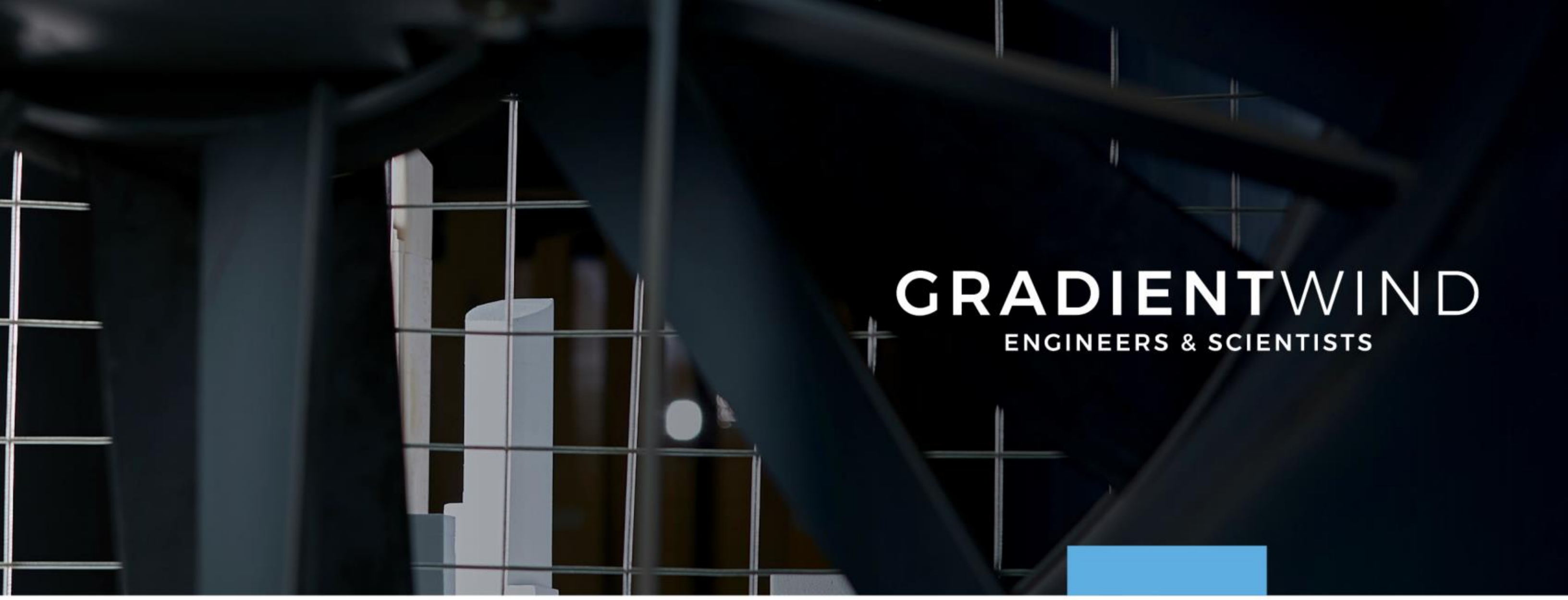
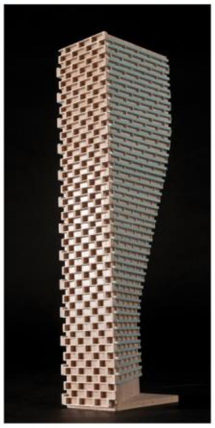
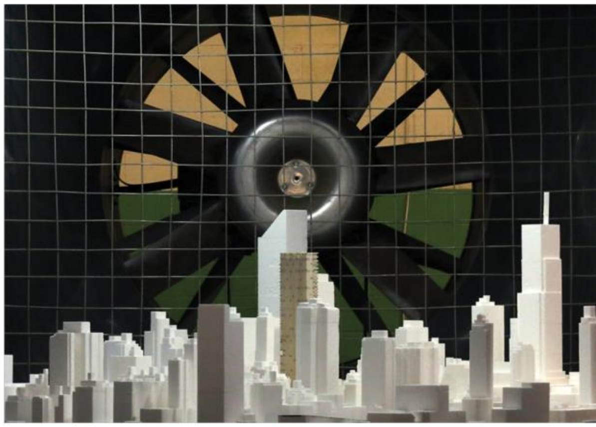


PEDESTRIAN LEVEL WIND STUDY

Baseline Tower Phase 3-6
Ottawa, Ontario

Report: 21-424-PLW-2024





July 18, 2024

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application resubmission requirements for Phases 3-6 of the multi-phased development, referred to as "Baseline Tower" and located at 2946 Baseline Road at the intersection of Baseline Road and Sandcastle Drive in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for sixteen (16) wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-11, and summarized as follows:

1) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, the existing surface parking serving Phases 1 and 2, neighbouring existing surface parking lots, in the vicinity of most building access points, and over most proposed laneways, walkways, and drop-off areas are considered acceptable.

    a. The proposed development is exposed to prevailing winds from multiple directions, particularly prevailing winds from the southwest clockwise to the northwest which are predicted to downwash over the western façades of Phases 5 and 6 towards grade, channel beneath the shared podium serving Phases 5 and 6 and between Phase 1 and 6, and accelerate around the northeast and southwest corner of Phase 6.

b. Regions of conditions that may occasionally be considered uncomfortable for walking during the spring and winter seasons are situated to the east of Phase 6 and beneath the shared podium serving Phases 5 and 6.

   - The region to the east of Phase 6 is predicted to impact isolated sections of the existing laneway shared with Phases 1 and 2 and the drop-off area and walkway to the east of Phase 6, while the region beneath the shared podium is predicted to impact isolated sections of the proposed east-west laneway and the walkway and building access points along the north elevation of Phase 5.
   - To provide calmer conditions along the walkway to the east of Phase 6, the introduction of mitigation elements such as wind screens, decorative walls, or arrangements of coniferous trees along the east elevation of Phase 6 may be beneficial to reduce wind acceleration over the area. Additionally, canopies and wind screens or decorative walls placed at the northwest and southwest corners of Phases 5 and 6, respectively, may be beneficial to deflect downwash incident on the west elevation of the towers and to reduce wind acceleration at the noted corners.
   - An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

c. It is recommended to recess the commercial entrance near the northwest corner of Phase 3-4, the building access points along the north elevation of Phase 5, and the commercial entrances along the east elevation of Phase 6 and at the southwest corner of Phase 6 into their respective façades by at least 2 m, owing to the windier conditions in the vicinity of these entrances.

2) During the typical use period, (that is, May to October, inclusive) wind comfort conditions over the parkland dedication to the west of Phase 3-4 and the plaza to the east of Phase 5 are predicted to be suitable for a mix of sitting and standing.

a. Depending on the programming of the parkland dedication and plaza, the noted wind conditions may be considered acceptable. Specifically, if the windier areas within these spaces will not accommodate seating or more sedentary activities, the noted wind conditions would be considered acceptable. As required by programming, comfort levels may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

b. The extent of mitigation measures is dependent on the programming of the noted spaces. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

3) Regarding the common amenity terrace serving Phase 3-4 at Level 2, wind comfort conditions are predicted to be suitable for sitting throughout the year, which is considered acceptable.

4) During the typical use period (May to October, inclusive), wind conditions within the common amenity terrace serving Phases 5 and 6 at Level 4 are predicted to be suitable for mostly a mix of standing and strolling, with sitting conditions predicted close to the tower façades and an isolated region suitable for walking to the northwest of Phase 5. Notably, the Level 4 amenity terrace was modelled with 1.8-m-tall wind screens along its full perimeter.

   a. To improve comfort levels within the Level 4 amenity terrace, it is recommended to implement taller wind screens along select perimeters of the terrace, typically glazed, rising to at least 2.4 m above the local walking surface. The placement of the taller screens would be programming-dependant. Additionally, mitigation inboard of the perimeter, which could take the form of 1.8-m-tall wind screens or clusters of coniferous plantings located around sensitive areas, and canopies located above designated seating areas, are recommended to further improve wind conditions within the terrace. Canopies extending above the terrace from the northwest elevations of the Phase 5 tower may also be beneficial to deflect downwash incident on the terrace.

b. The extent of the mitigation measures is dependent on the programming of the terrace. An appropriate mitigation strategy will continue to be developed and evolve in collaboration with the building and landscape architects as the design of the proposed development progresses.

5) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Addendum: The PLW study was completed based on architectural drawings prepared by NEUF architect(e)s in June 2024. Updated drawings were distributed to the consultant team in July 2024 in which the commercial entrances near the northwest corner of Phase 3-4, and the commercial entrances at the northwest corner of Phase 5, the northeast corner of Phase 6, and at the southwest corner of Phase 6 have been recessed into their respective façades, in accordance with the recommendations of the current study.

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Appendix A – Simulation of the Atmospheric Boundary Layer

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Brigil to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application resubmission requirements for Phases 3-6 of the multi-phased development, referred to as “Baseline Tower” and located at 2946 Baseline Road at the intersection of Baseline Road and Sandcastle Drive in Ottawa, Ontario (hereinafter referred to as “subject site” or “proposed development”). A PLW study was conducted in April 2023[1] for the previous design of the proposed development. Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by NEUF architect(e)s in June 2024, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, as well as recent satellite imagery.

2. TERMS OF REFERENCE

The subject site is located at 2946 Baseline Road in Ottawa, Ontario, situated to the southeast at the intersection of Baseline Road and Sandcastle Drive on a parcel of land to the immediate west of Baseline Tower Phases 1 and 2. The proposed development comprises four phases, Phase 3-4, Phase 5, and Phase 6, situated to the south, central, and north of the subject site, respectively. All buildings are topped with a mechanical penthouse (MPH).

East-west laneways extend from Sandcastle Drive to meet an existing laneway along the east elevation of the subject site extending from Baseline Road. Surface parking and drop-off areas are provided along the eastern laneway and to the south of Phase 2. Access to shared underground parking levels is provided by a vehicular entrance and a parking ramp at the northeast corners of Phases 3-4 and 5, respectively, via the noted internal laneways. A parkland dedication is proposed to the west of Phase 3-4 and a plaza is situated to the east of Phase 5.

[1] Gradient Wind Engineering Inc., ‘*Baseline Tower Phase 4-6 – Pedestrian Level Wind Study*’, [Apr 26, 2023]

Phase 3-4 comprises a nine-storey building with a nominally 'L'-shaped planform with its short axis oriented along Sandcastle Drive. Above the shared underground parking levels and a basement level, the ground floor includes commercial spaces to the west, a main entrance, a bike storage, and a coworking space to the north, central building support spaces, and parking spaces throughout the interior of the level. Levels 2 and 4 include central indoor amenity spaces and residential units throughout the remainder of the levels, while Levels 3 and 5-9 are reserved for residential occupancy. The building steps back from all elevations at Level 2, accommodating private terraces and a common amenity terrace to the south.

Phase 5 comprises a near rectangular 28-storey building, inclusive of a three-storey podium comprising a nominally 'I'-shaped planform, with its long axis-oriented along Sandcastle Drive. The podium levels (excluding the lower and upper ground floors) are shared with Phase 6, which comprises a near rectangular 32-storey building. The lower ground floor of Phase 5 includes a residential main entrance to the east, commercial spaces at the southeast and northwest corners, a social room and music room at the southwest corner, and bike storage to the north. The lower ground floor of Phase 6 includes a residential main entrance at the southeast corner, a loading space to the south, and commercial spaces throughout the remainder of the level. The upper ground floor of Phase 5 includes a coworking space and a storage space to the north and is open to below throughout the remainder of the level, while the upper ground floor of Phase 6 is open to below throughout the entire level. Levels 2 and 3 are reserved for residential use, with a pool mechanical room at the northeast corner of Phase 5 at Level 3. At Level 4, Phase 5 includes an indoor pool and spa to the east and a gym, yoga studio, and a lounge at the southwest corner, to the west, and at the northwest corner, respectively, while Phase 6 includes a social room to the south and residential units throughout the remainder of the level. The podium steps back from all elevations at Level 4 to accommodate a common amenity terrace, inclusive of a landscape area situated between Phases 5 and 6. Phases 5 and 6 are reserved for residential occupancy at Levels 5-28 and 5-32, respectively.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, include low-rise residential dwellings from the west clockwise to the north, mid-rise office buildings from the northeast clockwise to the east, low-rise residential dwellings from the east clockwise to the south, and two high-rise residential buildings to the southwest. Notably, Phase 1 and 2 of the Baseline Tower development are currently under construction to the immediate east of the subject site.

The far-field surroundings, defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site, are characterized primarily by low-rise massing with isolated mid- and high-rise buildings in all compass directions, and open exposures (fields and green spaces) from the southeast clockwise to the northwest.

Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, while Figures 2A-2H illustrate the computational models used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures, where required.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on CFD simulations of wind speeds across the subject site within a virtual environment, meteorological analysis of the Ottawa area wind climate, and synthesis of computational data with City of Ottawa wind comfort and safety criteria[2]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

4.1 Computer-Based Context Modelling

A computer based PLW study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport.

[2] City of Ottawa Terms of References: Wind Analysis
https://documents.ottawa.ca/sites/default/files/torwindanalysis_en.pdf

The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the subject site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly stronger wind speeds.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 16 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 550 m. The process was performed for two context massing scenarios, as noted in Section 2.

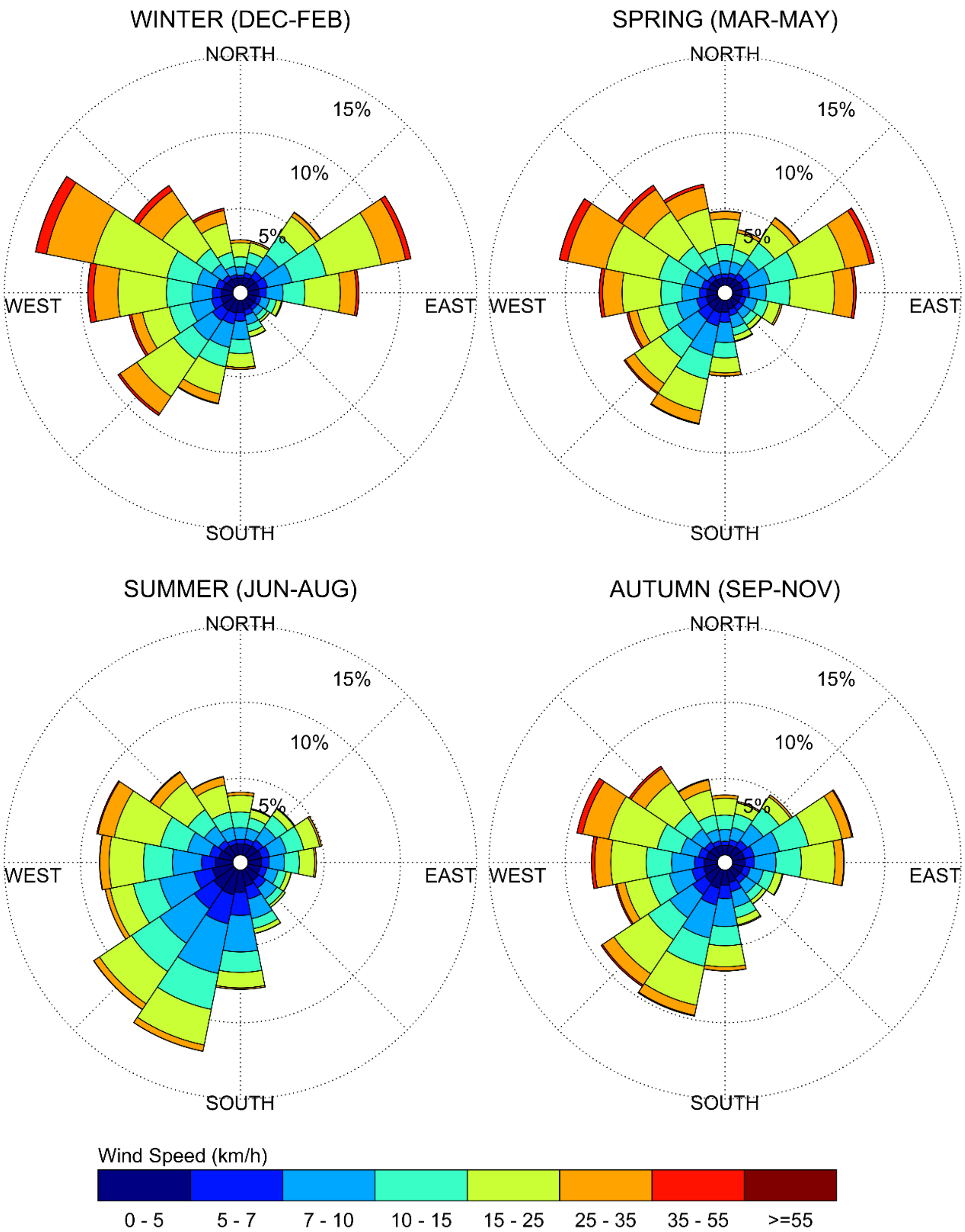
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces serving the proposed development were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. Gradient height represents the theoretical depth of the boundary layer of the earth's atmosphere, above which the mean wind speed remains constant. Further details of the wind flow simulation technique are presented in Appendix A.

4.3 Historical Wind Speed and Direction Data

A statistical model for winds in Ottawa was developed from approximately 40 years of hourly meteorological wind data recorded at Ottawa Macdonald-Cartier International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed during the appropriate hours of pedestrian usage (that is, between 06:00 and 23:00) and divided into four distinct seasons, as stipulated in the wind criteria. Specifically, the spring season is defined as March through May, the summer season is defined as June through August, the autumn season is defined as September through November, and the winter season is defined as December through February, inclusive.

The statistical model of the Ottawa area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in kilometers per hour (km/h). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The prominent wind speeds and directions can be identified by the longer length of the bars. For Ottawa, the most common winds occur for westerly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional prominence and relative magnitude of wind speed changes somewhat from season to season.

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h, measured at 10 m above the ground.

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

Pedestrian wind comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature and relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes based on 20% non-exceedance mean wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. The gust speeds, and equivalent mean speeds, are selected based on the Beaufort scale, which describes the effects of forces produced by varying wind speed levels on objects. Wind conditions suitable for sitting are represented by the colour blue, standing by green, strolling by yellow, and walking by orange; uncomfortable conditions are represented by the colour magenta. Specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

Wind Comfort Class	Mean Speed (km/h)	Description
SITTING	≤ 10	Mean wind speeds no greater than 10 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 16 km/h.
STANDING	≤ 14	Mean wind speeds no greater than 14 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 22 km/h.
STROLLING	≤ 17	Mean wind speeds no greater than 17 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 27 km/h.
WALKING	≤ 20	Mean wind speeds no greater than 20 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 32 km/h.
UNCOMFORTABLE	> 20	Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Regarding wind safety, the pedestrian safety wind speed criterion is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of 90 km/h is classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause an average elderly person in good health to fall. Notably, pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 32 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the subject site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the target comfort classes, which are dictated by the location type for each region (that is, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest target comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Target Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing
Café / Patio / Bench / Garden	Sitting / Standing
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting / Standing
Garage / Service Entrance	Walking
Parking Lot	Walking
Vehicular Drop-Off Zone	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, illustrating wind conditions at grade level for the proposed and existing massing scenarios, and by Figures 8A-D and 10A-D, which illustrate conditions over the common amenity terraces serving Phase 3-4 and Phases 5 and 6, respectively. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figure 7 illustrates wind comfort conditions at grade level, while Figures 9 and 11 illustrate wind comfort conditions over the Level 2 common amenity terrace serving Phase 3-4 and the Level 4 common amenity terrace serving Phases 5 and 6, respectively, consistent with the comfort classes detailed in Section 4.4.

The details of these conditions are summarized in the following sections for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

Sidewalks and Transit Stops along Baseline Road: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Baseline Road are predicted to be suitable for standing, or better during the summer, with an isolated region suitable for strolling, becoming suitable for a mix of standing and strolling during the autumn, winter, and spring, with an isolated region suitable for walking to the north of the subject site during the spring and winter. Conditions in the vicinity of the nearby westbound transit stop to the north of Baseline Road are predicted to be suitable for sitting during the summer, becoming suitable for standing during the autumn, winter, and spring. Conditions in the vicinity of the nearby eastbound transit stop to the south of Baseline Road, which is served by a typical transit shelter, are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for strolling during the spring and winter. The noted conditions are considered acceptable.

Conditions over the sidewalks along Baseline Road under the existing massing are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for mostly standing during the spring and winter. Under the existing massing, conditions in the vicinity of the nearby westbound transit stop are predicted to be suitable for sitting during summer, becoming suitable for standing during the autumn, winter, and spring, while conditions in the vicinity of the nearby eastbound transit stop are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the spring and winter. While the introduction of the proposed development produces windier conditions over some areas along Baseline Road in comparison to existing conditions, wind conditions over the nearby westbound transit stop are predicted to remain unchanged following the introduction of the proposed development, and wind comfort conditions with the proposed development are nevertheless considered acceptable for the noted public sidewalks and transit stops.

Existing Surface Parking and Proposed Drop-off Areas and Walkways along Eastern Laneway: Prior to the introduction of the proposed development, conditions over the laneway between Phases 1 and 2 and Phases 5 and 6, inclusive of the adjoining surface parking and drop-off areas serving Phases 1 and 2, are predicted to be suitable for standing, or better, throughout the year, with regions suitable for strolling during the spring and winter.

Following the introduction of the proposed development, wind comfort conditions over the noted shared laneway to the east of Phases 5 and 6, inclusive of the existing surface parking and drop-off areas and the proposed adjoining drop-off areas and walkways serving Phases 5 and 6, are predicted to be suitable for a mix of standing and strolling during the summer, with an isolated region suitable for walking, becoming suitable for walking, or better, during the autumn, winter, and spring. An isolated region of conditions that may occasionally be considered uncomfortable for walking is predicted to the east of Phase 6 during the spring and winter seasons.

Specifically, prevailing winds from the southwest are predicted to accelerate along the western façades of Phases 1 and 2 and between Phases 4 and 5 and Phases 1 and 2, while those from the west clockwise to the north-northwest are predicted to downwash over the western façade of Phase 1 towards grade, accelerate around the northeast corner of Phase 6, and channel and accelerate between Phase 1 and Phase 6. To the east of Phase 6, conditions are predicted to be suitable for walking for approximately 74% of the time during the spring and winter seasons, representing 6% exceedances of the walking threshold. The noted conditions are predicted to impact sections of the existing laneway shared with Phases 1 and 2, and the drop-off area and walkway to the east of Phase 6. To provide calmer conditions along the noted walkway, mitigation in the form of landscape elements, such as wind screens, decorative walls, and arrangements of coniferous trees along the east elevation of Phase 6, may be beneficial to reduce wind acceleration over the area. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

Existing Surface Parking South of Phase 2: Following the introduction of the proposed development, wind comfort conditions over the existing surface parking situated to the south of Phase 2 are predicted to be suitable for standing, or better, during the summer and autumn, with an isolated region suitable for strolling, becoming suitable for walking, or better, during the spring and winter. The noted conditions are considered acceptable.

Conditions over the surface parking lot under the existing massing are predicted to be suitable for standing, or better, throughout the year. While the introduction of the proposed development produces windier conditions over the noted area in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Existing Surface Parking Lots to the South, Southwest, and West of Subject Site: Following the introduction of the proposed development, conditions over the existing neighbouring surface parking lot situated to the south of the subject site are predicted to be suitable for mostly standing during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. Conditions over the existing neighbouring surface parking lots situated to the west and southwest of the subject site are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Under the existing massing, conditions over the noted surface parking lots are predicted to be suitable for standing, or better, throughout the year. While the introduction of the proposed development produces slightly windier conditions over the surface parking lot to the south, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Sandcastle Drive: Following the introduction of the proposed development, wind conditions over the nearby public sidewalks along Sandcastle Drive are predicted to be suitable for standing, or better during the summer and autumn, with isolated regions suitable for strolling, becoming suitable for a mix of standing and strolling during the spring and winter, with isolated regions suitable for walking. The noted conditions are considered acceptable.

Conditions over the sidewalks along Sandcastle Drive under the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and suitable for standing, or better, during the spring and winter. While the introduction of the proposed development produces windier conditions along Sandcastle Drive in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Parkland Dedication and Plaza: As illustrated in Figure 7, wind comfort conditions during the typical use period over the parkland dedication to the west of Phase 3-4 are predicted to be mixed between sitting and standing. Specifically, conditions suitable for sitting are predicted over the majority of the parkland dedication, and standing conditions are predicted to the north and south.

Conditions during the typical use period over the plaza to the east of Phase 5 are predicted to be suitable for mostly standing, with conditions predicted to be suitable for sitting to the west, as illustrated in Figure 7.

Depending on the programming of the parkland dedication and the plaza, the noted wind conditions may be considered acceptable. Specifically, if the noted windier areas will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable without mitigation.

If required by programming, comfort levels within the parkland dedication and the plaza may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation. The extent of mitigation measures is dependent on the programming of the noted spaces. As required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

Proposed Laneways, Drop-Off Areas, and Walkways Within Subject Site: Wind conditions over the proposed laneway and the adjoining walkways situated between Phases 5 and 6 are predicted to be suitable for strolling, or better, during the summer, with an isolated region suitable for walking, becoming suitable for a mix of standing, strolling, and walking, during the autumn, winter, and spring. Owing to prevailing northeasterly winds and winds from the west clockwise to the northwest that are predicted to accelerate beneath the shared podium during the spring and winter seasons, in combination with winds from the west clockwise to the northwest that are predicted to downwash over the western façades of Phases 5 and 6 and accelerate around the southwest corner of Phase 6, an isolated region of conditions that may occasionally be considered uncomfortable for walking is predicted between Phases 5 and 6 during the spring and winter seasons.

Specifically, conditions in the noted area are also predicted to be suitable for walking for approximately 78% and 75% of the time during the spring and winter seasons, respectively, representing 2% and 5% exceedances of the walking threshold. The noted conditions are predicted to impact sections of the proposed laneway between Phases 5 and 6, and the walkway and the secondary building access points along the north elevation of Phase 5.

To provide calmer conditions along the walkway beneath the podium, the introduction of mitigation elements such as canopies and wind screens or decorative walls at the northwest and southwest corners of Phases 5 and 6, respectively, may be beneficial to deflect downwash incident on the west elevation of the towers and to reduce wind acceleration at the noted corners. If required, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

Conditions over the proposed laneway situated between Phases 3-4 and 5 are predicted to be suitable for a mix of standing and strolling during the summer and autumn, becoming suitable for a mix of strolling and walking during the spring and winter. Conditions over the drop-off area to the northwest of Phase 3-4 are predicted to be suitable for mostly strolling, or better, during the summer and autumn, and suitable for walking during the spring and winter, while conditions over the drop-off area to the east of Phase 5 are predicted to be suitable for a mix of standing and strolling during the summer, becoming suitable for a mix of strolling and walking throughout the remainder of the year. Conditions over the remaining walkways within the subject site are predicted to be suitable for walking, or better, throughout the year.

Building Access Points: Wind conditions in the vicinity of the commercial entrances near the northwest corner of Phase 3-4 are predicted to be suitable for standing during the summer, becoming suitable for strolling during the autumn, and suitable for a mix of strolling and walking during the spring and winter. Conditions in the vicinity of the secondary building access points along the north elevation of Phase 5 are predicted to be suitable for a mix of standing and strolling during the summer, becoming suitable for a mix of strolling and walking during the autumn, and suitable for a mix of walking and conditions that may occasionally be considered uncomfortable for walking during the spring and winter. Conditions in the vicinity of the commercial entrance along the east elevation of Phase 6 are predicted to be suitable for strolling, or better, during the summer and autumn, becoming suitable for a mix of standing, strolling, and walking during the spring and winter. Conditions in the vicinity of the commercial entrance to the southwest of Phase 6 are predicted to be suitable for standing during the summer, a mix of standing and strolling during the autumn, and strolling and walking during the spring and winter. It is recommended to recess the noted entrances into their respective façades by at least 2 m.

Conditions in the vicinity of the remaining building access points serving the proposed development are predicted to be suitable for standing, or better, which is considered acceptable.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Wind comfort conditions within the common amenity terraces serving Phase 3-4 at Level 2 and Phases 5 and 6 at Level 4 and recommendations regarding mitigation, where required, are described as follows:

Phase 3-4, Level 2 Amenity Terrace: Wind conditions within the common amenity terrace serving Phase 3-4 at Level 2 are predicted to be suitable for sitting throughout the year, which is considered acceptable.

Phases 5 and 6, Level 4 Amenity Terrace: The Level 4 amenity terrace serving Phases 5 and 6 was modelled with a 1.8-m-tall wind screen along its full perimeter. During the typical use period, wind conditions within the terrace are predicted to be mostly mixed between standing and strolling, as illustrated in Figure 11. Specifically, conditions suitable for sitting are predicted closer to the tower façades, regions of strolling conditions are predicted to the southwest and northwest of Phase 5 and over the central terrace area, an isolated region of walking conditions is predicted to the northwest of Phase 5, and standing conditions are predicted throughout the remainder of the terrace.

To improve comfort levels within the Level 4 amenity terrace, it is recommended to implement taller wind screens along select perimeters of the terrace, the placement of which would be programming-dependant. Specifically, 2.4-m-tall wind screens, typically glazed and solid, are recommended.

Furthermore, mitigation inboard of the perimeter, which could take the form of 1.8-m-tall wind screens or clusters of coniferous plantings located around sensitive areas, and canopies located above designated seating areas, are recommended to further improve wind comfort conditions within the terrace. Additionally, canopies that wrap around the northwest corners of the Phase 5 tower above the terrace may be beneficial to deflect downwash incident on the terrace from prevailing winds from the western compass quadrants.

The extent of the mitigation measures is dependent on the programming of the noted terrace. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within or surrounding the subject site are expected to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-11. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, the existing surface parking serving Phases 1 and 2, neighbouring existing surface parking lots, in the vicinity of most building access points, and over most proposed laneways, walkways, and drop-off areas are considered acceptable.

    a. The proposed development is exposed to prevailing winds from multiple directions, particularly prevailing winds from the southwest clockwise to the northwest which are predicted to downwash over the western façades of Phases 5 and 6 towards grade, channel beneath the shared podium serving Phases 5 and 6 and between Phase 1 and 6, and accelerate around the northeast and southwest corner of Phase 6.

b. Regions of conditions that may occasionally be considered uncomfortable for walking during the spring and winter seasons are situated to the east of Phase 6 and beneath the shared podium serving Phases 5 and 6.

   - The region to the east of Phase 6 is predicted to impact isolated sections of the existing laneway shared with Phases 1 and 2 and the drop-off area and walkway to the east of Phase 6, while the region beneath the shared podium is predicted to impact isolated sections of the proposed east-west laneway and the walkway and building access points along the north elevation of Phase 5.
   - To provide calmer conditions along the walkway to the east of Phase 6, the introduction of mitigation elements such as wind screens, decorative walls, or arrangements of coniferous trees along the east elevation of Phase 6 may be beneficial to reduce wind acceleration over the area. Additionally, canopies and wind screens or decorative walls placed at the northwest and southwest corners of Phases 5 and 6, respectively, may be beneficial to deflect downwash incident on the west elevation of the towers and to reduce wind acceleration at the noted corners.
   - An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

c. It is recommended to recess the commercial entrance near the northwest corner of Phase 3-4, the building access points along the north elevation of Phase 5, and the commercial entrances along the east elevation of Phase 6 and at the southwest corner of Phase 6 into their respective façades by at least 2 m, owing to the windier conditions in the vicinity of these entrances.

2) During the typical use period, (that is, May to October, inclusive) wind comfort conditions over the parkland dedication to the west of Phase 3-4 and the plaza to the east of Phase 5 are predicted to be suitable for a mix of sitting and standing.

a. Depending on the programming of the parkland dedication and plaza, the noted wind conditions may be considered acceptable. Specifically, if the windier areas within these spaces will not accommodate seating or more sedentary activities, the noted wind conditions would be considered acceptable. As required by programming, comfort levels may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

b. The extent of mitigation measures is dependent on the programming of the noted spaces. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses.

3) Regarding the common amenity terrace serving Phase 3-4 at Level 2, wind comfort conditions are predicted to be suitable for sitting throughout the year, which is considered acceptable.

4) During the typical use period (May to October, inclusive), wind conditions within the common amenity terrace serving Phases 5 and 6 at Level 4 are predicted to be suitable for mostly a mix of standing and strolling, with sitting conditions predicted close to the tower façades and an isolated region suitable for walking to the northwest of Phase 5. Notably, the Level 4 amenity terrace was modelled with 1.8-m-tall wind screens along its full perimeter.

a. To improve comfort levels within the Level 4 amenity terrace, it is recommended to implement taller wind screens along select perimeters of the terrace, typically glazed, rising to at least 2.4 m above the local walking surface. The placement of the taller screens would be programming-dependant. Additionally, mitigation inboard of the perimeter, which could take the form of 1.8-m-tall wind screens or clusters of coniferous plantings located around sensitive areas, and canopies located above designated seating areas, are recommended to further improve wind conditions within the terrace. Canopies extending above the terrace from the northwest elevations of the Phase 5 tower may also be beneficial to deflect downwash incident on the terrace.

b. The extent of the mitigation measures is dependent on the programming of the terrace. An appropriate mitigation strategy will continue to be developed and evolve in collaboration with the building and landscape architects as the design of the proposed development progresses.

5) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Sincerely,

Gradient Wind Engineering Inc.

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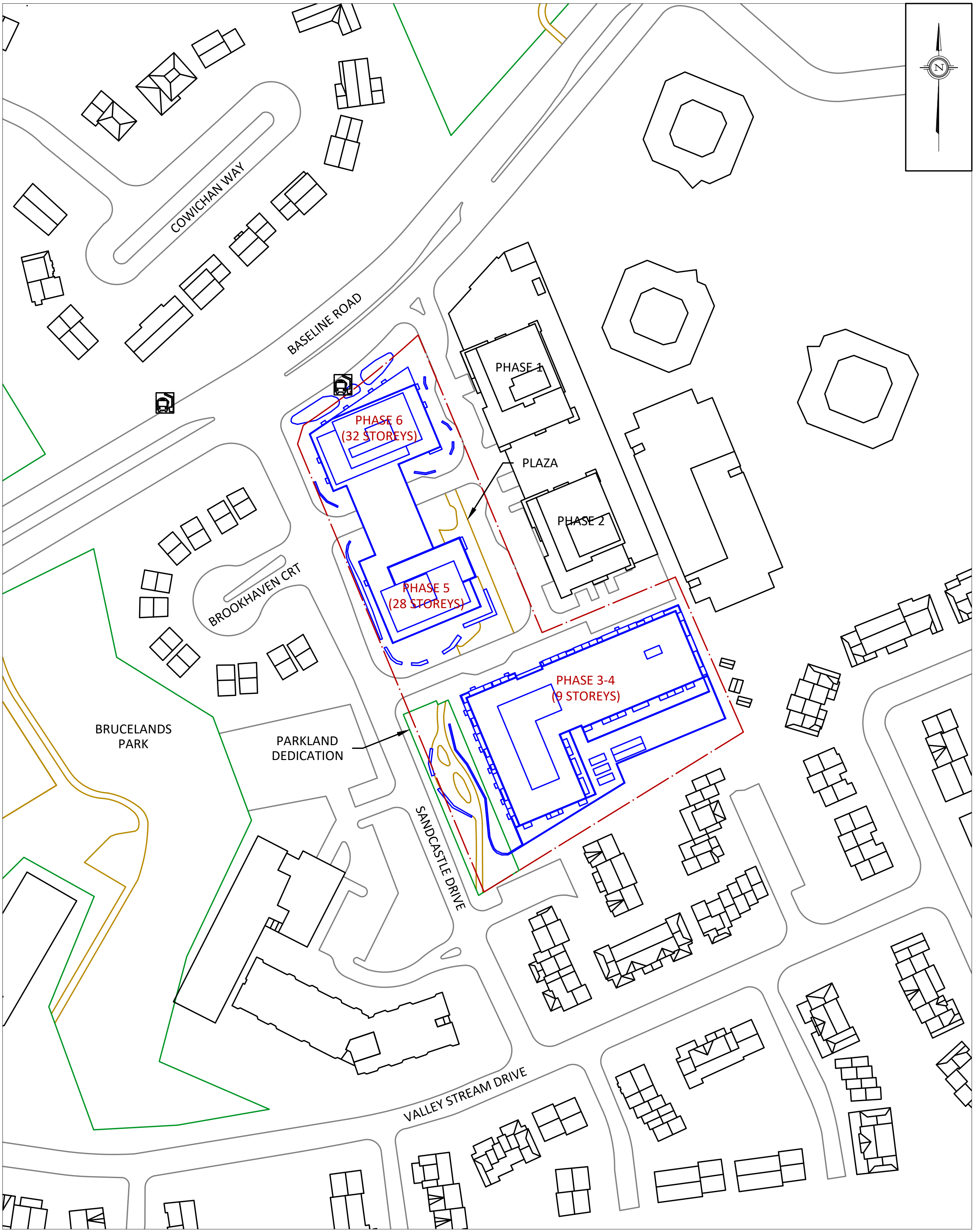

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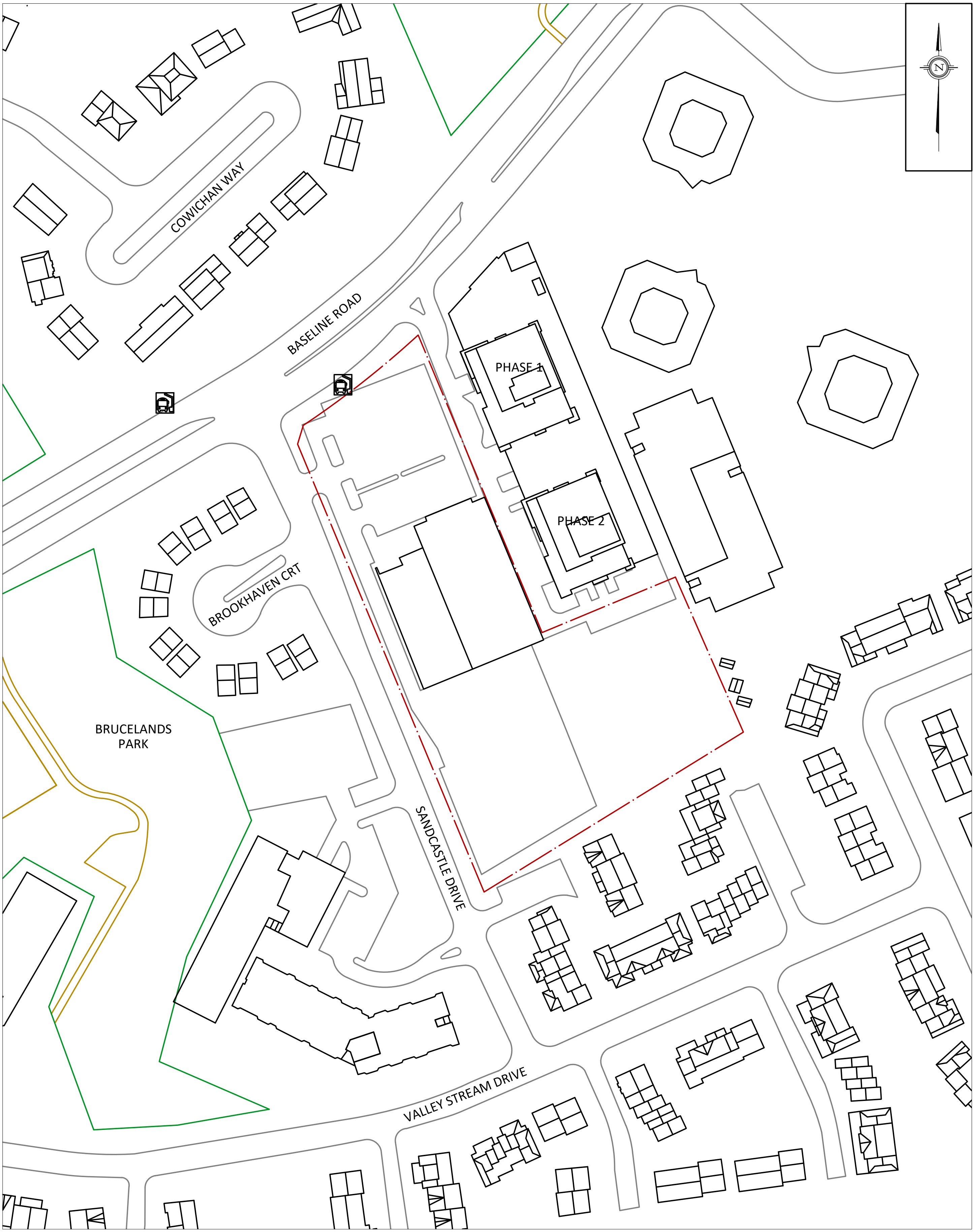
PROJECT	BASELINE TOWER PHASE 4-6, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:2000	DRAWING NO. 21-424-PLW-2024-1A	FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
DATE	JULY 18, 2024	DRAWN BY S.K.	



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PROJECT	BASELINE TOWER PHASE 4-6, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE	1:2000	DRAWING NO. 21-424-PLW-2024-1B	
DATE	JULY 18, 2024	DRAWN BY S.K.	

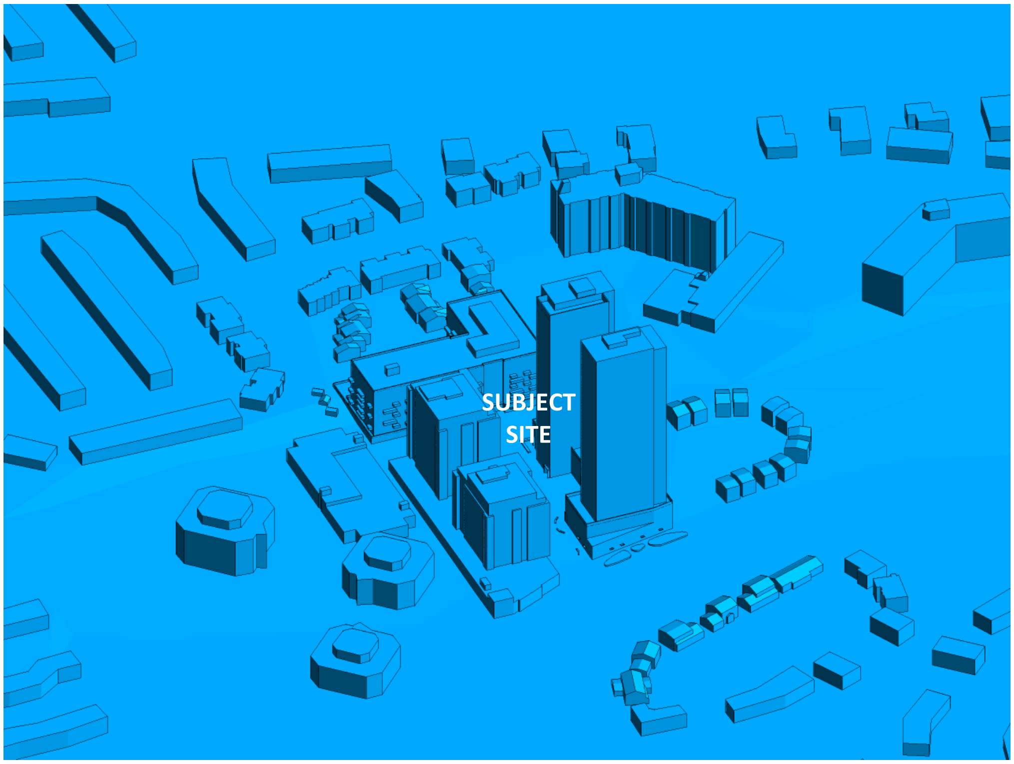


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

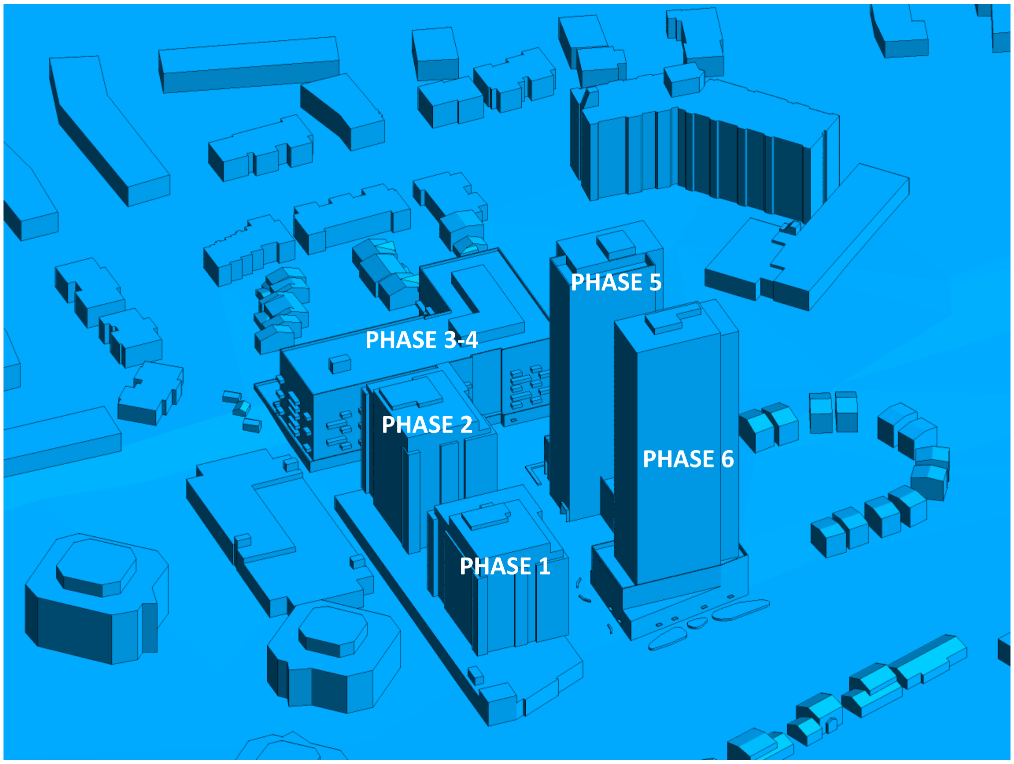


FIGURE 2B: CLOSE UP OF FIGURE 2A

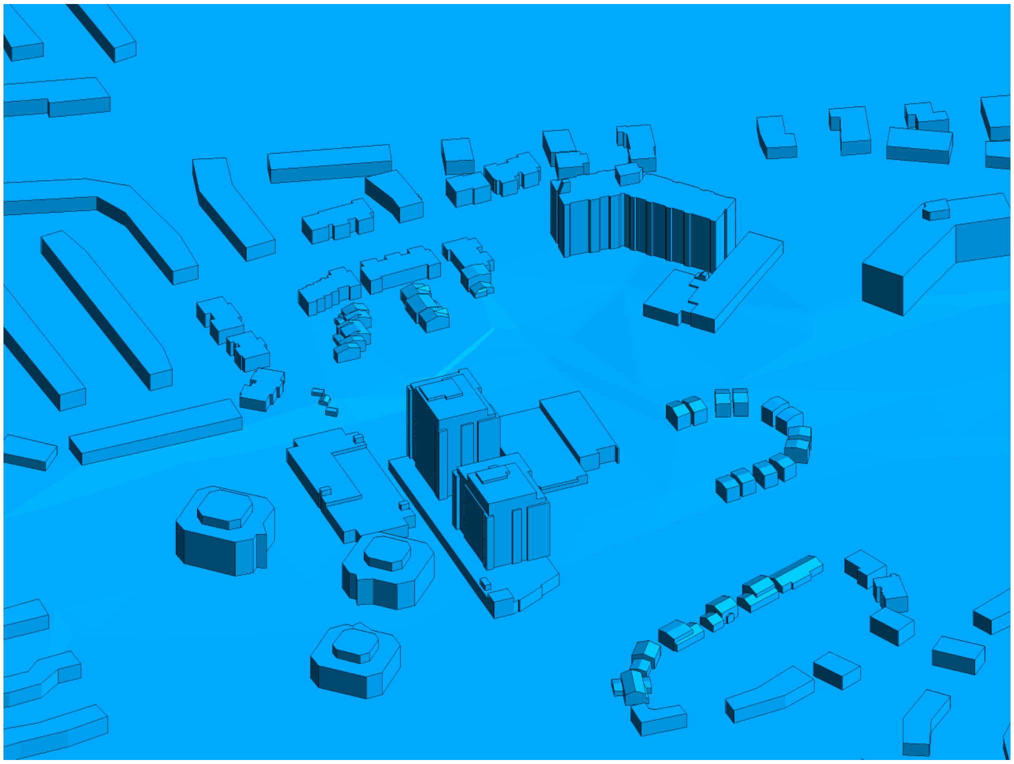


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

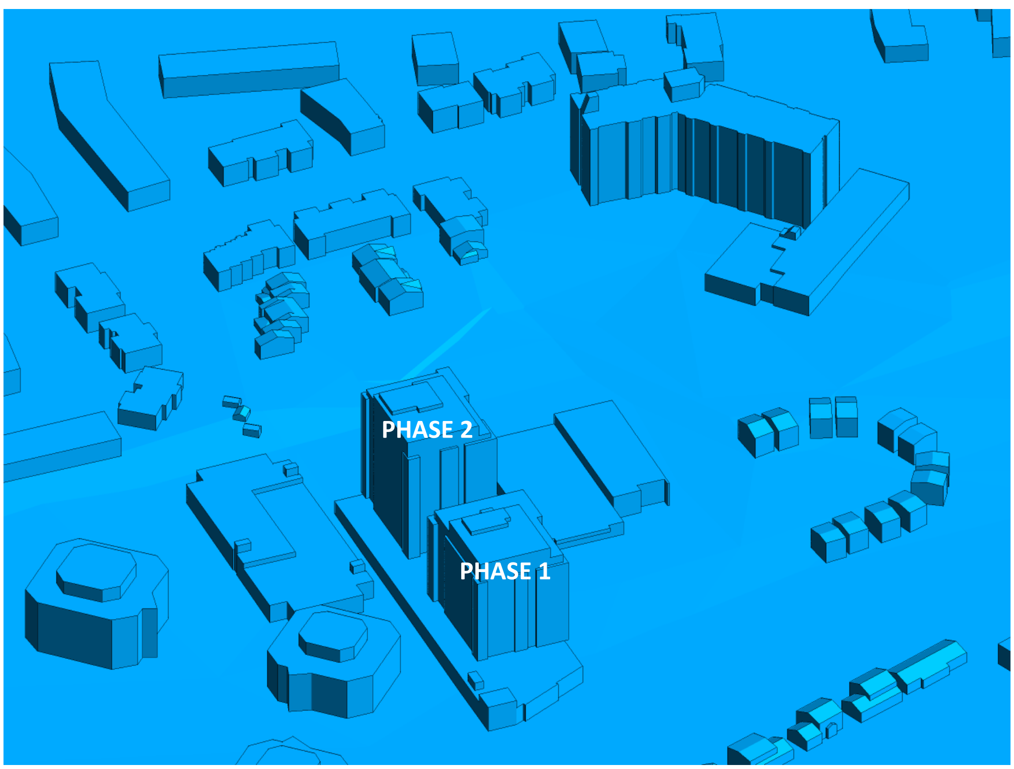


FIGURE 2D: CLOSE UP OF FIGURE 2C

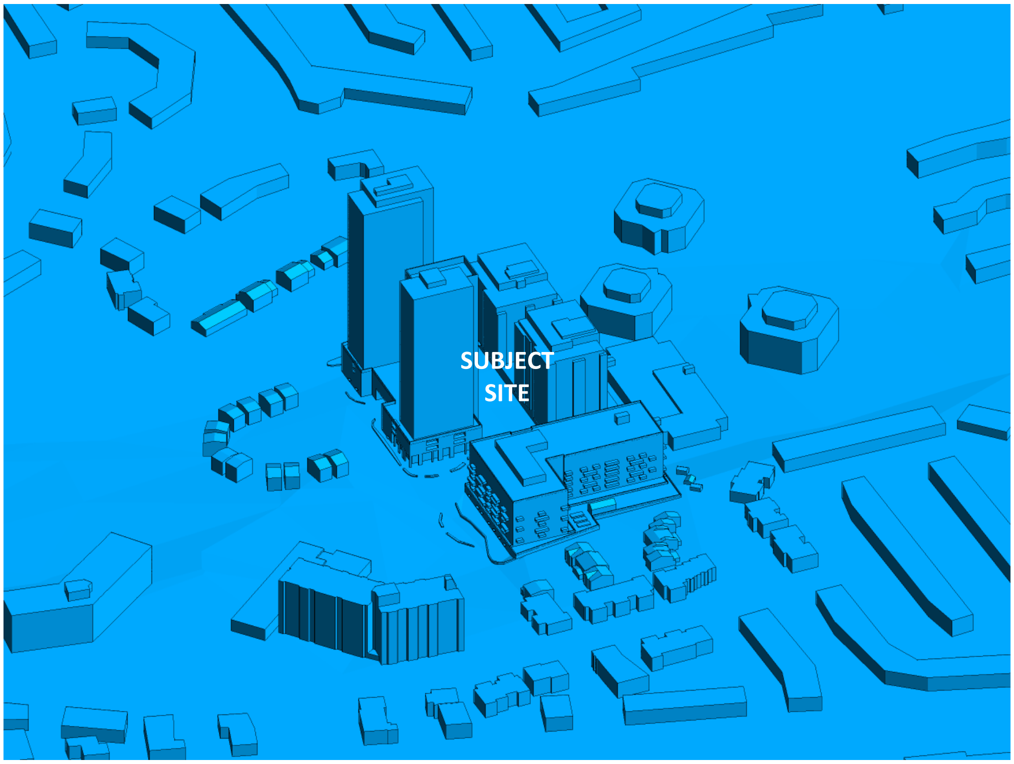


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

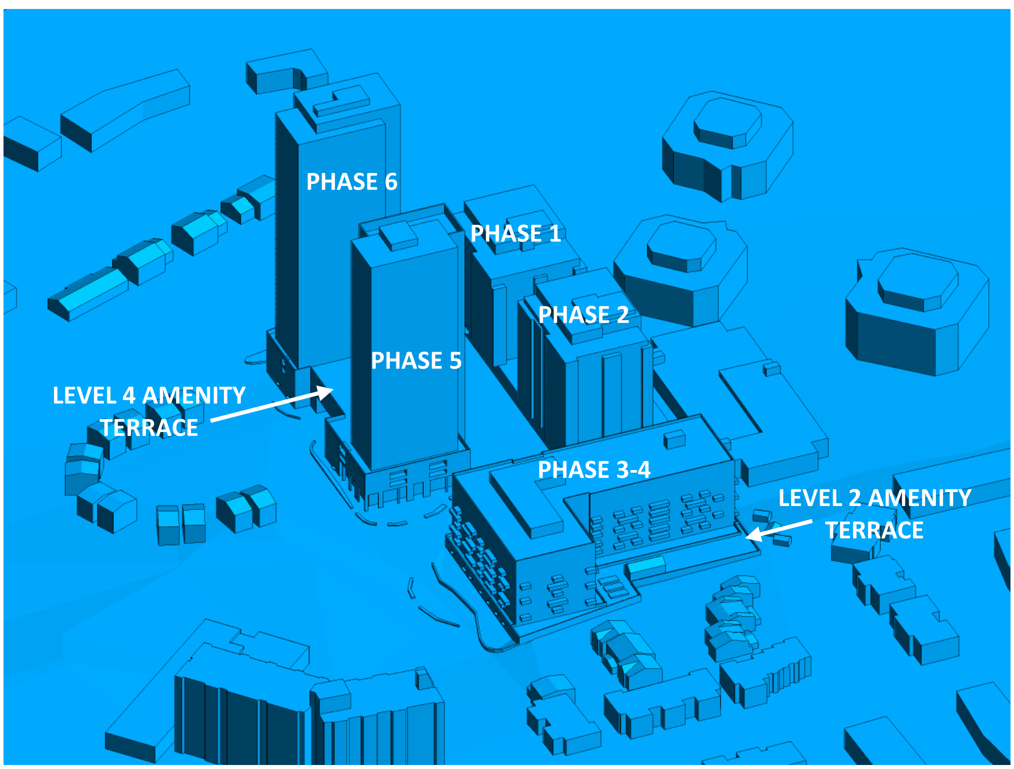


FIGURE 2F: CLOSE UP OF FIGURE 2E

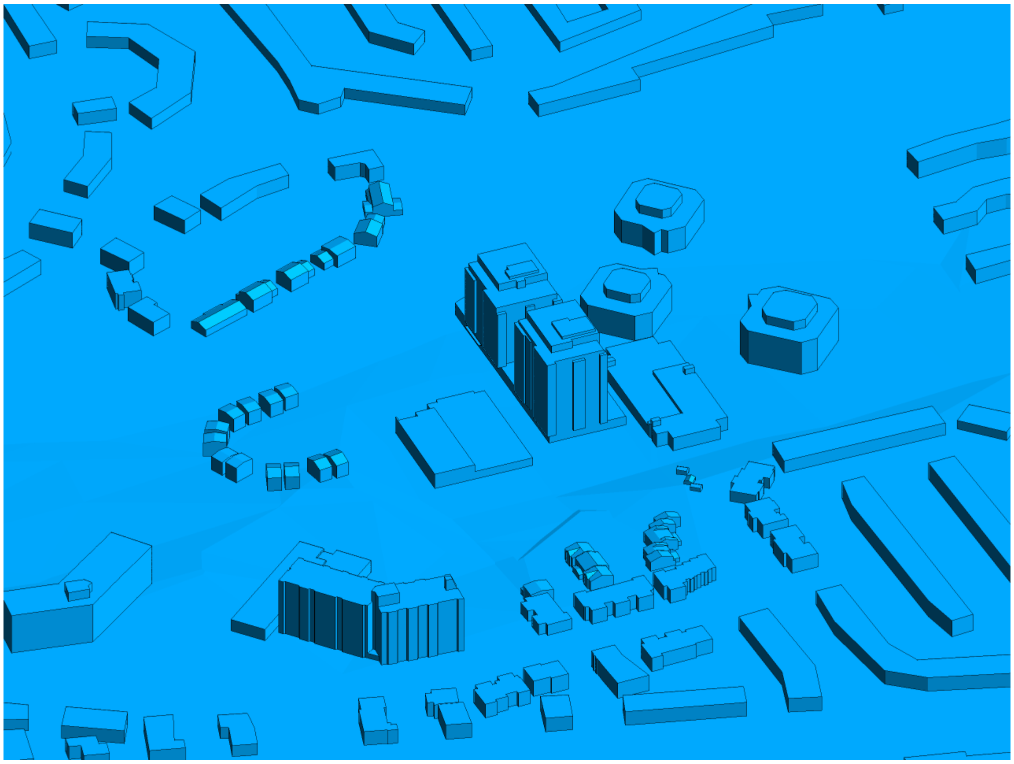


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

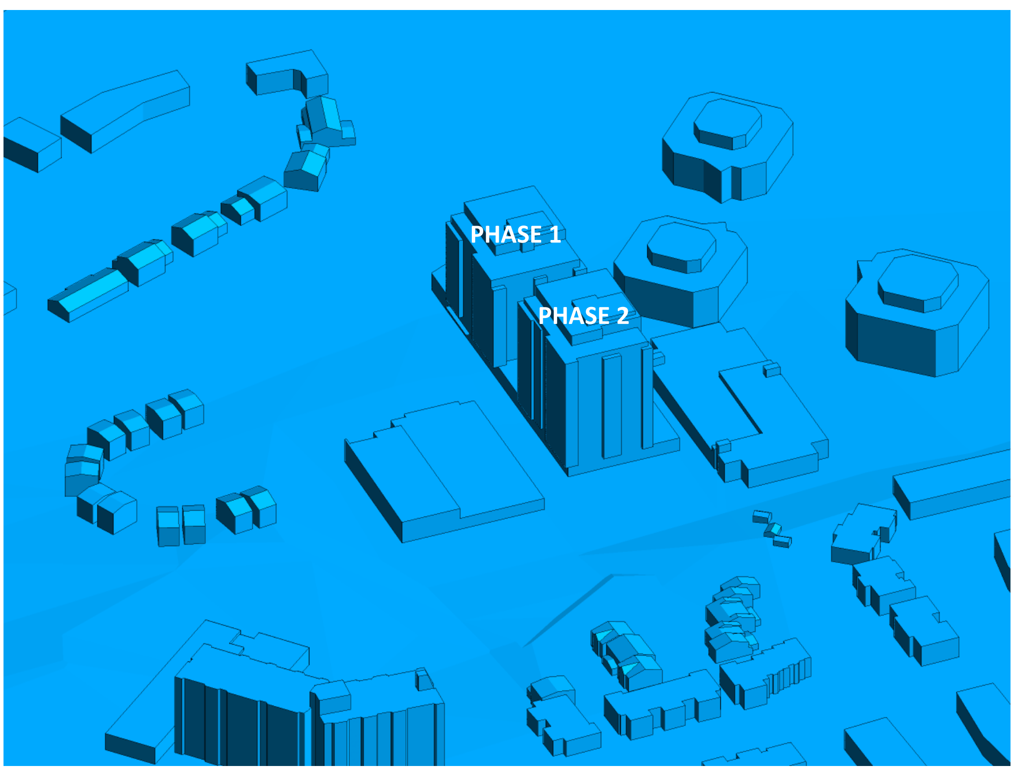


FIGURE 2H: CLOSE UP OF FIGURE 2G

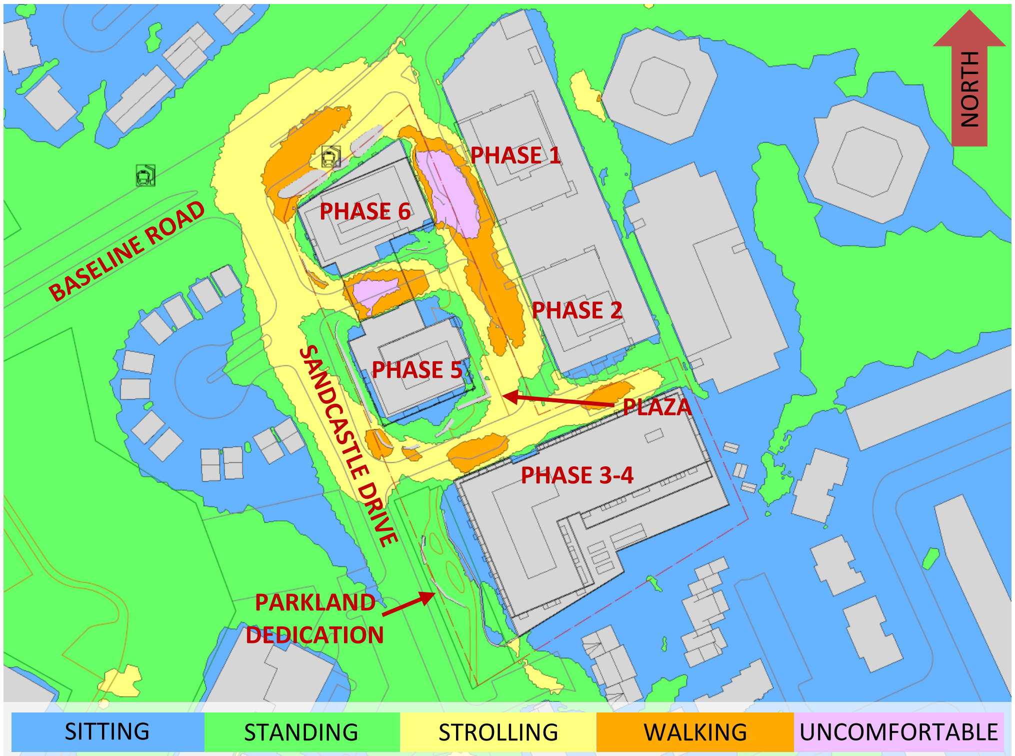


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

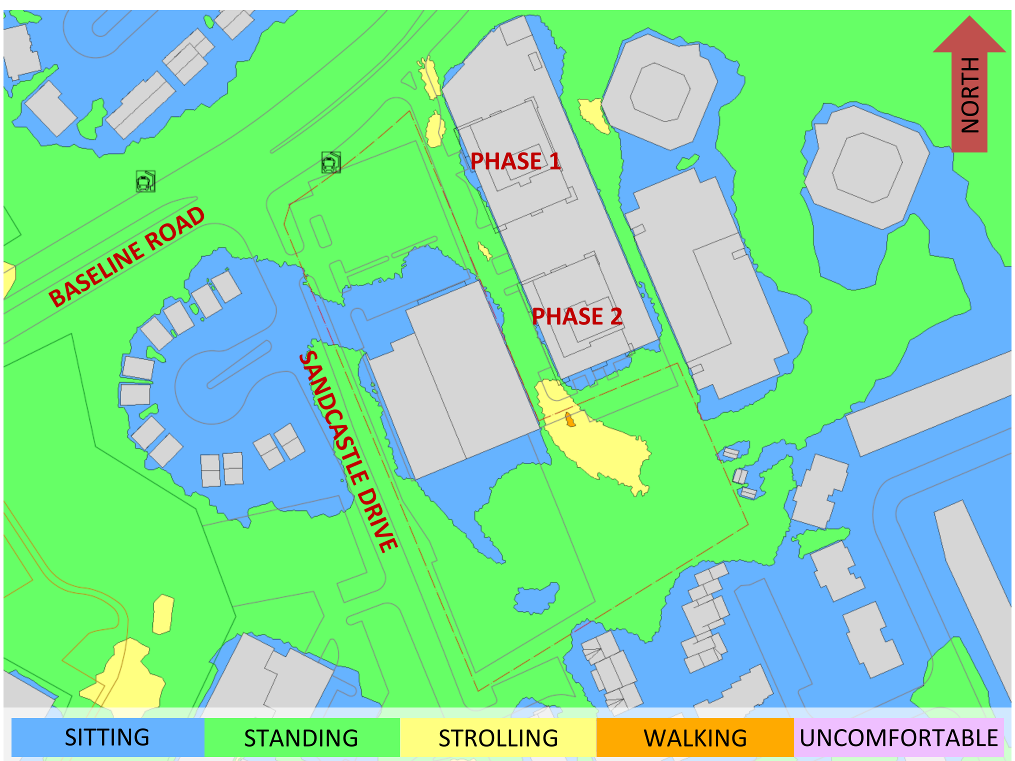


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

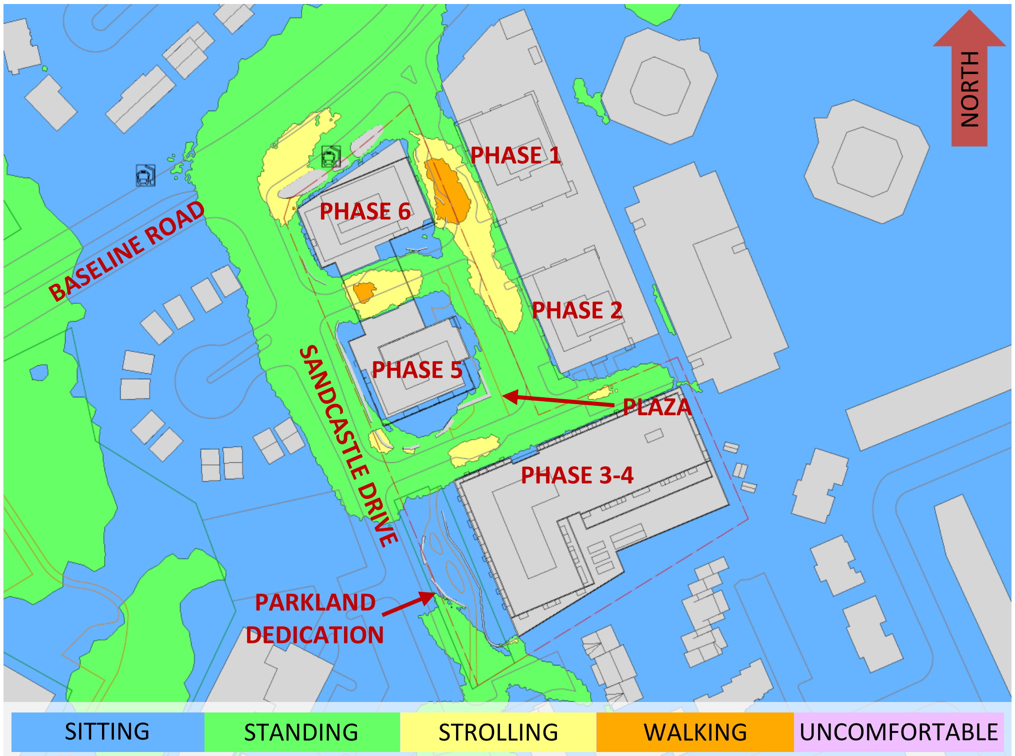


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

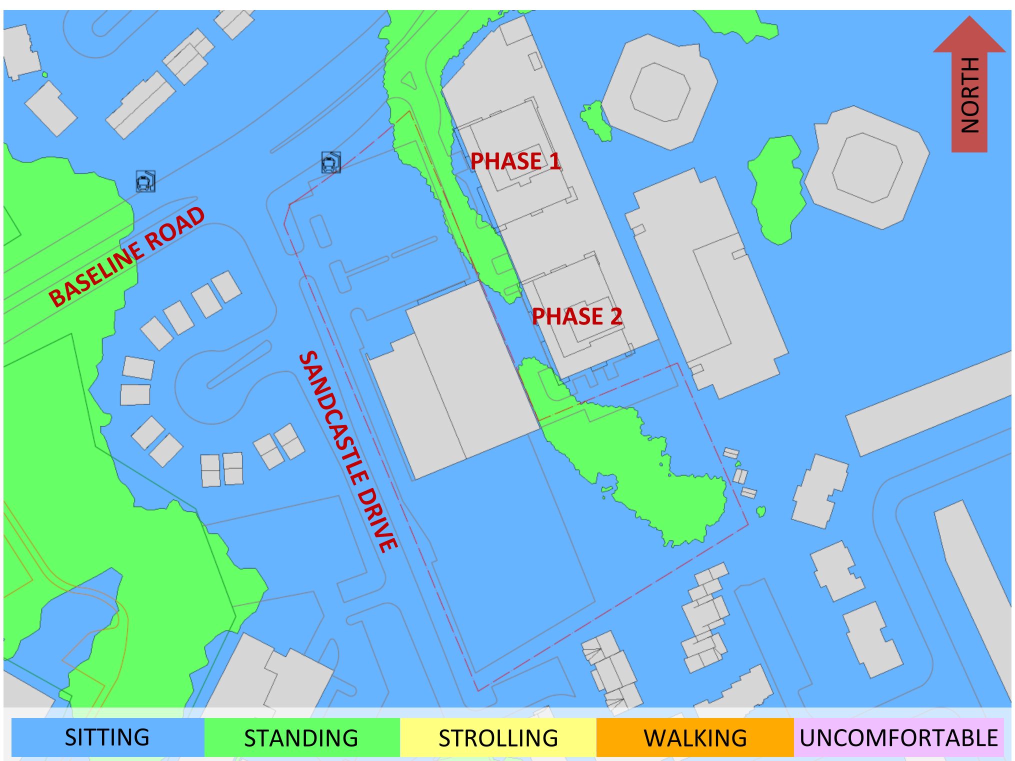


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

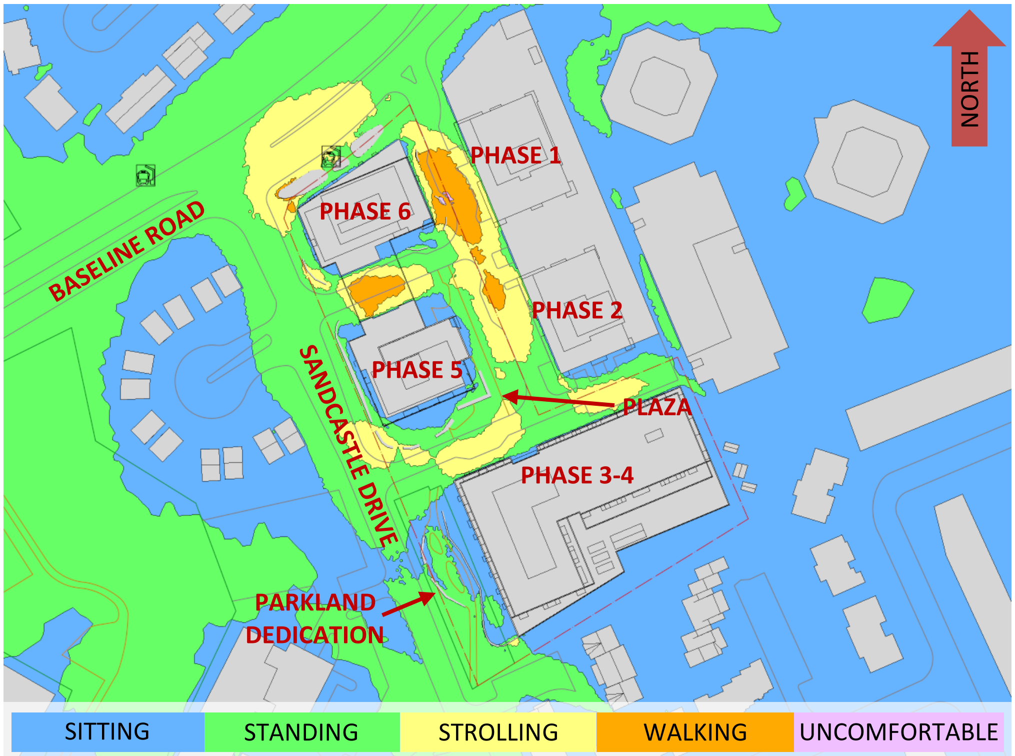


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

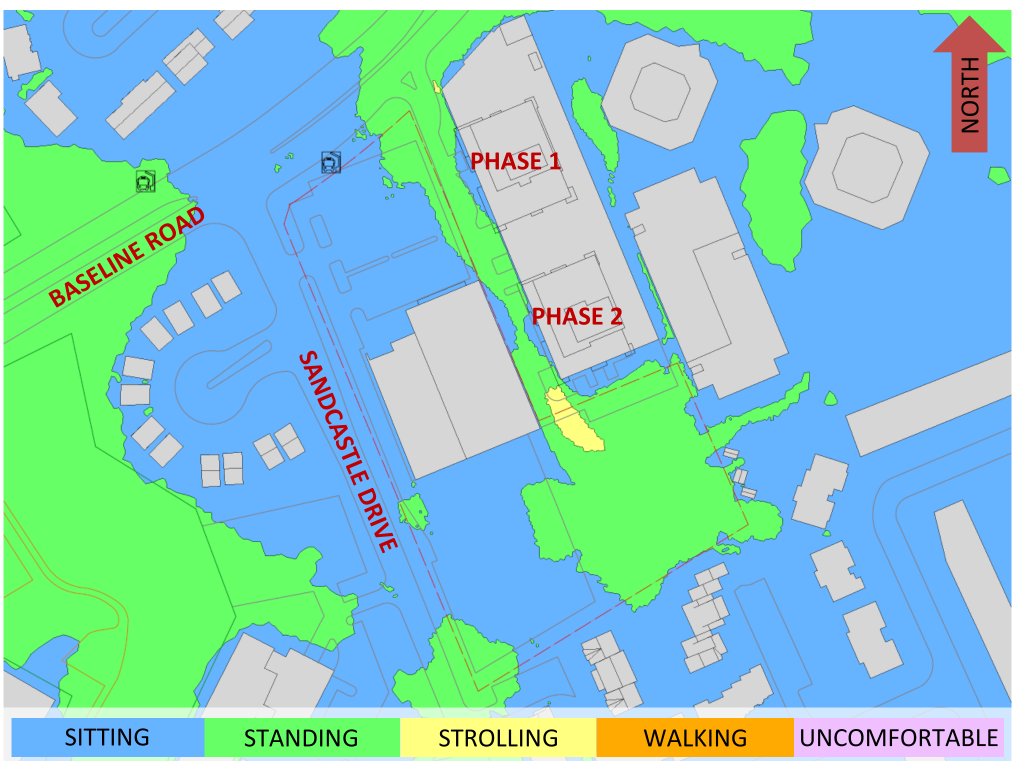


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

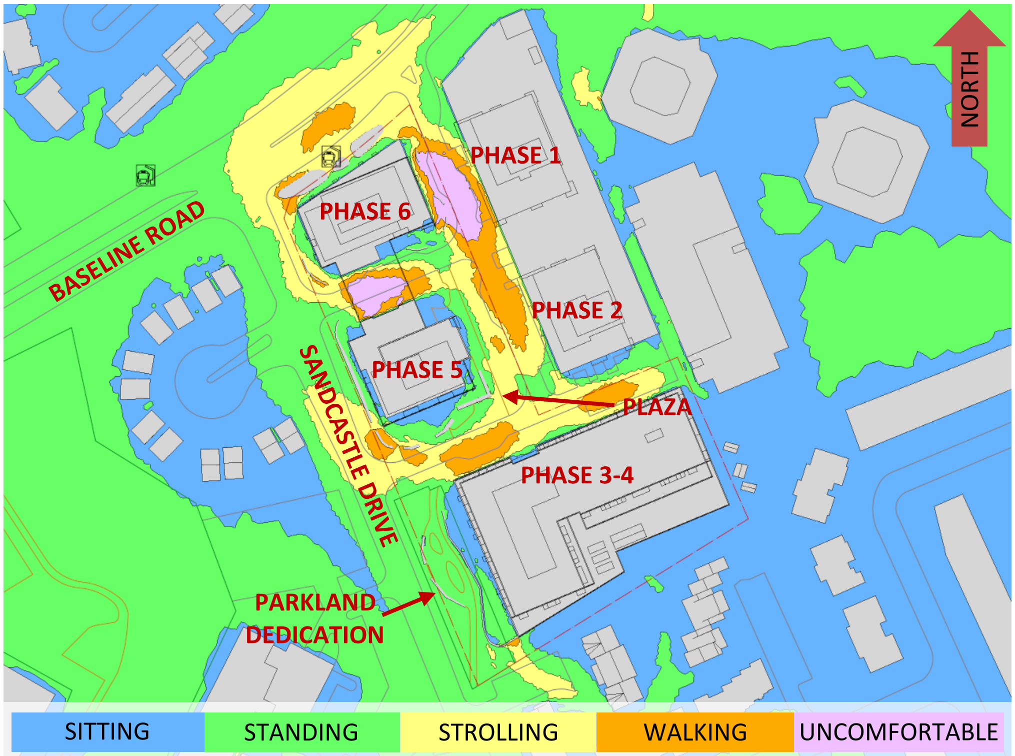


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

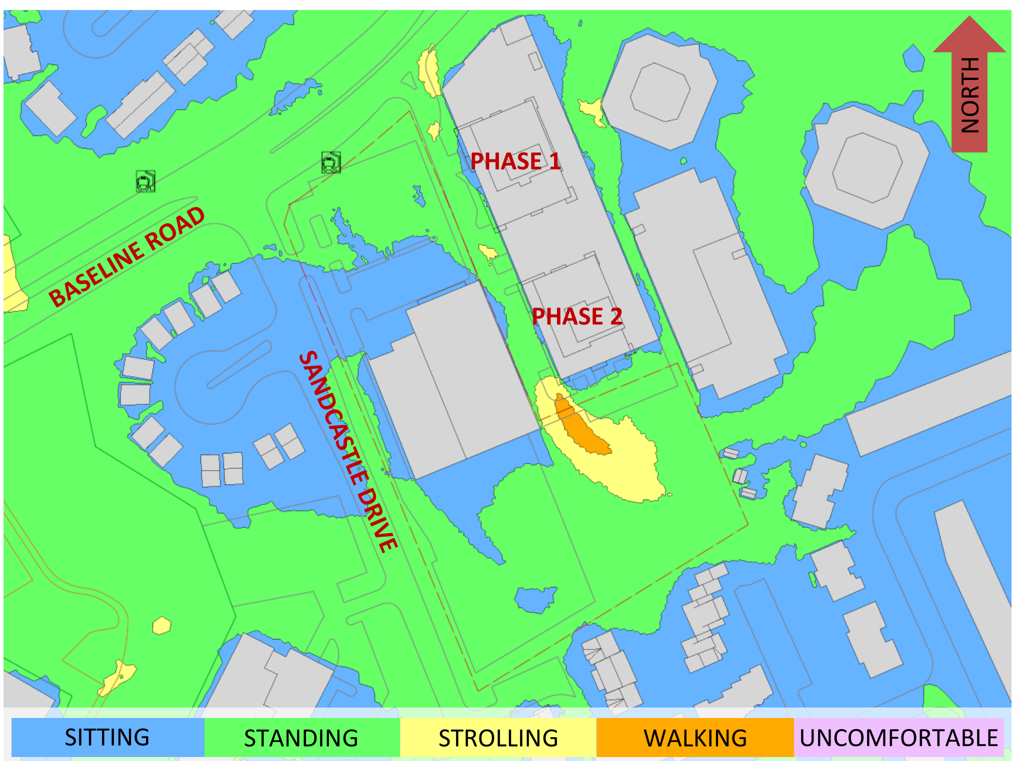


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

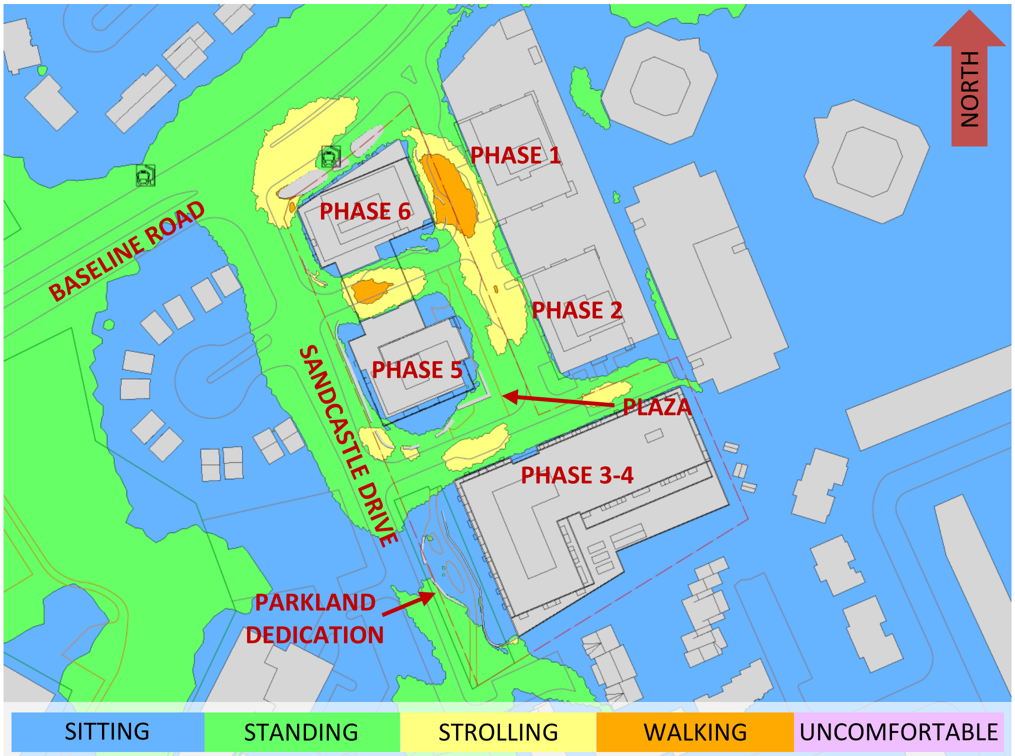


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

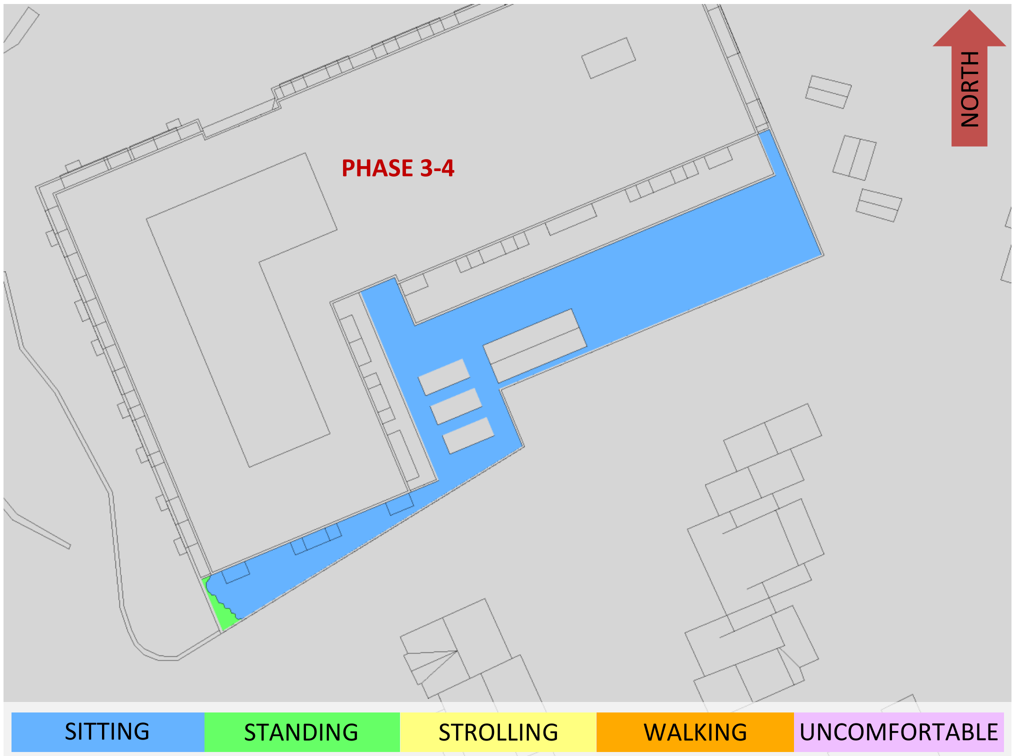


FIGURE 8A: SPRING – WIND COMFORT, PHASE 3-4 LEVEL 2 AMENITY TERRACE

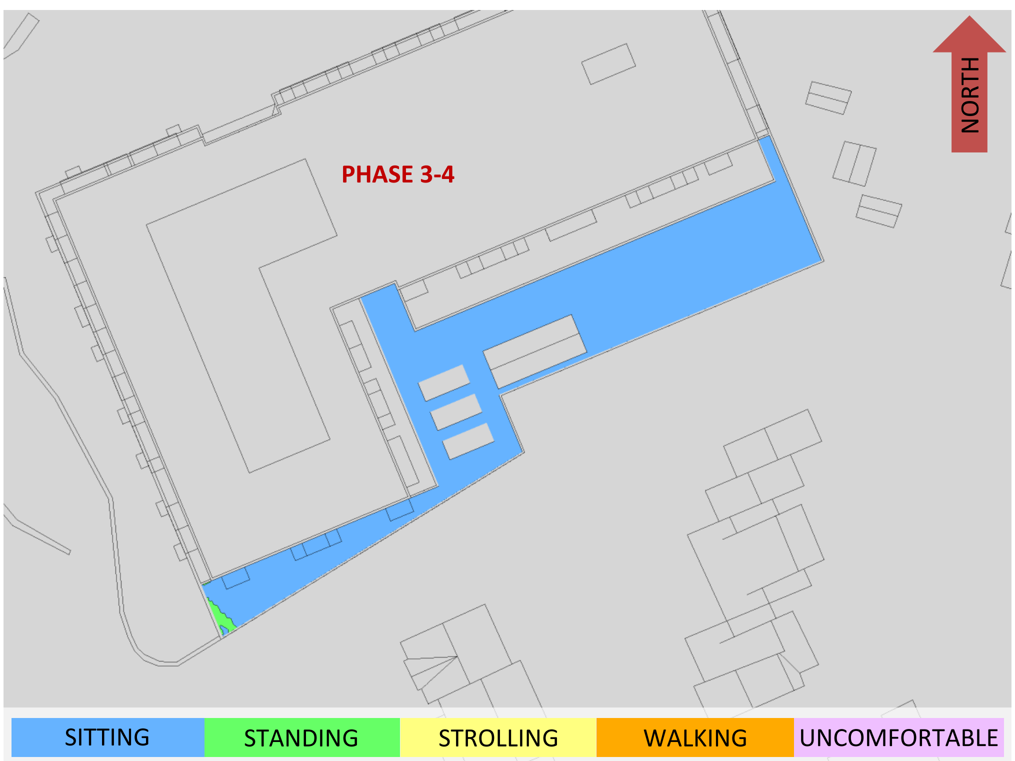


FIGURE 8B: SUMMER – WIND COMFORT, PHASE 3-4 LEVEL 2 AMENITY TERRACE

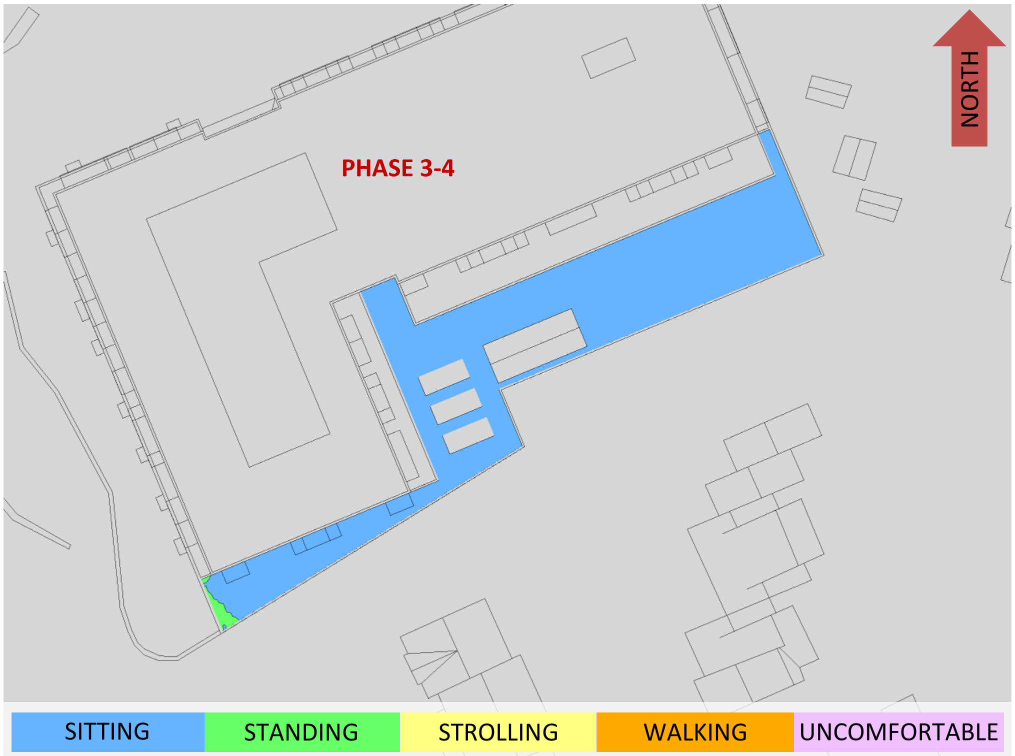


FIGURE 8C: AUTUMN – WIND COMFORT, PHASE 3-4 LEVEL 2 AMENITY TERRACE

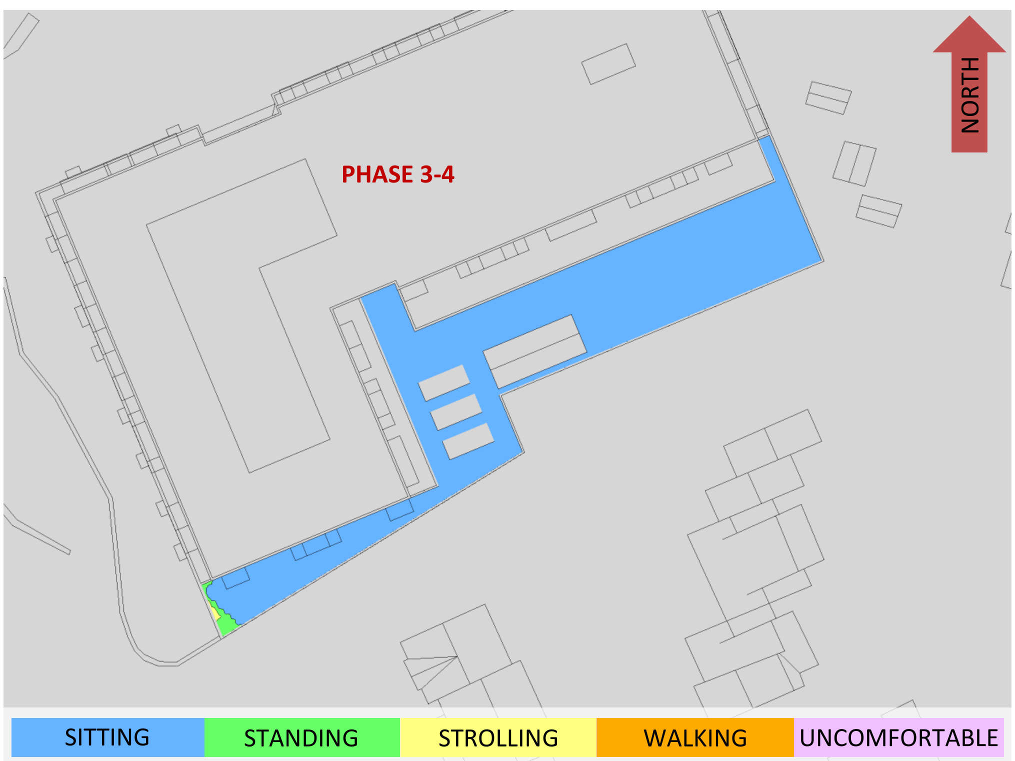


FIGURE 8D: WINTER – WIND COMFORT, PHASE 3-4 LEVEL 2 AMENITY TERRACE

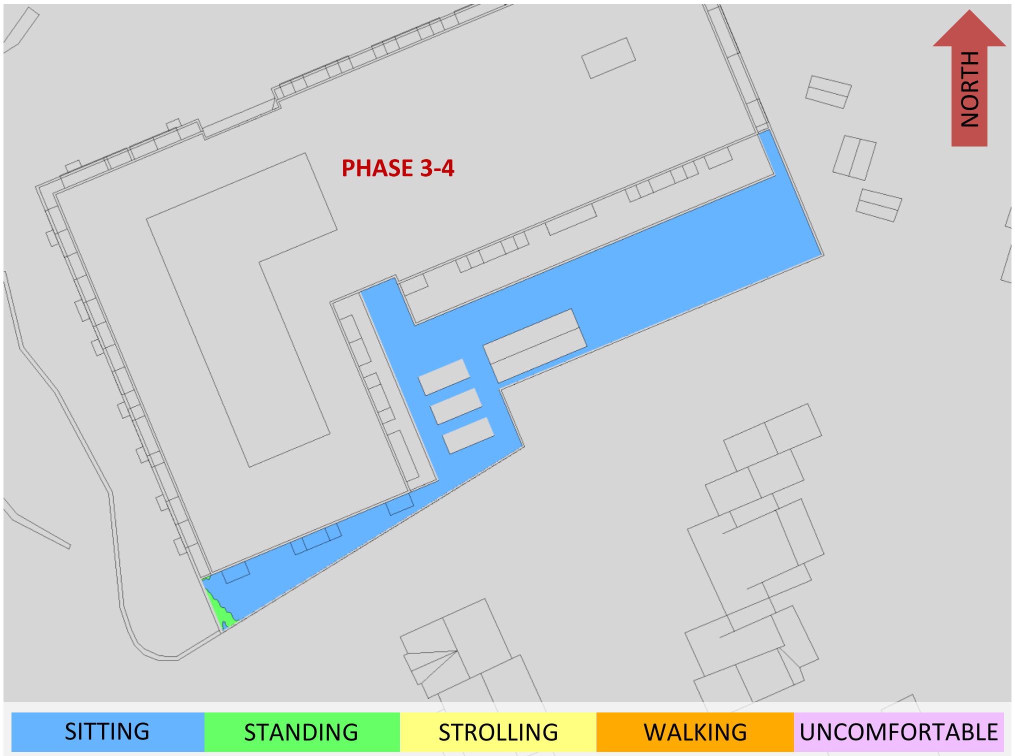


FIGURE 9: TYPICAL USE PERIOD – PHASE 3-4 LEVEL 2 AMENITY TERRACE

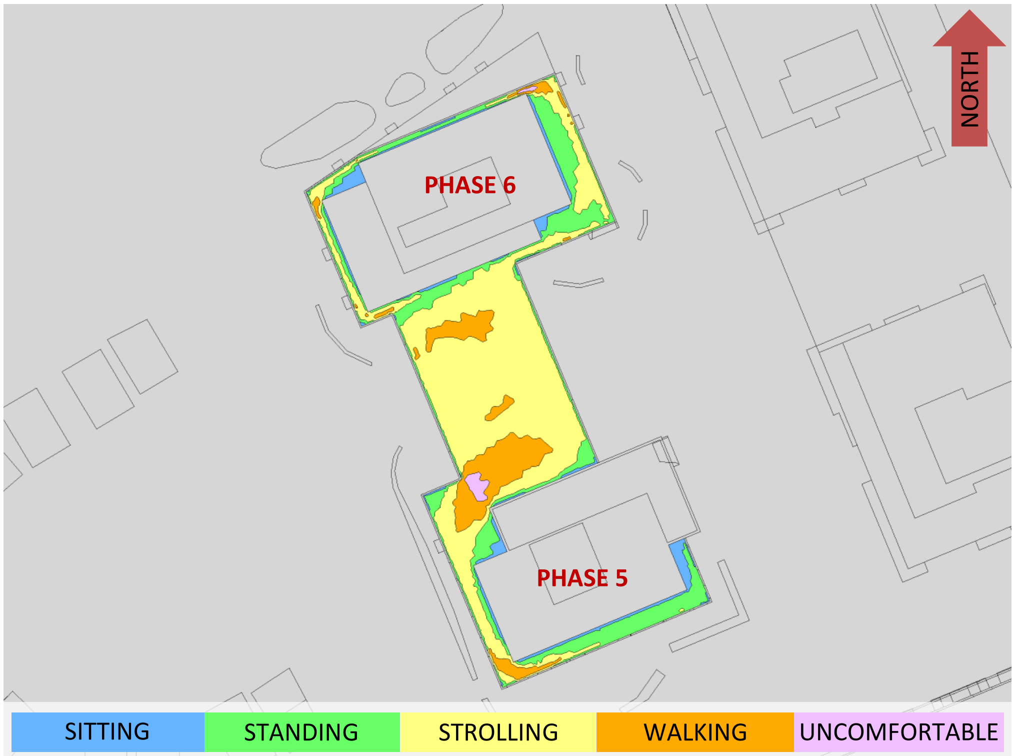


FIGURE 10A: SPRING – WIND COMFORT, PHASES 5 AND 6 LEVEL 4 AMENITY TERRACE

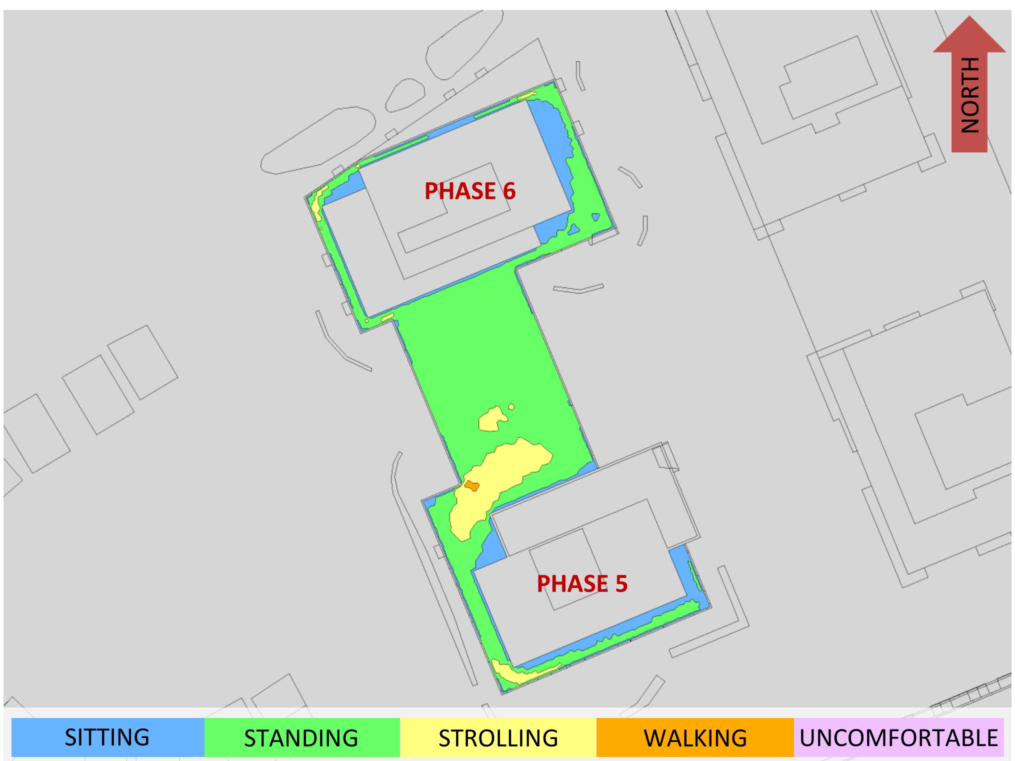


FIGURE 10B: SUMMER – WIND COMFORT, PHASES 5 AND 6 LEVEL 4 AMENITY TERRACE

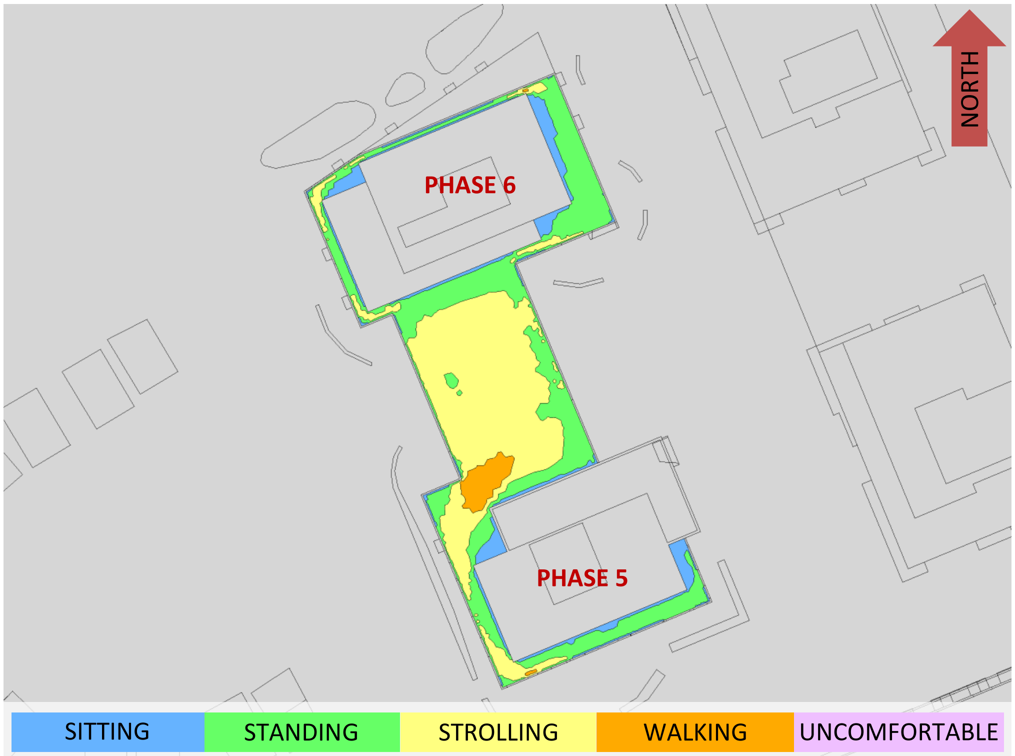


FIGURE 10C: AUTUMN – WIND COMFORT, PHASES 5 AND 6 LEVEL 4 AMENITY TERRACE

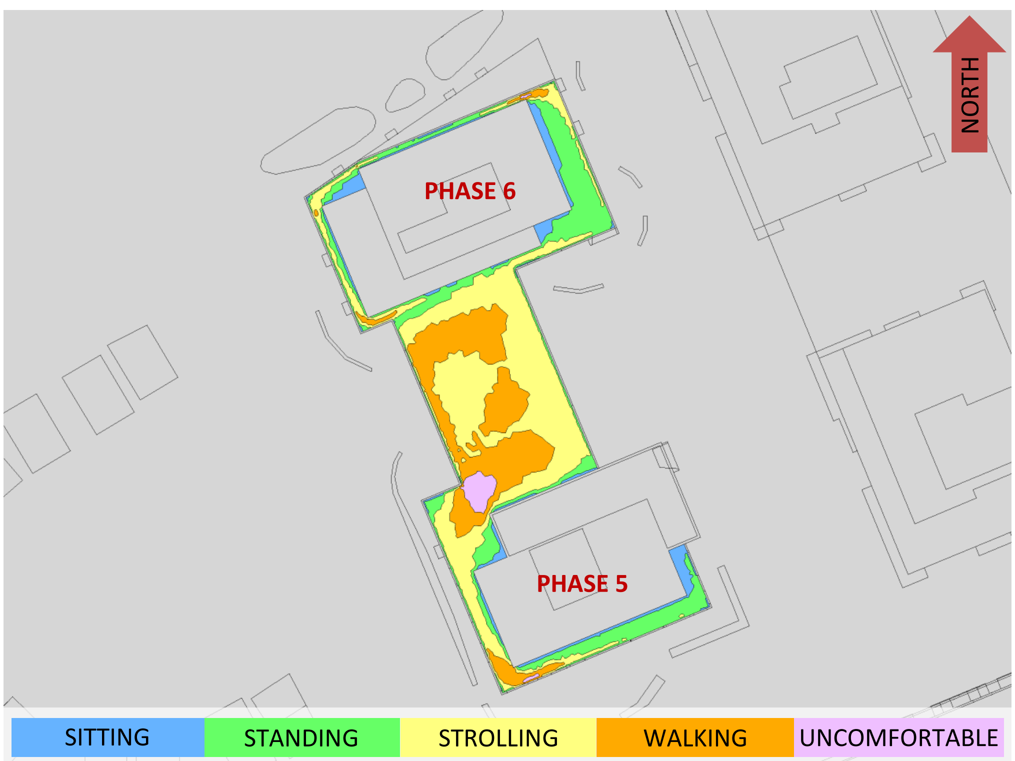


FIGURE 10D: WINTER – WIND COMFORT, PHASES 5 AND 6 LEVEL 4 AMENITY TERRACE

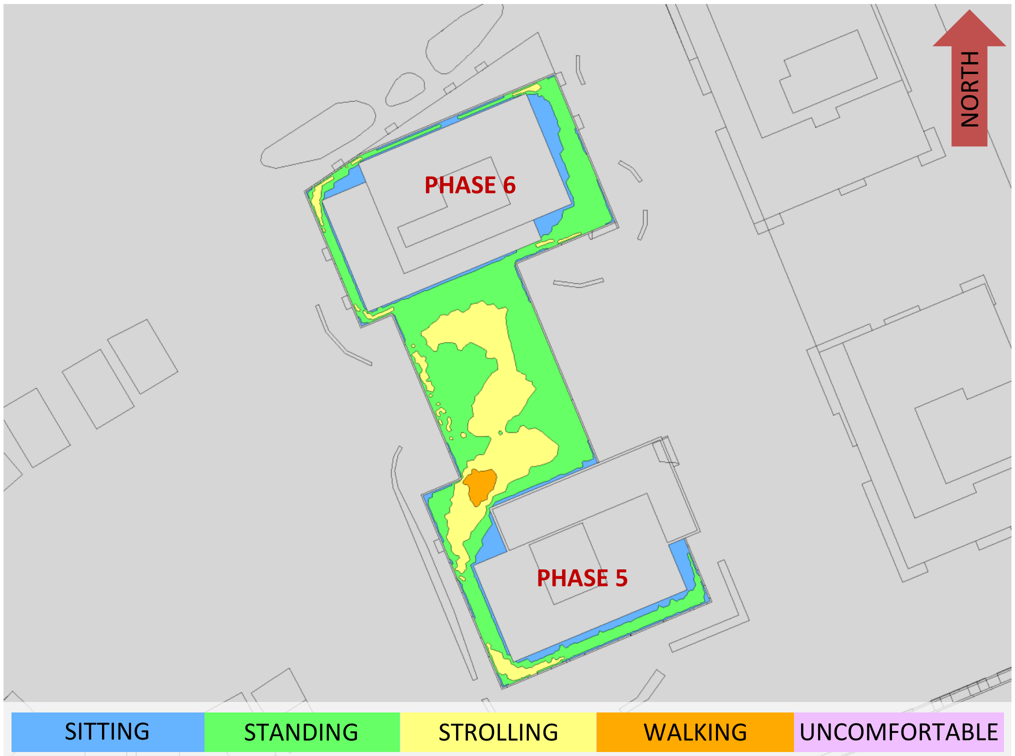
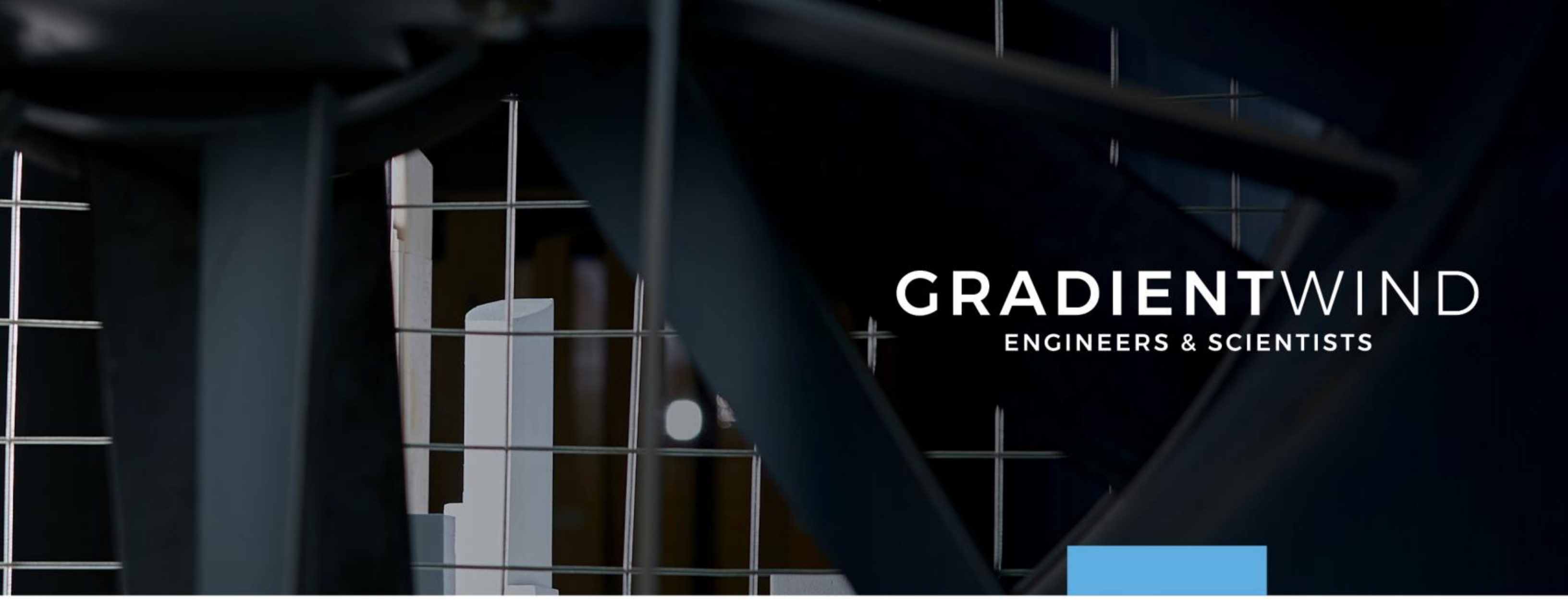
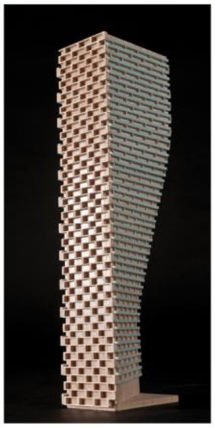
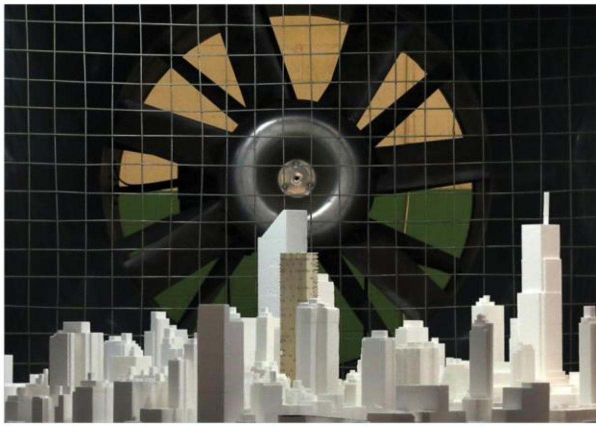


FIGURE 11: TYPICAL USE PERIOD – PHASES 5 AND 6 LEVEL 4 AMENITY TERRACE







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

The atmospheric boundary layer (ABL) is defined by the velocity and turbulence profiles according to industry standard practices. The mean wind profile can be represented, to a good approximation, by a power law relation, Equation (1), giving height above ground versus wind speed (1), (2).

$$U = U_g \left(\frac{Z}{Z_g} \right)^{\alpha} \qquad \text{Equation (1)}$$

where, $\boldsymbol{U}$ = mean wind speed, $\boldsymbol{U_g}$ = gradient wind speed, $\boldsymbol{Z}$ = height above ground, $\boldsymbol{Z_g}$ = depth of the boundary layer (gradient height), and α is the power law exponent.

For the model, U_g is set to 6.5 metres per second, which approximately corresponds to the 60% mean wind speed for Ottawa based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

Z_g is set to 540 m. The selection of gradient height is relatively unimportant, so long as it exceeds the building heights surrounding the subject site. The value has been selected to correspond to our physical wind tunnel reference value.

α is determined based on the upstream exposure of the far-field surroundings (that is, the area that it not captured within the simulation model).

Table 1 presents the values of α used in this study, while Table 2 presents several reference values of α. When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the α values are a weighted average with terrain that is closer to the subject site given greater weight.

TABLE 1: UPSTREAM EXPOSURE (ALPHA VALUE) VS TRUE WIND DIRECTION

Wind Direction (Degrees True)	Alpha Value (α)
0	0.25
22.5	0.25
45	0.25
67.5	0.24
90	0.24
112.5	0.23
135	0.22
157.5	0.21
180	0.19
202.5	0.29
225	0.21
247.5	0.21
270	0.20
292.5	0.20
315	0.21
337.5	0.22

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	Alpha Value (α)
Open Water	0.14-0.15
Open Field	0.16-0.19
Light Suburban	0.21-0.24
Heavy Suburban	0.24-0.27
Light Urban	0.28-0.30
Heavy Urban	0.31-0.33

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain (3).

$$I(Z) = \begin{cases} 0.1\left(\frac{Z}{Z_g}\right)^{-\alpha-0.05}, & Z > 10\text{ m} \\ 0.1\left(\frac{10}{Z_g}\right)^{-\alpha-0.05}, & Z \leq 10\text{ m} \end{cases}$$ Equation (2)

$$L_t(Z) = \begin{cases} 100\text{ m}\sqrt{\frac{Z}{30}}, & Z > 30\text{ m} \\ 100\text{ m}, & Z \leq 30\text{ m} \end{cases}$$ Equation (3)

where, ***I*** = turbulence intensity, L_t = turbulence length scale, ***Z*** = height above ground, and **α** is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

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[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

[2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law Wind Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.

[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.