PEDESTRIAN WIND ENVIRONMENT STATEMENT

1 DENISON STREET, NORTH SYDNEY

WA637-07F01(REV2)- WS REPORT

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Prepared for:

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DOCUMENT CONTROL

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November 1, 2016	Revised treatments.	1	SA	KP	AB
November 8, 2016	Comparison with previous design scheme.	2	SA	KP	AB

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EXECUTIVE SUMMARY

This report is in relation to the proposed development located at 1 Denison Street, North Sydney, and presents an opinion on the likely wind conditions affecting the various trafficable outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the Sydney region; north-easterly, southerly and westerly winds. The analysis of the wind effects relating to the subject development is carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the architectural drawings which have been prepared by the project architect Bates Smart, received on October 27, 2016. A comparison is also made with the results of the Pedestrian Wind Environment Study undertaken for the previously approved DA design (Windtech report reference: WA637-04F02(rev0), dated July 23, 2010). No wind tunnel tests have been undertaken for the subject development, and hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects. Note that wind tunnel testing of the subject development is in the process of being undertaken in order to verify the conditions within and around the site and the extent of the recommended treatments.

The results of this assessment indicate that the various neighbouring buildings will offer moderate shielding against direct prevailing winds which will benefit wind conditions at the Ground and Lower Ground levels. However, due to the alignment of the surrounding streets, it is anticipated that the pedestrian footpaths surrounding the site will be exposed to winds which are accelerated due to the building canyon effect. The outdoor terrace on Level 2 is relatively exposed to the prevailing westerly winds as a result of the low height of the existing Tower Square building. Similarly, the proposed "Cross Street" thoroughfare is anticipated to experience wind funnelling effects as a result of the geometry of the local built form, a potential for downwashed westerly winds from the tower façade above, and the alignment of "Cross Street" with the westerly direction. To address these potentially adverse wind effects, and to provide suitable wind conditions for pedestrians, the following treatments are recommended:

- Tree planting on the pedestrian footpaths on the eastern, southern and western aspects at Ground and Lower Ground Level.
- Provision for the inclusion of an awning at the Level 1 slab height, above the western entrance to the "Cross Street" thoroughfare. However, if the neighbouring Tower Square building is to be redeveloped, depending on the height of that redevelopment the aforementioned awning may not be necessary.
- 2m tall dense hedge planting, or impermeable screening, along the western perimeter of the Level 2 terrace.

- Provision for landscaping/planting/screening within the outdoor Level 2 terrace.

The form of the proposed development around the ground level is similar to that of the previously approved DA design. The orientations of the outer facades at ground level are parallel with adjacent streets, and both designs feature a through-site link that runs east-west. As such the wind conditions within pedestrian trafficable areas of the latest design scheme of the proposed development are expected to be similar to those of the previously approved DA design scheme. As such, the treatments recommended within this report for the latest design scheme follow from those determined in the wind tunnel study of the previously approved design scheme. Note however that wind tunnel testing has not yet been undertaken for the latest design scheme.

With the inclusion of the abovementioned recommendations in the final design, it is expected that wind conditions for all trafficable outdoor areas within and around the development will be acceptable for their intended uses. However, note that extent of these recommended treatments are in the process of being verified through wind-tunnel testing.

1 DESCRIPTION OF THE PROPOSED DEVELOPMENT AND SURROUNDS

The proposed development site is located in the North Sydney business district, immediately south of the Beau Monde Apartments. The site is bounded by Denison Street to the west and Little Spring Street to the east, with Spring Street to the south. Berry Street runs further to the north on the opposite side of the Beau Monde Tower.

Situated within the North Sydney business district, the subject development site is largely surrounded by medium to high rise commercial and residential buildings. A survey of the local land topography around the site indicates a general downhill slope towards the south-eastern corner of the site. An aerial image of the site and the local surroundings is shown in Figure 1.

The subject development is a 40 storey commercial office tower atop retail tenancies on the Ground and Lower Ground Levels. The development features an outdoor terrace area atop a two level podium, with an open public thoroughfare running east/west through the ground level of the site.

The critical trafficable outdoor areas associated with the proposed development, which are the focus for pedestrian wind effects in this assessment, are detailed as follows:

- Ground level pedestrian entrances, walkways and seating areas around the various frontages of the development.
- The proposed "Cross Street" thoroughfare between Denison Street and Little Spring Street.
- The outdoor terrace area on Level 2.

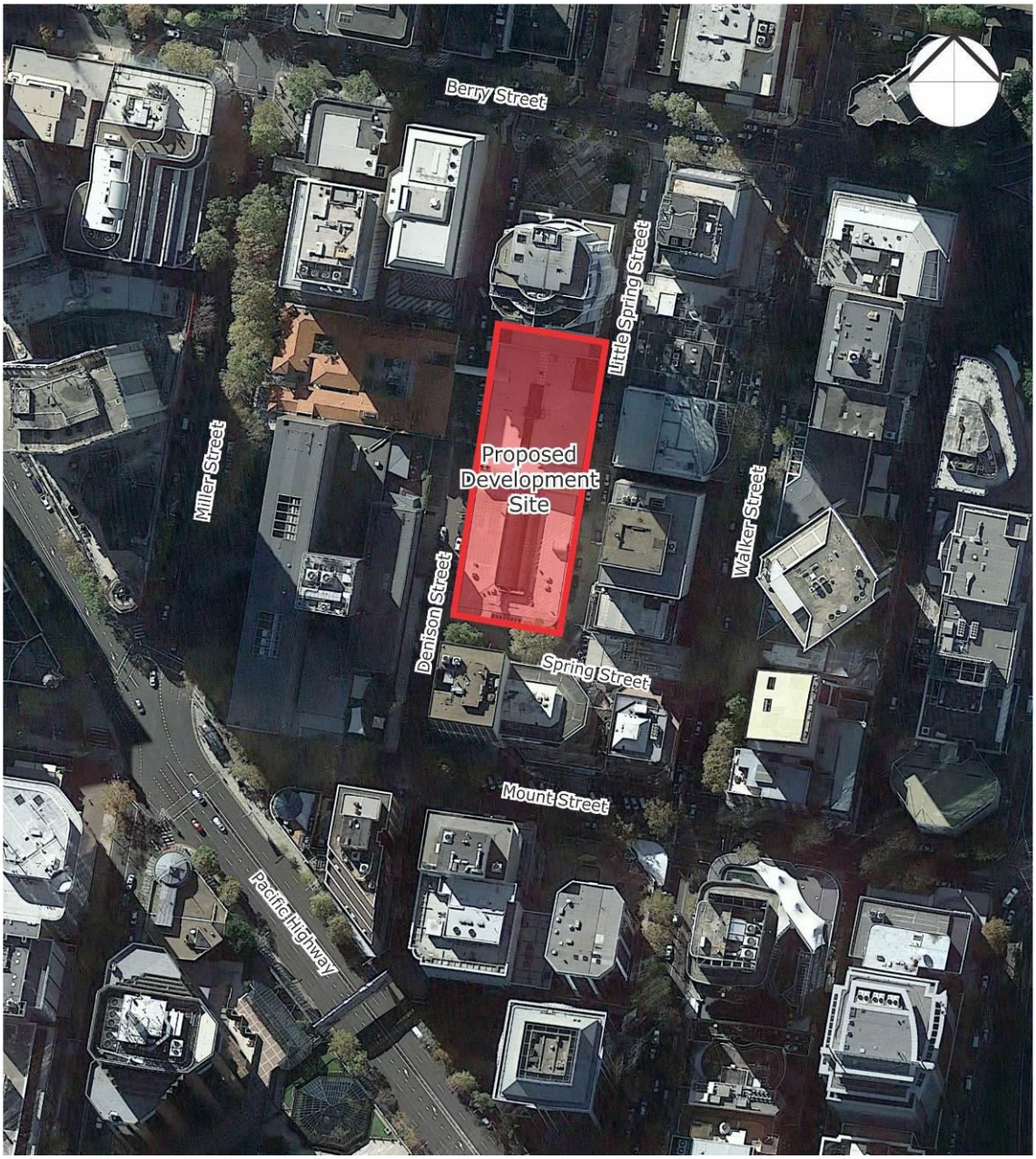

Figure 1: Aerial Image of the Proposed Development Site

2 WIND CLIMATE OF THE SYDNEY REGION

The Sydney region is governed by three principle wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on a detailed analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1939 to 2008). From this analysis, a directional plot of the annual and weekly recurrence winds for the Sydney region is also determined, as shown in Figure 1. The frequency of occurrence of these winds is also shown in Figure 1.

As shown in Figure 1, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

Table 1: Principle Time of Occurrence of Winds for Sydney

Month	Wind Direction		
	North-Easterly	Southerly	Westerly
January	X	X	
February	X	X	
March	X	X	
April		X	X
May			X
June			X
July			X
August			X
September		X	X
October	X	X	
November	X	X	
December	X	X	

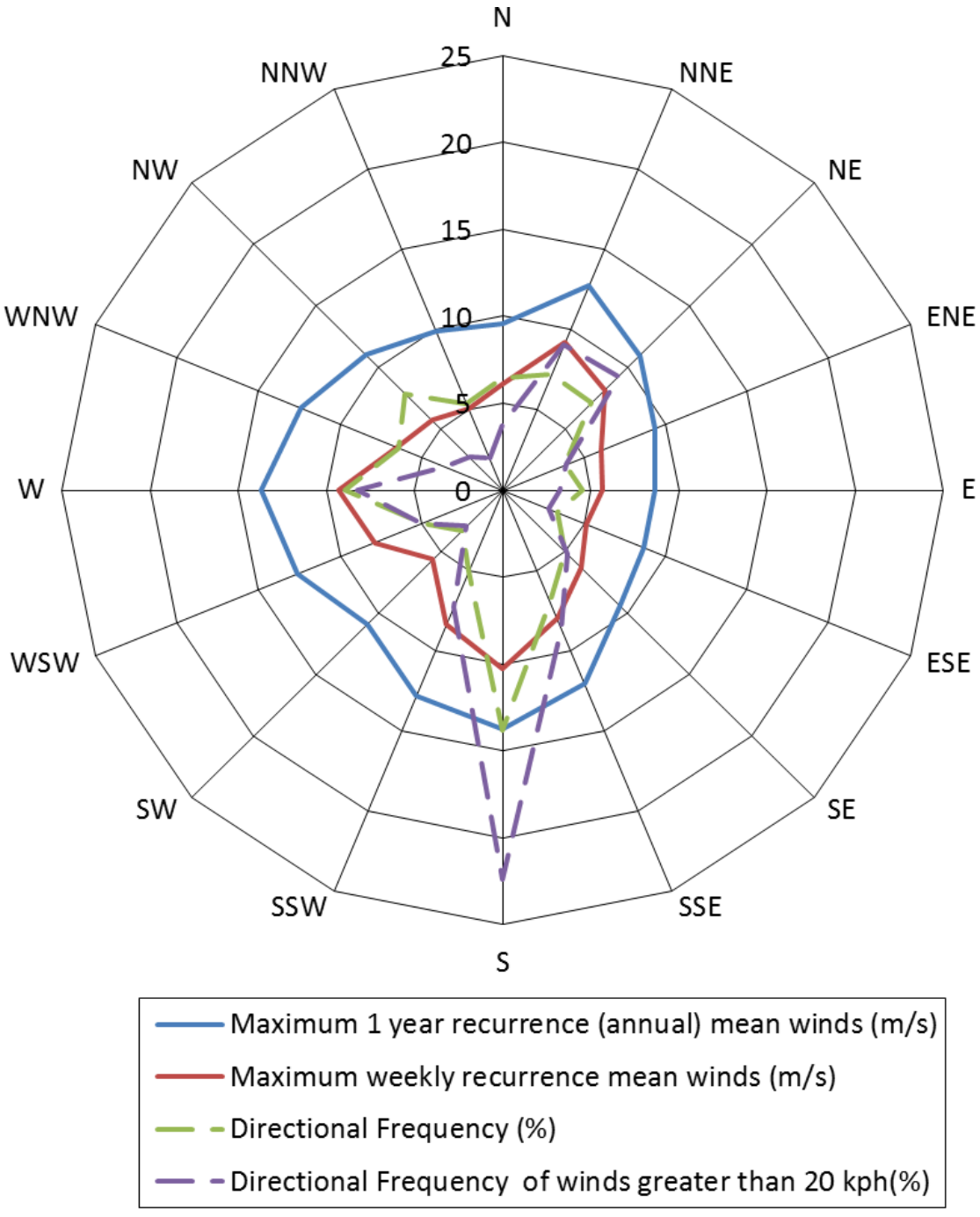

Figure 1: Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10-minute mean observations from Kingsford Smith Airport from 1939 to 2008, corrected to open terrain at 10m)

3 WIND EFFECTS ON PEOPLE

The acceptability of wind in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Various other researchers, such as Davenport, Lawson, Melbourne, Penwarden, etc, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. Some Councils and Local Government Authorities have also adopted elements of some of these into their planning control requirements in Australia. The following table is an example, which was developed by Penwarden in 1975, and describes the effects of various wind intensities on people. Note that the applicability column relates to the indicated wind conditions occurring frequently (exceeded approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Table 2: Summary of Wind Effects on People (Penwarden, 1975)

Type of Winds	Mean Wind Speed (m/s)	Effects	Applicability
Calm, light air	0 - 1.5	Calm, no noticeable wind.	Generally acceptable for Stationary, long exposure activities such as in outdoor restaurants, landscaped gardens and open air theatres.
Light breeze	1.6 - 3.3	Wind felt on face.	
Gentle breeze	3.4 - 5.4	Hair is disturbed, Clothing flaps.	
Moderate breeze	5.5 - 7.9	Raises dust, dry soil and loose paper. Hair disarranged.	Generally acceptable for walking & stationary, short exposure activities such as window shopping, standing or sitting in plazas.
Fresh breeze	8.0 - 10.7	Force of wind felt on body.	Acceptable as a main pedestrian thoroughfare
Strong breeze	10.8 - 13.8	Umbrellas used with difficulty, Hair blown straight, Difficult to walk steadily, Wind noise on ears unpleasant.	Acceptable for areas where there is little pedestrian activity or for fast walking.
Near gale	13.9 - 17.1	Inconvenience felt when walking.	
Gale	17.2 -20.7	Generally impedes progress, Great difficulty with balance.	Unacceptable as a public accessway.
Strong gale	20.8 - 24.4	People blown over by gusts.	Completely unacceptable.

It should be noted that wind speeds can only be accurately quantified with a wind tunnel study. This assessment addresses only the general wind effects and any localised effects that are identifiable by visual inspection and the acceptability of the conditions for outdoor areas are determined based on their intended use (rather than referencing specific wind speeds). Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

4 RESULTS AND DISCUSSION

The expected wind conditions affecting the various trafficable outdoor areas within and around the subject development are discussed in the following sub-sections of this report for the three predominant wind directions for the Sydney region; north-easterly, southerly, and westerly winds. The interaction between the wind and the building morphology in the area was considered, and important features taken into account include the distances between the building forms, their overall heights and bulk, as well as the landform. Note that only the potentially critical wind effects are discussed in this report, and the extent of the treatments recommended below are in the process of being verified through wind tunnel testing.

4.1 Site Location

Situated within the North Sydney business district, the surrounding medium to high rise buildings in proximity to the site are expected to offer moderate shielding of the prevailing winds. This shielding is expected to benefit wind conditions around the lower levels of the development.

The positioning of the outdoor terrace on Level 2 coincides with the relatively lower-rise existing Tower Square development to the west of the site. As such, this existing neighbouring building is unlikely to provide effective shielding against direct westerly winds, which may cause adverse wind effects within this relatively exposed terrace area on Level 2.

As the proposed height of the subject development places it in the approximate range of 50m to 100m above the majority of the adjacent buildings, there is potential for the upper portion of the tower façade to catch the direct prevailing winds. Due to the smooth design of the outer façade on upper levels, direct winds may be redirected downwards towards the lower levels, which may result in undesirable downwash effects.

4.2 Ground Level Entrances, Footpaths and Outdoor Seating

The Ground and Lower Ground Levels are expected to benefit from the shielding of direct winds provided by the various surrounding buildings. There is potential however for the prevailing southerly winds to funnel through the Denison St roadway to the south of the development, and side-stream along the western façade at Ground Level. As seating areas are proposed along this western frontage, tree-planting as indicated in Figure 2 is recommended in order to mitigate this potentially adverse wind effect caused by the prevailing southerly winds. Due to the narrow confines of the surrounding roads, there is increased potential for the prevailing winds to be re-directed and side-streamed along the primary aspects of the proposed development. For this reason, additional tree planting as detailed in Figure 2 is also recommended alongside the southern and eastern facades. Note that tree planting should be of an evergreen variety to ensure year-round effectiveness in wind mitigation, and capable of growing to a height of approximately 4-5m with a 4-5m diameter canopy.

The majority of the Ground Level areas will benefit from their slightly recessed design beneath a soffit or balcony above, and should aid in achieving comfortable wind conditions for pedestrians traversing the site at Ground Level. Due to the heightened sensitivity to wind conditions for outdoor seating areas, it is recommended to retain the balconies above the outdoor seating along Denison Street, as the protruding slabs of those balconies will serve to mitigate any downwash effects caused by winds being redirected off the tower façade above.

4.3 Proposed "Cross Street" Thoroughfare

The public thoroughfare linking Denison Street to Little Spring Street through the development at Ground Level is aligned with the westerly direction and therefore invites potential for the prevailing westerly winds to funnel through this corridor. Although the existing Tower Square building on the opposite side of Denison Street provides direct shielding of these winds at Ground Level, the built form of the subject development on the levels above will likely have the effect of capturing westerly winds passing over Tower Square, and redirecting them down and into this corridor. To remedy the potential for this adverse flow effect, it is recommended that provisions be made to incorporate an awning overheard of the western entrance of the proposed "Cross Street", at the height of the Level 1 floor slab, as indicated in Figure 3.

However, as Tower Square is marked for redevelopment as part of the Sydney Metro project, the height of this future development may serve to ameliorate the abovementioned wind effects. Depending on the height of that redevelopment the aforementioned awning may not be necessary.

4.4 Level 2 Terrace

As the elevation of the Level 2 terrace is relatively similar to the roof level of the adjacent Tower Square development, this outdoor area may experience adverse wind effects as a result of the prevailing westerly winds accelerating over the Tower Square rooftop and across the exposed Level 2 Terrace. To ameliorate the potential of this flow effect, 2m tall dense hedge planting, or 2m tall impermeable screening, is advised for the western perimeter of the Level 2 outdoor terrace. In addition, provisions should be made for planting or screening or similar landscaping scattered across the outdoor terrace, so as to prevent flow reattachment downwind of the western terrace perimeter. These treatments are detailed in Figure 3.

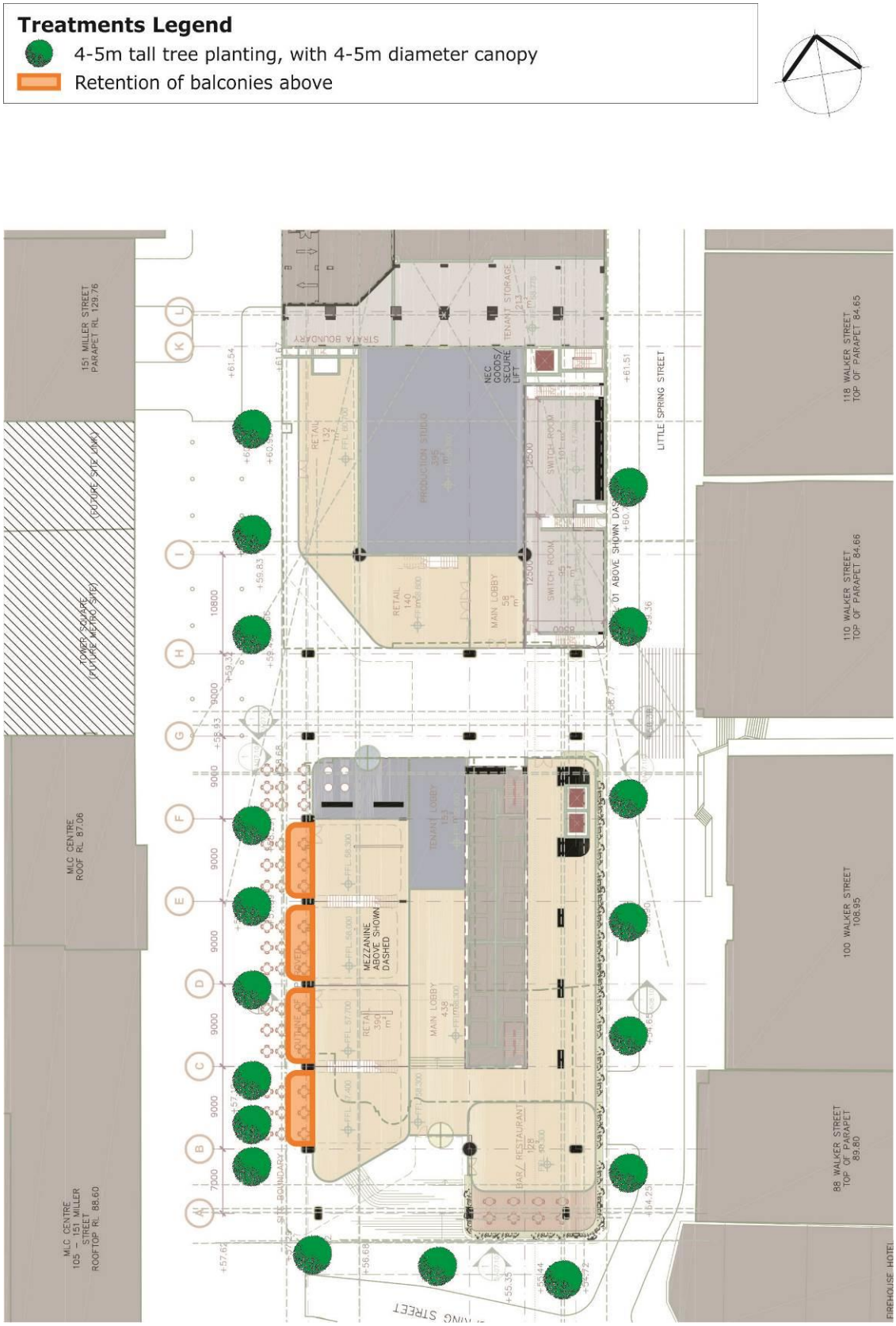

Figure 2: Recommended Treatments – Ground Level

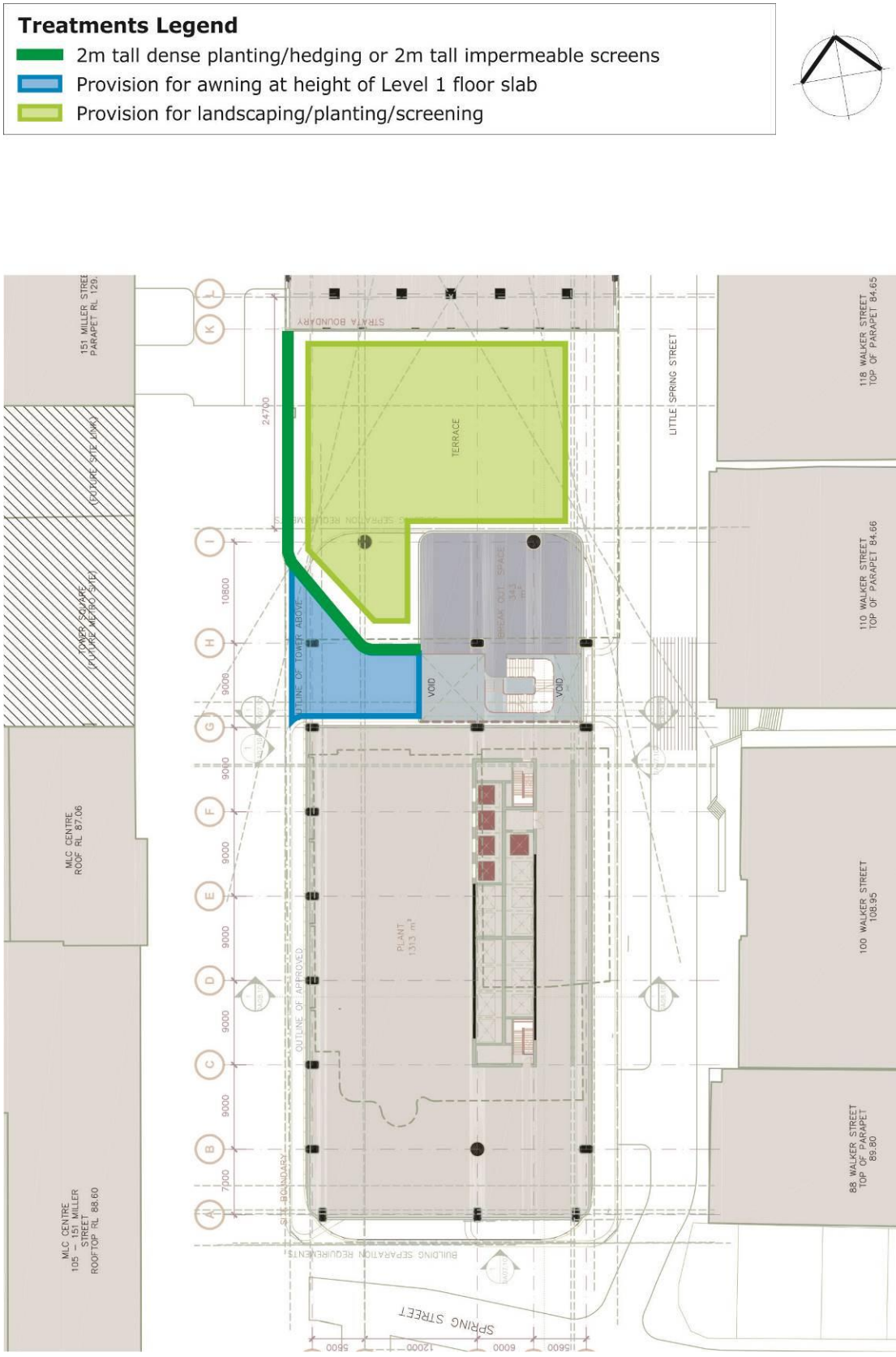

Figure 3: Recommended Treatments – Level 2