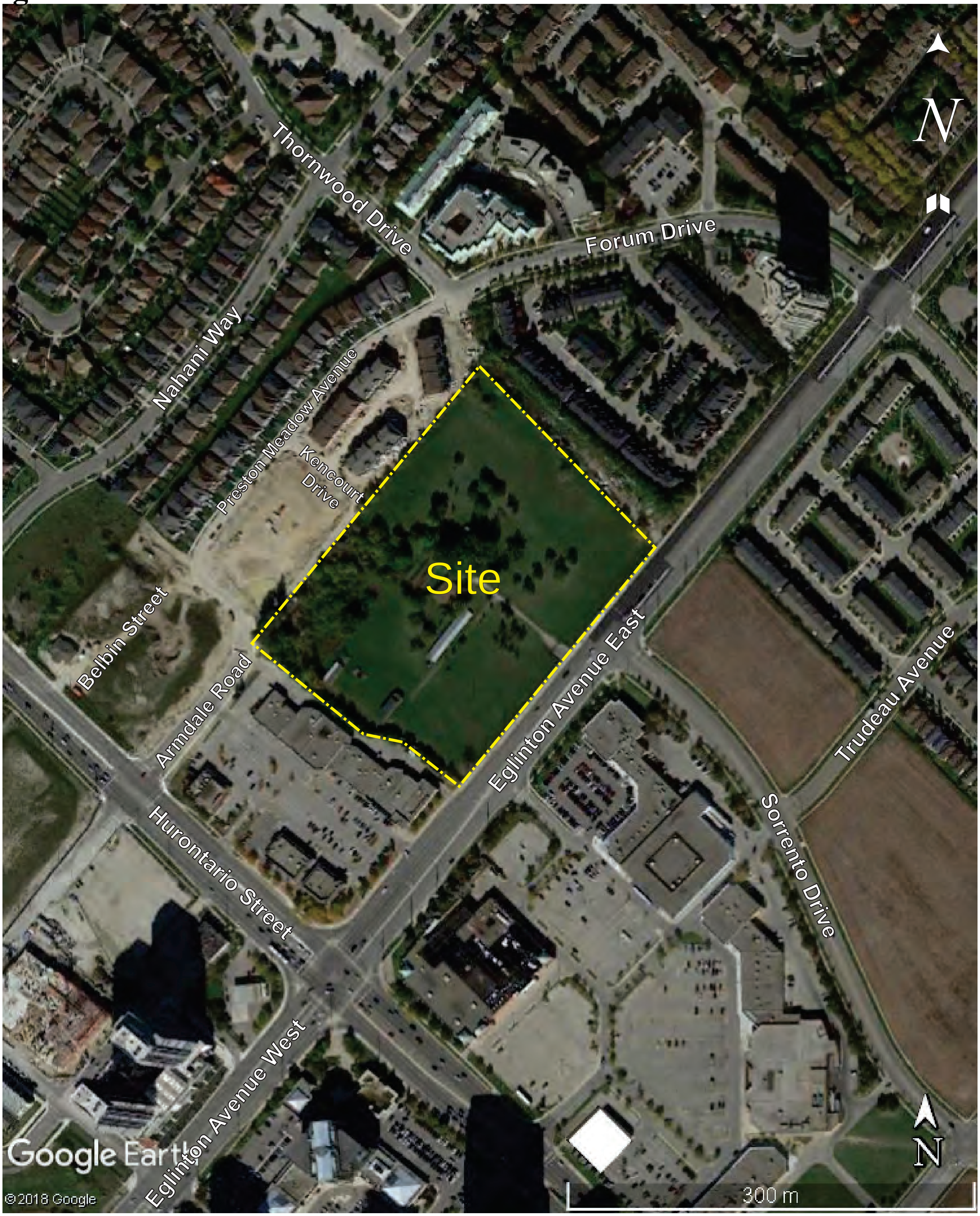


Figure 2b: Site Plan

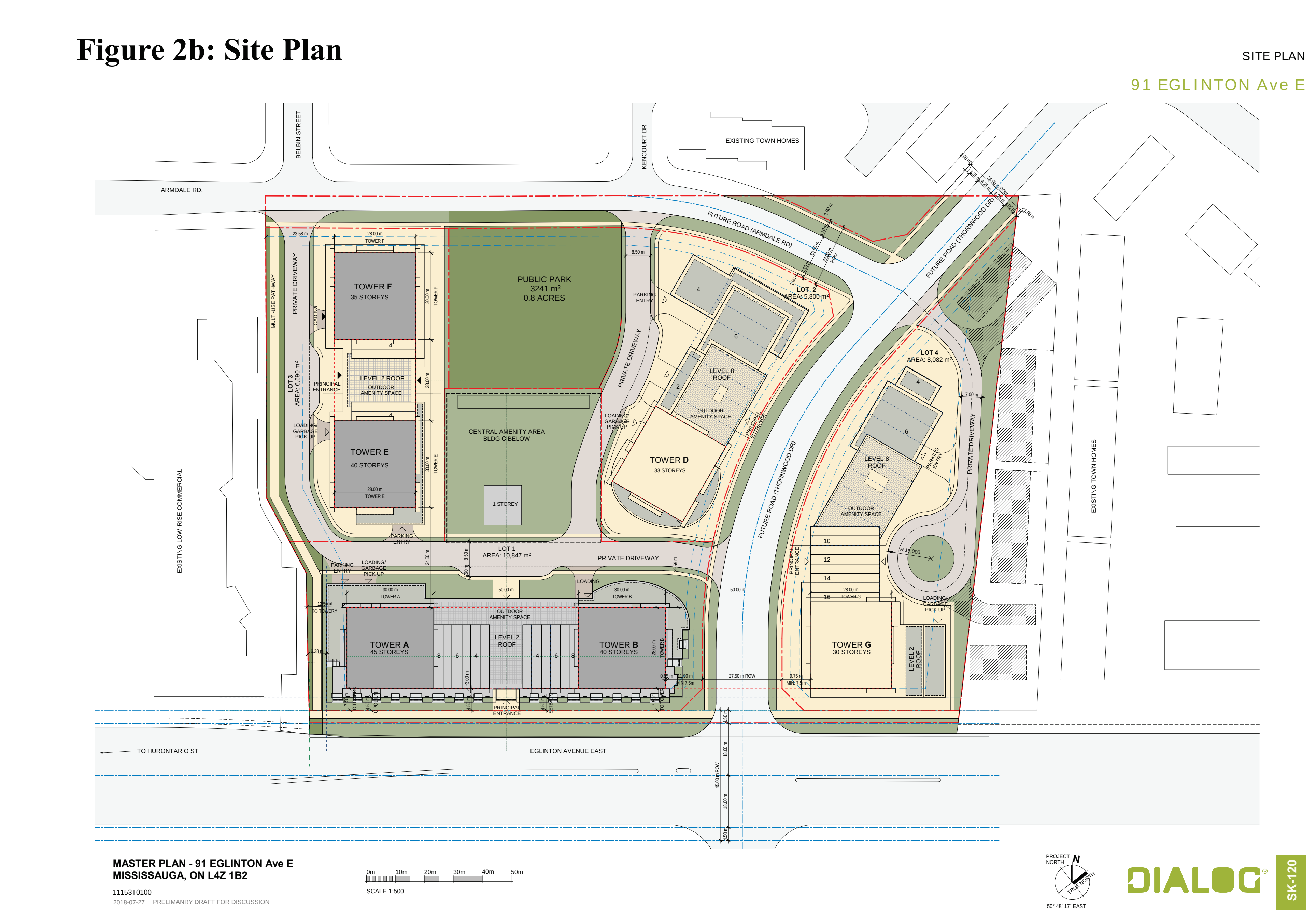
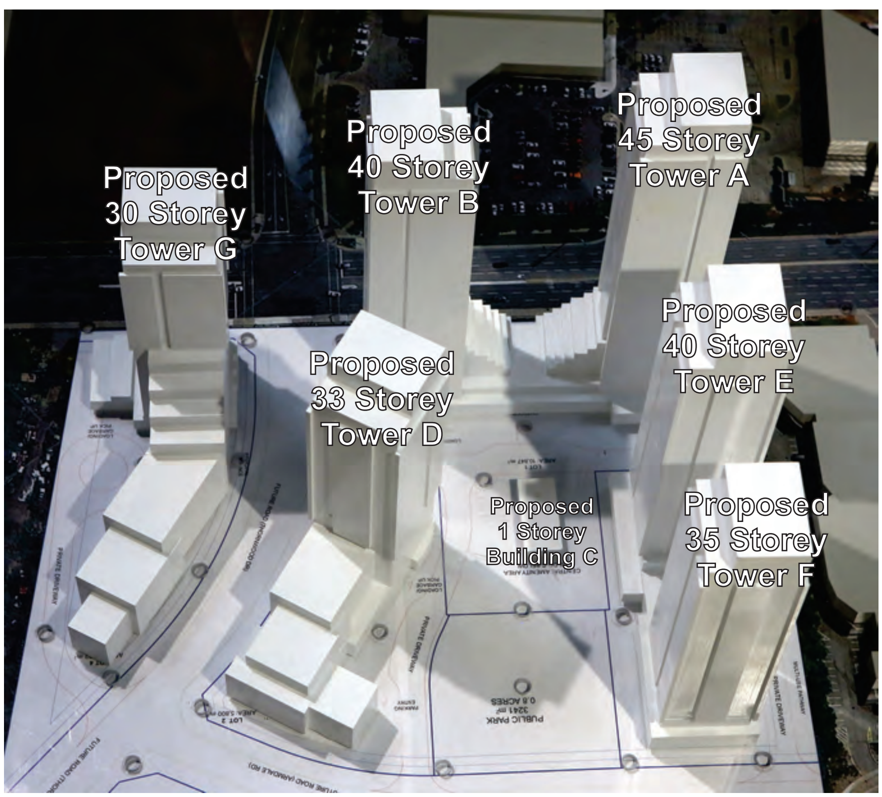


Figure 3: 1:500 Scale model of test site

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.

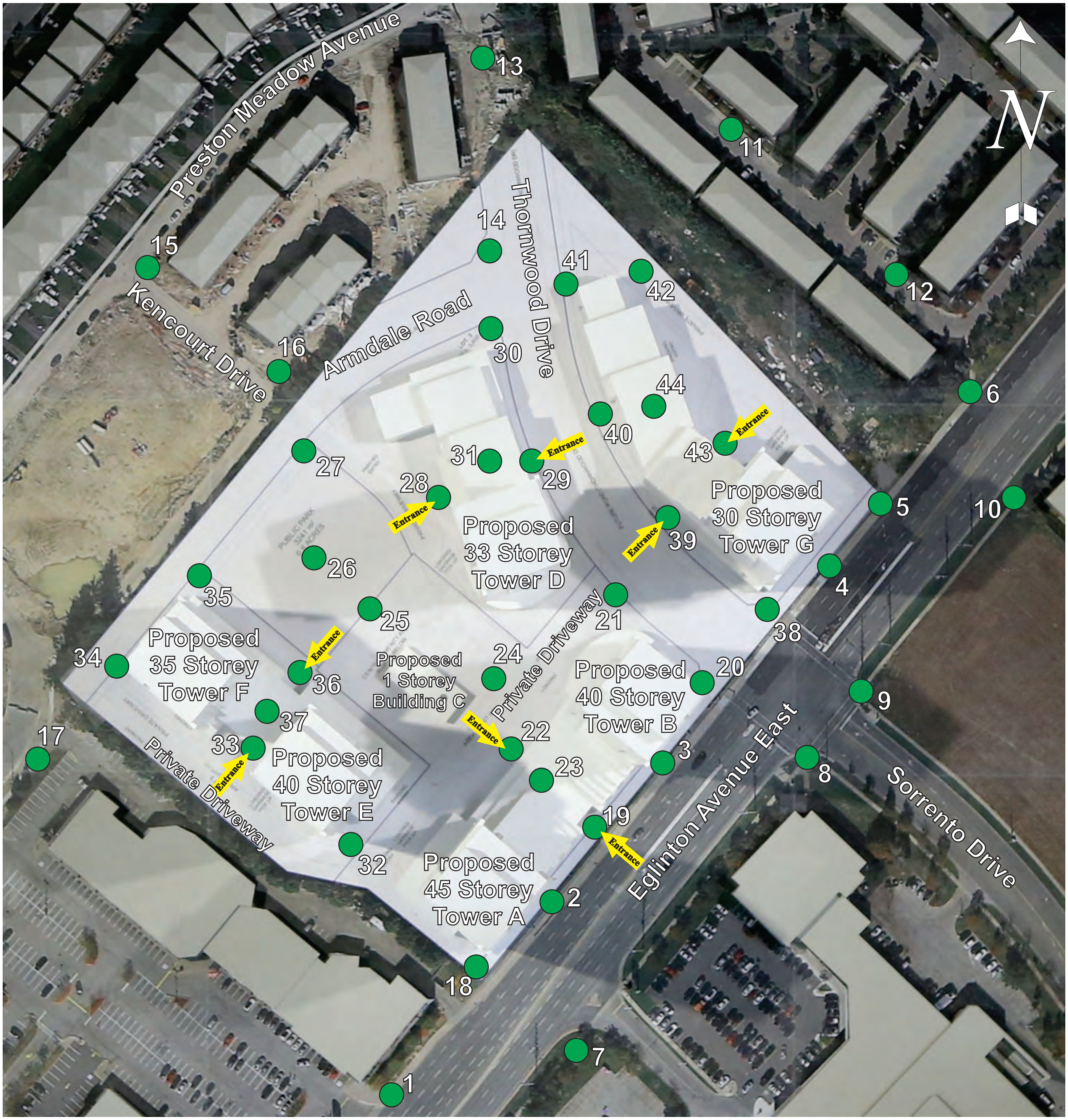


Figure 5a: Annual Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
(1980 - 2012)

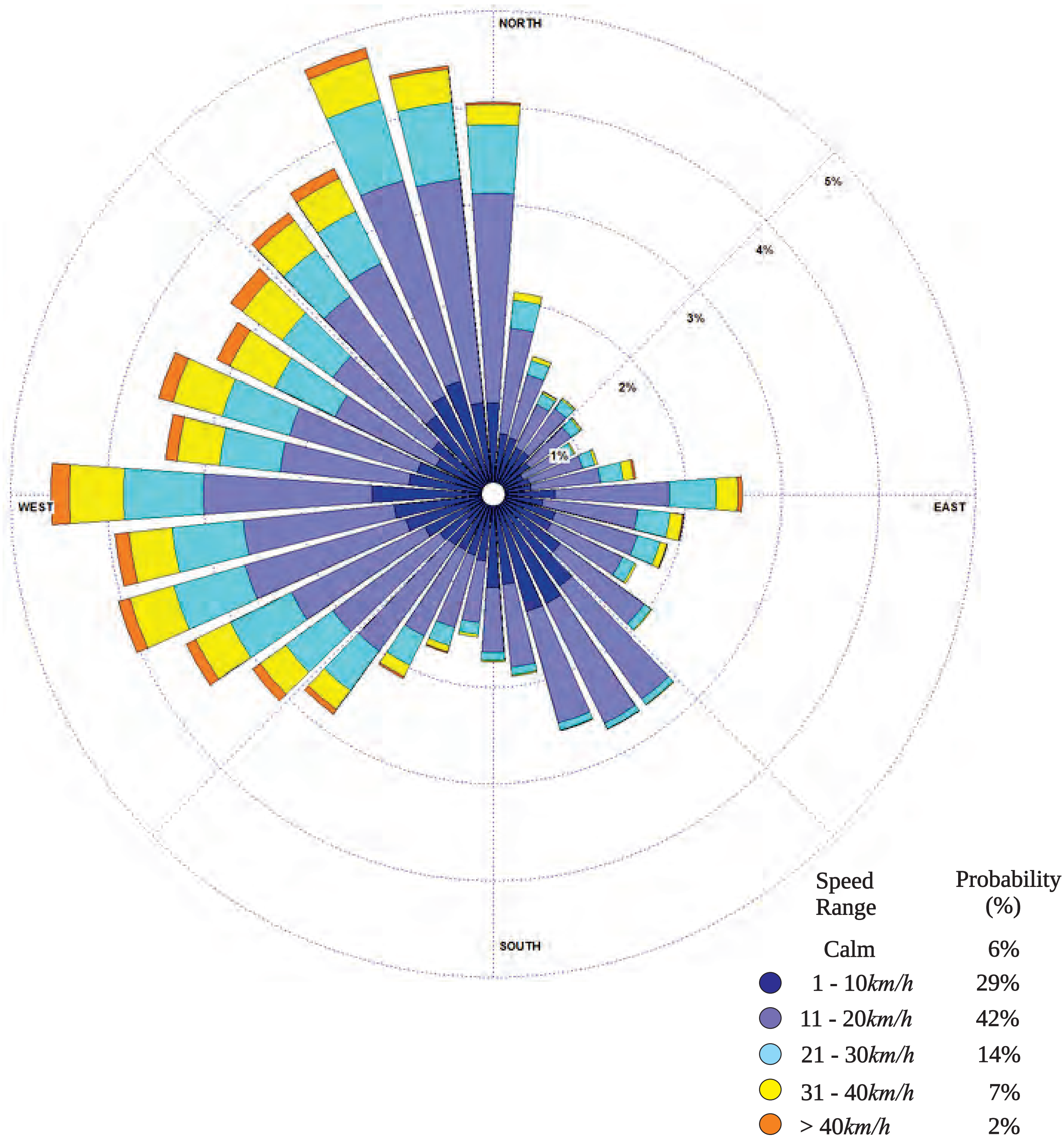
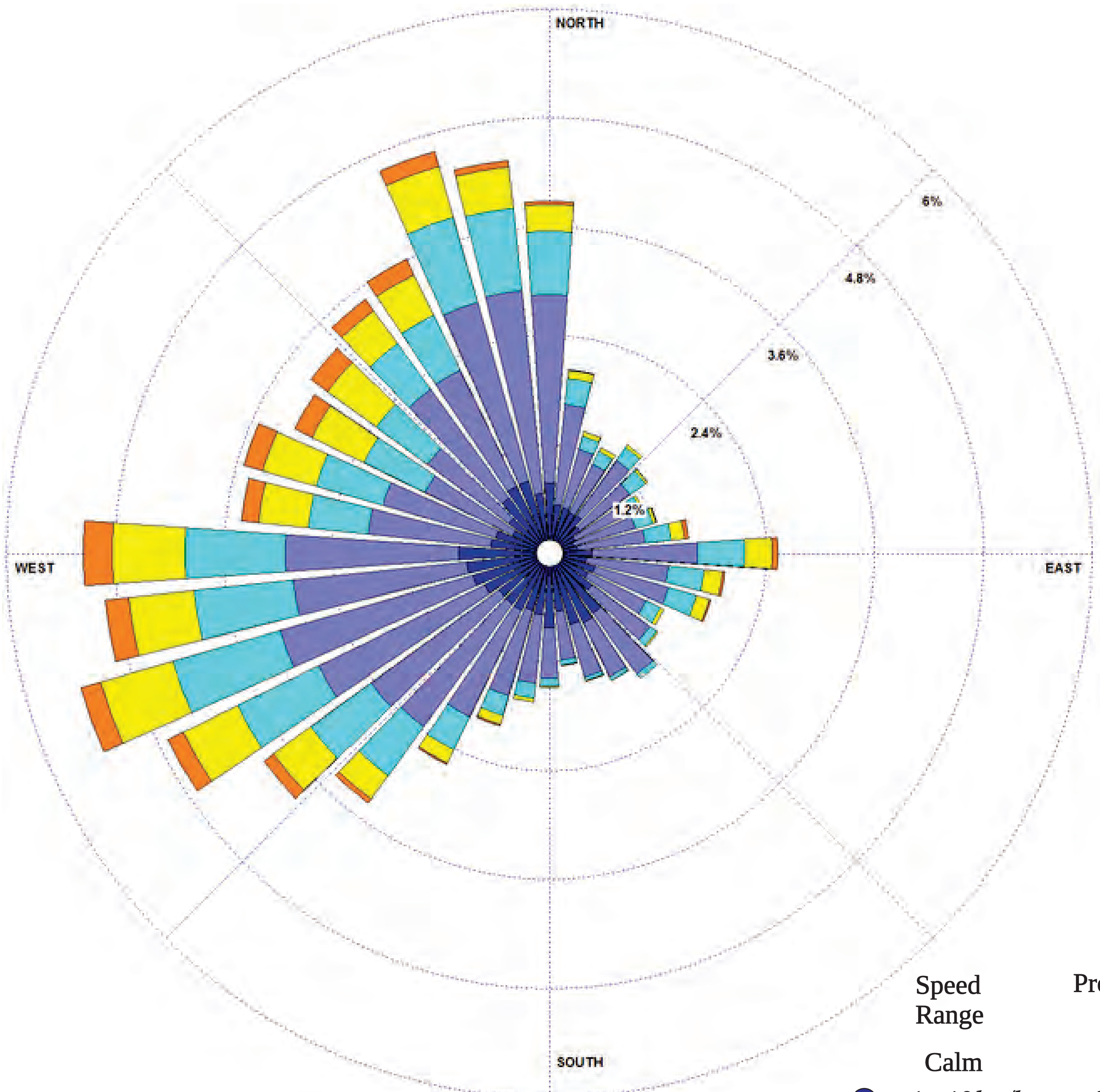


Figure 5b: Winter Wind Rose - Pearson International Airport.

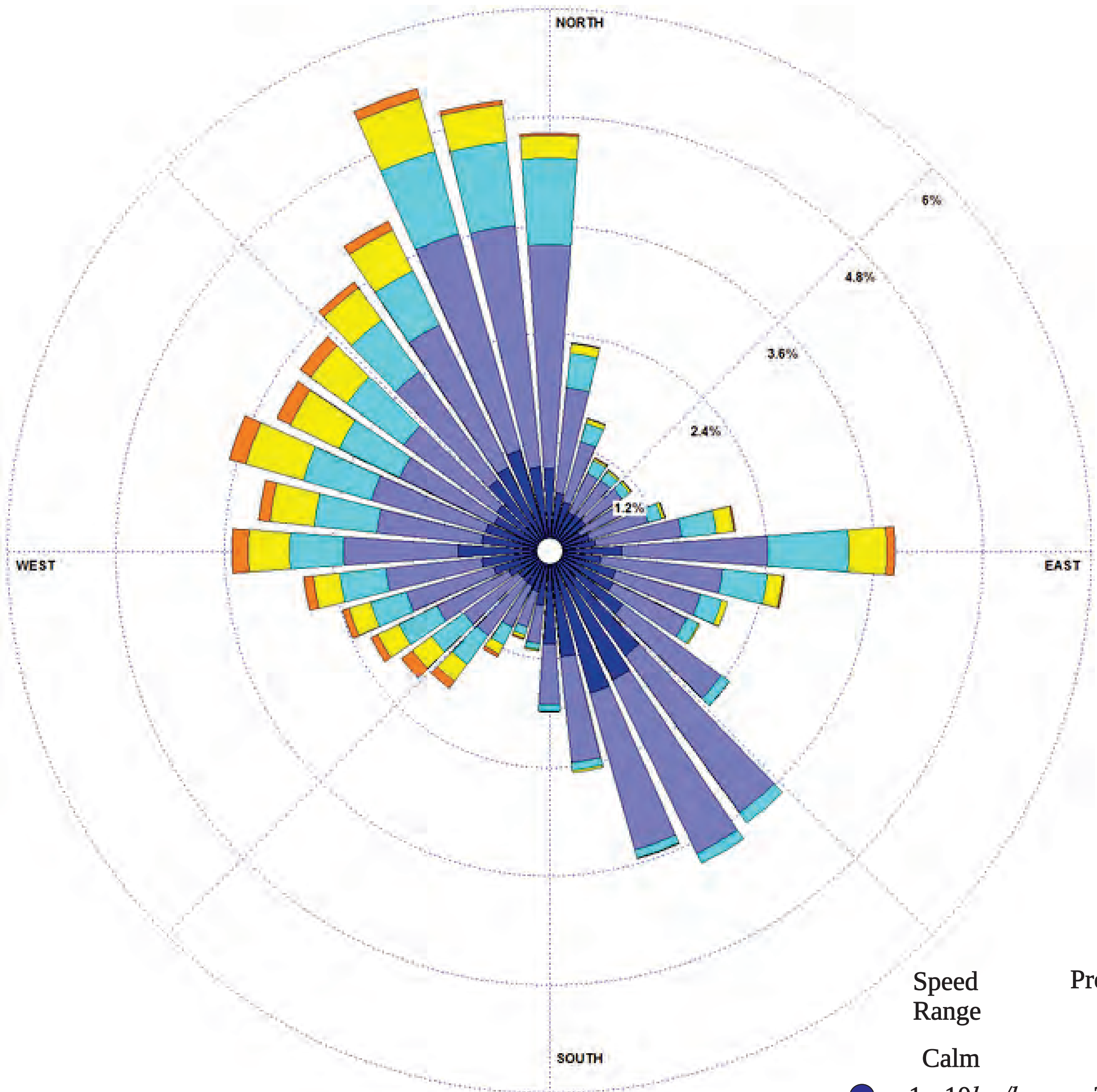
Historical Directional Distribution of Winds (@ 10*m* height)
November 16 through March 31 (1980 - 2012)



Speed Range	Probability (%)
Calm	5%
1 - 10*km/h*	23%
11 - 20*km/h*	42%
21 - 30*km/h*	17%
31 - 40*km/h*	10%
> 40*km/h*	3%

Figure 5c: Spring Wind Rose - Pearson International Airport.

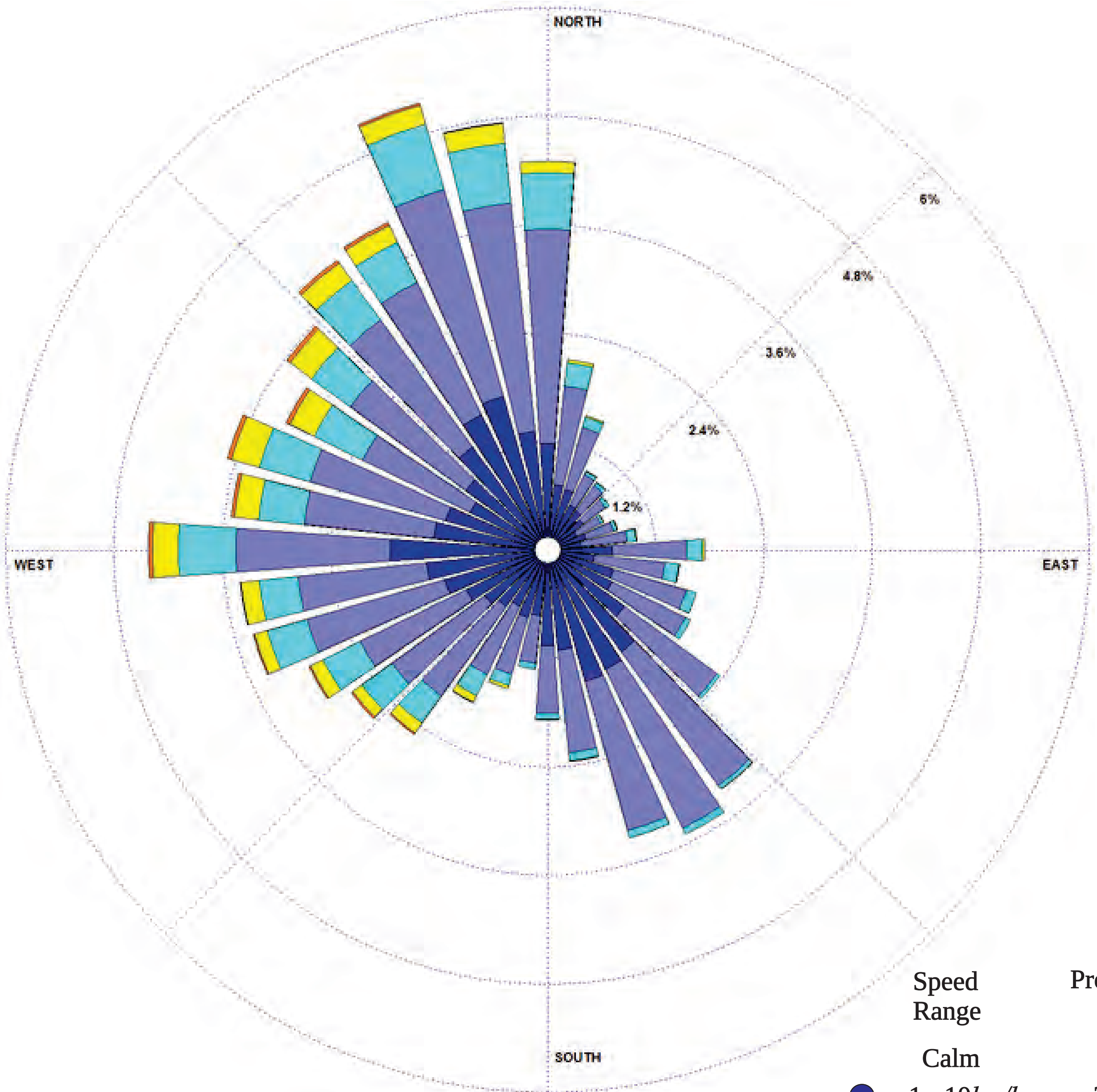
Historical Directional Distribution of Winds (@ 10*m* height)
April 1 through June 15 (1980 - 2012)



Speed Range	Probability (%)
Calm	6%
1 - 10*km/h*	28%
11 - 20*km/h*	42%
21 - 30*km/h*	14%
31 - 40*km/h*	8%
> 40*km/h*	2%

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

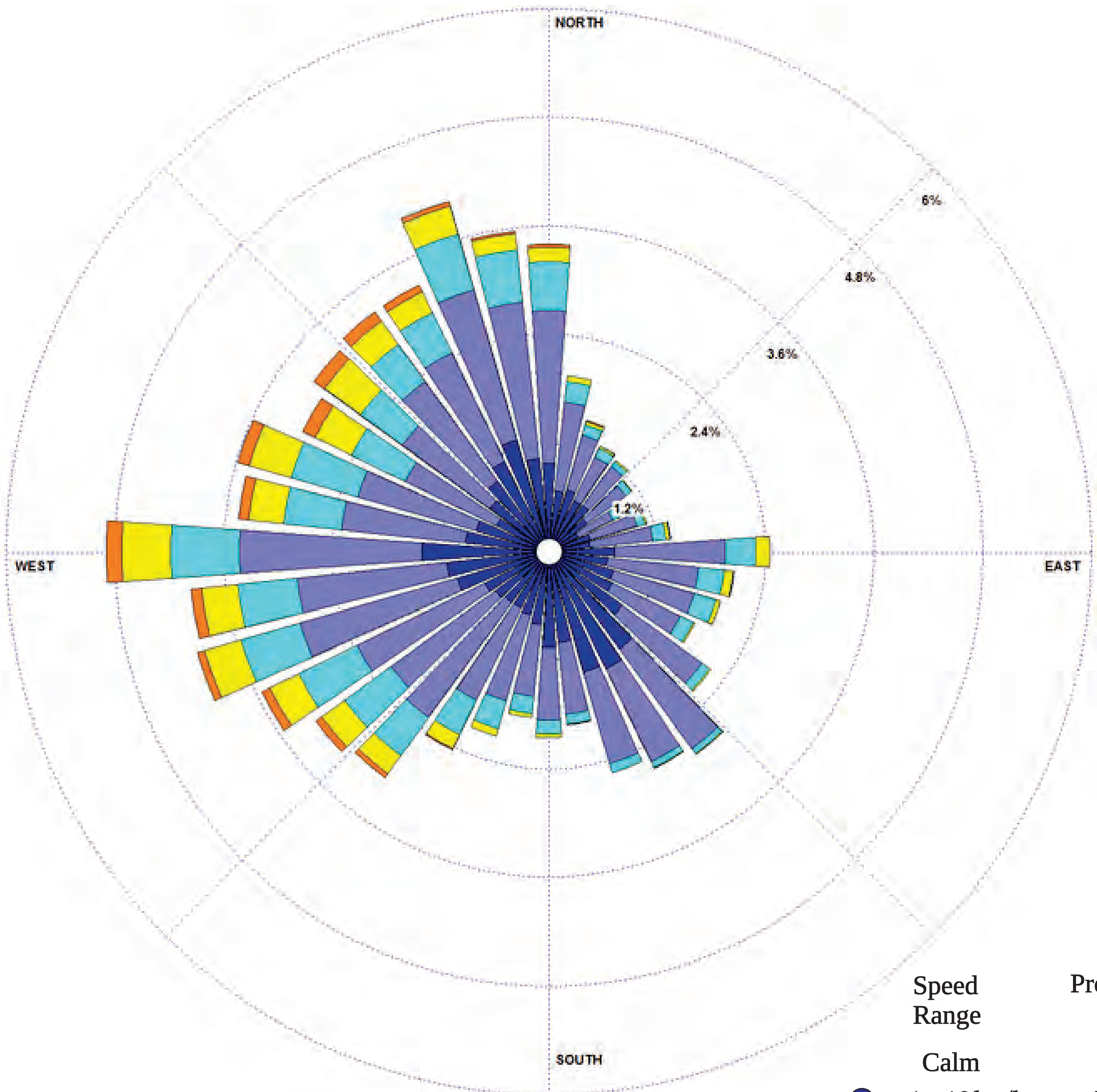
Historical Directional Distribution of Winds (@ 10*m* height)
June 16 through September 15 (1980 - 2012)



Speed Range	Probability (%)
Calm	7%
1 - 10*km/h*	36%
11 - 20*km/h*	43%
21 - 30*km/h*	10%
31 - 40*km/h*	4%
> 40*km/h*	<1%

Figure 5e: Fall Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
September 16 through November 15 (1980 - 2012)



Speed Range	Probability (%)
Calm	7%
1 - 10*km/h*	31%
11 - 20*km/h*	41%
21 - 30*km/h*	13%
31 - 40*km/h*	6%
> 40*km/h*	2%

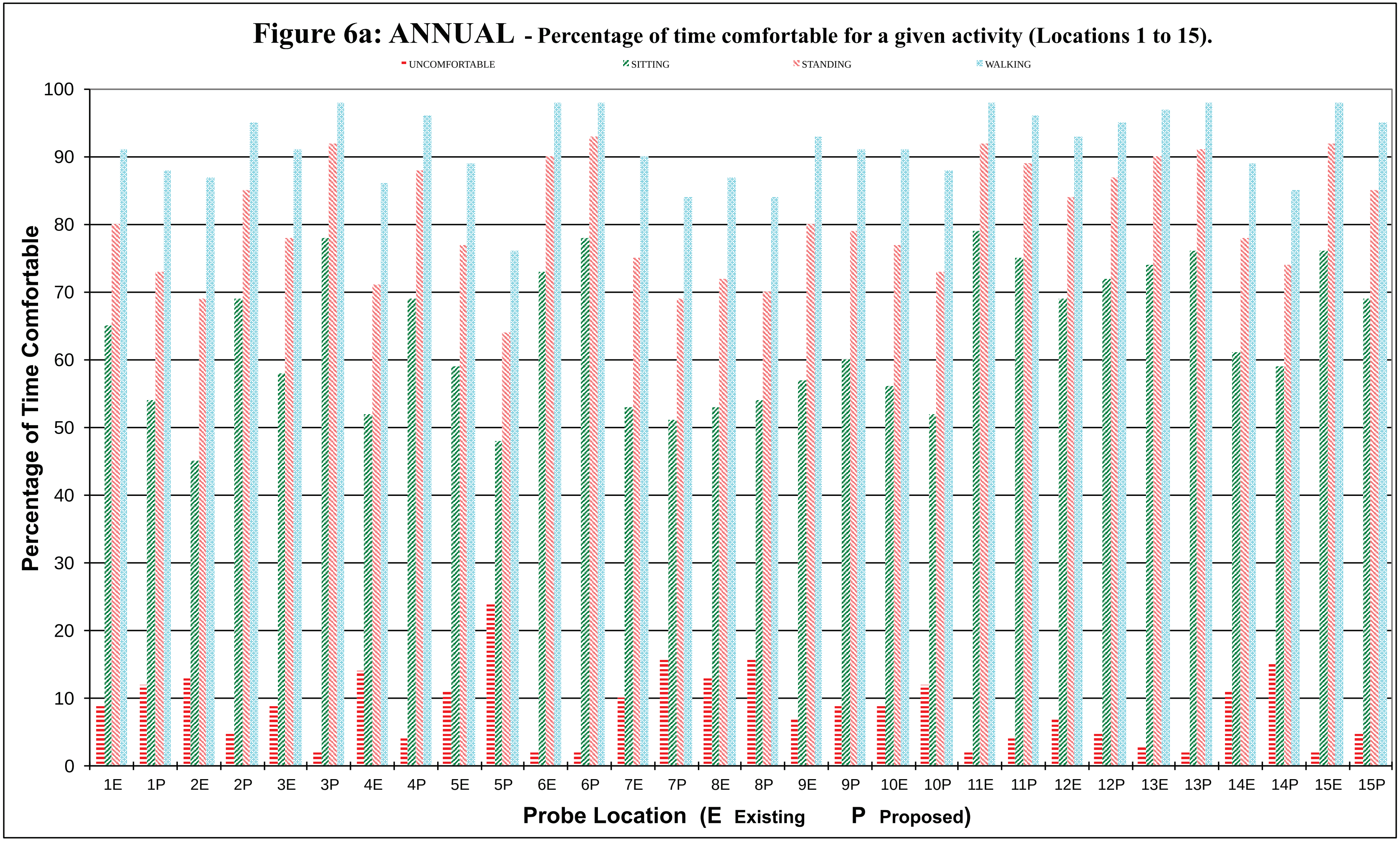


Figure 6a: ANNUAL - Percentage of time comfortable for a given activity (Locations 1 to 15).
UNCOMFORTABLE
SITTING
STANDING
WALKING
Percentage of Time Comfortable
0
10
20
30
40
50
60
70
80
90
100
1E 1P 2E 2P 3E 3P 4E 4P 5E 5P 6E 6P 7E 7P 8E 8P 9E 9P 10E 10P 11E 11P 12E 12P 13E 13P 14E 14P 15E 15P
Probe Location (E Existing P Proposed)

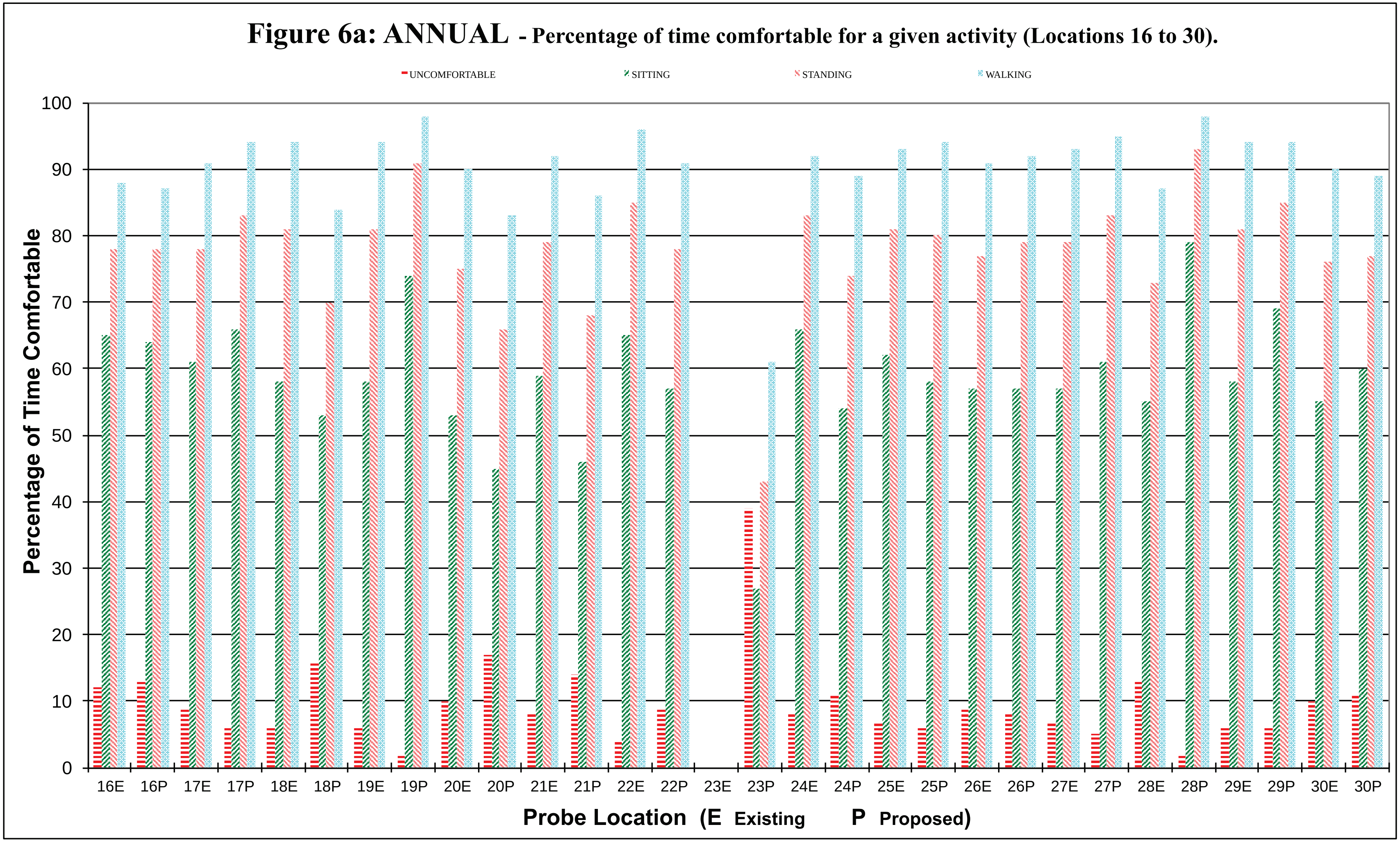
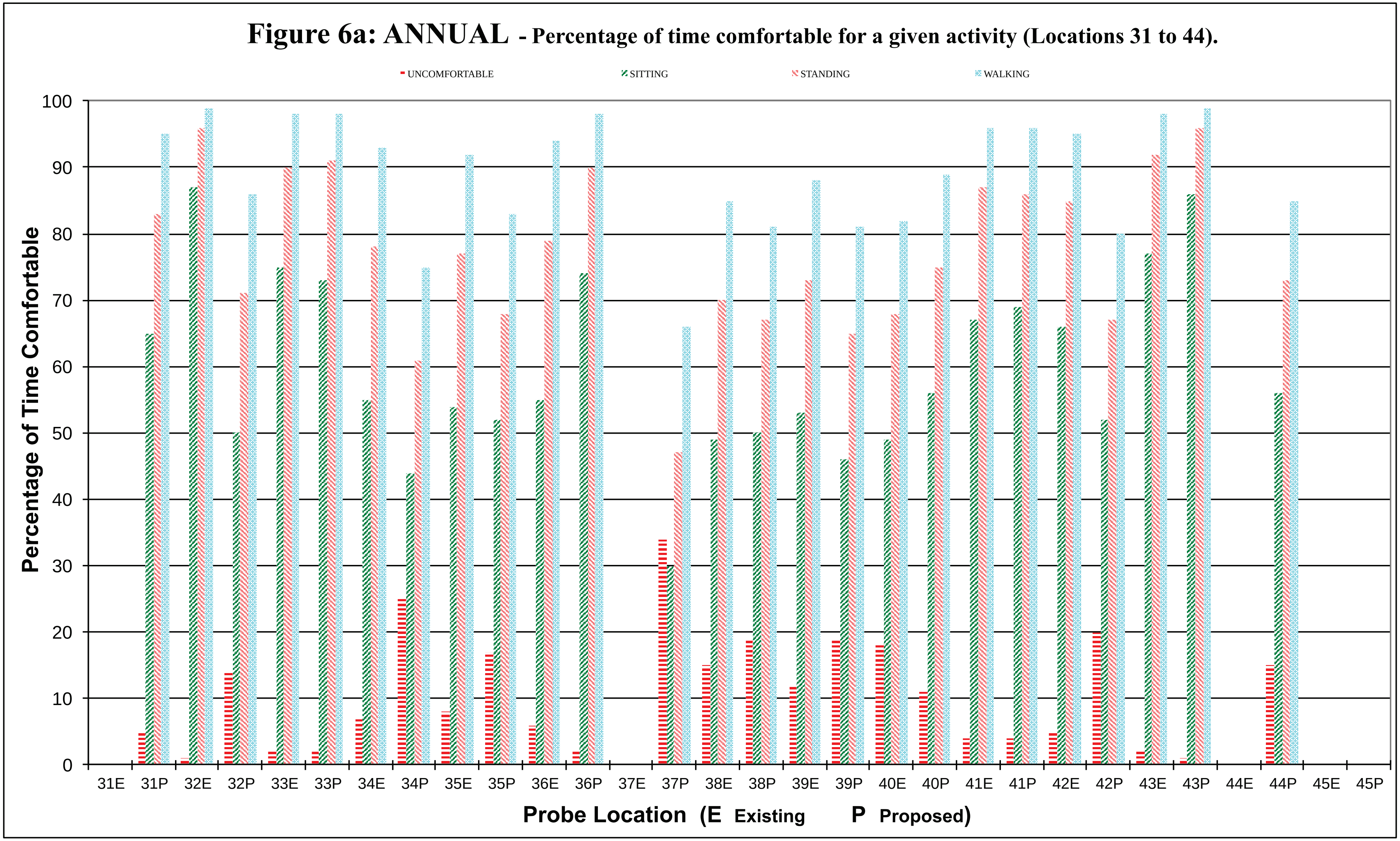


Figure 6a: ANNUAL - Percentage of time comfortable for a given activity (Locations 16 to 30).
UNCOMFORTABLE
SITTING
STANDING
WALKING
Percentage of Time Comfortable
0
10
20
30
40
50
60
70
80
90
100
16E
16P
17E
17P
18E
18P
19E
19P
20E
20P
21E
21P
22E
22P
23E
23P
24E
24P
25E
25P
26E
26P
27E
27P
28E
28P
29E
29P
30E
30P
Probe Location (E Existing P Proposed)



Theakston Environmental

Figure 6b: WINTER - Percentage of time comfortable for a given activity (Locations 1 to 15).

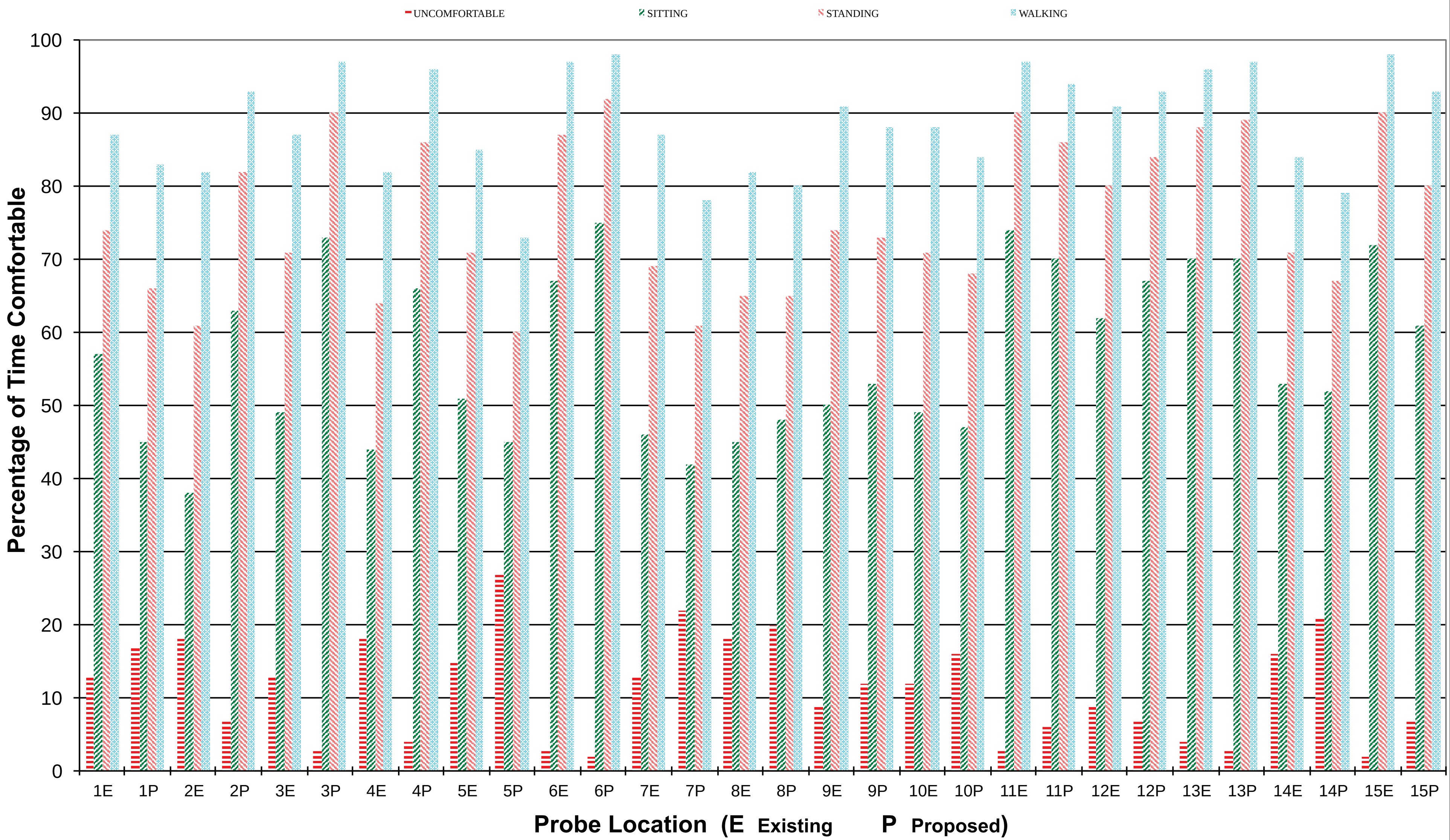
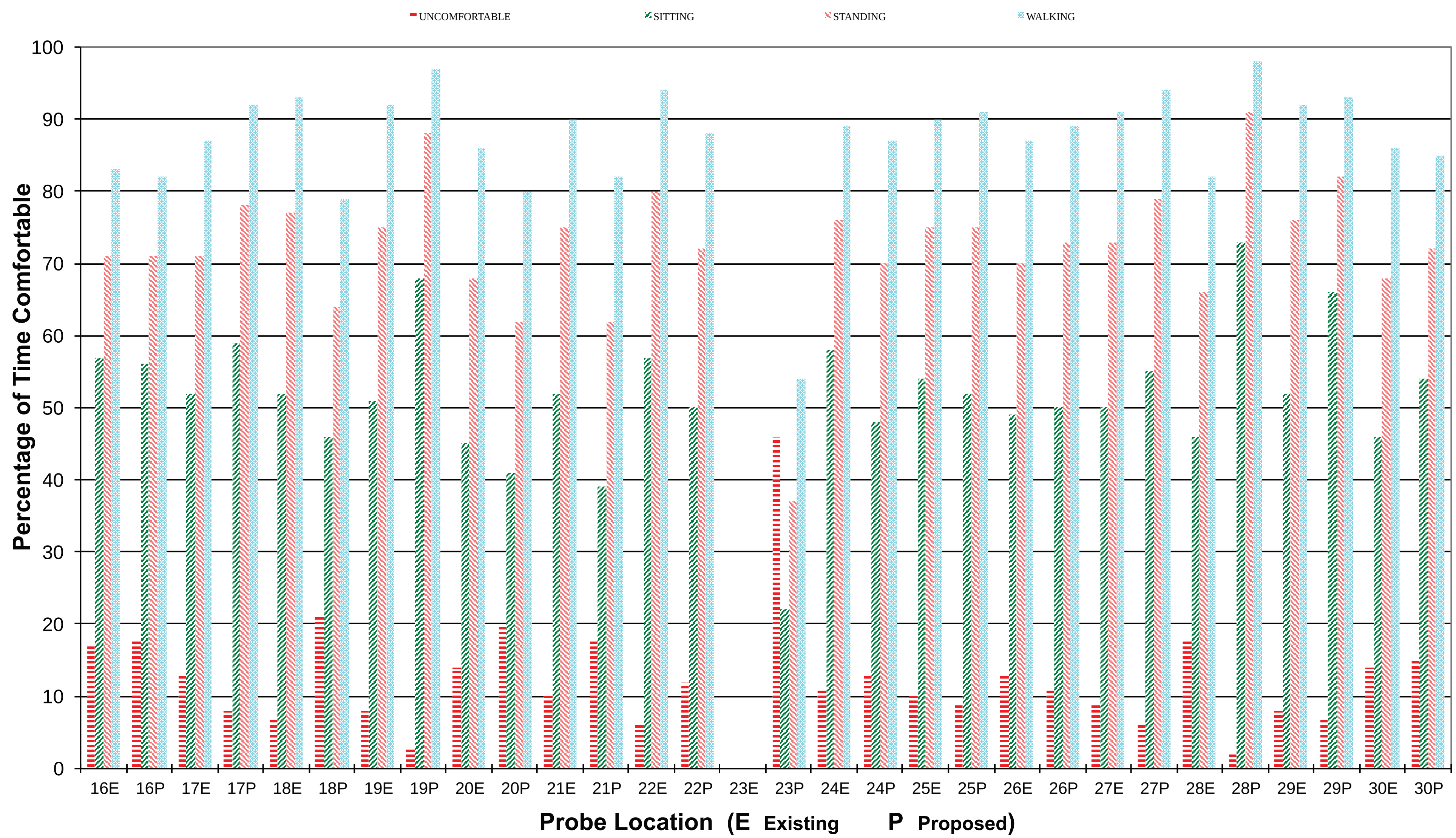
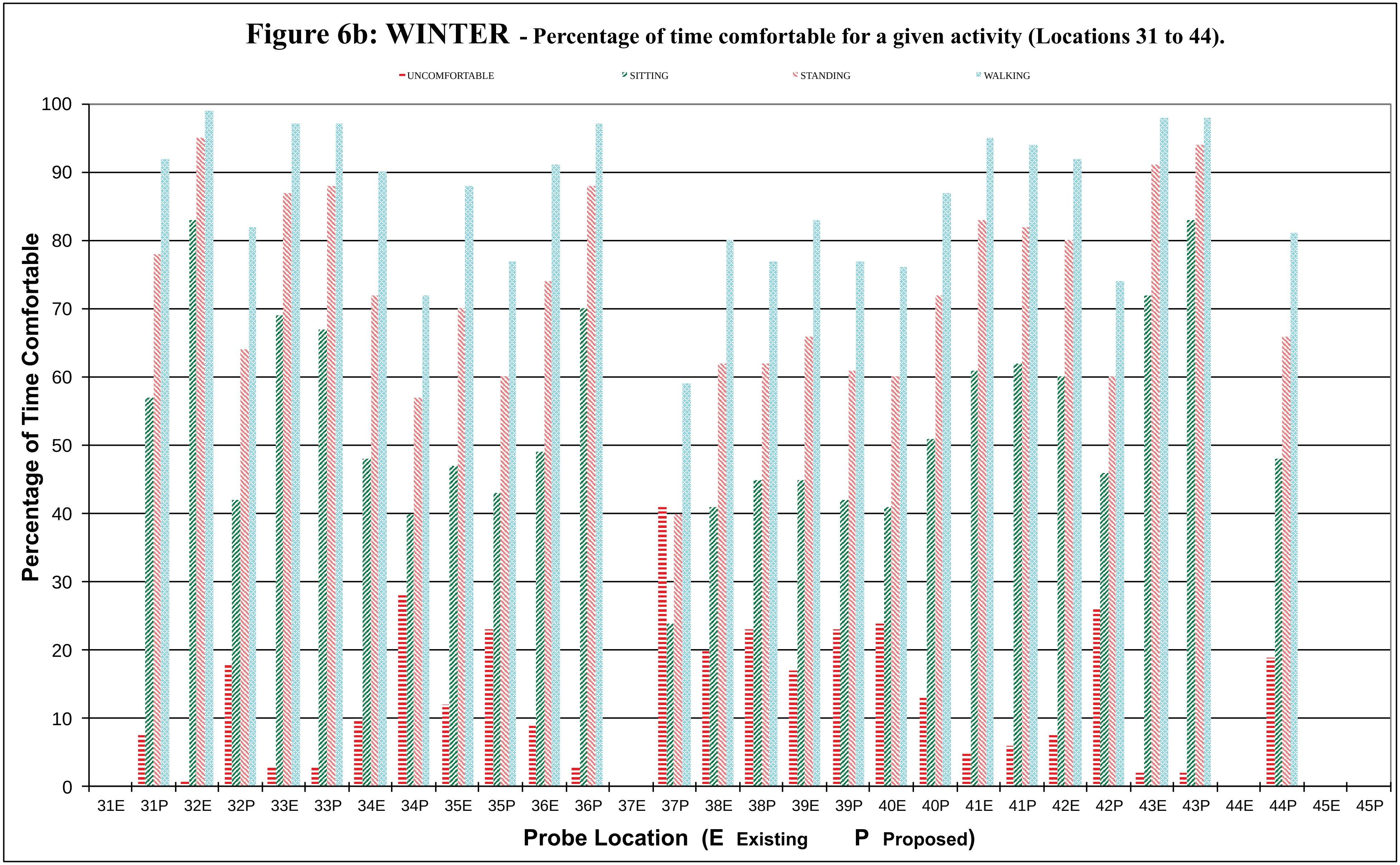


Figure 6b: WINTER - Percentage of time comfortable for a given activity (Locations 16 to 30).





Theakston Environmental

Figure 6c: SPRING - Percentage of time comfortable for a given activity (Locations 1 to 15).

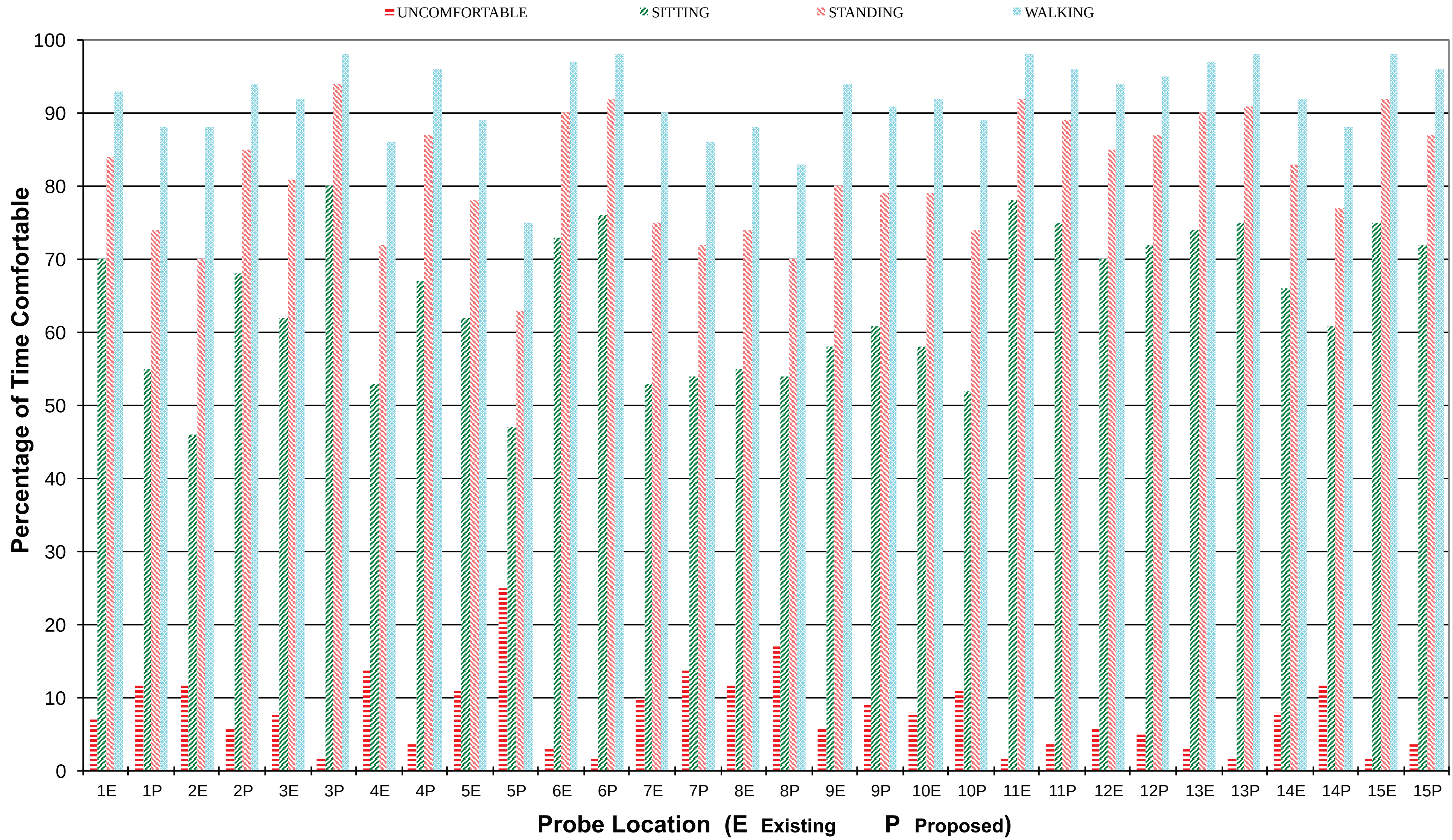
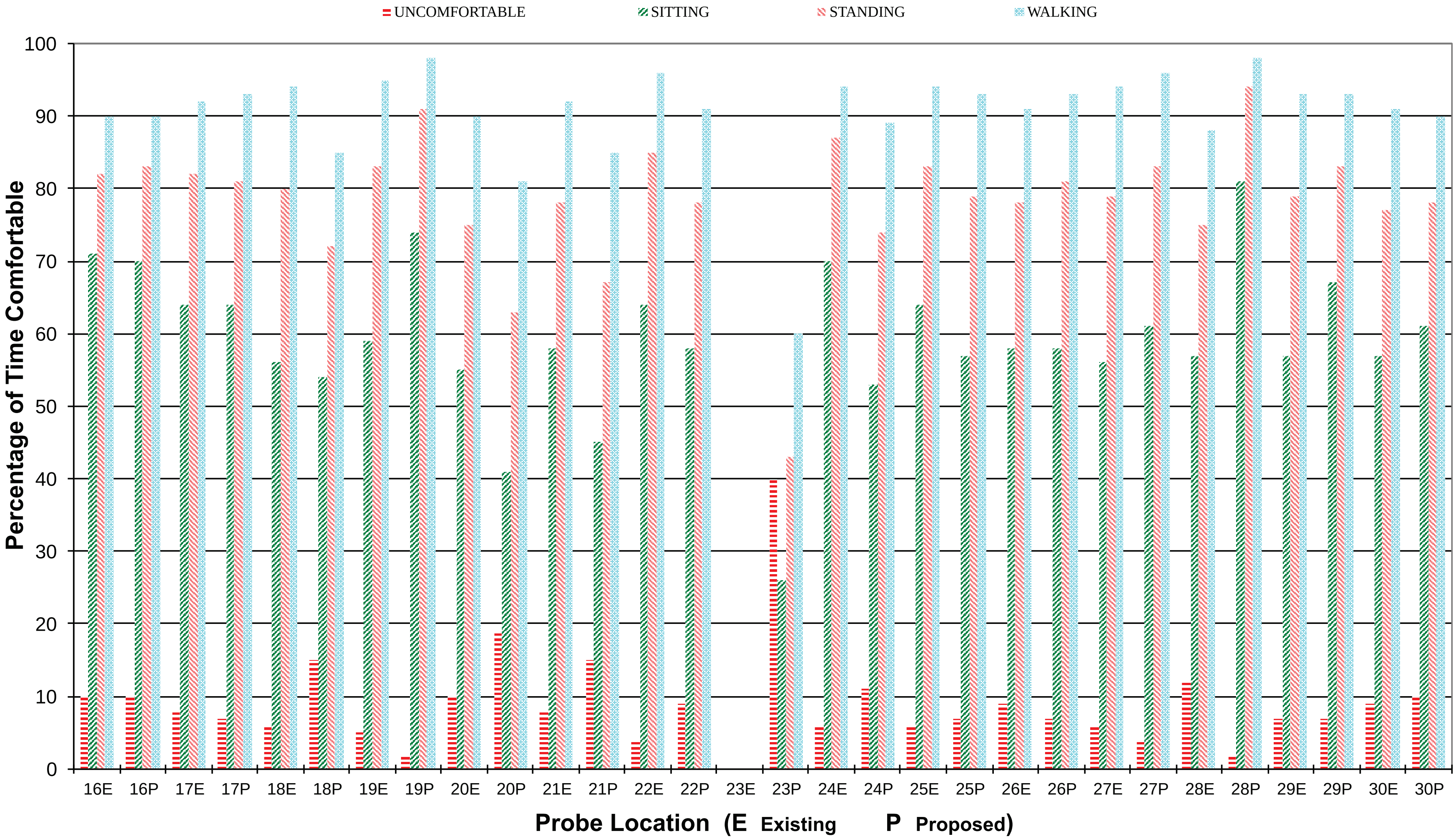
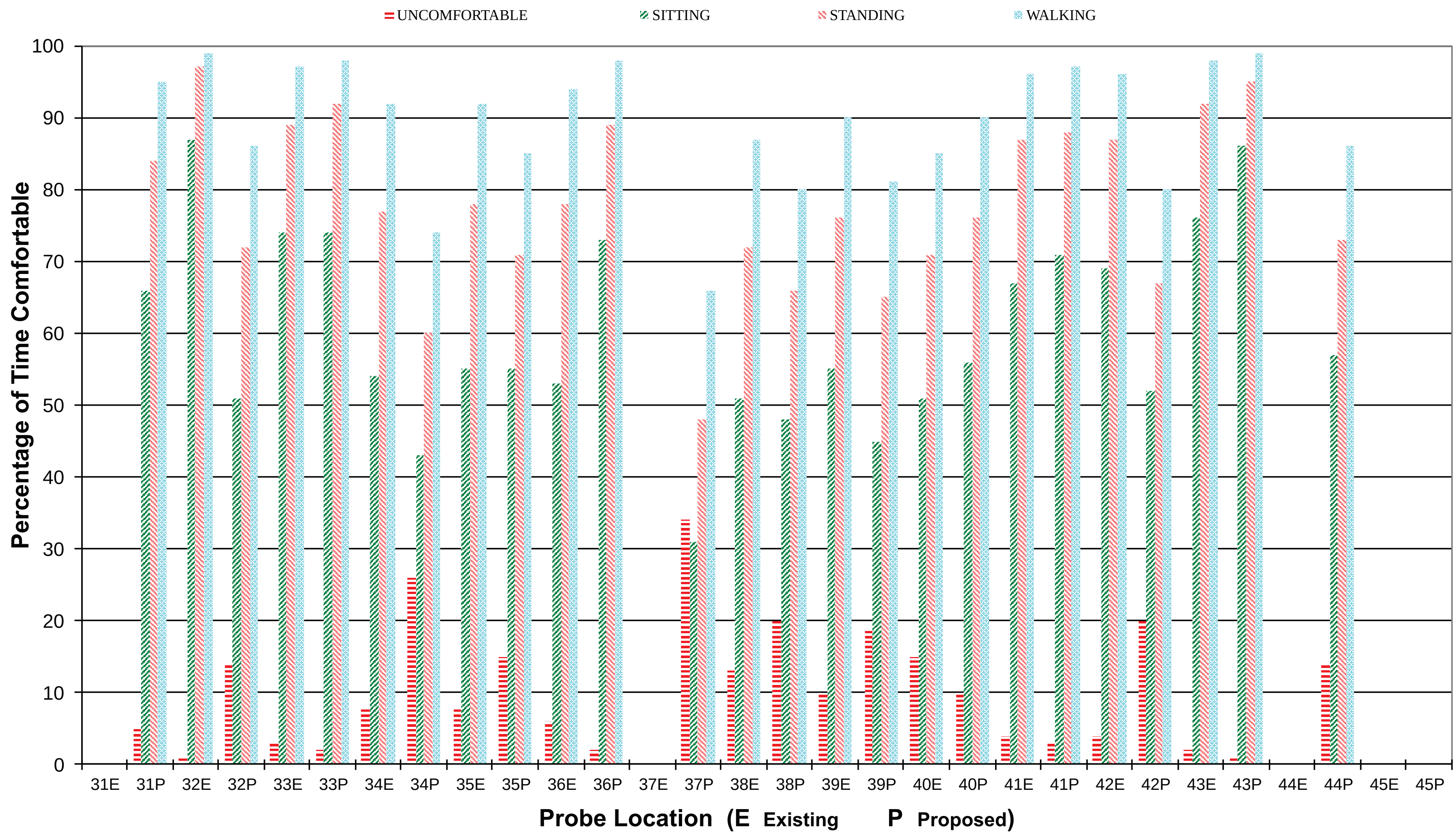


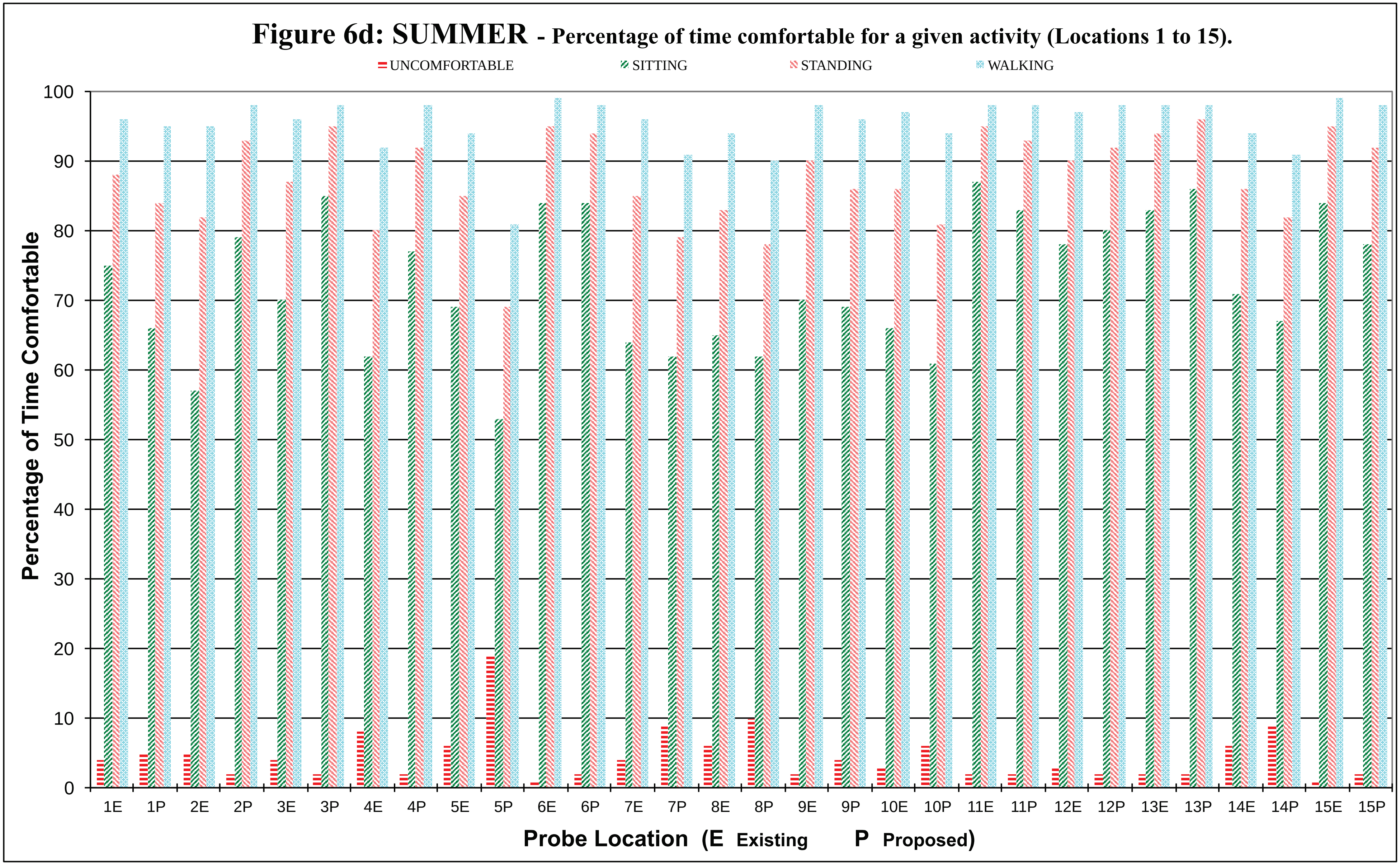
Figure 6c: SPRING - Percentage of time comfortable for a given activity (Locations 16 to 30).



Theakston Environmental

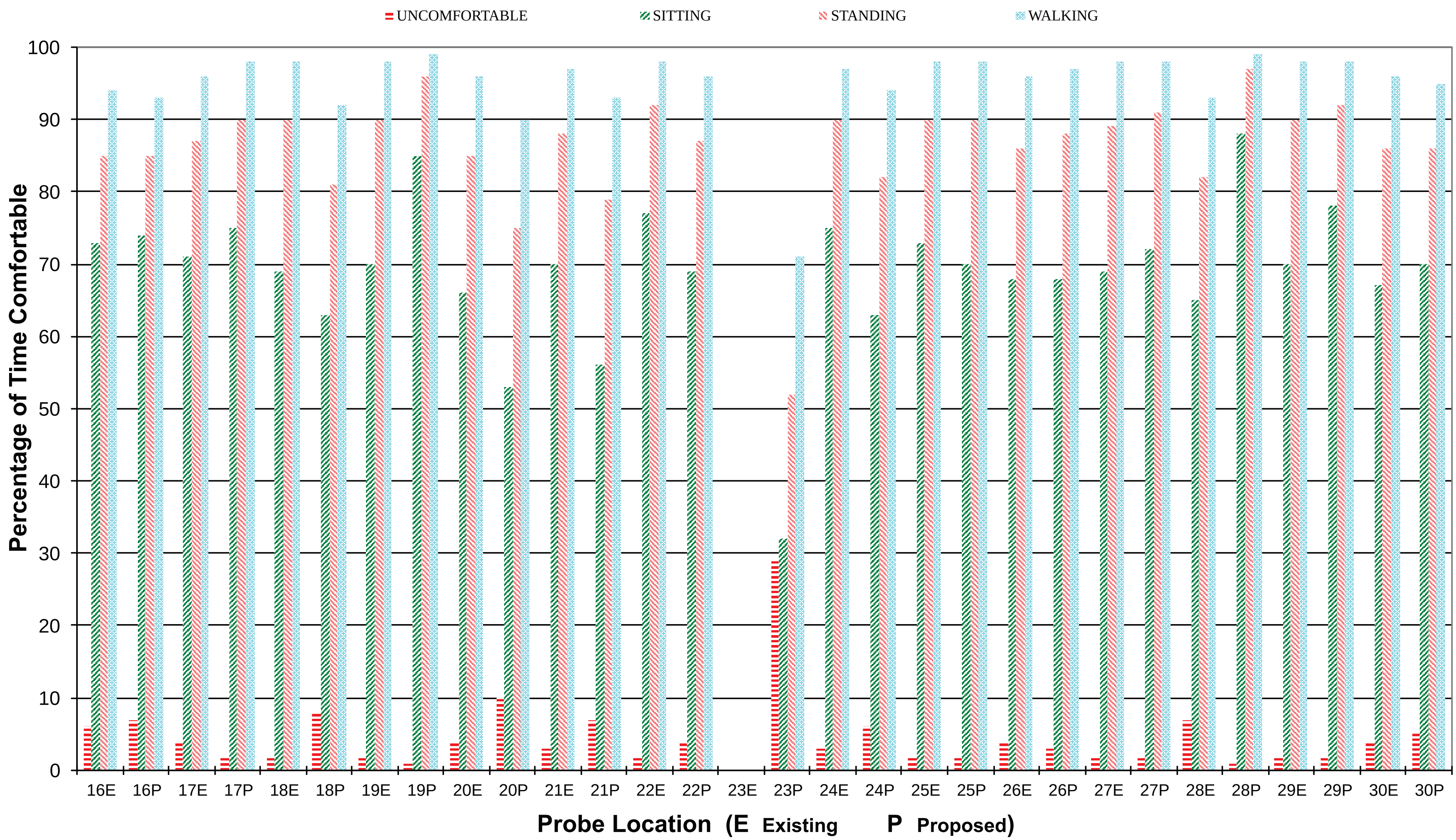
Figure 6c: SPRING - Percentage of time comfortable for a given activity (Locations 31 to 44).





Theakston
Environmental

Figure 6d: SUMMER - Percentage of time comfortable for a given activity (Locations 16 to 30).



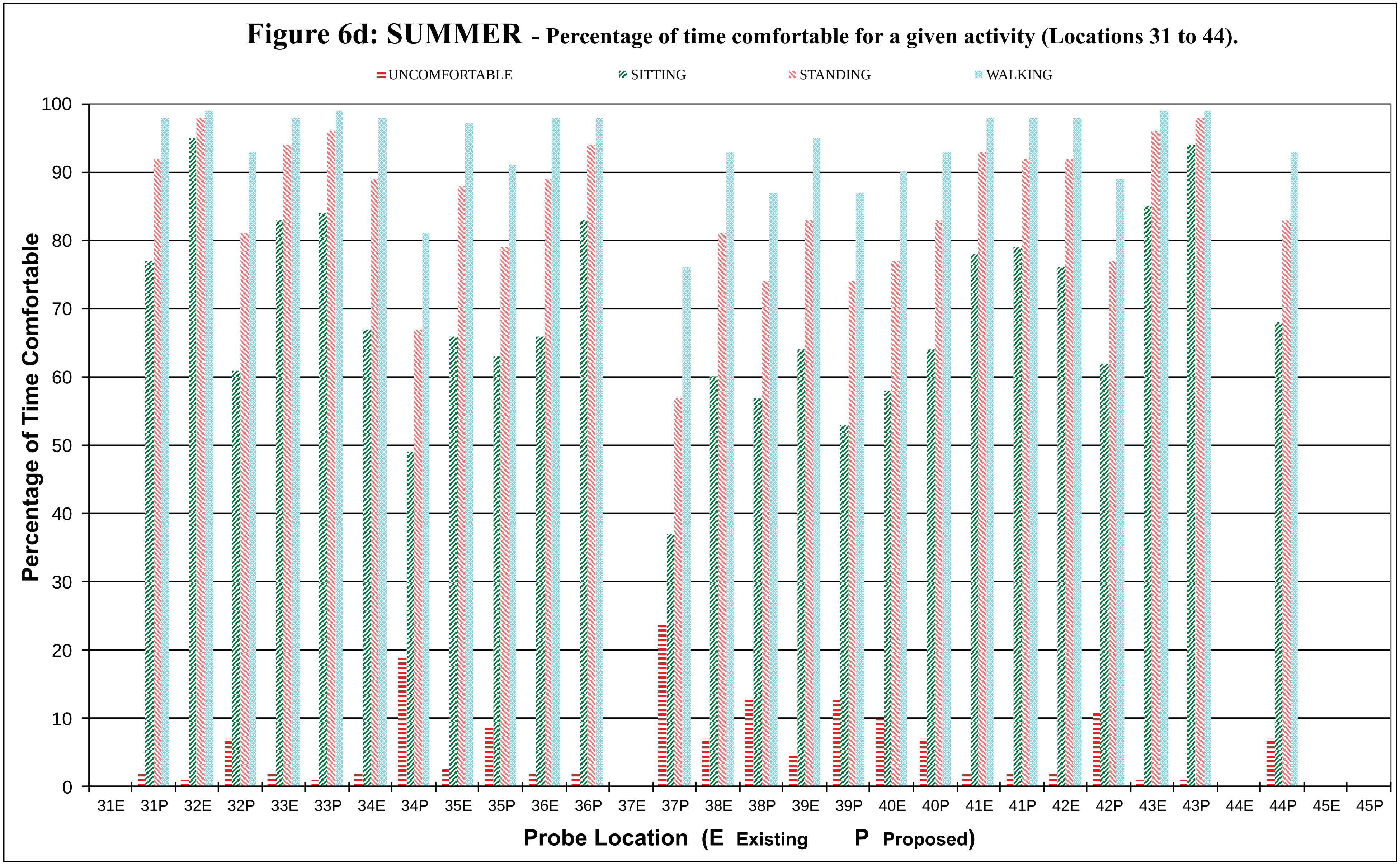


Figure 6d: SUMMER - Percentage of time comfortable for a given activity (Locations 31 to 44).
UNCOMFORTABLE
SITTING
STANDING
WALKING
Percentage of Time Comfortable
0
10
20
30
40
50
60
70
80
90
100
31E 31P 32E 32P 33E 33P 34E 34P 35E 35P 36E 36P 37E 37P 38E 38P 39E 39P 40E 40P 41E 41P 42E 42P 43E 43P 44E 44P 45E 45P
Probe Location (E Existing P Proposed)

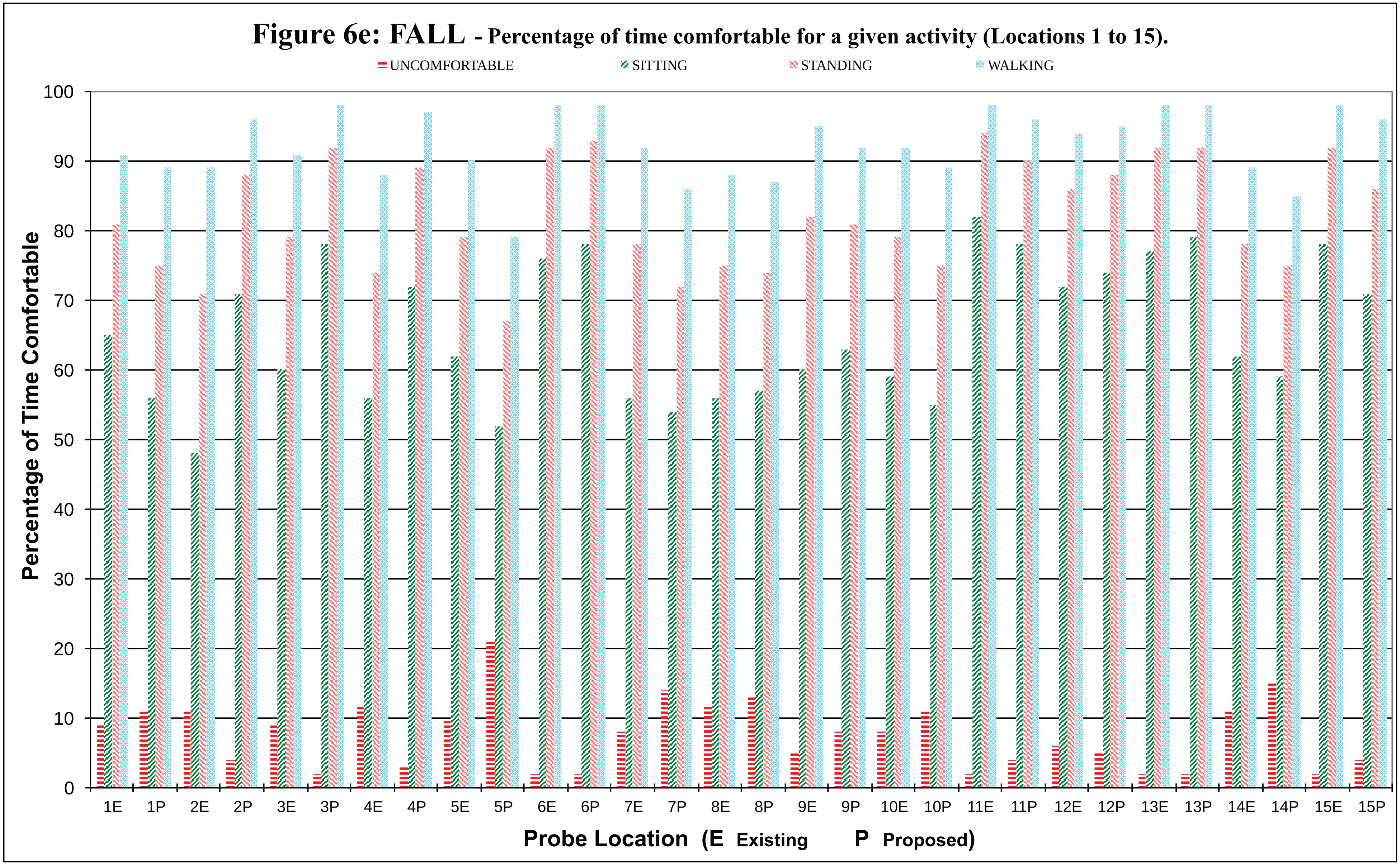
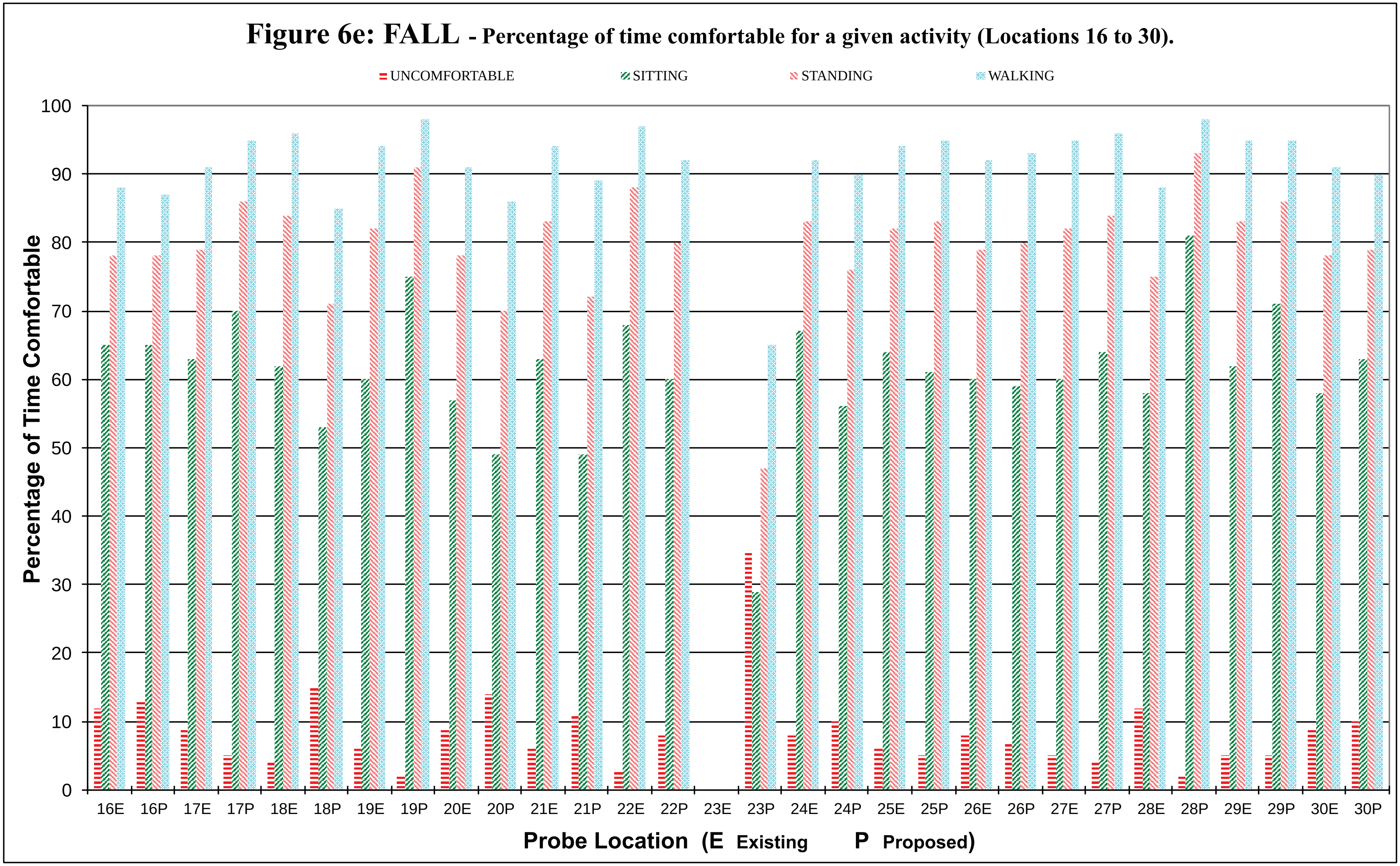


Figure 6e: FALL - Percentage of time comfortable for a given activity (Locations 1 to 15).
UNCOMFORTABLE
SITTING
STANDING
WALKING
Percentage of Time Comfortable
0
10
20
30
40
50
60
70
80
90
100
1E
1P
2E
2P
3E
3P
4E
4P
5E
5P
6E
6P
7E
7P
8E
8P
9E
9P
10E
10P
11E
11P
12E
12P
13E
13P
14E
14P
15E
15P
Probe Location (E Existing P Proposed)



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Environmental

Figure 6e: FALL - Percentage of time comfortable for a given activity (Locations 31 to 44).

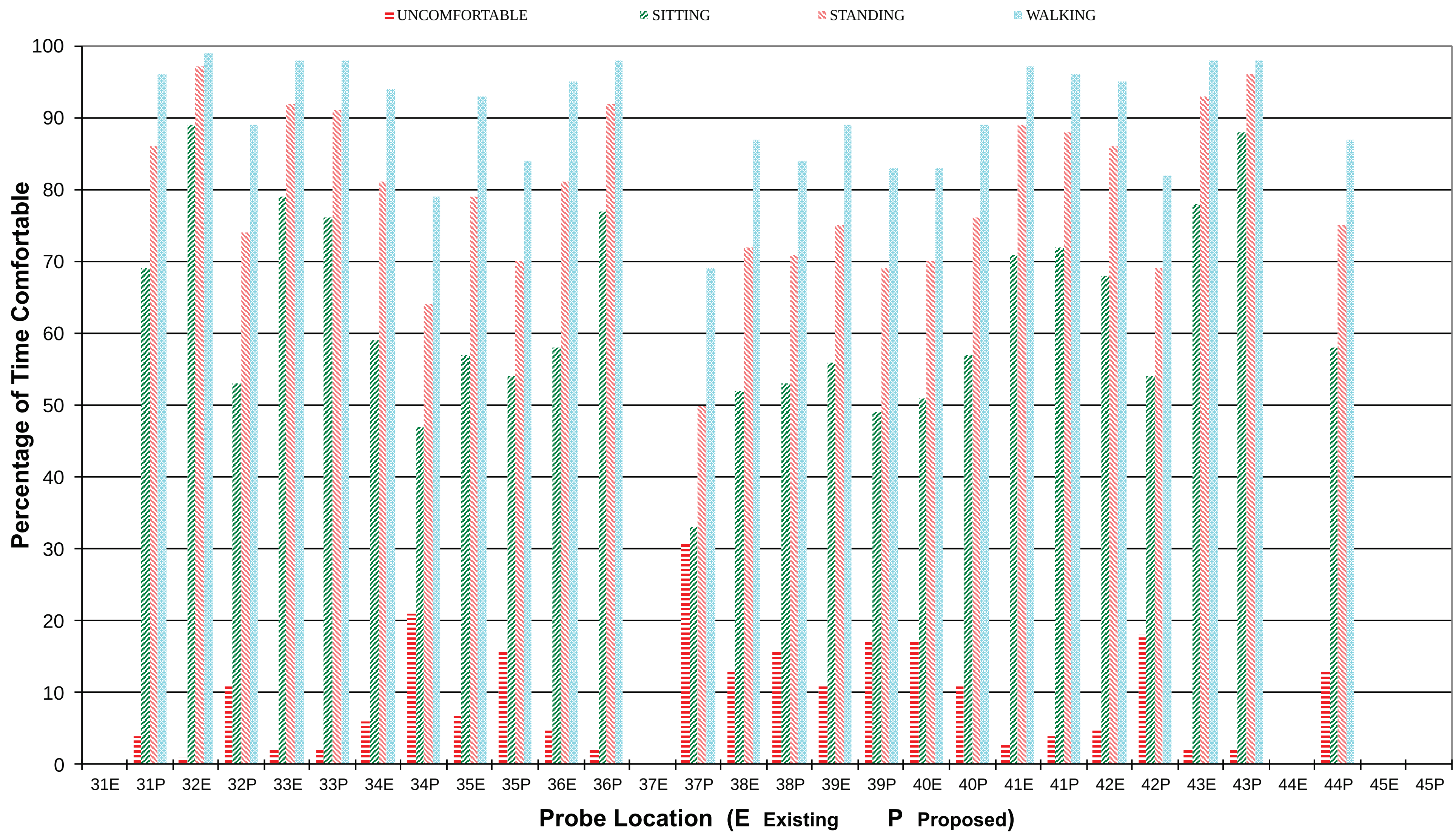
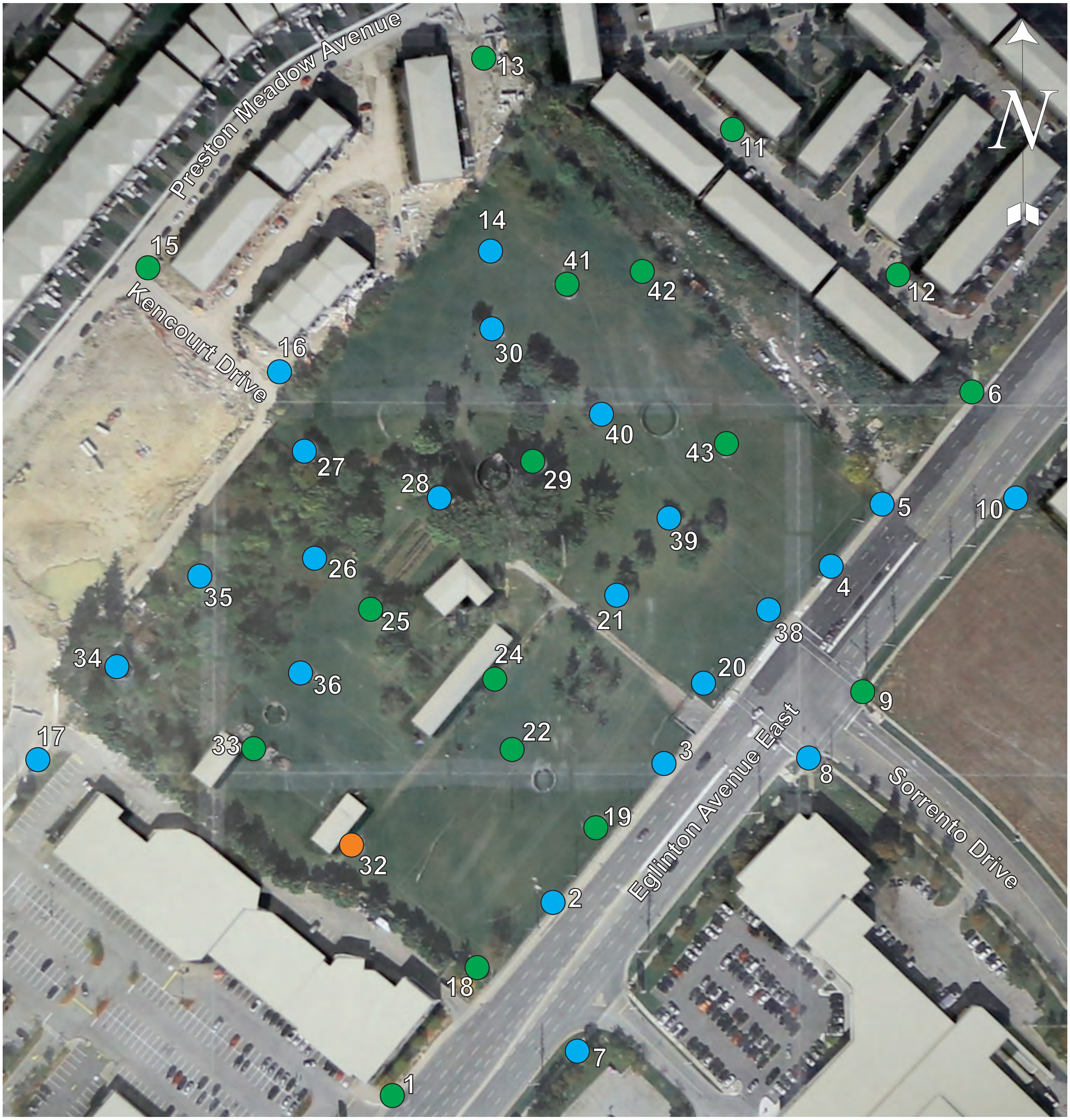


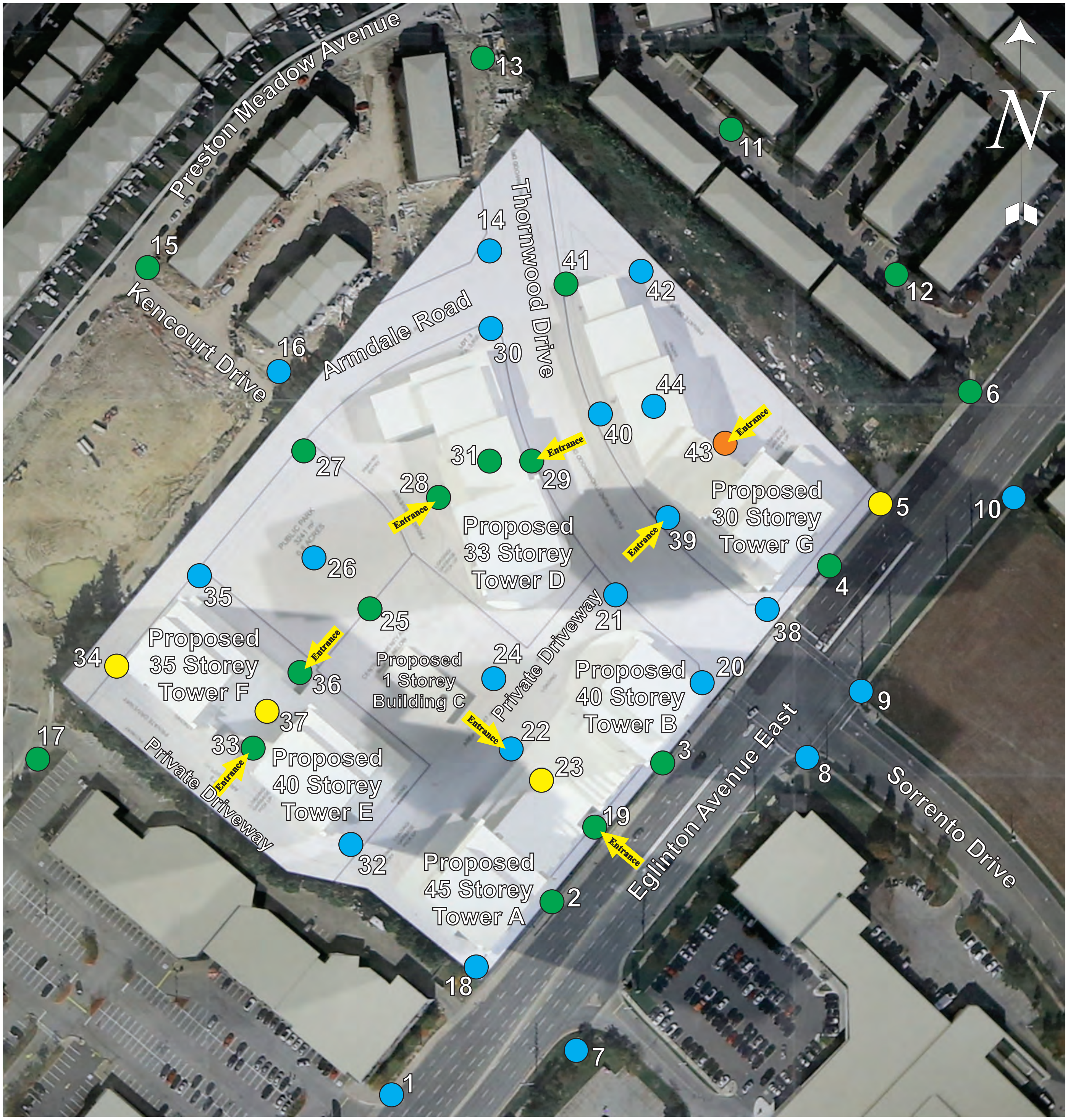
Figure 7a: Pedestrian level wind velocity comfort categories.



Comfort Categories - Annual - Existing

Sitting · Standing · Walking · Uncomfortable

Figure 7b: Pedestrian level wind velocity comfort categories.



Comfort Categories - Annual - Proposed

Sitting Standing Walking Uncomfortable

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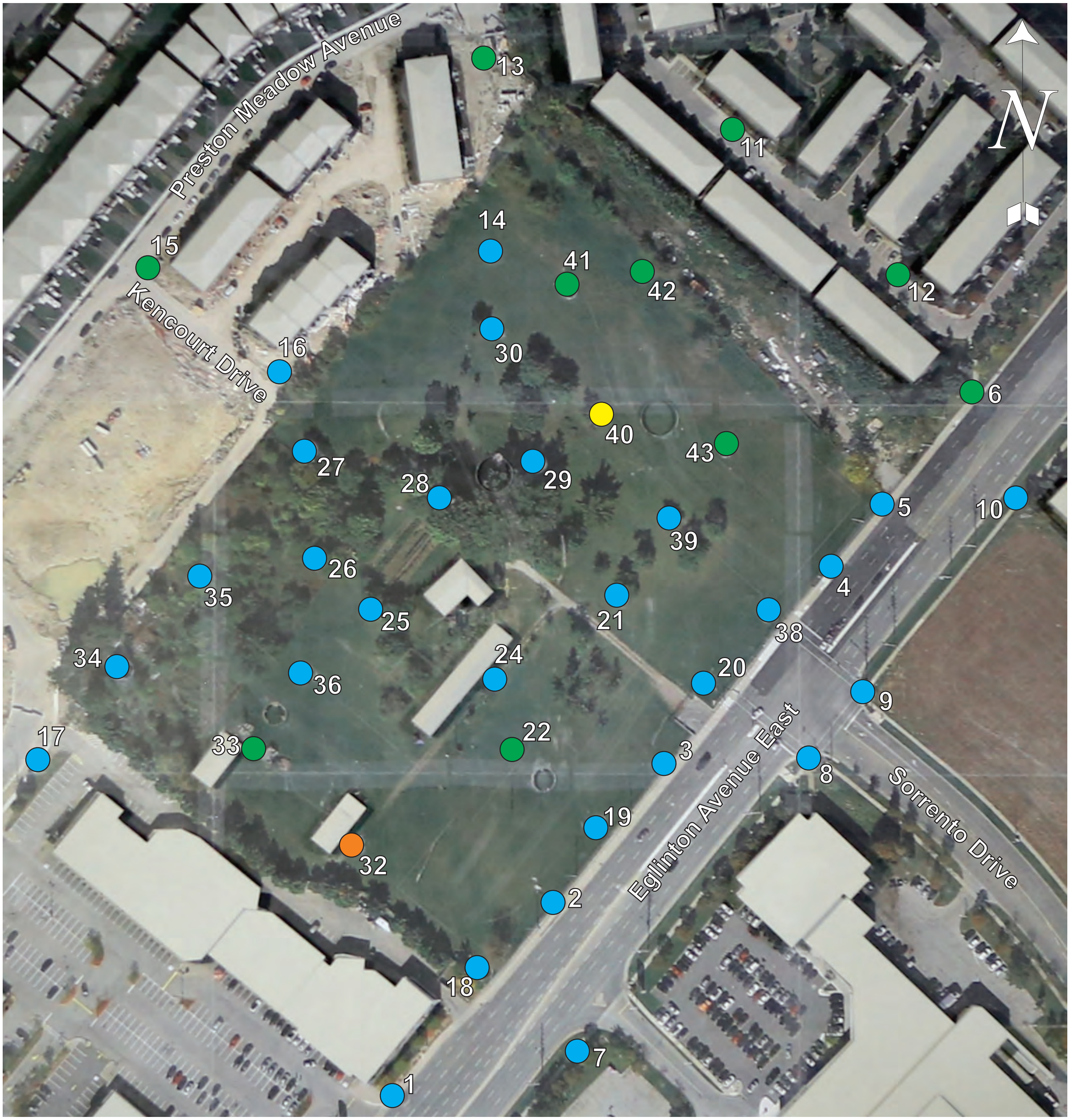
Environmental

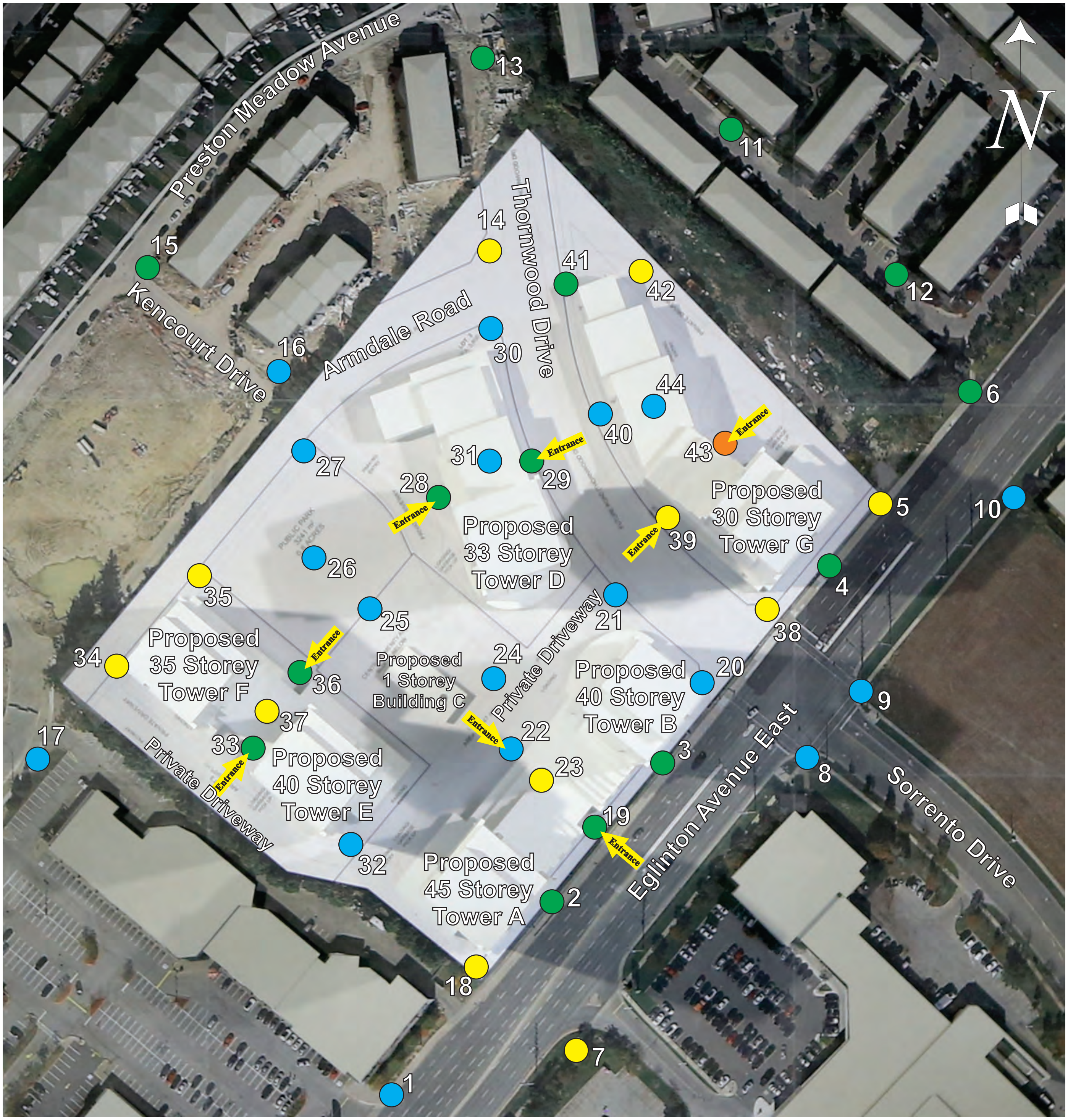
Figure 7c: Pedestrian level wind velocity comfort categories.



Comfort Categories - Winter - Existing

Sitting Standing Walking Uncomfortable

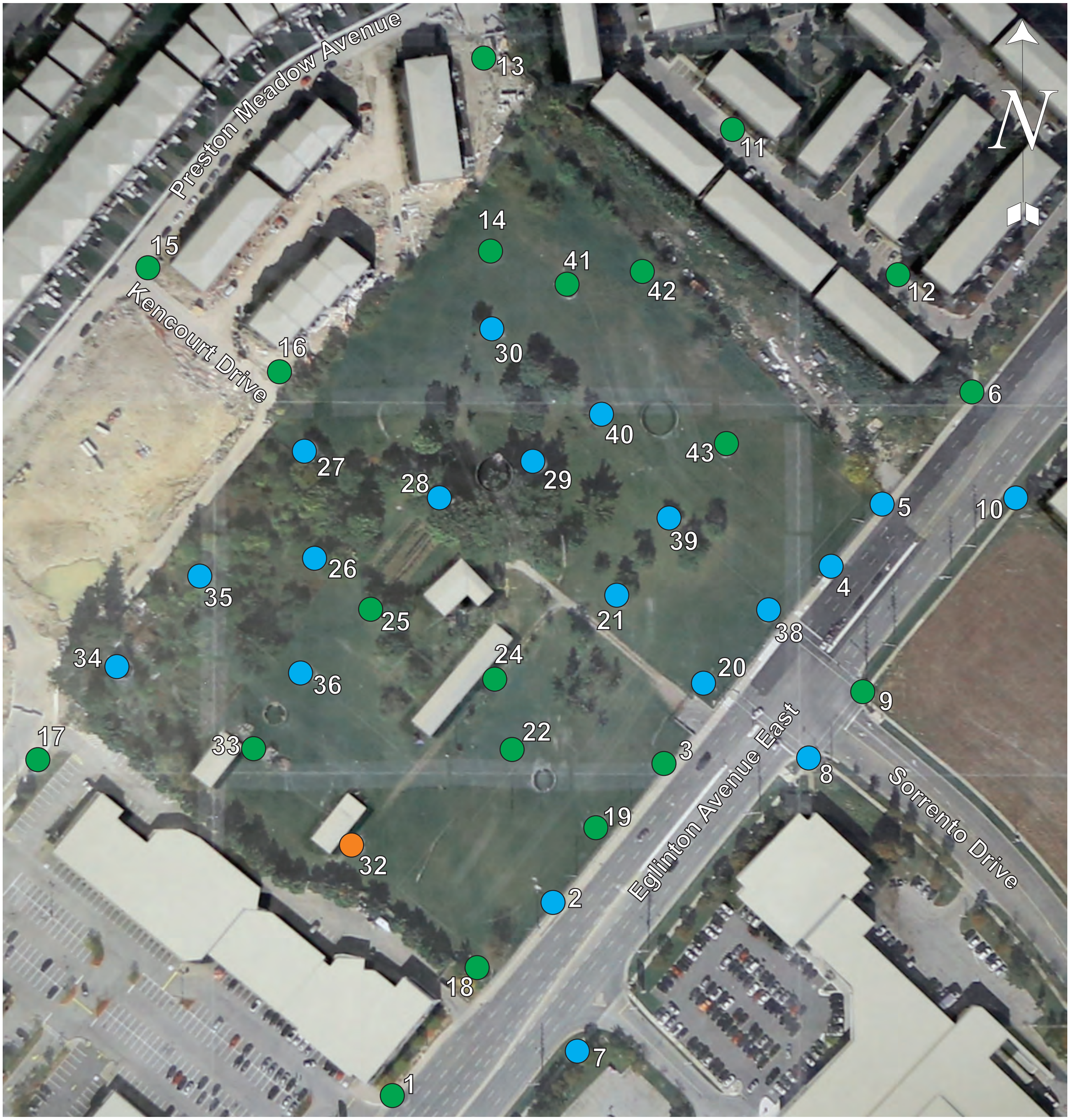
Figure 7d: Pedestrian level wind velocity comfort categories.



Comfort Categories - Winter - Proposed

Sitting Standing Walking Uncomfortable

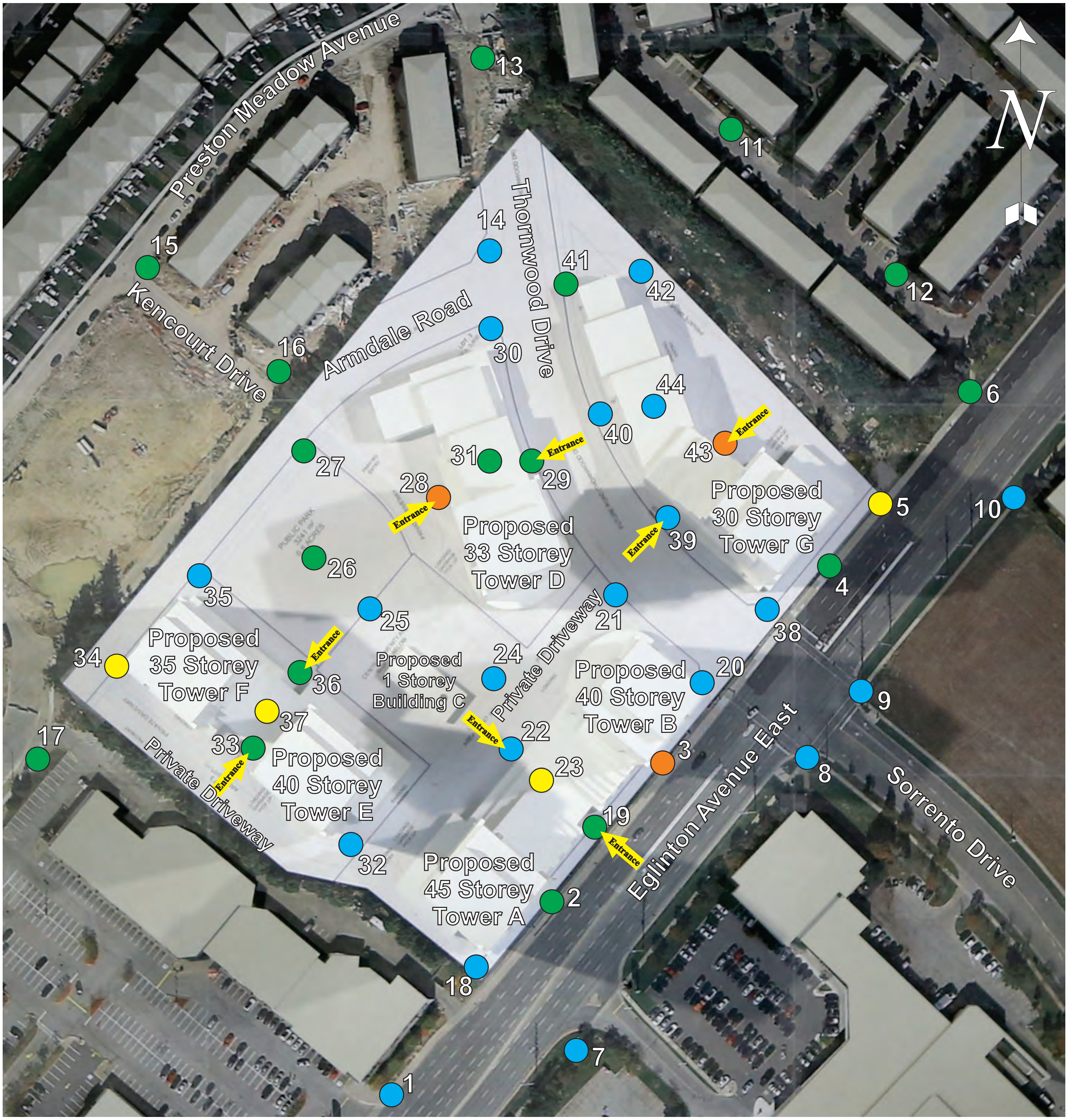
Figure 7e: Pedestrian level wind velocity comfort categories.



Comfort Categories - Spring - Existing

Sitting Standing Walking Uncomfortable

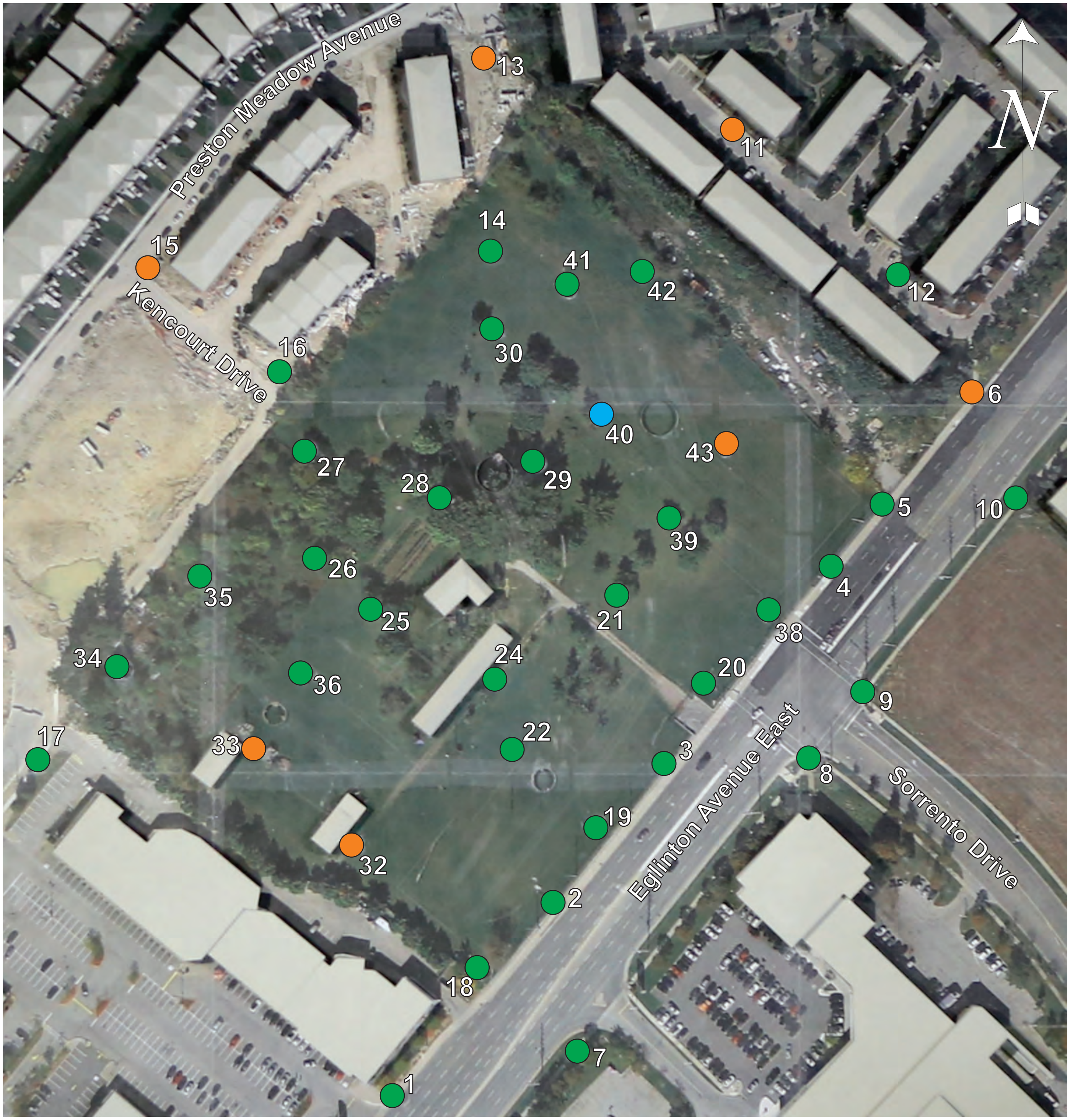
Figure 7f: Pedestrian level wind velocity comfort categories.



Comfort Categories - Spring - Proposed

Sitting Standing Walking Uncomfortable

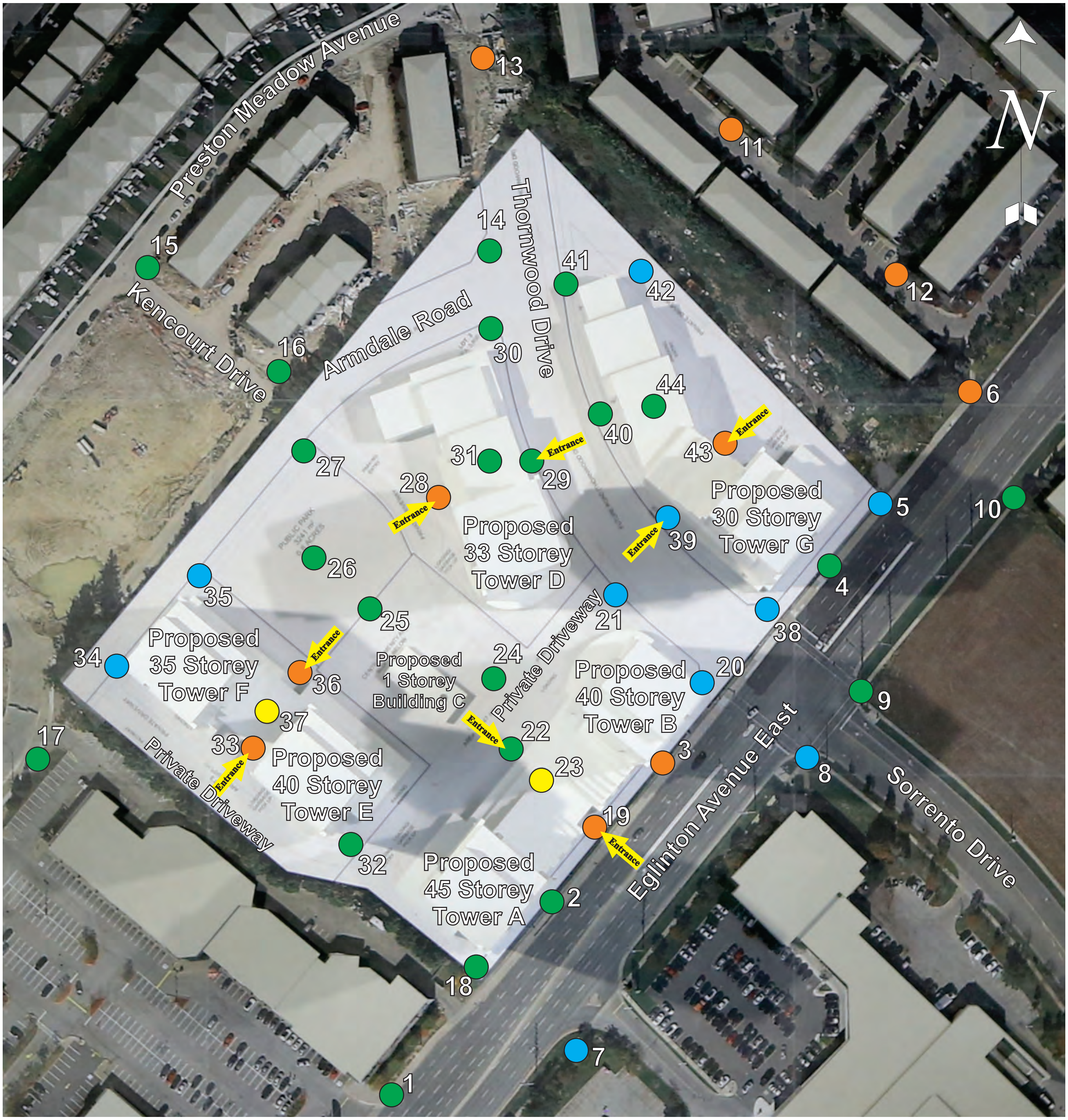
Figure 7g: Pedestrian level wind velocity comfort categories.



Comfort Categories - Summer - Existing

Sitting Standing Walking Uncomfortable

Figure 7h: Pedestrian level wind velocity comfort categories.



Comfort Categories - Summer - Proposed

Sitting Standing Walking Uncomfortable

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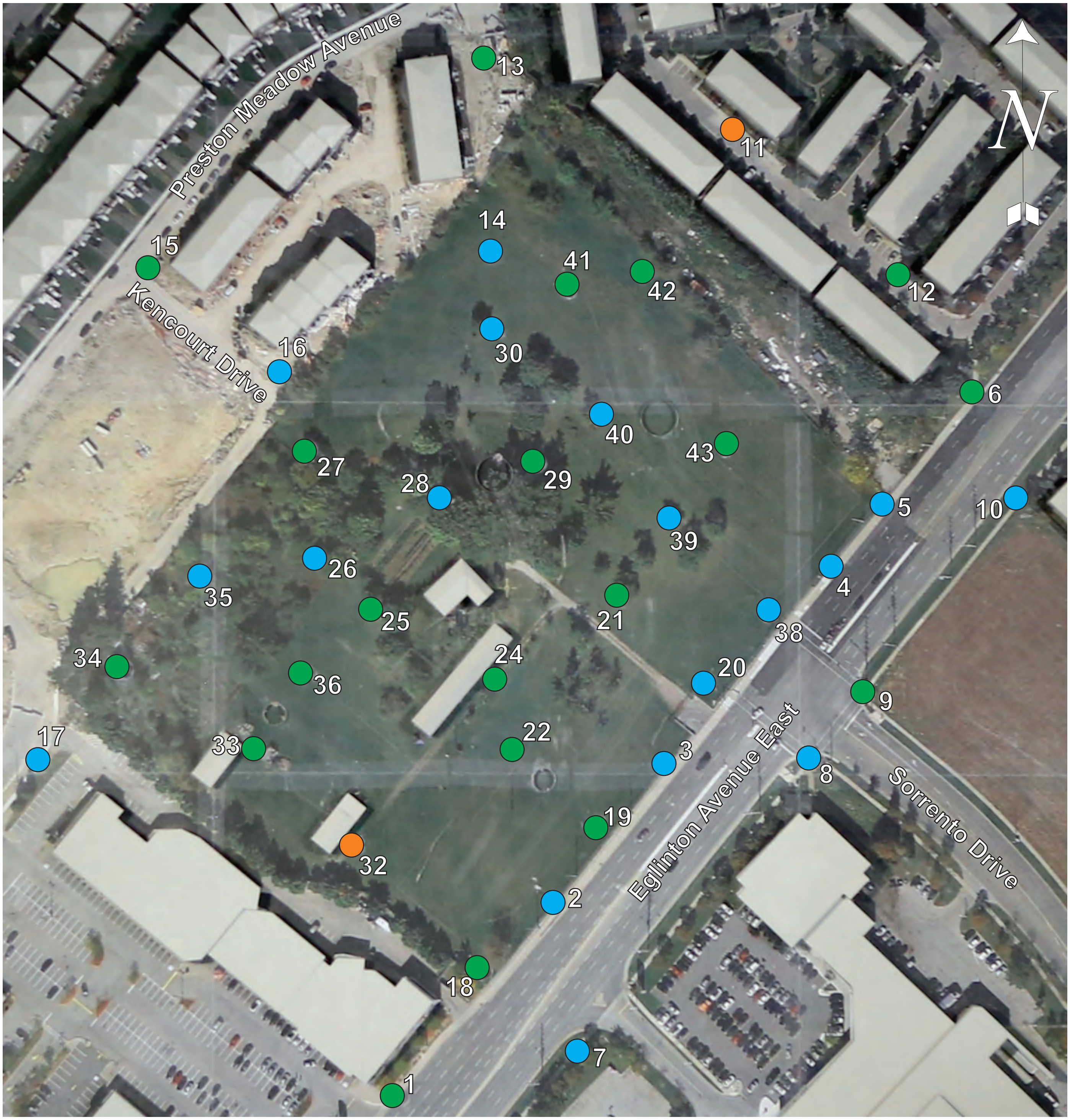
Environmental

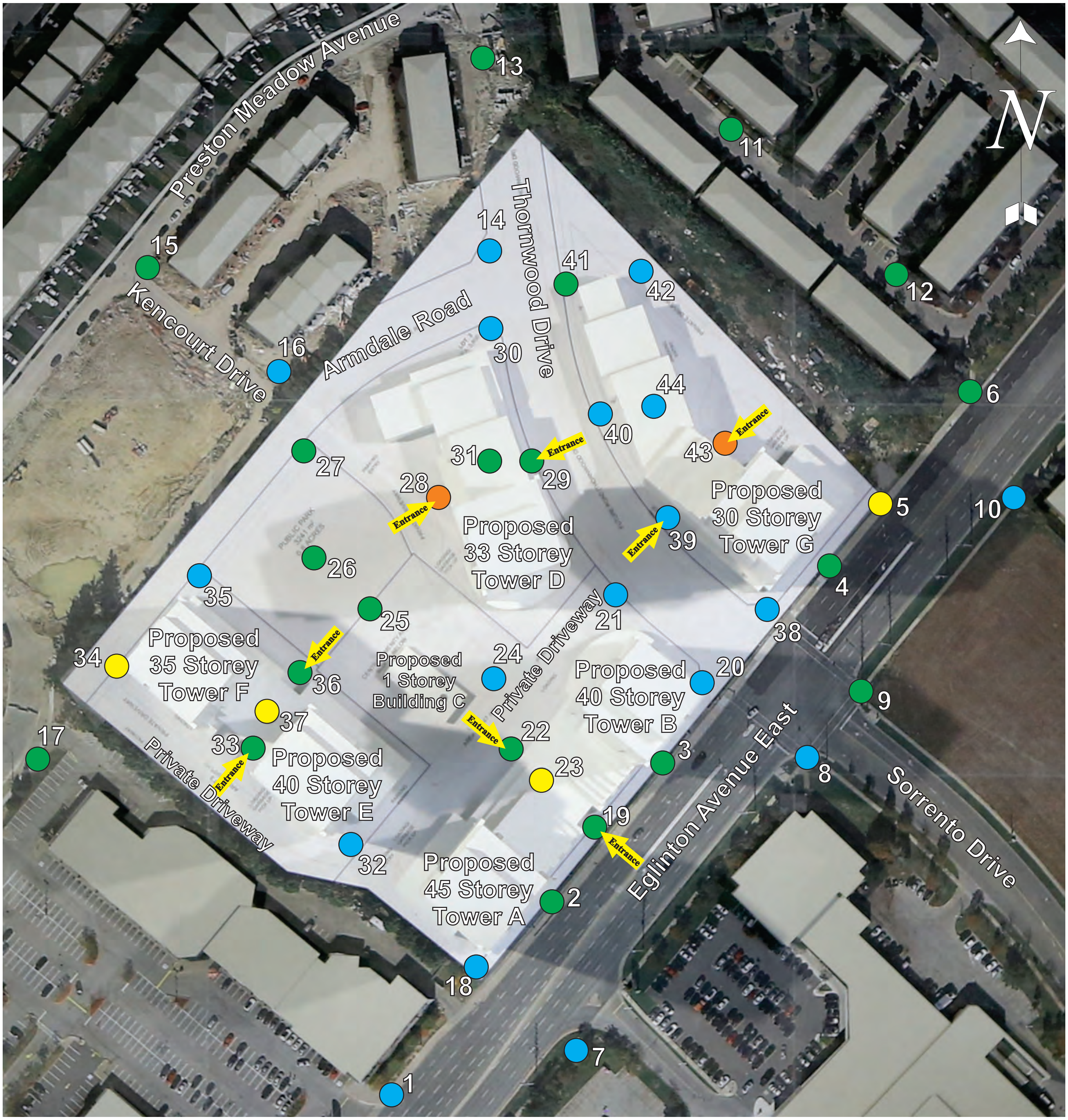
Figure 7i: Pedestrian level wind velocity comfort categories.



Comfort Categories - Fall - Existing

Sitting Standing Walking Uncomfortable

Figure 7j: Pedestrian level wind velocity comfort categories.



Comfort Categories - Fall - Proposed

Sitting Standing Walking Uncomfortable

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:

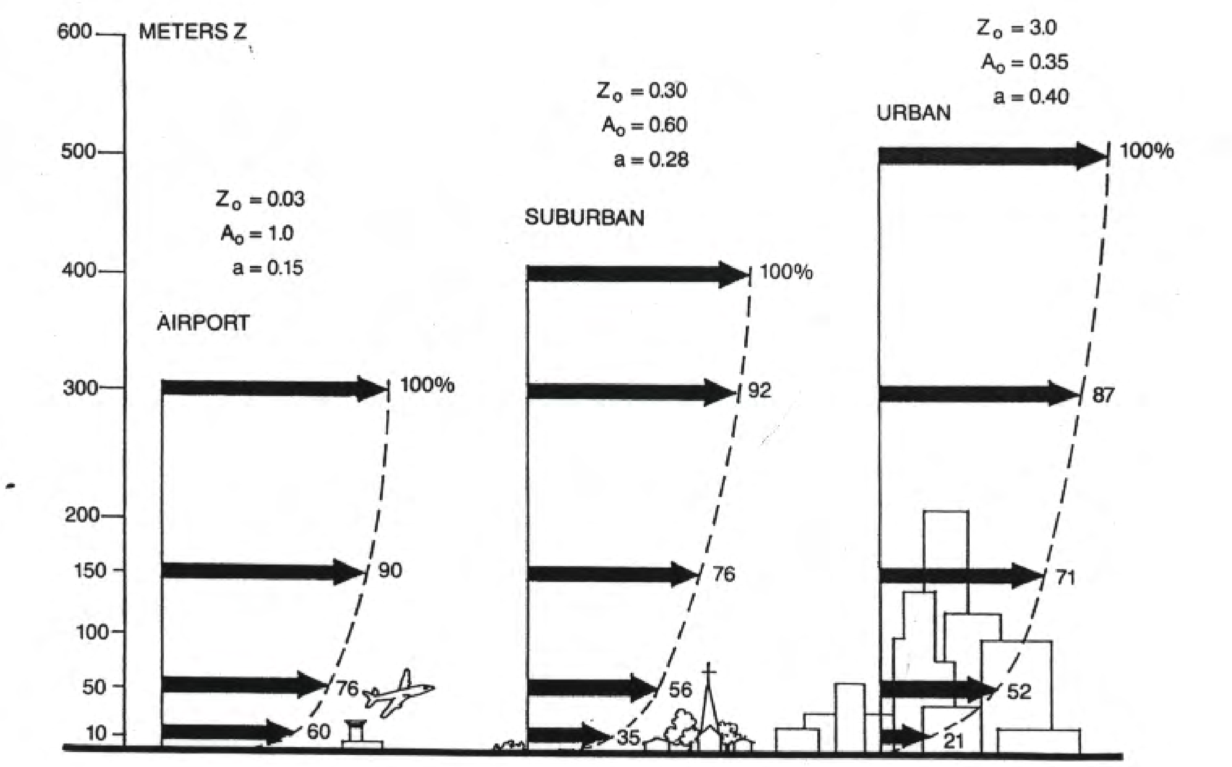


Figure A: Mean wind speed profiles for various terrain (from ASHRAE 1989).

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.

The Beaufort Scale

Beaufort Number	Description	Wind Speed			Observations
		mph	km/h	Knots	
0	Calm	0	0	0	Tree leaves don't move; smoke rises vertically; sea is calm, mirror like.
1	Light Air	1-3	1-5	1-3	Tree leaves don't move; smoke drifts slowly; direction of wind shown by smoke, not by vane; sea is lightly rippled.
2	Slight Breeze	4-7	6-11	4-6	Tree leaves rustle; flags wave slightly; vanes show wind direction; small wavelets or scale waves.
3	Gentle Breeze	8-12	12-19	7-10	Leaves and twigs in constant motion; small flags extended; long unbreaking waves.
4	Moderate Breeze	13-18	20-29	11-16	Small branches move; flags flap; waves with whitecaps.
5	Fresh Breeze	19-24	30-38	17-21	Small trees sway; flags flap and ripple; moderate waves with many whitecaps.
6	Strong Breeze	25-31	39-50	22-27	Large branches sway; umbrellas used with difficulty; flags beat and pop; larger waves with regular whitecaps.
7	Moderate Gale	32-38	51-61	28-33	Sea heaps up, white foam streaks; whole trees sway; difficult to walk; large waves.
8	Fresh Gale	39-46	62-74	34-40	Twigs break off trees; moderately high sea with blowing foam.
9	Strong Gale	47-54	75-86	41-47	Branches break off trees; tiles blown from roofs; high crested waves.
10	Whole Gale	55-63	87-101	48-55	Some trees blown down; damage to buildings; high churning white seas and exceptionally high waves hiding ships from view.
11	Storm	64-74	102-120	56-63	Widespread damage to trees and buildings; mountainous waves. Sea covered in white foam.
12	Hurricane	75+	120+	64+	Severe and extensive damage.

Wind speeds indicated above are at a reference height of 10 metres, as are the wind speeds indicated on the Figure 6 wind roses. The mean wind speeds at pedestrian level would be approximately 80% of these values. The relationship between wind speed and height relative to terrain is discussed in the appendices.

The table below correlates the Beaufort Scale with the average pedestrian comfort response as listed in Figure 7a – 7d, of the report, which provide an indication of the safety and comfort of pedestrians. The scale reflected on the figures takes into consideration the area around the subject building and in the immediate vicinity of the subject building, as affected by the wind patterns induced by the location, orientation and configuration of the proposed structure. At each point, as the wind velocity increases, the comfort level decreases. Also, at lower temperatures, relative comfort level might be expected to be reduced by one Beaufort number for every 20 degrees Celsius reduction in temperature, however, this is not applied to the wind driven results provided.

		Relative Comfort		
Activity	Areas Applicable	Perceptible	Tolerable	Uncomfortable
Occasional Use	Sidewalks	6	7	8
Walking	Sidewalks, Parking Lots	5	6	7
Strolling	Parks, Entrances	4	5	6
Standing, Sitting, Short exp.	Parks, Plaza areas	3	4	5
Standing, Sitting, Long exp.	Outdoor Restaurants	2	3	4
Representative criteria for acceptability			< 1 occn./week	< 1 occn./month

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

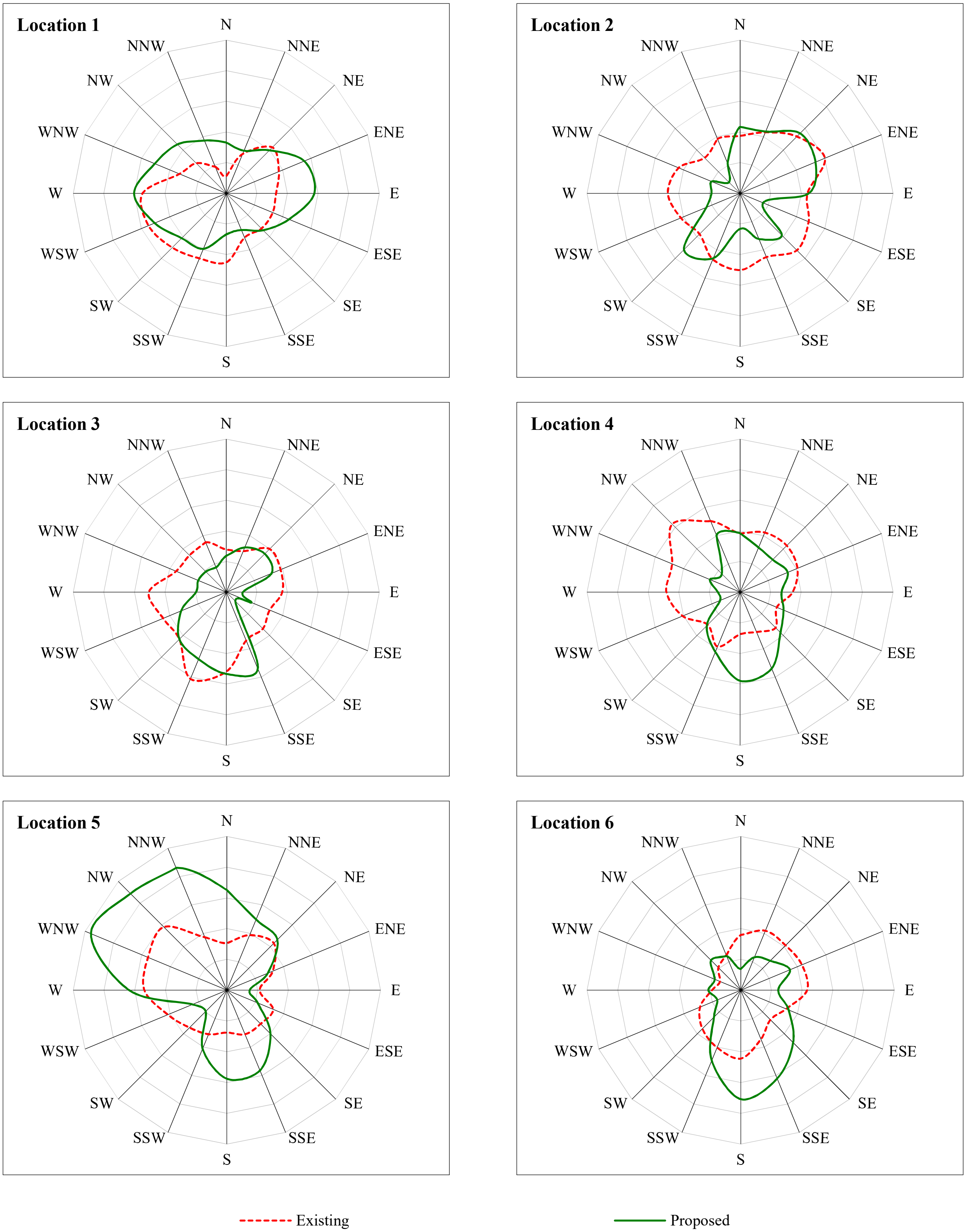


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

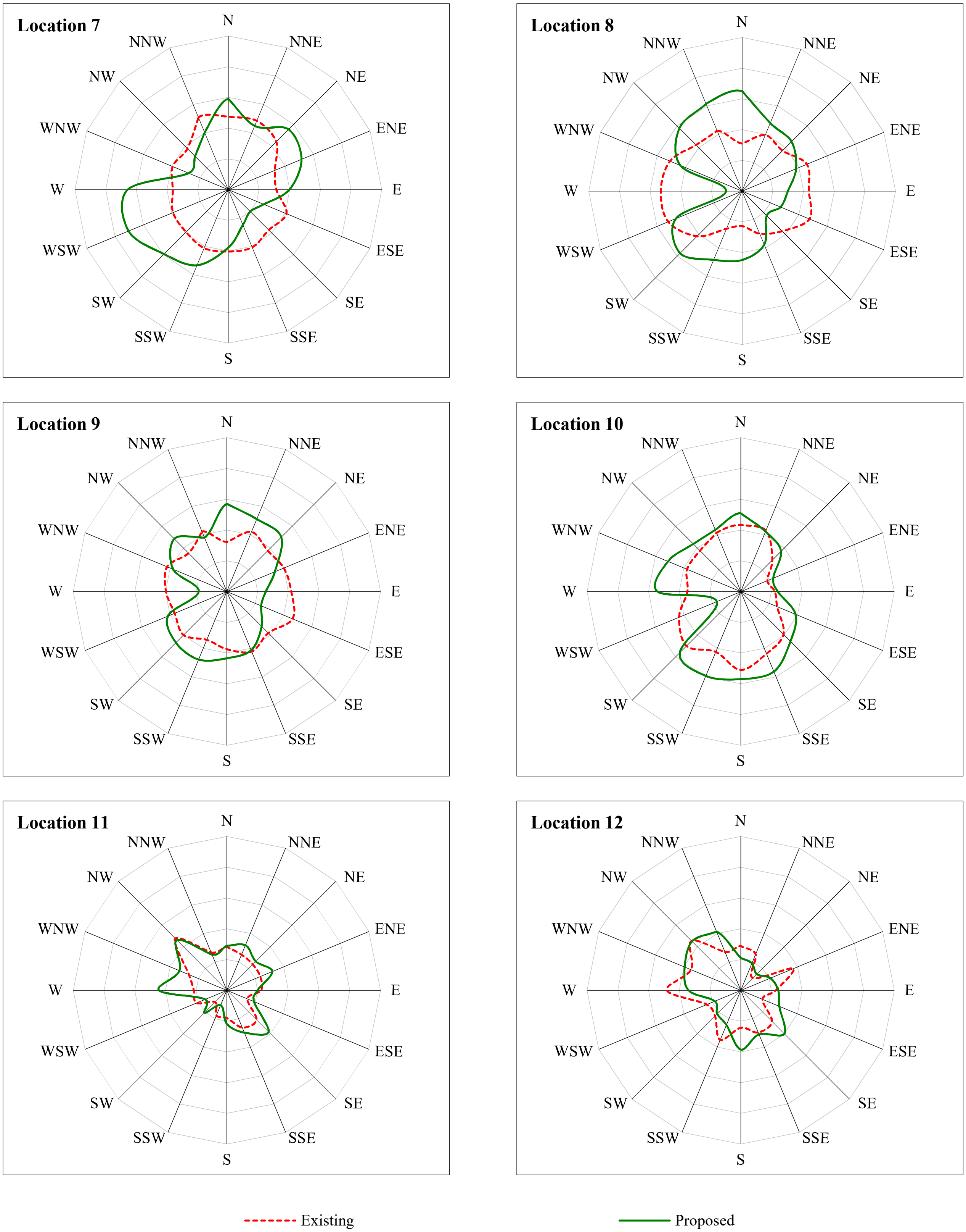


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

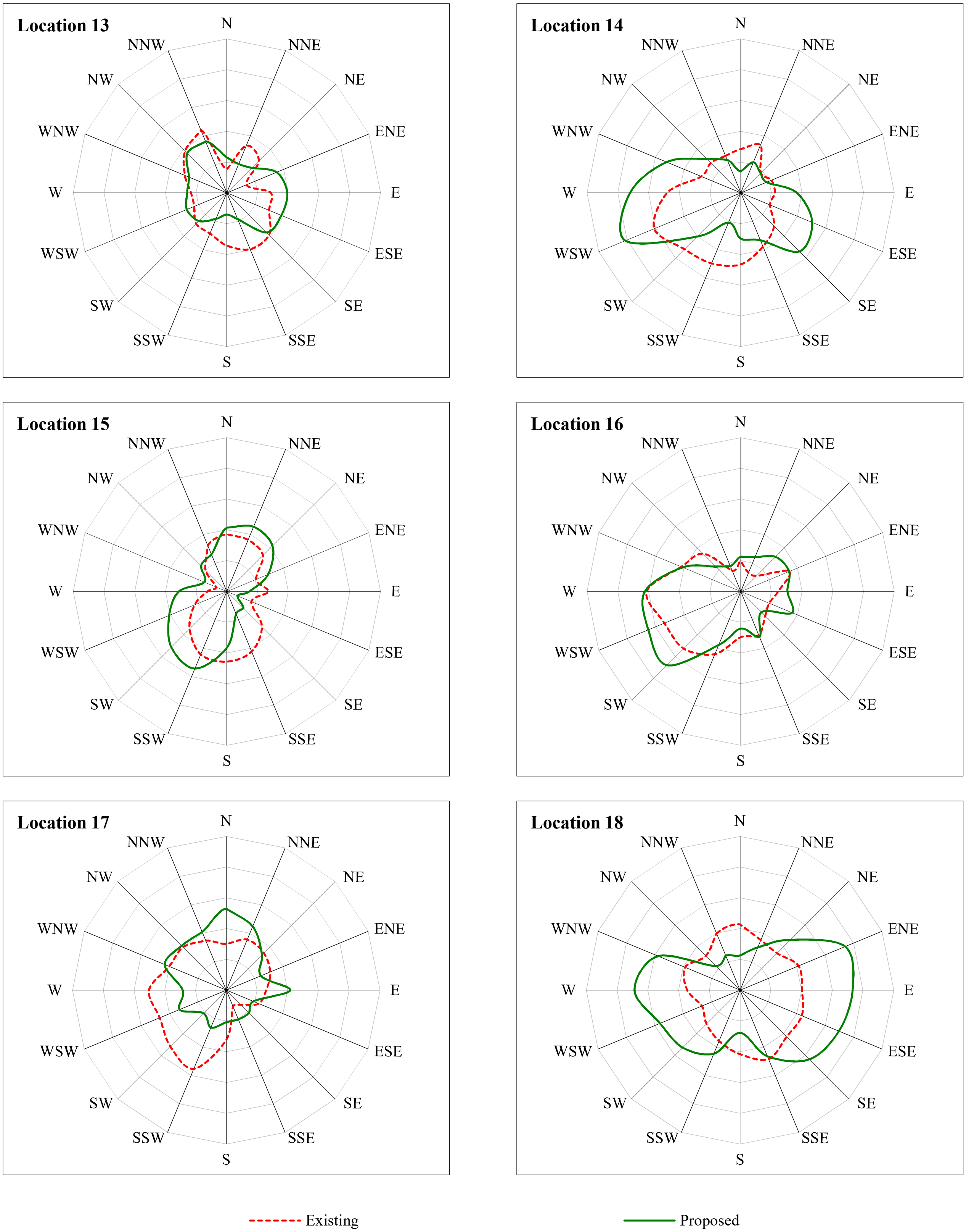


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

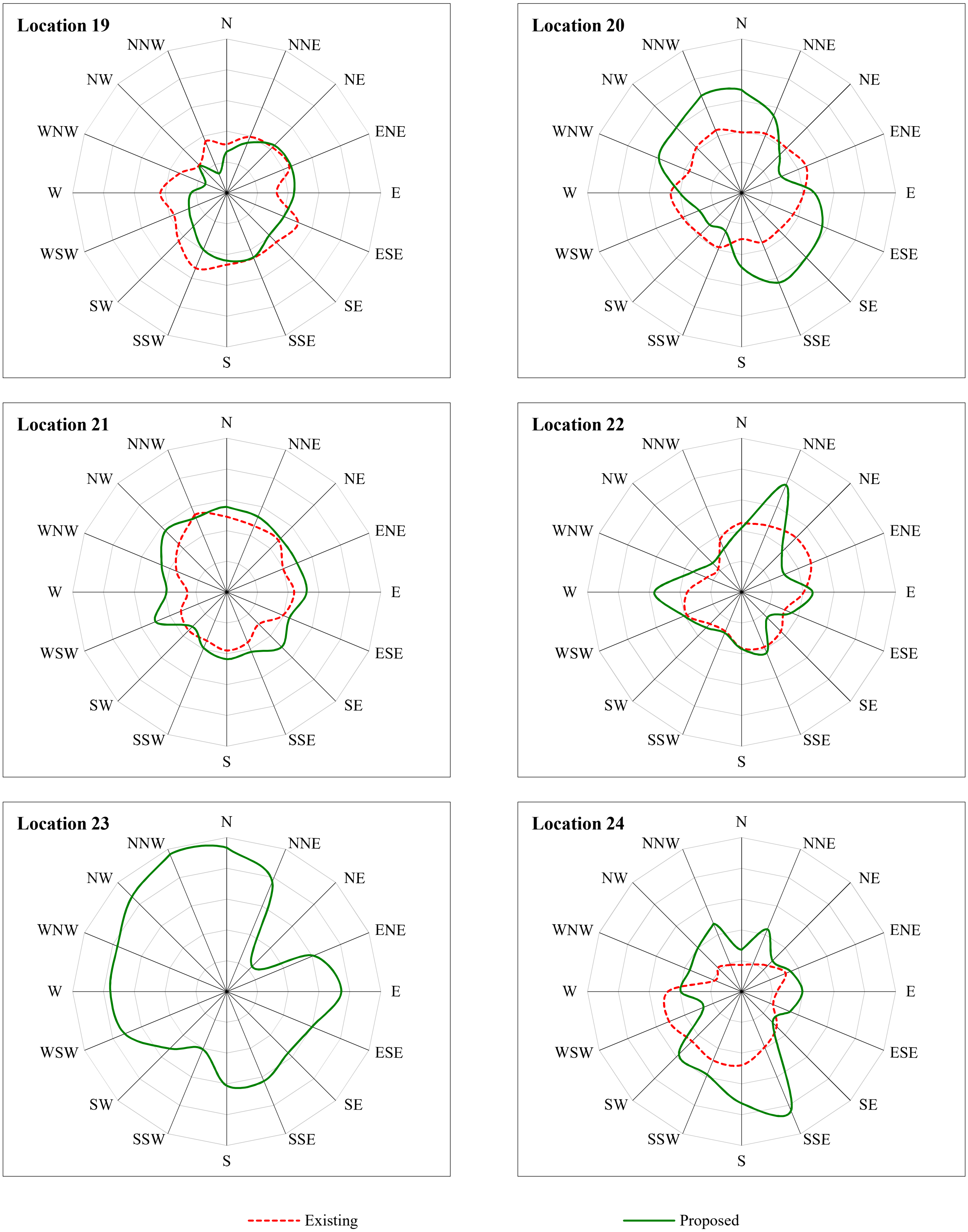


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

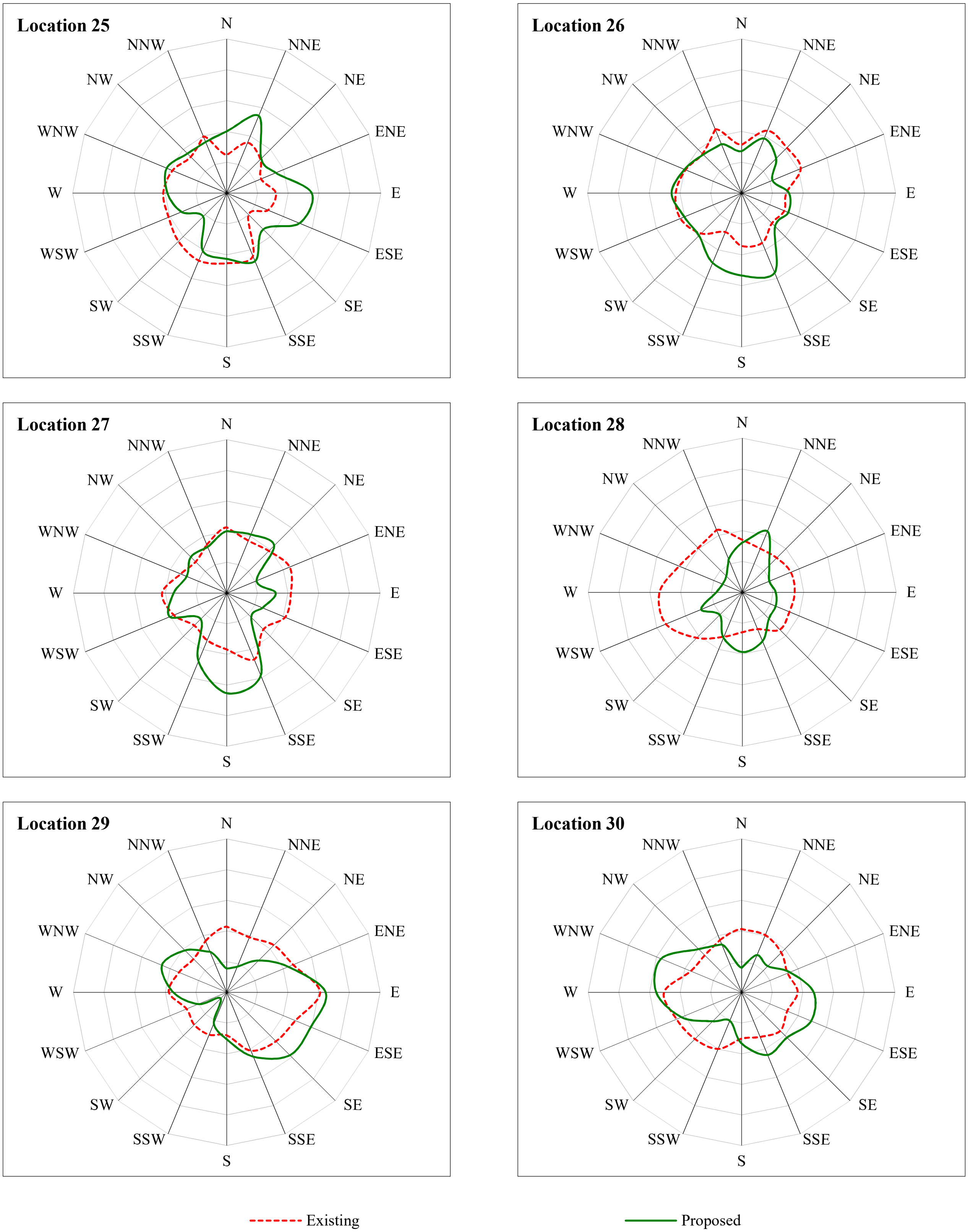


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

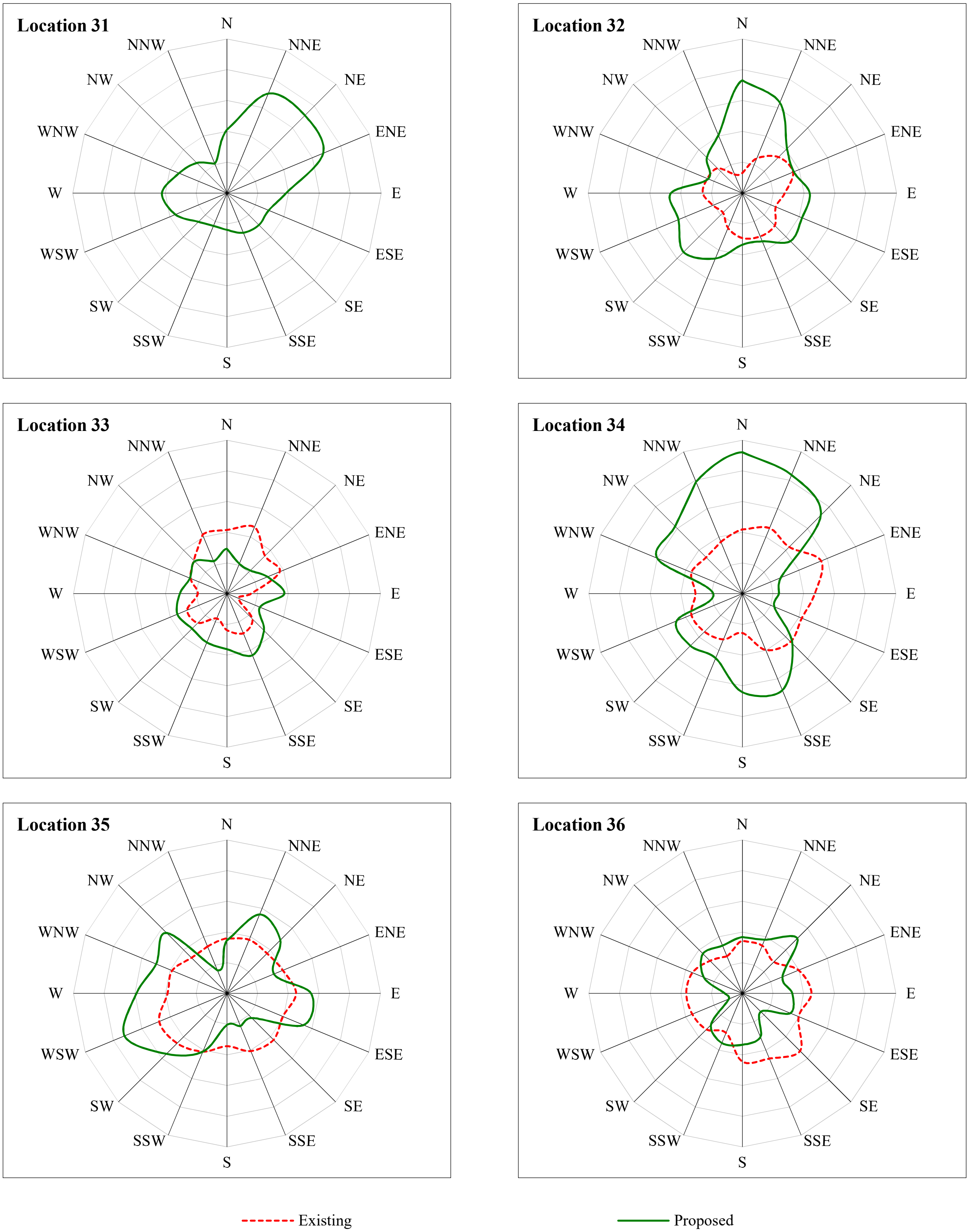


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

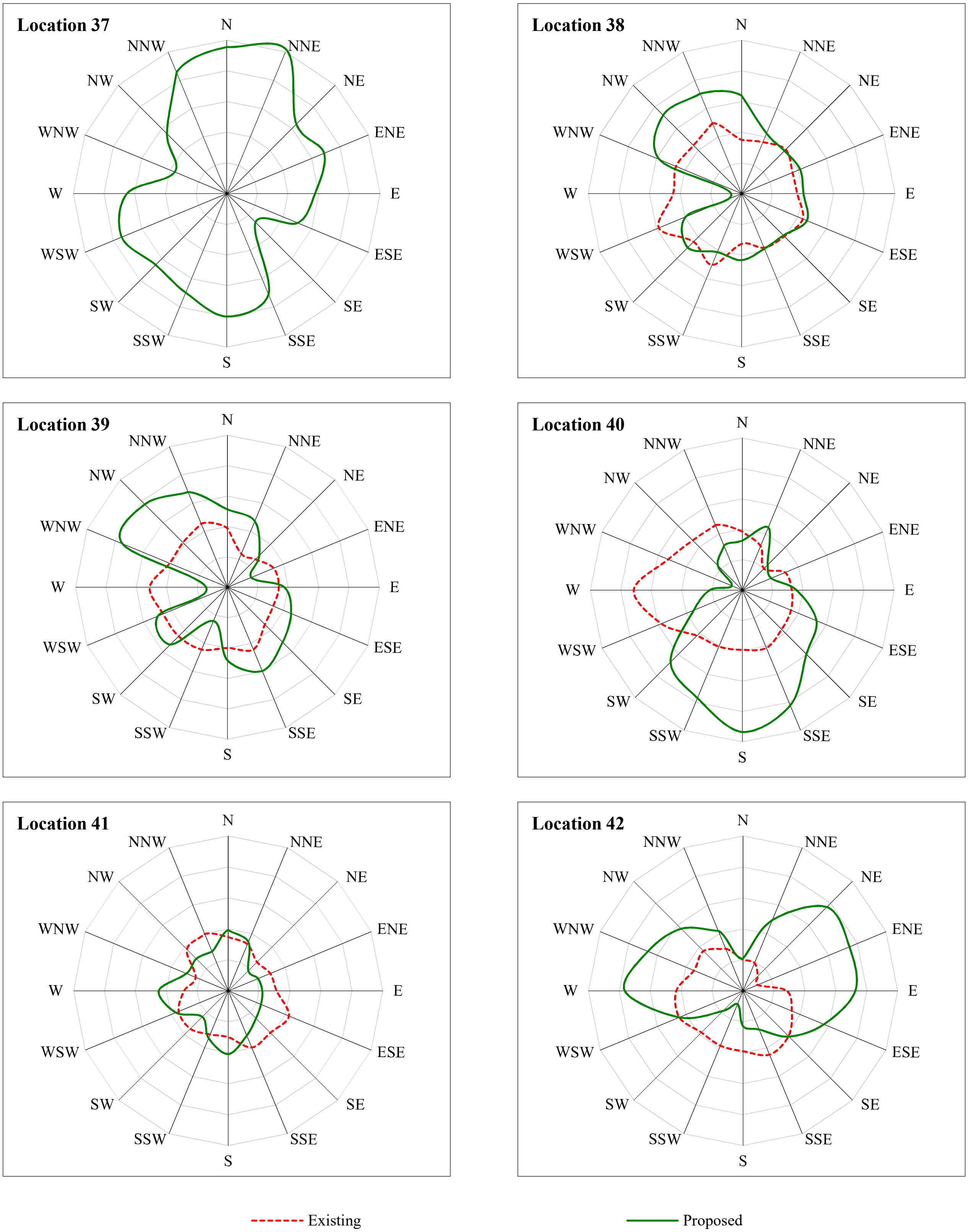
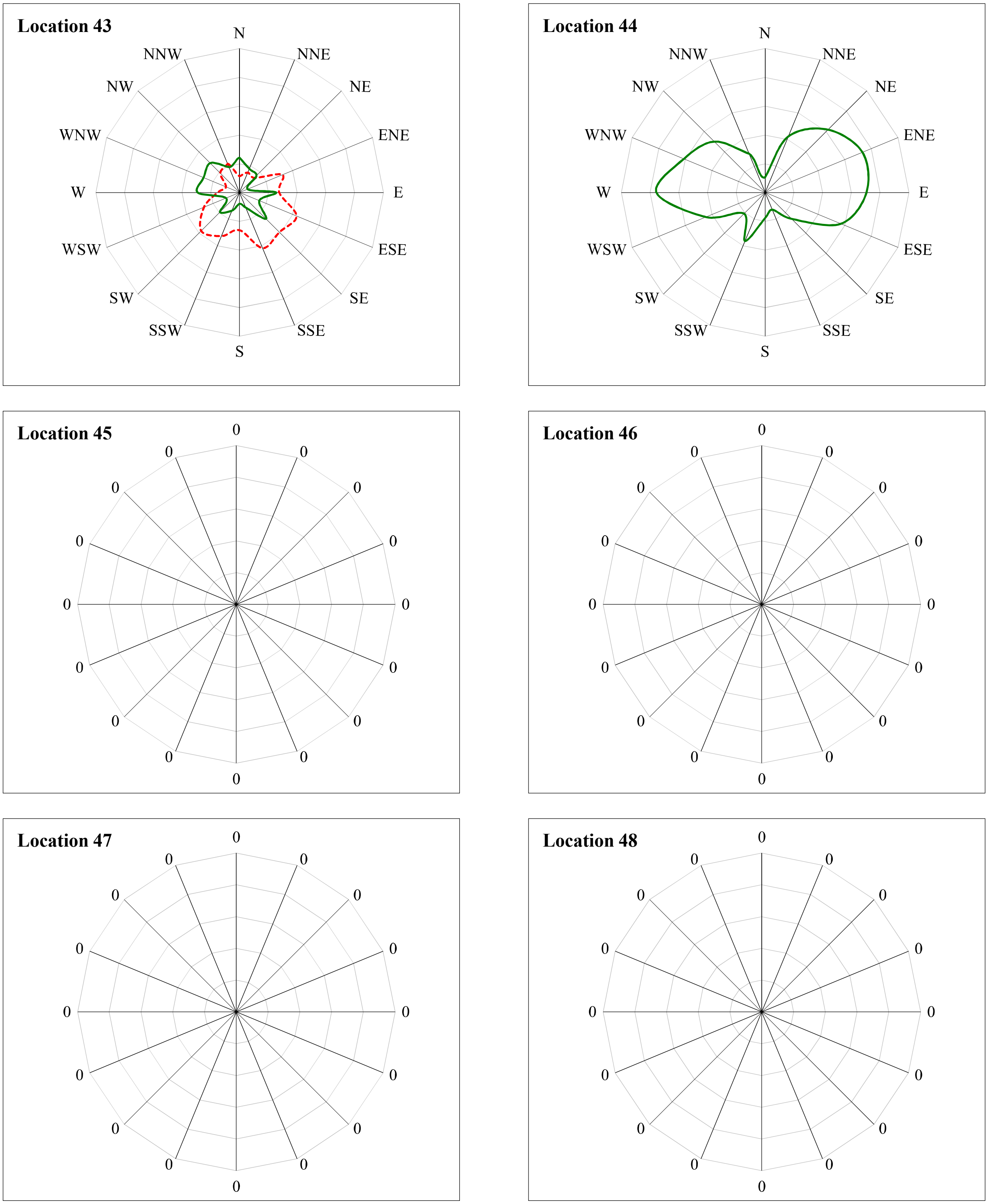


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.



Existing Proposed

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