

REPORT

150 KNEELAND STREET

BOSTON, MA

REVISED PEDESTRIAN WIND ASSESSMENT

PROJECT #1803303

OCTOBER 06, 2018



SUBMITTED TO

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1. INTRODUCTION



Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Hudson Group to assess the pedestrian wind conditions for the proposed 150 Kneeland Street development in Boston, MA (see Image 1). This study represents an updated and revised analysis in response to comments provided by Kathleen Pedersen, BPDA's environmental review specialist. This assessment is based on the following:

- a review of regional long-term meteorological data from Boston Logan International Airport;
- design drawings received from RODE Architects August 20, 2018;
- wind-tunnel studies undertaken by RWDI for similar projects in the Boston Area, including Parcel 24 and South Station projects;
- our engineering judgement and knowledge of wind flows around buildings¹⁻³;
- use of software developed by RWDI (Windestimator²) for estimating the potential wind conditions around building forms; and,
- At the request of the BPDA, the use of the *UrbaWind*[™] software (a commercially available computational fluid dynamics package produced by *Metrodyn Inc.*) to aid in visualization of general wind flow patterns for a qualitative wind assessment.

This qualitative approach provides a screening-level estimation

of potential wind conditions. In order to quantify these conditions or refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel would be required.

Note that other wind issues, such as those related to cladding and structural wind loads, air quality, etc., are not considered in the scope



Image 1: Rendering of the Proposed Project – View from Southeast

1. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", *Journal of Wind Engineering and Industrial Aerodynamics*, vol.104-106, pp.397-407.
2. H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004*, Nashville, Tennessee.
3. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", *10th International Conference on Wind Engineering*, Copenhagen, Denmark.

2. BUILDING AND SITE INFORMATION



The proposed development is located at the northeast corner of the intersection of Kneeland St. and Utica St. in Boston, MA (Image 2 and 3). The site is immediately surrounded by a basketball court to the southwest and by mid-rise buildings in all other directions. Tall buildings are located a few blocks away to the west through northeast of the site. Downtown Boston and Fort Point Channel are approximately 0.2 miles to the north and east, respectively. The site is currently occupied by 1 and 4-story buildings.

The proposed development consists of a 21-story tower (see Images 1 and 3). The pedestrian areas of interest include the main entrance and public sidewalks.

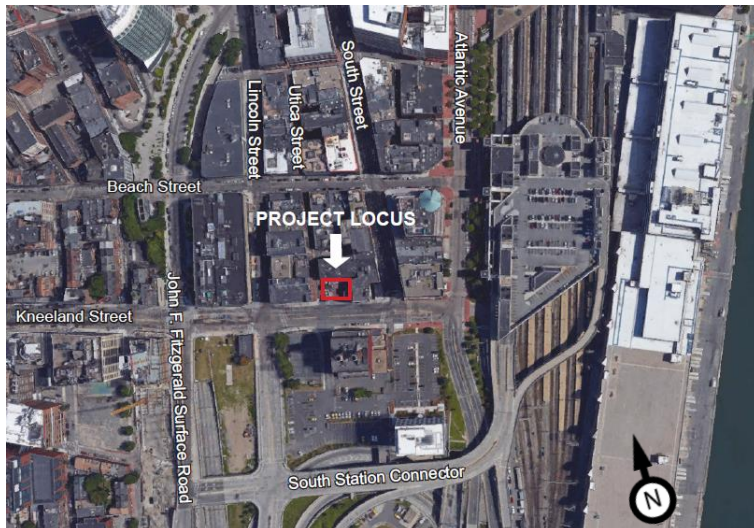


Image 2: Rendering of the Existing Site and Surrounding (Courtesy of GoogleEarth™)

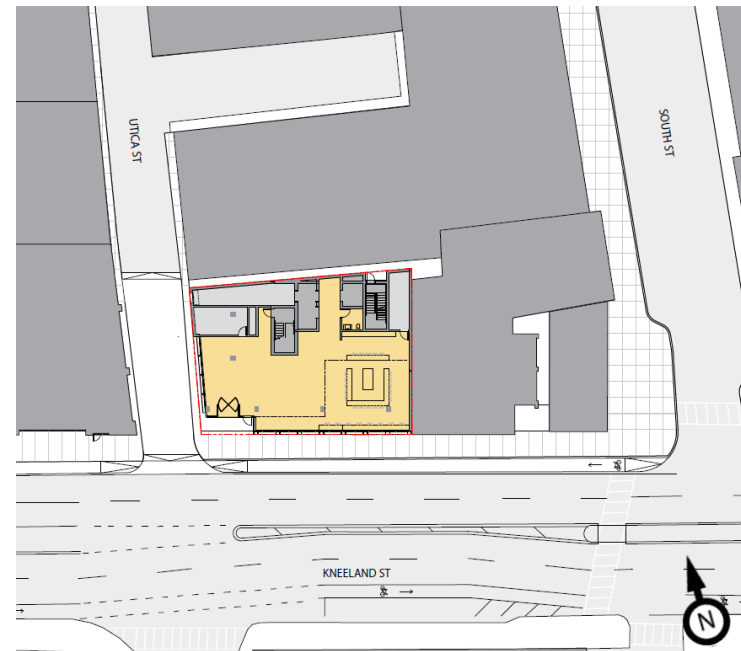


Image 3: Site Plan

3. METEOROLOGICAL DATA



Wind statistics at Boston Logan International Airport between 1990 and 2015, inclusive, were analyzed for the spring (March to May), summer (June to August), fall (September to November) and winter (December to February) seasons. Image 4 graphically depicts the distributions of wind frequency and directionality for the four seasons and for the annual period. When all winds are considered (regardless of speed), winds from the northwest and southwest quadrants are predominant. Northeasterly winds are also frequent, especially in the spring.

Strong winds with mean speeds greater than 20 mph (red bands in the images) are predominantly from the northwesterly directions throughout the year, but are also frequent from the southwesterly and northeasterly directions.

Winds from the northwest, west, southwest and northeast directions are considered most relevant to the current study, although winds from other directions were also considered in our assessment.

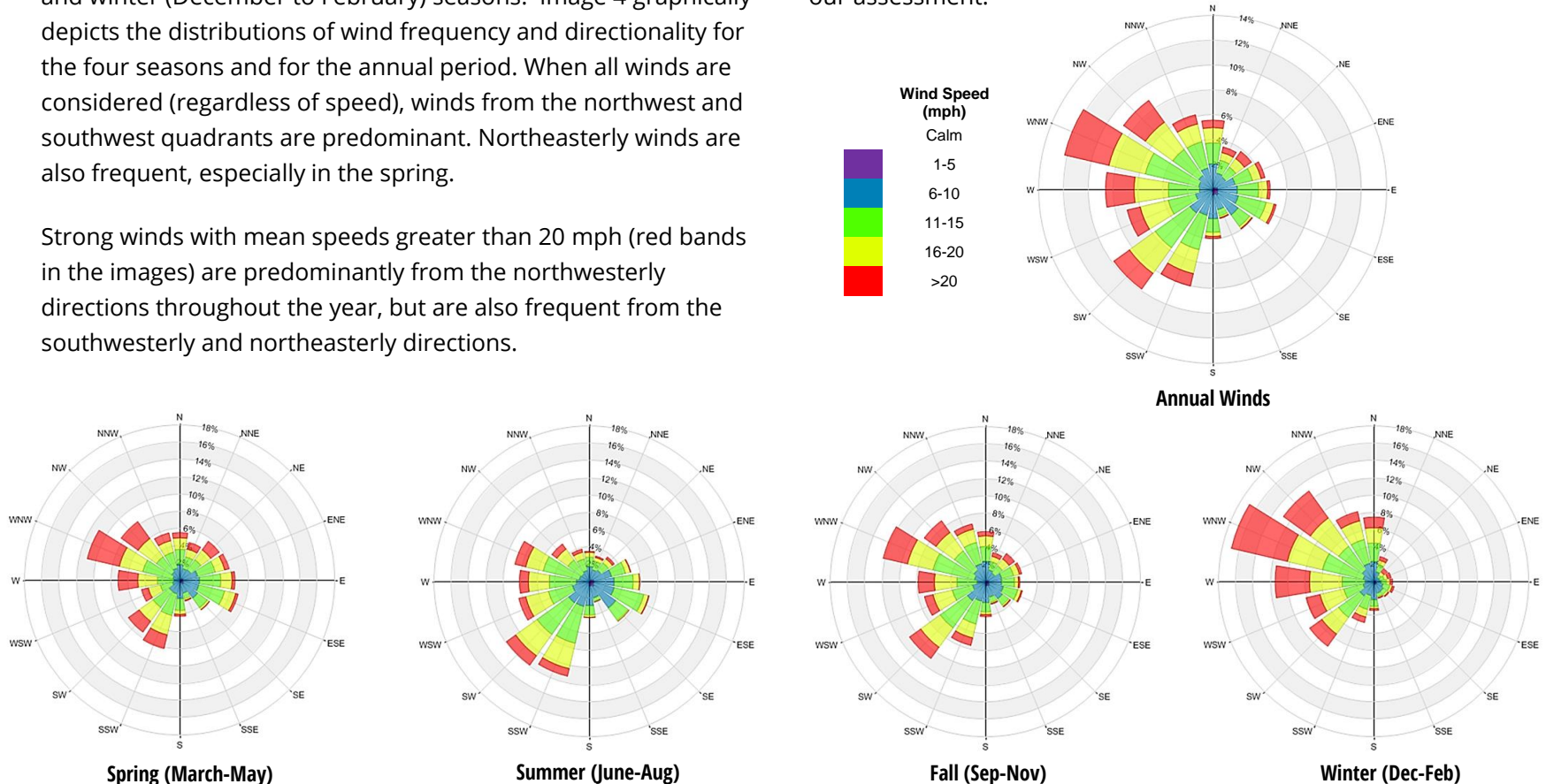


Image 4: Directional Distribution of Winds Approaching Boston Logan International Airport (1990 – 2015)

4. BPDA WIND CRITERIA



The Boston Planning and Development Agency (BPDA) has adopted two standards for assessing the relative wind comfort and safety of pedestrians.

First, the BPDA wind design guidance criterion states that an effective gust velocity (hourly mean wind speed +1.5 times the root-mean-square wind speed) of 31 mph should not be exceeded more than one percent of the time.

The second set of criteria used by the BPDA to determine the acceptability of specific locations is based on the work of Melbourne . This set of criteria is used to determine the relative level of pedestrian wind comfort for activities such as sitting, standing, or walking. The criteria are expressed in terms of benchmarks for the 1-hour mean wind speed exceeded 1% of the time (i.e., the 99-percentile mean wind speed). They are as follows:

BPDA Mean Wind Criteria*

Dangerous	> 27 mph
Uncomfortable for Walking	> 19 and \leq 27 mph
Comfortable for Walking	> 15 and \leq 19 mph
Comfortable for Standing	> 12 and \leq 15 mph
Comfortable for Sitting	\leq 12 mph

*Applicable to the hourly mean speed exceeded one percent of the time.

Pedestrians on sidewalks and parking lots will be active and wind speeds comfortable for walking are appropriate. Lower wind speeds comfortable for standing are desired for building entrances where people are apt to linger. For any outdoor amenity at and above grade, low wind speeds comfortable for sitting are desired in the summer, when it is typically in use.

The wind climate found in a typical location in Boston is generally comfortable for the pedestrian use of sidewalks and thoroughfares and meets the BPDA effective gust velocity criterion of 31 mph at most areas, while windier conditions may be expected near the corners of tall buildings exposed to the prevailing winds. However, without any mitigation measures, this wind climate is likely to be frequently unsuitable for more passive activities such as sitting.

Discussions related to pedestrian wind comfort and safety will be based on the annual wind climate. Typically, the summer and fall winds tend to be more comfortable than annual winds, while the winter and spring winds are less comfortable than annual winds.

5. COMPUTER MODEL



At the request of the BPDA, wind flows around the proposed development and the surroundings were simulated using *Urbawind™*, which is a software developed by *Metrodyn Inc.*

Winds from the selected directions were simulated for the purpose of this requested study. The computer model of the proposed development, used for the purpose of the simulation, is shown in Image 5.

For the purpose of this computational study, the 3D model was simplified to include the necessary massing details that would affect the local wind flows in the area and around the site. Landscaping was not included in the computer model in order to provide conservative wind conditions (as is typically the case for all pedestrian wind studies).

The results of the simulations presented in Images 12, 14, 16 and 17 of this report are in the form of still images of color contours of wind comfort categories (illustrated in color on this page of the assessment). The results correspond to a horizontal plane approximately 5 foot above grade level.

These results are for the average annual wind condition. The comfort conditions presented are approximate and intended for reference. The following color scale is used for representation of the wind comfort conditions:



Regions with purple to blue represent low wind speed areas comfortable for sitting, dark green to light green indicates still low speeds but comfortable for standing; light green to yellow indicates medium wind speeds comfortable for walking, and orange to red regions are associated with higher winds speeds uncomfortable for walking. The red regions are associated with the highest wind speed regions that may not be suitable for pedestrian usage and are potentially dangerous.

In all of the images (12, 14, 16 and 17), noted on the following pages, all locations are comfortable for walking or better and some are suitable for sitting or standing.

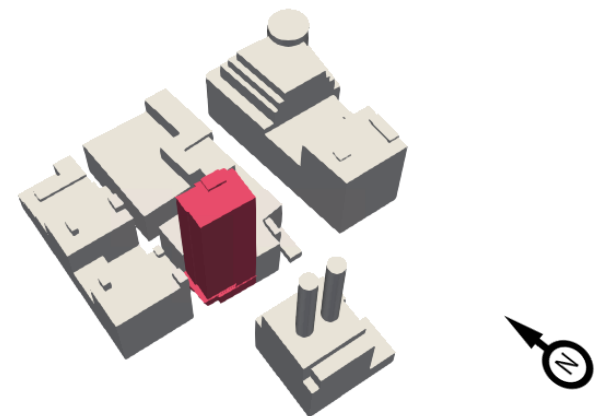


Image 5 – Computer Model of the Proposed Building and Surroundings

5. OTHER WIND TUNNEL EVALUATIONS CONSIDERED



Results of the wind tunnel studies for two projects in the vicinity of the site of 150 Kneeland St. Project have been considered for evaluating the wind conditions around the Project site. These two projects are Parcel 24 and South Station, wind tunnel study model photos and test results are which are shown in Images 5 through 8. The relevance of the two projects to 150 Kneeland St. Project has been discussed in Section 6.

- Parcel 24



Image 6: Wind Tunnel Study Model for Parcel 24 Project

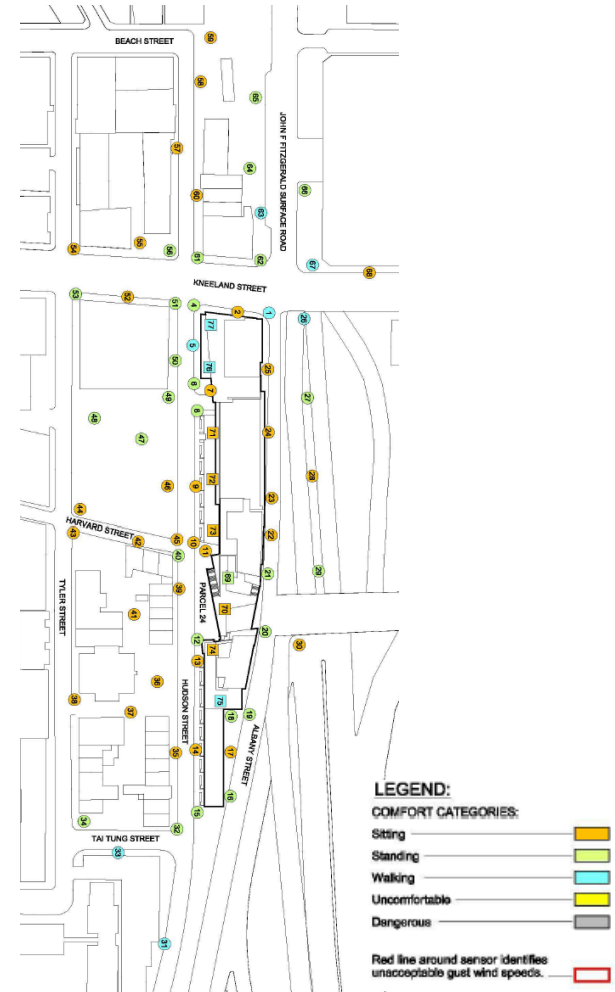


Image 7: Pedestrian Wind Conditions (Mean Speed) – Parcel 24 Project

5. OTHER WIND TUNNEL EVALUATIONS CONSIDERED



- South Station

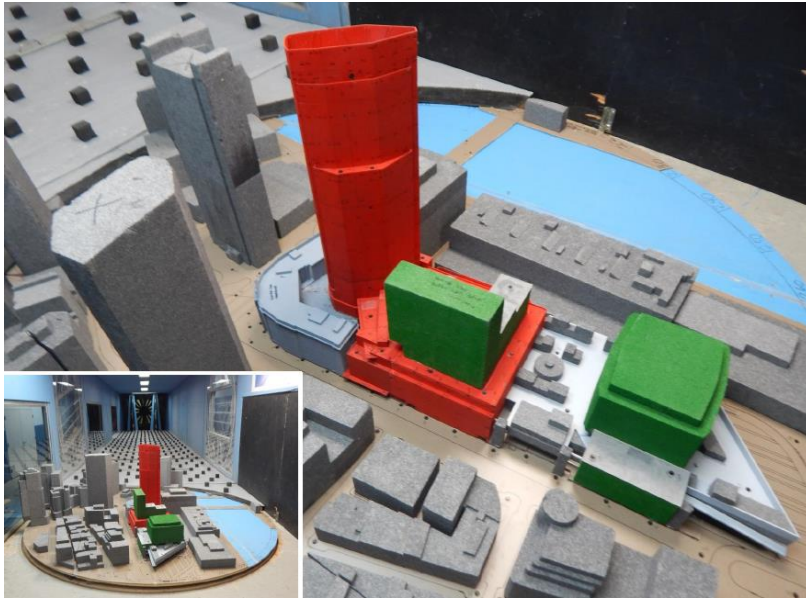


Image 8: Wind Tunnel Study Model for South Station Project

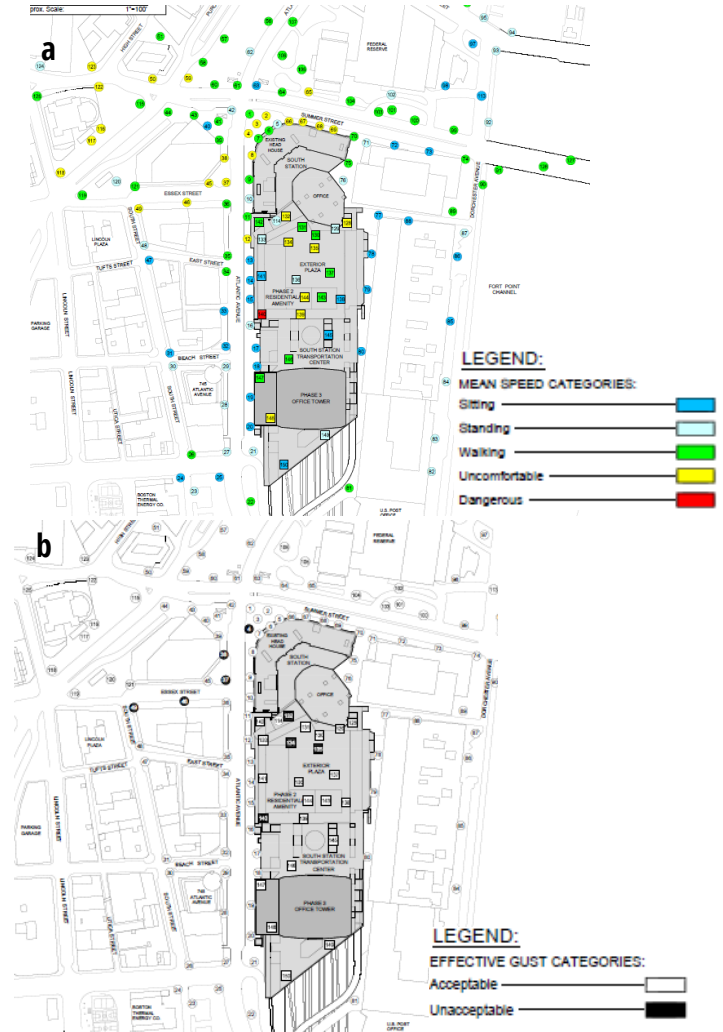


Image 9: Pedestrian Wind Conditions (South Station) – a) Mean Speed, b) Effective Gust Speed

6. PEDESTRIAN WIND CONDITIONS



Background

Predicting wind speeds and occurrence frequencies is complicated. It involves building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate. Over the years, RWDI has conducted thousands of wind-tunnel model studies regarding pedestrian wind conditions around buildings, yielding a broad knowledge base. This knowledge has been incorporated into RWDI's proprietary software that allows, in many situations, for a qualitative, screening-level numerical estimation of pedestrian wind conditions without wind tunnel testing.

Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. Such a downwashing flow (see Image 10) is the main cause for increased wind activity around tall buildings at the grade level. If this building/wind combination occurs for prevailing winds, there is a greater potential for increased wind activity.

Given the tall buildings upwind of the strong prevailing northwesterly and northeasterly winds and the positive design features of the development which will be discussed later in this report, winds at all pedestrian areas on and around the development are expected to meet the effective gust criterion, for both the No-Build and Build configurations. Detailed discussions on the potential wind comfort conditions at key pedestrian areas are provided in the next sections.

RWDI has an extensive library of wind tunnel results on projects in the area. To help supplement the assessment for 150 Kneeland St., the wind tunnel results for Parcel 24 and South Station were used as a reference for evaluating the wind conditions. The wind speeds around South Station are expected to be higher compared to the conditions around 150 Kneeland St. site as the proposed buildings are significantly larger and taller. The conditions around 150 Kneeland St. are expected to be comparable to Parcel 24 as a result of similarities in their height. It is worth noting that the proposed pencil tower at 150 Kneeland Street will have less of an impact on the existing wind conditions than the proposed tower at South Station and the existing buildings at Parcel 24 will have/had on their respective surroundings.

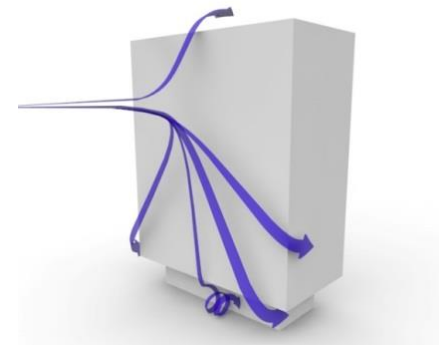


Image 10: Downwashing Flow

6. PEDESTRIAN WIND CONDITIONS



Sidewalks

The tall buildings to the west through northeast of the site will provide blockage from the strong winds from those directions, while the building itself will provide additional blockage to the sidewalks from the strong northeasterly winds. The south façade of the proposed development is exposed to the southwesterly winds which could accelerate down the façade and reach the ground. A similar phenomenon, could occur for the northwesterly winds along the west façade. The large canopy along the west façade is a positive feature which will help to redirect these winds downwashing off the west façade away from the ground (see Image 11). Generally wind speeds along the sidewalks of Kneeland St. and Utica St. might be slightly higher than what is currently experienced; however, conditions are expected to be comfortable for walking or better throughout the year which is appropriate for the intended use (Image 12). Calmer conditions suitable for standing along the sidewalks of Kneeland St. can be achieved by increasing the depth of the canopy along the south façade to allow redirection of winds away from the ground.

Wind conditions at the sidewalks of Lincoln St and South St. are not expected to be impacted by the addition of the proposed development due to the distance of the building from those sidewalks.

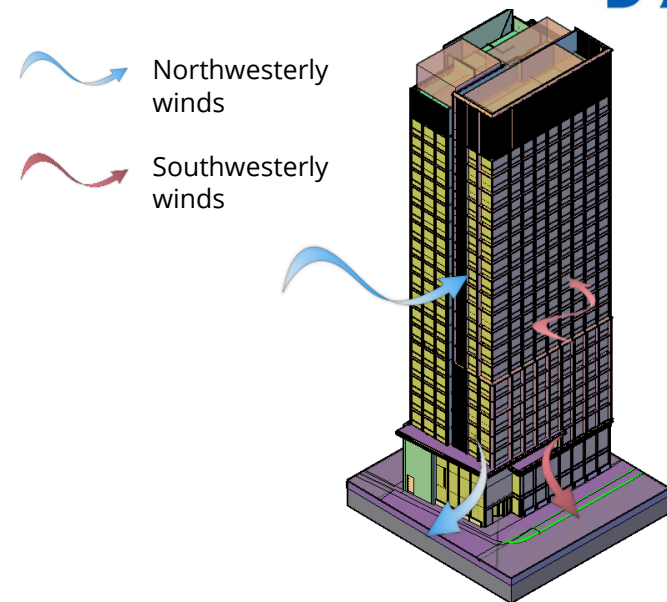


Image 11: 3D Rendering of the Proposed Development – View from Southwest

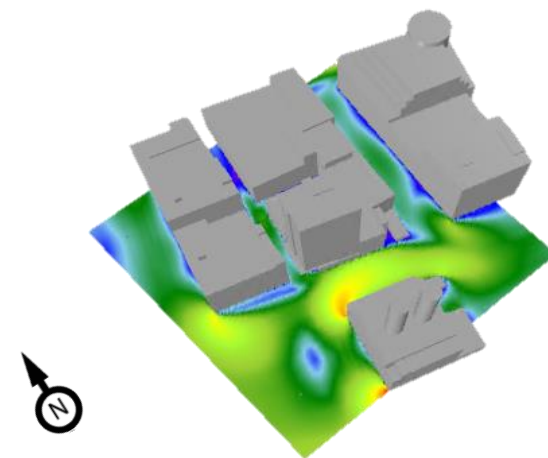


Image 12: Northwest Urbawind Simulation of the Sidewalks

6. PEDESTRIAN WIND CONDITIONS



Main Entrance

The main entrance to the development is at its southwest corner, marked by a red triangle in Image 13. The canopy along the west facade of the building is a positive feature which will help to deflect winds away from the entrance. Additionally the entrance is recessed from the main façade which will provide an area with low wind speeds in front of it. Appropriate wind conditions, suitable for standing or better, are expected at this entrance throughout the year (Image 14).

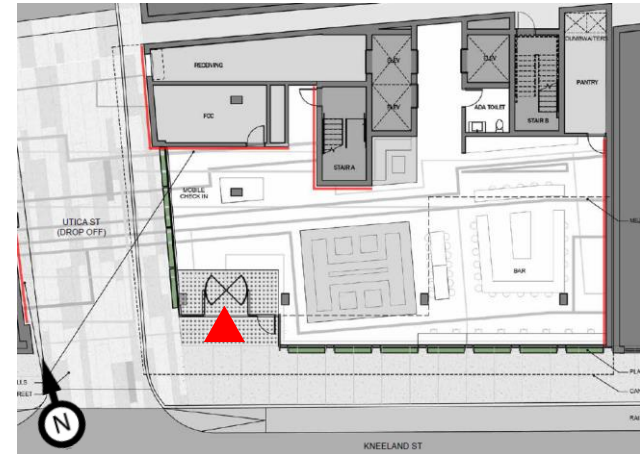


Image 13: Ground Floor Plan

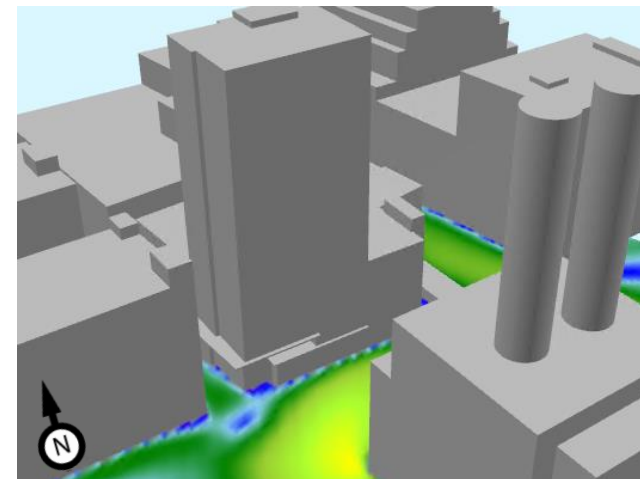


Image 14: Northwest Urbawind Simulation at Southwest Entrance

6. PEDESTRIAN WIND CONDITIONS



Other Public Areas of Pedestrian Use

Reggie Wong Memorial Park is located diagonally across the proposed development at the southeast corner of the intersection of Lincoln St. and Kneeland St., while Rose Kennedy Greenway is located two blocks to the west of the proposed development (see Image 15). These two areas are located far enough from the proposed development not to be significantly impacted by the local wind flow patterns. Wind conditions will remain similar to or better than what is currently experienced at these areas (Images 16 and 17). These areas are expected to be suitable for walking conditions or better which is appropriate for the intended use.



Image 15: Other Public Areas

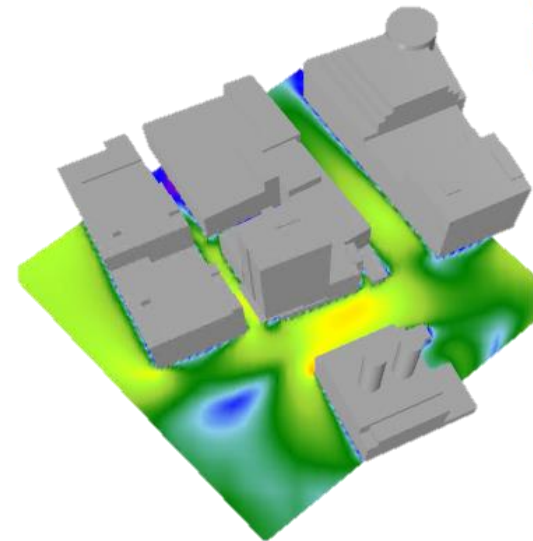


Image 16: Southwest Urbawind Simulation of Proposed Conditions

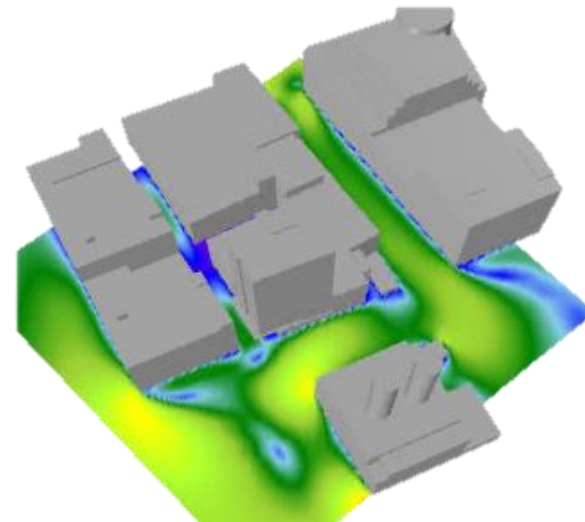


Image 17: Northwest Urbawind Simulation of Proposed Conditions

7. SUMMARY



Wind conditions on and around the proposed 150 Kneeland Street development are discussed in this report, based on the local wind climate, surrounding buildings, Urbawind Simulations and our past experience with wind tunnel testing of similar buildings.

Strong winds at this site are predominantly from the northwesterly directions throughout the year, but are also frequent from the southwesterly and northeasterly directions.

The proposed project has several positive design features such as a recessed entrance and the large canopy along the west facade. These positive design features together with the tall buildings partially blocking the direction of the predominant winds, the northwest through northeast of the site, will result in wind conditions that are comfortable for the intended uses around the development.

Conditions comfortable for walking or better are expected along the sidewalks of Kneeland St., Utica St., Lincoln St. and South St. These conditions are similar to what is occurring around the existing site and are considered suitable for this purpose.

The recessed entrance at the southwest corner of the building is expected to be comfortable for standing or better throughout the year. These are suitable conditions for a main entranceway.

Wind conditions at Reggie Wong Memorial Park and Rose Kennedy Greenway are not expected to be impacted by the addition of the proposed development with conditions expected to be comfortable for standing or walking throughout the year.

Further, winds at all above mentioned areas are expected to meet the effective gust criterion.

8. APPLICABILITY OF RESULTS



The assessment presented in this report are for the 150 Kneeland Street development based on the design drawings and documents received from RODE Architects on August 20, 2018. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.