ATTACHMENT E

REPORT

HUDSON PLACE 2

VICTORIA, BC

PEDESTRIAN WIND ASSESSMENT

PROJECT #1901548
APRIL 5, 2019

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Townline to assess the pedestrian wind conditions for the proposed Hudson Place 2 development in Victoria, BC (Image 1). This assessment was based on the following:

- a review of regional long-term meteorological data from nearby weather stations;
- design drawings received by RWDI in March 2019;
- wind-tunnel studies undertaken by RWDI for similar projects;
- our engineering judgement and knowledge of wind flows around buildings[1-3]; and,
- use of software developed by RWDI (Windestimator[2]) for estimating the potential wind conditions around generalized building forms.

This qualitative approach provides a screening-level estimation of potential wind conditions. Conceptual wind control measures to improve wind comfort are recommended, where necessary. In order to quantify these conditions or refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel are typically required.

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

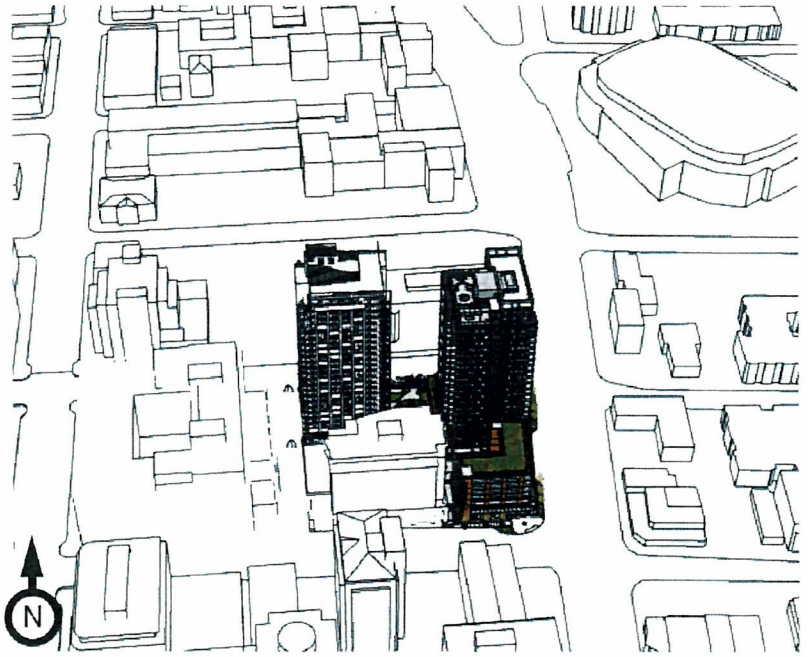

Image 1: South view of the proposed Hudson Place 1 (left) and 2 (right)

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 to be located on the west side of Blanshard Street between Fisgard Street to the south and Herald Street to the north in Victoria, BC (Images 1 and 2). It consists of a 23-storey tower with a 6-storey podium to the south (Image 3).

On the same street block there are the existing 12-storey Hudson Mews to the southwest and the 24-storey Phase 1 tower to the northwest (Images 1 and 2). They will provide sheltering for the current development from winds of the westerly directions. Surroundings around the site are generally dense, low and medium-rise buildings. Open water bodies are located to the distant south and east.

Pedestrian areas on and around the development include public sidewalks, residential and retail entrances and outdoor terraces at Levels 2 and 23.

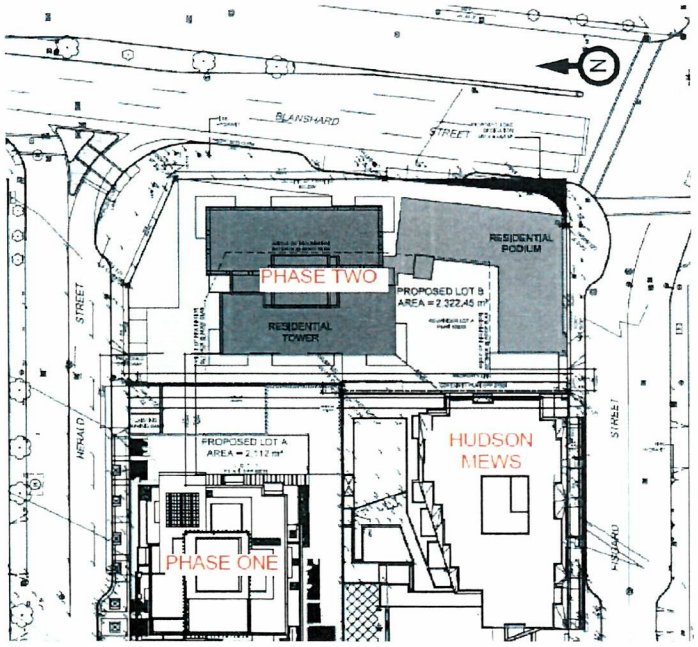

Image 2: Context plan

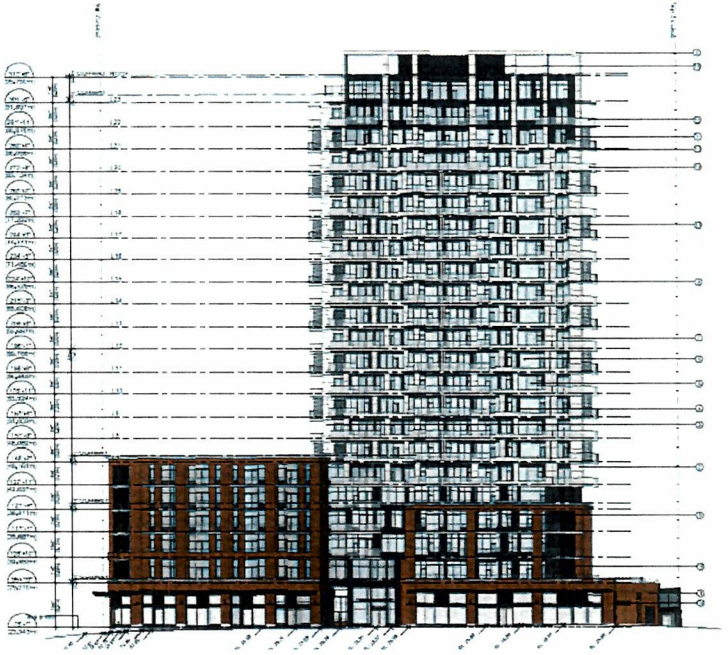

Image 3: East elevation

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3. METEOROLOGICAL DATA

Wind data recorded at major airports are often used as reference for wind conditions in the area. However, both Victoria and Vancouver International Airports are located in distance from the site and have different topographic conditions. Data from the nearby Victoria Harbour Seaplane Airport (Image 4) are considered most representative. The distributions of wind frequency and directionality for the summer (May through October) and winter (November through April) seasons are shown in Image 5.

When all wind data are considered, winds are frequent from the southwesterly directions in the summer. In the winter, winds are frequent from the north, west and southeast directions. Strong winds of a mean speed greater than 30 km/h occur more often in winter than in the summer. They are often from the west, southwest and southeast directions.

Image 4: Project site and three nearby weather stations (credit: Google™ Earth)

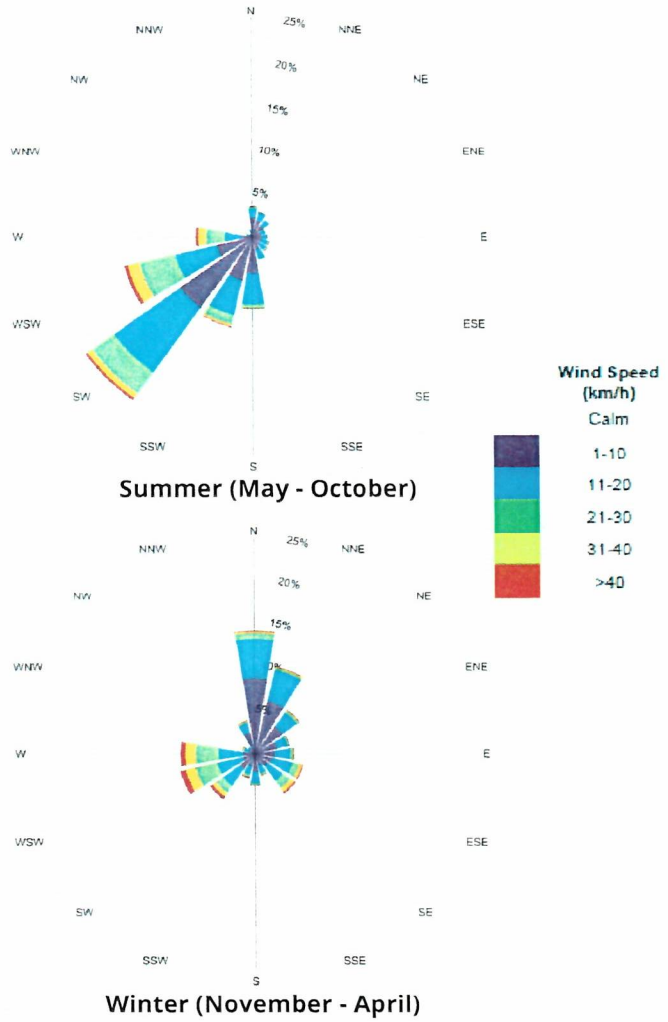


Image 5: Winds approaching Victoria Harbour Seaplane Airport (1994-2015)

3. METEOROLOGICAL DATA

For reference purposes, wind roses from the other two weather stations in the area are also analyzed (Image 6 for Esquimalt Harbour and Victoria Gonzales Heights Met Station). Although the wind directions vary with stations due to their relative locations to the coast lines, winds from southwest and northeast are most frequent, with the strong winds (yellow and red bands) from the west, southwest and southeast directions. These three directions could potentially be the source of uncomfortable wind conditions, depending upon the site exposure or development design. The analysis methods, however, have accounted for these and all winds directions.

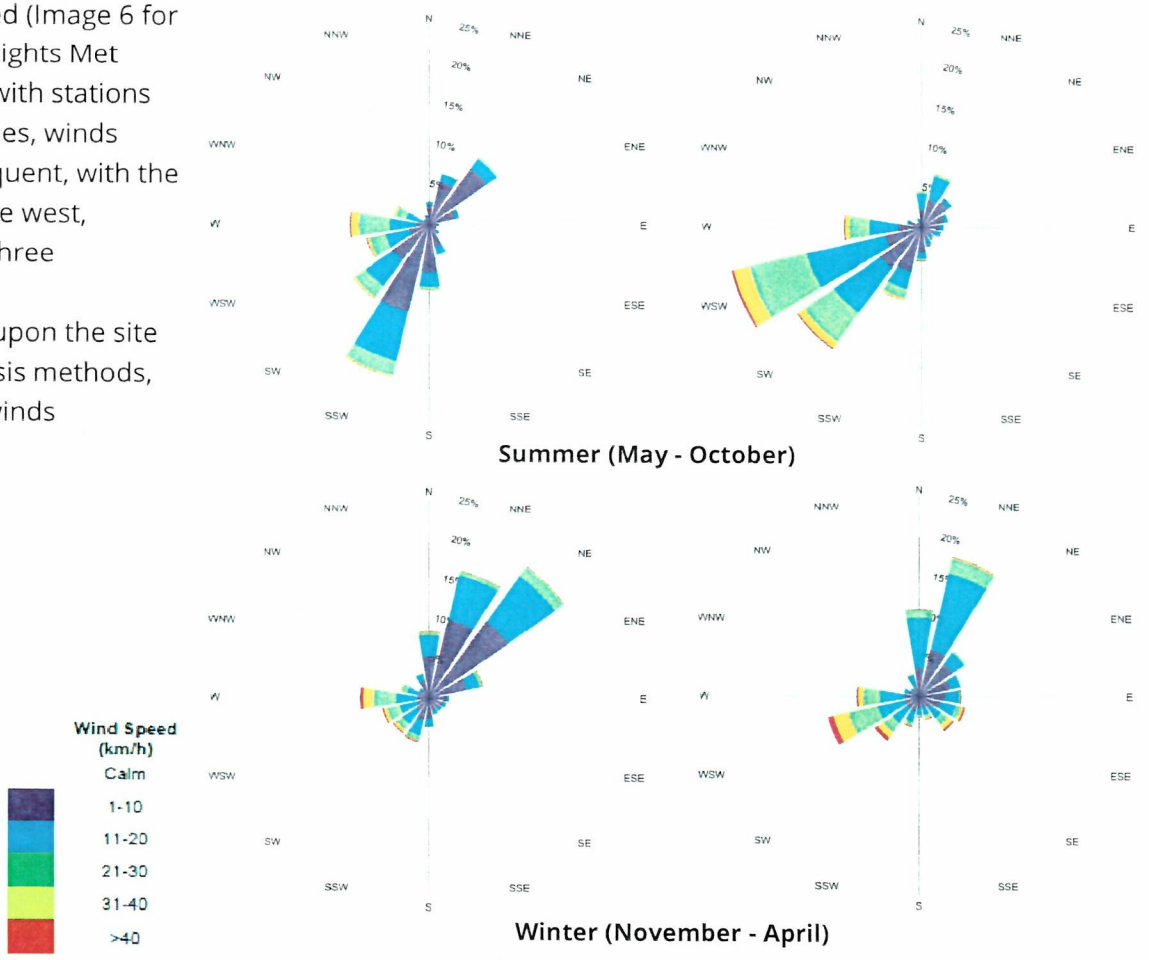


Image 6: Esquimalt Harbour (2003-2015, left) and Gonzales Heights (1985-2015, right)

4. PEDESTRIAN WIND CRITERIA

The RWDI pedestrian wind criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities as well as by the building design and city planning community. The criteria are as follows:

Pedestrian Safety

Pedestrian safety is associated with excessive gust wind speeds that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (**90 km/h**) occur more than 0.1% of the time or 9 hours per year, the wind conditions are considered severe.

Pedestrian Comfort

Wind comfort can be categorized by typical pedestrian activities:
Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.
Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.
Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.
Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable: None of the comfort categories are met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associate wind speeds are expected for at least four out of five days (80% of the time). Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m height and open terrain).

These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks; lower wind speeds comfortable for standing are required for building entrances, where pedestrians may linger; and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the outdoor amenity terraces, especially during the summer season when these areas are used more often.

5. PEDESTRIAN WIND CONDITIONS

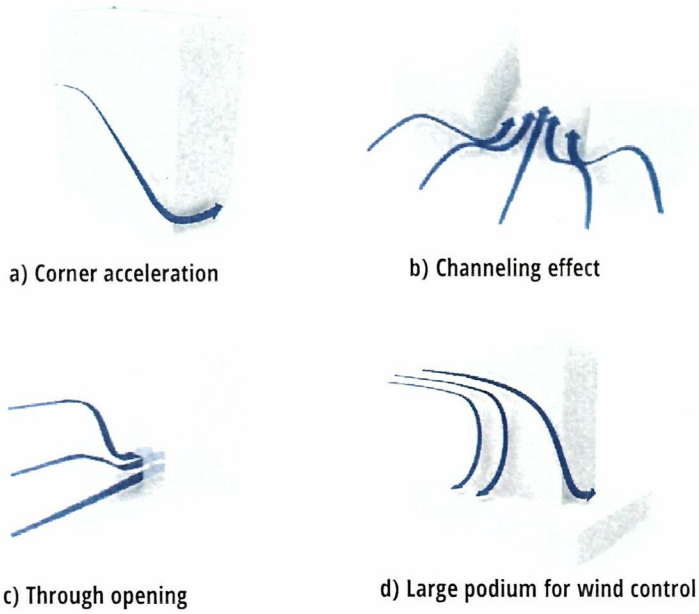
Background

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.

The proposed Phase 2 tower is similar in height to the Phase 1 tower to the immediate northwest (Image 1), but taller than its surroundings in the remaining directions. Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. Such a downwashing flow is the main cause for increased wind activity around tall buildings at grade level. It increases the wind speeds around exposed building corners (Image 7a), along a gap between buildings (7b) and through an opening underneath the building (7c). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity.

Building setbacks, podiums and stepped façades will reduce the direct impact of downwashing wind flows at grade (see Image 7d); however, higher wind activities are expected on the podium itself where calm wind conditions are often desired for passive pedestrian activities.

Given the local wind climate and the size of the proposed tower, it is our opinion that the future wind conditions will meet the wind safety criterion on and around the development. Detailed discussions on the potential wind comfort at key pedestrian areas are provided below.



a) Corner acceleration

b) Channeling effect

c) Through opening

d) Large podium for wind control

Image 7: General wind flow patterns

5. PEDESTRIAN WIND CONDITIONS

Entrances and Sidewalks

Image 8 consists of a ground floor plan and three perspective views for the base of the proposed building.

Due to its location and orientation, the proposed tower will be sheltered by the Phase 1 tower from the westerly winds and the proposed podium to the south of the tower will reduce the impact of winds downwashing from the south façade. However, the north and east façades of the tower are fully exposed to winds from the north and southeast.

The proposed steps on the north façade, the canopies along the east and south façades and recessed main entrances with vestibules are all positive design features for wind control. As a result, suitable wind conditions are predicted at the main entrances A1 and A2 (Image 8), and entrances at the north and south sides (A3 and A4, respectively).

Image 8: Ground floor plan and perspective views of the tower base

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Entrances and Sidewalks (continued)

The gate underneath the proposed building (B1 in Image 9) may become a "wind tunnel" (Image 7c) when winds are from the west, southwest and southeast. The accelerating winds may affect the main entrances A1 and A2. If feasible, a solid and tall wall should be included at this location, or additional wind control measures should be considered for the main entrance areas, in the form of planters and screens at the location shown by green lines in Image 9.

Entrances along Blanshard Street (B2 in Image 9) will be affected by the north, northeast and southeast winds. Lower wind speeds can be achieved around these areas by recessing the entrances and/or installing screens/planters, if feasible. Examples of these wind control concepts are shown in Image 9. Pedestrians on sidewalks will be active and can tolerate slightly higher wind speeds. The future wind conditions along adjacent sidewalks are expected to be suitable throughout the year.

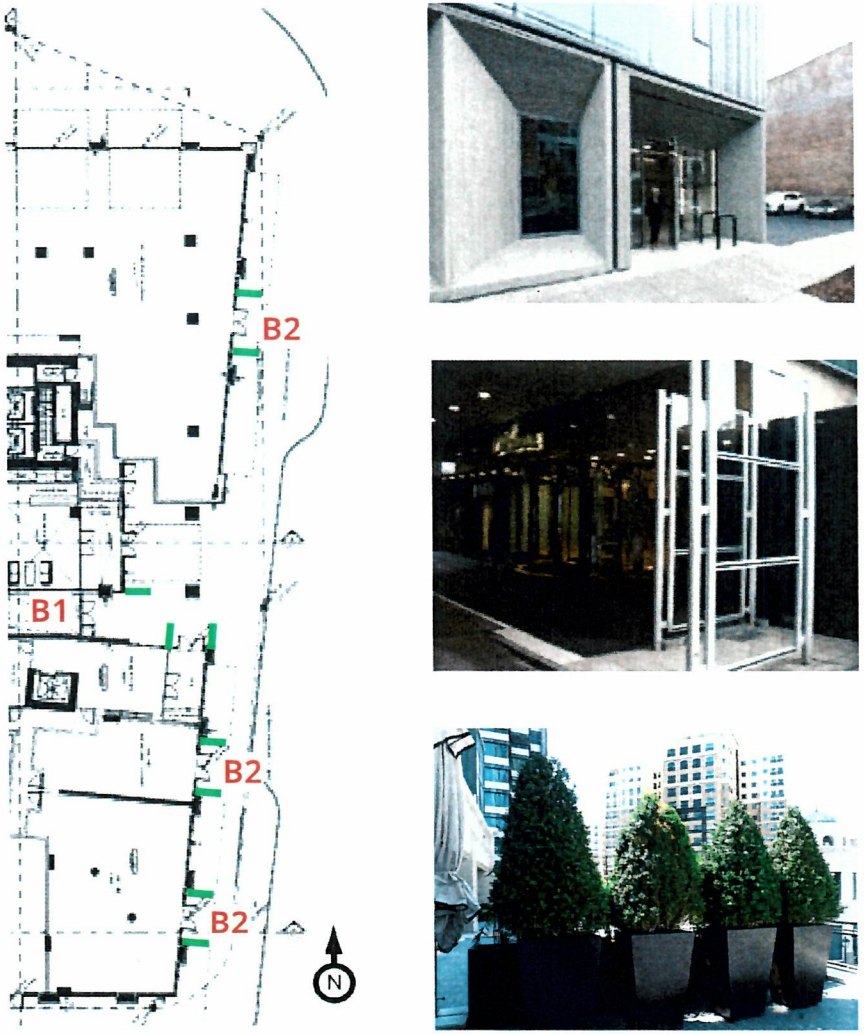

Image 9: Wind control examples and locations for exposed entrances

5. PEDESTRIAN WIND CONDITIONS

Podium and Roof Terraces

There are three large outdoor terraces on the proposed development: C1 at Level 2, C2 at Level 23 and C3 between the Phase 1 and 2 towers (mid diagram in Image 10).

The outdoor amenity C1 is largely enclosed by the existing and proposed buildings from all directions, and suitable wind conditions are expected at C1 throughout the year.

Wind speeds increase with elevations. The rooftop terrace C2 will be windy due to its elevation and exposure. Windy conditions are also expected on the terrace at Level 2 between the existing and proposed towers (C3) due to channeling winds (Image 7b) from the north and southwest directions. The proposed development includes several positive design features for wind control, such as the guardrails and canopy on the roof top (left diagram in Image 10) and two rows of trees along the north and south perimeters of C3 (right diagram). It is likely that additional wind control measures will be needed to further reduce the wind activity in these seating areas. Examples of landscaping, screens, trellises and so on are shown in Image 11 for reference.

If desired, wind tunnel testing can be conducted to quantify these wind conditions and, if necessary, to develop wind control solutions.

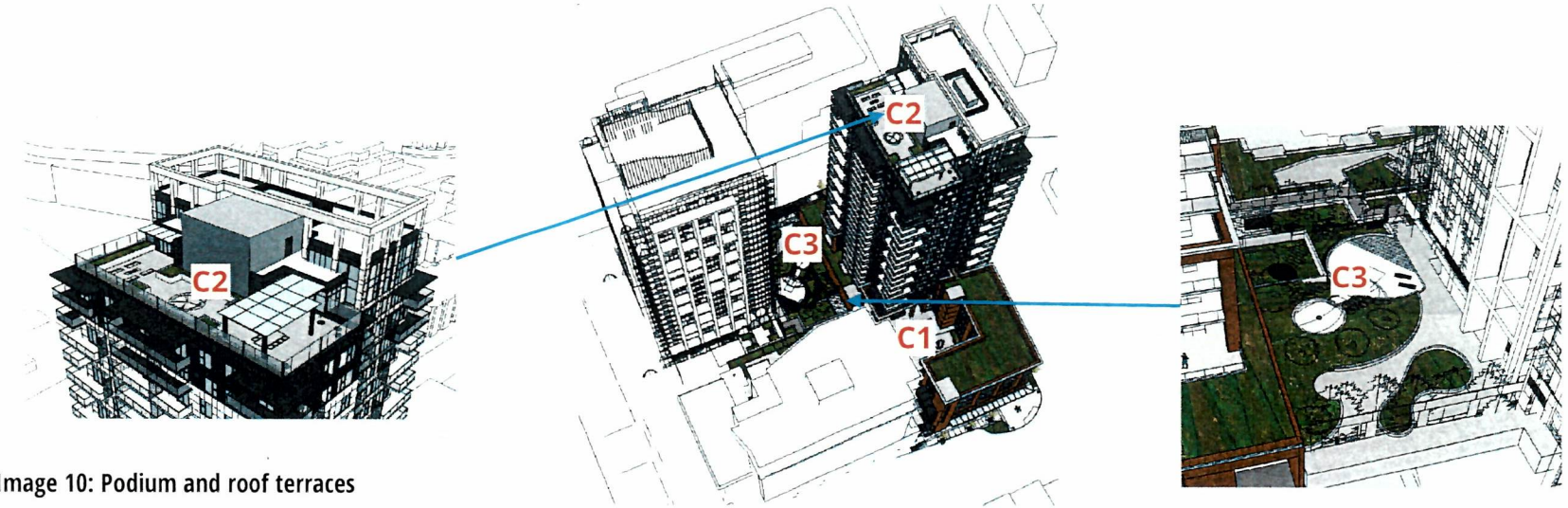

Image 10: Podium and roof terraces

5. PEDESTRIAN WIND CONDITIONS

Image 11: Examples of wind control measures for amenity terraces

6. SUMMARY

Wind conditions on and around the proposed Hudson Place 2 development are discussed in this report, based on the local wind climate, the current building design, surrounding buildings and our past experience with wind-tunnel testing for similar building projects.

The proposed development has a number of positive design features such as the south podium, main entrance locations and landscaping over terraces. Appropriate wind conditions are expected along the surrounding sidewalks, at recessed main entrances and at the Level 2 amenity enclosed by the existing and proposed development.

Wind speeds may be higher than desired at the gate underneath the building, the east retail entrances, the rooftop terrace and at the outdoor amenity between the Phase 1 and 2 towers. Wind control features have been recommended which can be applied if more comfortable conditions at these areas are desired.

7. APPLICABILITY

The assessment presented in this report is for the proposed Hudson Place 2 development, based on the design drawings and documents received by RWDI in March 2019. 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.