



NATURAL VENTILATION STATEMENT
V BY CROWN, PARRAMATTA

WA714-10F02(REV0)- NVS REPORT

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Prepared for:

Crown International Holdings Group

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DOCUMENT CONTROL

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The information contained herein is for the purpose of pedestrian wind environment effects only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the scope of this report.

EXECUTIVE SUMMARY

This report is in relation to the proposed development known as V by Crown, located at 45 Macquarie Street, Parramatta and presents an opinion on the on the natural ventilation performance and characteristics of the various residential units of the subject development.

The conclusions of this report are drawn from our extensive experience in this field and are based on the latest architectural drawings prepared by project architect Allen Jack + Cottier, received 31st June, 2012. The results of the study have been compared against the wind-driven natural ventilation criteria detailed in the State Environmental Planning Policy No. 65 (SEPP65). This report addresses only the general wind effects and any localised effects that are identifiable by visual inspection.

The results of the assessment indicate that the subject development will not satisfy the SEPP65 requirement for natural ventilation due to the large number of single-aspect residential apartments. Hence the proposed development site is expected to satisfy the 60% SEPP65 requirement for natural ventilation.

A further assessment has been undertaken for the residential apartments based on our experience in the field of wind-driven natural ventilation including full-scale and wind tunnel modelling and comparisons, as well as the previous natural ventilation study undertaken for this site. Due to the effective use of façade detailing including a stepped façade for the apartments, and notches on the eastern and western aspects of the development, it is expected that development will satisfy the requirements for natural ventilation. This will be need to be verified via means of wind tunnel testing.

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1 WIND CLIMATE OF THE SYDNEY REGION

Natural ventilation for a residential unit is most beneficial during the summer months of the year, when the occupants of the unit are most likely to open the windows of their unit and also when the cooling effect of airflow through the unit is most effective.

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 an analysis of wind rose data obtained by the Bureau of Meteorology from Kingsford Smith Airport between 1939 and 2000. The wind roses are attached in the appendix of this report.

Natural ventilation is more beneficial for the occupant of a development during the warmer months of the year. An analysis of the Sydney wind climate data for the 6 warmer months of the year (October to March), indicates that the north-easterly and southerly winds are dominant for this period, while the westerly winds are more predominant during the winter months. The north-easterly winds account for 39% of all occurrences during the warmer months, while the southerly winds account for 43% of all occurrences.

Table 1 Principle Time of Occurrence of Winds for Sydney

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

A directional plot of the annual and weekly recurrence winds for the Sydney region is shown in Figure 1 below. The frequency of occurrence of these winds is also shown. This plot has been produced based on an analysis of recorded wind speed data obtained from Sydney's Kingsford Smith Airport from 1939 to 2008.

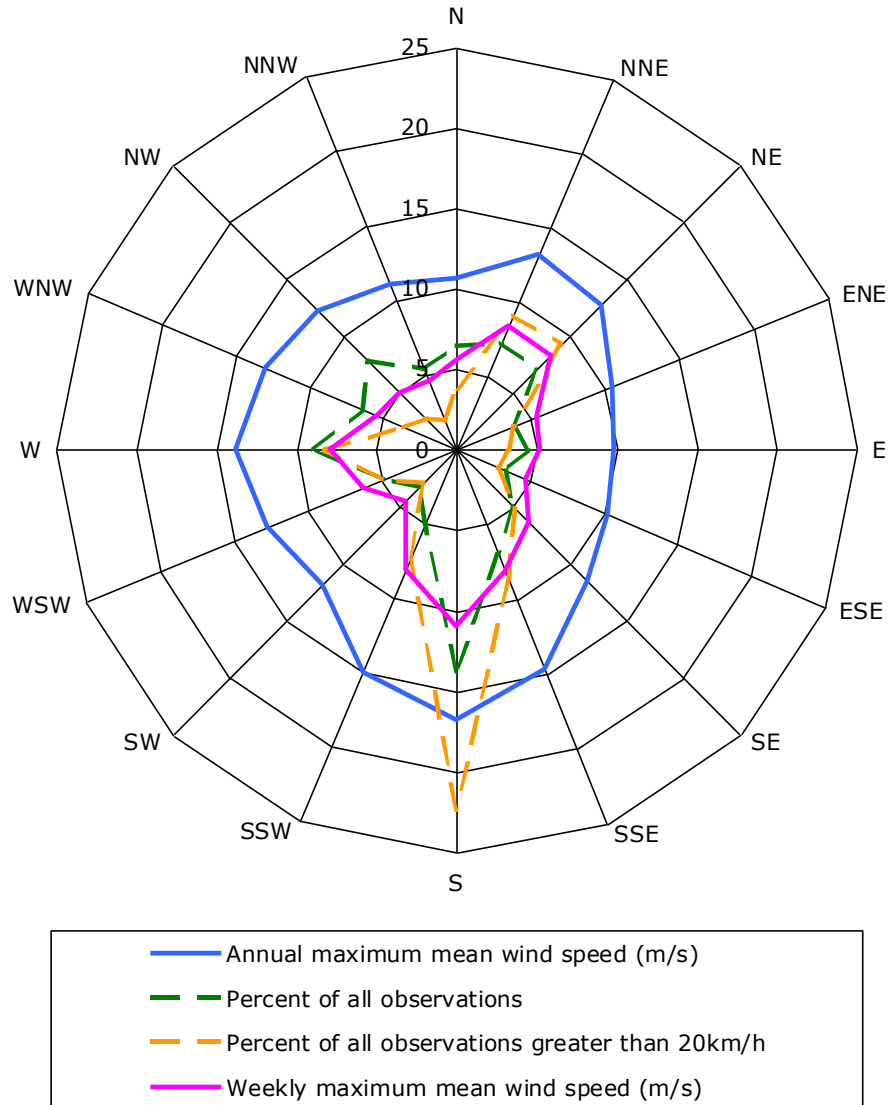


Figure 1 Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10 minute mean observations from Kingsford Smith Airport from 1939 to 2008, corrected to open terrain at 10m)

2 NATURAL VENTILATION CRITERIA

Natural ventilation of indoor areas can be used to improve both the level of occupant comfort and the air quality of an internal space. Natural ventilation is beneficial in improving occupant comfort during the warmer months of the year when the occupants will generally have windows and doors open, while during the winter months it is considered primarily beneficial for air quality purposes. The predominant wind directions for the Sydney region has been analysed in Section 1.0. From this analysis, only the north-easterly and southerly winds should be considered as the contributors to natural ventilation for occupant comfort purposes, since these are the predominant wind directions during the warmer months of the year. The westerly winds are predominant during the cooler winter months and would be beneficial for air quality purposes only.

The NSW State Environmental Planning Policy No. 65 (SEPP65) specifies that for a development to be considered naturally ventilated, at least 60% of the individual units must be considered to be naturally ventilated. For units to be considered naturally ventilated, it is required that they perform to the minimum performance of a double-ended unit or corner unit, with effective openings either on orthogonal aspects or opposite aspects. These effects are shown in Figures 2 and 3 which are taken from SEPP65.

In addition to the analysis for SEPP65 compliance, if the proposed development fails to comply with the SEPP65 criteria, an additional assessment for natural ventilation is presented based on principles derived from our experience numerous wind tunnel tests of residential developments. This alternative assessment is based on a set of criteria which can determine the number of units which are expected to achieve similar performance to those units that are deemed to satisfy the SEPP65 requirements. This alternative set of criteria considers the predominant wind directions for the area during the warmer months of the year as well as the ability of the façade profile to create sufficient pressure differentials between openings to the living and bedroom spaces that will generate wind flow. A comparison between the measured wind tunnel tests technique for natural ventilation and full-scale testing published by Peddie and Rofail (2011) demonstrated a close comparison.

The level of performance of a residential apartment is dependent on a number of key aspects. Windtech has formulated a set of key criteria as an alternative approached based off our detailed experience, this is detailed as follows:

- (i) The individual unit needs to have openings located either on orthogonal aspects or opposite aspects. **(SEPP65 Requirement)**
- (ii) One of the aspects of the individual unit needs to have openings which are either normal or orthogonal to the north-easterly direction, with minimal obstruction. For a single-aspect unit only the orthogonal case is considered (this criterion must be used in conjunction with criteria (iv)).

(iii) One of the aspects of the individual unit needs to have openings which are either normal or orthogonal to the southerly direction, with minimal obstruction. For a single-aspect unit only the orthogonal case is considered (this criterion must be used in conjunction with criteria (iv)).

(iv) The façade of the single aspect unit with window openings to the living area needs to be stepped (in or out) by at least 2 metres. The setback in the window opening locations needs to be such that it can generate a positive pressure at one opening and a neutral or negative pressure at the other opening. Note for this to be effective, one component should be located approximately in line to the building profile.

(v) ANSI/ASHRAE 62.1-2010, Ventilation for Acceptable Indoor Air Quality. The American ventilation standard provides recommendations for the location of spaces from an operable wall opening depending on the dwellings opening configuration and ceiling height (H):

- **Single Side Opening**, for spaces with operable openings on one side, a maximum distance of 2H from the operable openings.
- **Double Side Opening**, for spaces with operable openings on two opposite sides, a maximum distance of 5H from an opening.
- **Corner Openings**, for spaces with operable openings on two adjacent sides, a maximum distance of 5H along a line between two openings which are furthest apart.

Based on the above set of criterion, the expected level of natural ventilation for each dwelling is derived from the following combinations:

If the dwelling satisfies **Criterion i**, it is deemed to satisfy the requirements of SEPP65 and be considered naturally ventilated.

If the dwelling satisfies **all five criteria** then it is considered to have **exceptional** natural ventilation characteristics.

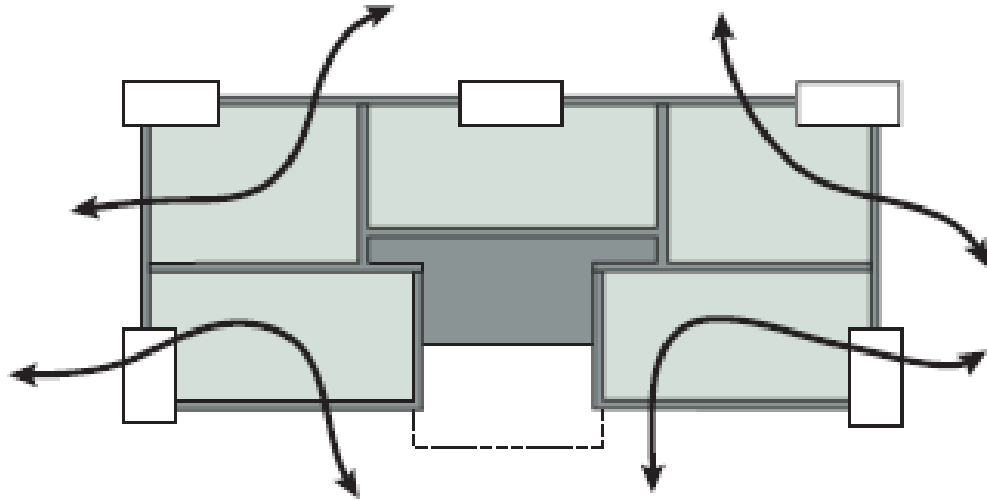
If the dwelling satisfies **Criterion i** as well as **Criterion ii, iii and v** then it is considered to have **commendable** natural ventilation characteristics

If the dwelling satisfies **Criterion i and v** as well as and either **Criterion ii or iii**; or **Criterion iv and v** and either **Criterion ii or iii** then it is considered to have **very good** natural ventilation characteristics.

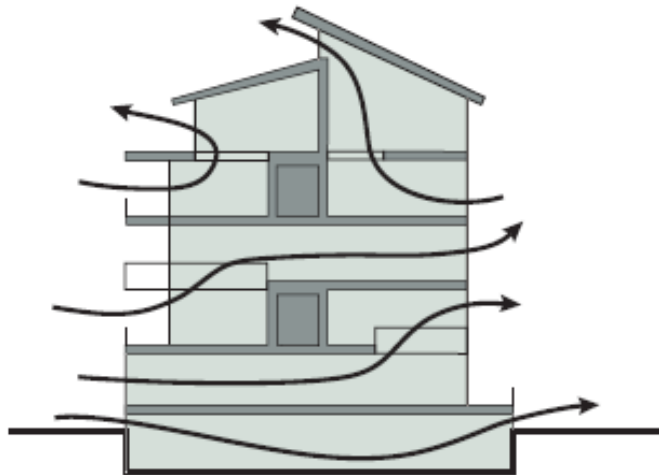
If the dwelling satisfies **Criterion i** only, or if the unit satisfies **Criterion iv** as well as **Criterion ii or iii** then it is considered to have **good** natural ventilation characteristics.

If the dwelling satisfies **Criterion v** and either **Criteria ii or iii** only then it is considered to have **below average** natural ventilation characteristics.

If the dwelling satisfies none of the abovementioned criteria or **Criterion ii, iii or iv** only, then it is deemed to have **poor** natural ventilation characteristics.



**Figure 2: Units Achieving Effective Natural Ventilation
(floor plan of a typical residential building)**



**Figure 3: Units Achieving Effective Natural Ventilation
(section elevation of a typical residential building)**

3 DESCRIPTION OF THE PROPOSED DEVELOPMENT AND SURROUNDINGS

The proposed development site consists of a 30 level residential development. 504 residential dwellings are proposed, spanning across 28 levels of the building. Ground floor consists of retail spaces and facilities associated with the archaeological site. Six basement levels dedicated to car-parking are also proposed. Openings to the residential apartments are proposed on all aspects of the subject development.

The subject site is located at 45 Macquarie Street, Parramatta and is bounded by Macquarie Street to the north, Marsden Street to the east and Hunter Street to the south. On the adjacent site to the west is a 12 storey office building, while to the north-west is the Jessie Street Centre. East of the subject site are a number of commercial buildings with heights up to six storeys above ground. To the south-east of the site is the St John's Cathedral, with Westfield Parramatta further beyond this.

There is a general rise towards the south-west in the local land topography around the subject site. An aerial image of the site is shown in the Figure 4 below.

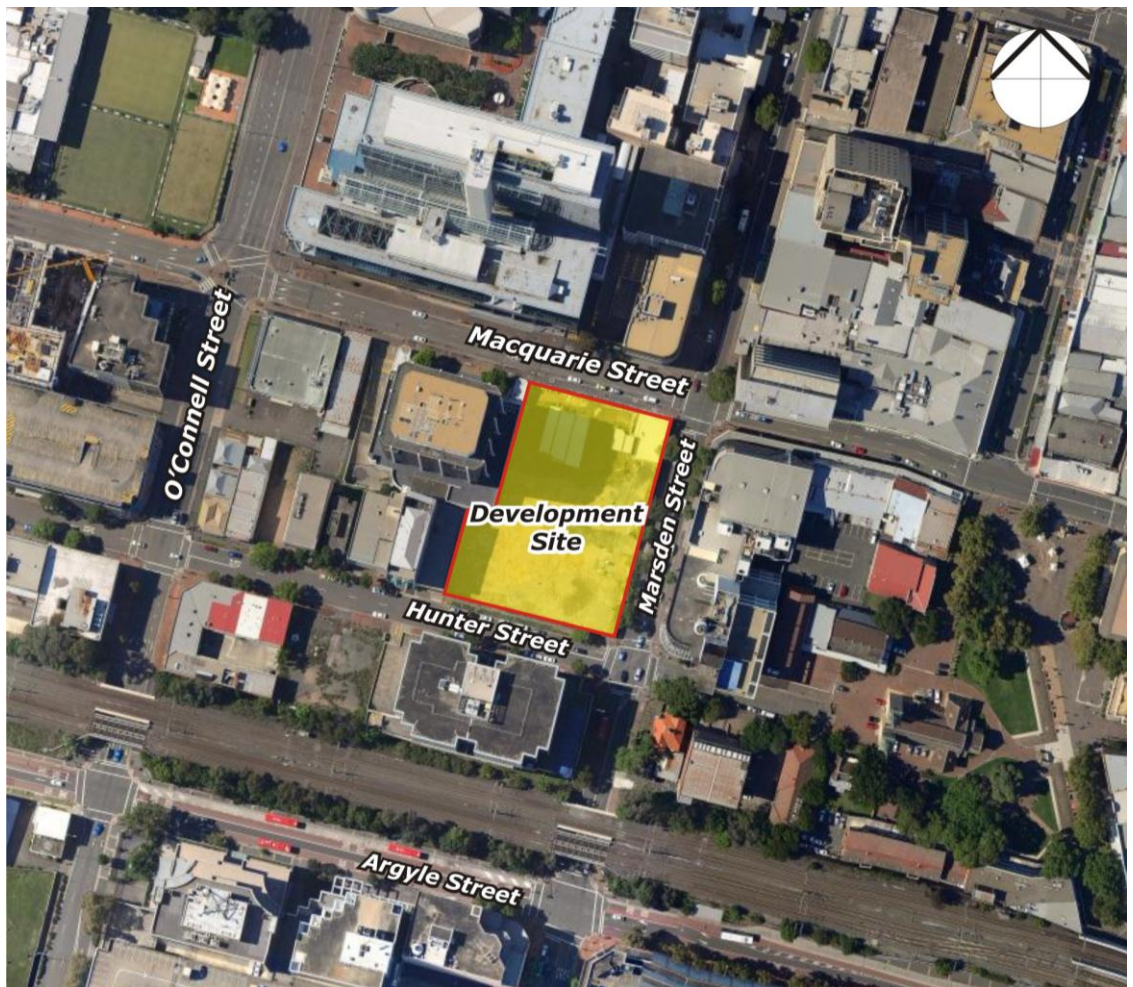


Figure 4 Aerial Image of the Site Location

4 RESULTS OF THE ANALYSIS

The natural ventilation assessment for the development took into account the predominant wind directions for the Sydney region, the interaction between the wind and the building morphology in the area. As discussed in Section 2.0, the westerly winds are not considered as effective in natural ventilation performance, since for the Sydney region these winds predominantly occur during the winter months, when wind-driven natural ventilation would not be considered desirable for the occupants of the development. Other important features which were taken into account for the assessment include the distances between the proposed building floor plan and orientation, as well as the landform surrounding the site. Note the future proposed developments to the north-west of the site are not expected to have upon the SEPP65 criterion for openings on opposite and orthogonal aspects.

4.1 Results from the Analysis

The results for the natural ventilation characteristics for the various residential units within the proposed development are presented in the following table. The analysis of the wind-driven natural ventilation characteristics considers the living space of the various residential units of the proposed development and potential for natural ventilation through this space. The indicated unit numbers in these tables correspond to the unit numbering scheme as indicated in the latest architectural drawings. Each residential unit is compared to the five basic criteria detailed in Section 2.0 of this report.

Table 2: Natural Ventilation Results

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
1.01	YES	YES	NO	NO	YES	Very Good
1.02	NO	YES	NO	NO	YES	Below Average
1.03	NO	YES	NO	NO	YES	Below Average
1.04	NO	YES	NO	YES	YES	Very Good
1.05	NO	YES	NO	YES	YES	Very Good
1.06	NO	YES	NO	NO	YES	Below Average
1.07	NO	YES	NO	NO	YES	Below Average
1.08	YES	YES	YES	NO	YES	Commendable
2.01	YES	YES	NO	NO	YES	Very Good
2.02	NO	YES	NO	NO	YES	Below Average
2.03	NO	YES	NO	NO	YES	Below Average
2.04	NO	YES	NO	YES	YES	Very Good
2.05	NO	YES	NO	YES	YES	Very Good
2.06	NO	YES	NO	NO	YES	Below Average
2.07	NO	YES	NO	NO	YES	Below Average
2.08	YES	YES	YES	NO	YES	Commendable

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
3.01	NO	NO	NO	YES	YES	Below Average
3.02	NO	NO	NO	YES	YES	Below Average
3.03	NO	NO	NO	YES	YES	Below Average
3.04	NO	NO	NO	YES	YES	Below Average
3.05	YES	YES	NO	YES	YES	Very Good
3.06	NO	YES	NO	YES	YES	Very Good
3.07	YES	YES	NO	YES	YES	Very Good
3.08	NO	YES	NO	YES	YES	Very Good
3.09	NO	YES	NO	NO	YES	Below Average
3.10	NO	YES	NO	NO	YES	Below Average
3.11	YES	YES	NO	NO	YES	Very Good
3.12	YES	YES	NO	YES	YES	Very Good
3.13	NO	YES	NO	YES	YES	Very Good
3.14	NO	YES	NO	YES	YES	Very Good
3.15	YES	YES	YES	YES	YES	Exceptional
3.16	YES	NO	YES	YES	YES	Very Good
3.17	NO	NO	YES	YES	YES	Very Good
3.18	YES	NO	YES	YES	YES	Very Good
3.19	YES	NO	NO	YES	YES	Very Good
3.20	NO	NO	NO	YES	YES	Below Average
3.21	NO	NO	NO	YES	YES	Below Average
3.22	NO	NO	NO	NO	YES	Below Average
3.23	NO	NO	NO	YES	YES	Below Average
3.24	NO	NO	NO	NO	YES	Below Average
4.01	NO	NO	NO	YES	YES	Below Average
4.02	NO	NO	NO	YES	YES	Below Average
4.03	NO	NO	NO	YES	YES	Below Average
4.04	NO	NO	NO	YES	YES	Below Average
4.05	YES	YES	NO	YES	YES	Very Good
4.06	NO	YES	NO	YES	YES	Very Good
4.07	YES	YES	NO	YES	YES	Very Good
4.08	NO	YES	NO	YES	YES	Very Good
4.09	NO	YES	NO	NO	YES	Below Average
4.10	NO	YES	NO	NO	YES	Below Average
4.11	YES	YES	NO	NO	YES	Very Good
4.12	YES	YES	NO	YES	YES	Very Good
4.13	NO	YES	NO	YES	YES	Very Good
4.14	NO	YES	NO	YES	YES	Very Good
4.15	YES	YES	YES	YES	YES	Exceptional
4.16	YES	NO	YES	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
4.17	NO	NO	YES	YES	YES	Very Good
4.18	YES	NO	YES	YES	YES	Very Good
4.19	YES	NO	NO	YES	YES	Very Good
4.20	NO	NO	NO	YES	YES	Below Average
4.21	NO	NO	NO	YES	YES	Below Average
4.22	NO	NO	NO	NO	YES	Below Average
4.23	NO	NO	NO	YES	YES	Below Average
4.24	NO	NO	NO	NO	YES	Below Average
5.01	NO	NO	NO	YES	YES	Below Average
5.02	NO	NO	NO	YES	YES	Below Average
5.03	NO	NO	NO	YES	YES	Below Average
5.04	NO	NO	NO	YES	YES	Below Average
5.05	YES	YES	NO	YES	YES	Very Good
5.06	NO	YES	NO	YES	YES	Very Good
5.07	YES	YES	NO	YES	YES	Very Good
5.08	NO	YES	NO	YES	YES	Very Good
5.09	NO	YES	NO	NO	YES	Below Average
5.10	NO	YES	NO	NO	YES	Below Average
5.11	YES	YES	NO	NO	YES	Very Good
5.12	YES	YES	NO	YES	YES	Very Good
5.13	NO	YES	NO	YES	YES	Very Good
5.14	NO	YES	NO	YES	YES	Very Good
5.15	YES	YES	YES	YES	YES	Exceptional
5.16	YES	NO	YES	YES	YES	Very Good
5.17	NO	NO	YES	YES	YES	Very Good
5.18	YES	NO	YES	YES	YES	Very Good
5.19	YES	NO	NO	YES	YES	Very Good
5.20	NO	NO	NO	YES	YES	Below Average
5.21	NO	NO	NO	YES	YES	Below Average
5.22	NO	NO	NO	NO	YES	Below Average
5.23	NO	NO	NO	YES	YES	Below Average
5.24	NO	NO	NO	NO	YES	Below Average
6.01	NO	NO	NO	YES	YES	Below Average
6.02	NO	NO	NO	YES	YES	Below Average
6.03	NO	NO	NO	YES	YES	Below Average
6.04	NO	NO	NO	YES	YES	Below Average
6.05	YES	YES	NO	YES	YES	Very Good
6.06	NO	YES	NO	YES	YES	Very Good
6.07	YES	YES	NO	YES	YES	Very Good
6.08	NO	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
6.09	NO	YES	NO	NO	YES	Below Average
6.10	NO	YES	NO	NO	YES	Below Average
6.11	YES	YES	NO	NO	YES	Very Good
6.12	YES	YES	NO	YES	YES	Very Good
6.13	NO	YES	NO	YES	YES	Very Good
6.14	NO	YES	NO	YES	YES	Very Good
6.15	YES	YES	YES	YES	YES	Exceptional
6.16	YES	NO	YES	YES	YES	Very Good
6.17	NO	NO	YES	YES	YES	Very Good
6.18	YES	NO	YES	YES	YES	Very Good
6.19	YES	NO	NO	YES	YES	Very Good
6.20	NO	NO	NO	YES	YES	Below Average
6.21	NO	NO	NO	YES	YES	Below Average
6.22	NO	NO	NO	NO	YES	Below Average
6.23	NO	NO	NO	YES	YES	Below Average
6.24	NO	NO	NO	NO	YES	Below Average
7.01	NO	NO	NO	YES	YES	Below Average
7.02	NO	NO	NO	YES	YES	Below Average
7.03	NO	NO	NO	YES	YES	Below Average
7.04	NO	NO	NO	YES	YES	Below Average
7.05	YES	YES	NO	YES	YES	Very Good
7.06	NO	YES	NO	YES	YES	Very Good
7.07	YES	YES	NO	YES	YES	Very Good
7.08	NO	YES	NO	YES	YES	Very Good
7.09	NO	YES	NO	NO	YES	Below Average
7.10	NO	YES	NO	NO	YES	Below Average
7.11	YES	YES	NO	NO	YES	Very Good
7.12	YES	YES	NO	YES	YES	Very Good
7.13	NO	YES	NO	YES	YES	Very Good
7.14	NO	YES	NO	YES	YES	Very Good
7.15	YES	YES	YES	YES	YES	Exceptional
7.16	YES	NO	YES	YES	YES	Very Good
7.17	NO	NO	YES	YES	YES	Very Good
7.18	YES	NO	YES	YES	YES	Very Good
7.19	YES	NO	NO	YES	YES	Very Good
7.20	NO	NO	NO	YES	YES	Below Average
7.21	NO	NO	NO	YES	YES	Below Average
7.22	NO	NO	NO	NO	YES	Below Average
7.23	NO	NO	NO	YES	YES	Below Average
7.24	NO	NO	NO	NO	YES	Below Average

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
8.01	NO	NO	NO	YES	YES	Below Average
8.02	NO	NO	NO	YES	YES	Below Average
8.03	NO	NO	NO	YES	YES	Below Average
8.04	NO	NO	NO	YES	YES	Below Average
8.05	YES	YES	NO	YES	YES	Very Good
8.06	NO	YES	NO	YES	YES	Very Good
8.07	YES	YES	NO	YES	YES	Very Good
8.08	NO	YES	NO	YES	YES	Very Good
8.09	NO	YES	NO	NO	YES	Below Average
8.10	NO	YES	NO	NO	YES	Below Average
8.11	YES	YES	NO	NO	YES	Very Good
8.12	YES	YES	NO	YES	YES	Very Good
8.13	NO	YES	NO	YES	YES	Very Good
8.14	NO	YES	NO	YES	YES	Very Good
8.15	YES	YES	YES	YES	YES	Exceptional
8.16	YES	NO	YES	YES	YES	Very Good
8.17	NO	NO	YES	YES	YES	Very Good
8.18	YES	NO	YES	YES	YES	Very Good
8.19	YES	NO	NO	YES	YES	Very Good
8.20	NO	NO	NO	YES	YES	Below Average
8.21	NO	NO	NO	YES	YES	Below Average
8.22	NO	NO	NO	NO	YES	Below Average
8.23	NO	NO	NO	YES	YES	Below Average
8.24	NO	NO	NO	NO	YES	Below Average
9.01	NO	NO	NO	YES	YES	Below Average
9.02	NO	NO	NO	YES	YES	Below Average
9.03	NO	NO	NO	YES	YES	Below Average
9.04	NO	NO	NO	YES	YES	Below Average
9.05	YES	YES	NO	YES	YES	Very Good
9.06	NO	YES	NO	YES	YES	Very Good
9.07	YES	YES	NO	YES	YES	Very Good
9.08	NO	YES	NO	YES	YES	Very Good
9.09	NO	YES	NO	NO	YES	Below Average
9.10	NO	YES	NO	NO	YES	Below Average
9.11	YES	YES	NO	NO	YES	Very Good
9.12	YES	YES	NO	YES	YES	Very Good
9.13	NO	YES	NO	YES	YES	Very Good
9.14	NO	YES	NO	YES	YES	Very Good
9.15	YES	YES	YES	YES	YES	Exceptional
9.16	YES	NO	YES	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
9.17	NO	NO	YES	YES	YES	Very Good
9.18	YES	NO	YES	YES	YES	Very Good
9.19	YES	NO	NO	YES	YES	Very Good
9.20	NO	NO	NO	YES	YES	Below Average
9.21	NO	NO	NO	YES	YES	Below Average
9.22	NO	NO	NO	NO	YES	Below Average
9.23	NO	NO	NO	YES	YES	Below Average
9.24	NO	NO	NO	NO	YES	Below Average
10.01	NO	NO	NO	YES	YES	Below Average
10.02	NO	NO	NO	YES	YES	Below Average
10.03	NO	NO	NO	YES	YES	Below Average
10.04	NO	NO	NO	YES	YES	Below Average
10.05	YES	YES	NO	YES	YES	Very Good
10.06	NO	YES	NO	YES	YES	Very Good
10.07	YES	YES	NO	YES	YES	Very Good
10.08	NO	YES	NO	YES	YES	Very Good
10.09	NO	YES	NO	NO	YES	Below Average
10.10	NO	YES	NO	NO	YES	Below Average
10.11	YES	YES	NO	NO	YES	Very Good
10.12	YES	YES	NO	YES	YES	Very Good
10.13	NO	YES	NO	YES	YES	Very Good
10.14	NO	YES	NO	YES	YES	Very Good
10.15	YES	YES	YES	YES	YES	Exceptional
10.16	YES	NO	YES	YES	YES	Very Good
10.17	NO	NO	YES	YES	YES	Very Good
10.18	YES	NO	YES	YES	YES	Very Good
10.19	YES	NO	NO	YES	YES	Very Good
10.20	NO	NO	NO	YES	YES	Below Average
10.21	NO	NO	NO	YES	YES	Below Average
10.22	NO	NO	NO	NO	YES	Below Average
10.23	NO	NO	NO	YES	YES	Below Average
10.24	NO	NO	NO	NO	YES	Below Average
11.01	NO	NO	NO	YES	YES	Below Average
11.02	NO	NO	NO	YES	YES	Below Average
11.03	NO	NO	NO	YES	YES	Below Average
11.04	NO	NO	YES	YES	YES	Very Good
11.05	YES	YES	NO	YES	YES	Very Good
11.06	NO	YES	NO	YES	YES	Very Good
11.07	YES	YES	NO	YES	YES	Very Good
11.08	NO	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
11.09	NO	YES	NO	NO	YES	Below Average
11.10	NO	YES	NO	NO	YES	Below Average
11.11	YES	YES	NO	NO	YES	Very Good
11.12	YES	YES	NO	YES	YES	Very Good
11.13	NO	YES	NO	YES	YES	Very Good
11.14	NO	YES	NO	YES	YES	Very Good
11.15	YES	YES	YES	YES	YES	Exceptional
11.16	YES	NO	YES	YES	YES	Very Good
11.17	NO	NO	YES	YES	YES	Very Good
11.18	YES	NO	YES	YES	YES	Very Good
11.19	YES	NO	NO	YES	YES	Very Good
11.20	NO	NO	NO	YES	YES	Below Average
11.21	NO	NO	NO	YES	YES	Below Average
11.22	NO	NO	NO	NO	YES	Below Average
11.23	NO	NO	NO	YES	YES	Below Average
11.24	NO	NO	NO	NO	YES	Below Average
12.01	NO	NO	NO	YES	YES	Below Average
12.02	NO	NO	NO	YES	YES	Below Average
12.03	NO	NO	NO	YES	YES	Below Average
12.04	NO	NO	YES	YES	YES	Very Good
12.05	YES	YES	NO	YES	YES	Very Good
12.06	NO	YES	NO	YES	YES	Very Good
12.07	YES	YES	NO	YES	YES	Very Good
12.08	NO	YES	NO	YES	YES	Very Good
12.09	NO	YES	NO	YES	YES	Very Good
12.10	NO	YES	NO	YES	YES	Very Good
12.11	YES	YES	NO	YES	YES	Very Good
12.12	YES	YES	NO	YES	YES	Very Good
12.13	NO	YES	NO	YES	YES	Very Good
12.14	NO	YES	NO	YES	YES	Very Good
12.15	YES	YES	YES	YES	YES	Exceptional
12.16	YES	NO	YES	YES	YES	Very Good
12.17	NO	NO	NO	NO	YES	Below Average
12.18	NO	NO	NO	NO	YES	Below Average
13.01	NO	NO	NO	YES	YES	Below Average
13.02	NO	NO	NO	YES	YES	Below Average
13.03	NO	NO	NO	YES	YES	Below Average
13.04	NO	NO	YES	YES	YES	Very Good
13.05	YES	YES	NO	YES	YES	Very Good
13.06	NO	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
13.07	YES	YES	NO	YES	YES	Very Good
13.08	NO	YES	NO	YES	YES	Very Good
13.09	NO	YES	NO	YES	YES	Very Good
13.10	NO	YES	NO	YES	YES	Very Good
13.11	YES	YES	NO	YES	YES	Very Good
13.12	YES	YES	NO	YES	YES	Very Good
13.13	NO	YES	NO	YES	YES	Very Good
13.14	NO	YES	NO	YES	YES	Very Good
13.15	YES	YES	YES	YES	YES	Exceptional
13.16	YES	NO	YES	YES	YES	Very Good
13.17	NO	NO	NO	NO	YES	Below Average
13.18	NO	NO	NO	NO	YES	Below Average
14.01	NO	NO	NO	YES	YES	Below Average
14.02	NO	NO	NO	YES	YES	Below Average
14.03	NO	NO	NO	YES	YES	Below Average
14.04	NO	NO	YES	YES	YES	Very Good
14.05	YES	YES	NO	YES	YES	Very Good
14.06	NO	YES	NO	YES	YES	Very Good
14.07	YES	YES	NO	YES	YES	Very Good
14.08	NO	YES	NO	YES	YES	Very Good
14.09	NO	YES	NO	YES	YES	Very Good
14.10	NO	YES	NO	YES	YES	Very Good
14.11	YES	YES	NO	YES	YES	Very Good
14.12	YES	YES	NO	YES	YES	Very Good
14.13	NO	YES	NO	YES	YES	Very Good
14.14	NO	YES	NO	YES	YES	Very Good
14.15	YES	YES	YES	YES	YES	Exceptional
14.16	YES	NO	YES	YES	YES	Very Good
14.17	NO	NO	NO	YES	YES	Below Average
14.18	NO	NO	NO	NO	YES	Below Average
14.19	NO	NO	NO	NO	YES	Below Average
15.01	NO	NO	NO	YES	YES	Below Average
15.02	NO	NO	NO	YES	YES	Below Average
15.03	NO	NO	NO	YES	YES	Below Average
15.04	NO	NO	YES	YES	YES	Very Good
15.05	YES	YES	NO	YES	YES	Very Good
15.06	NO	YES	NO	YES	YES	Very Good
15.07	YES	YES	NO	YES	YES	Very Good
15.08	NO	YES	NO	YES	YES	Very Good
15.09	NO	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
15.10	NO	YES	NO	YES	YES	Very Good
15.11	YES	YES	NO	YES	YES	Very Good
15.12	YES	YES	NO	YES	YES	Very Good
15.13	NO	YES	NO	YES	YES	Very Good
15.14	NO	YES	NO	YES	YES	Very Good
15.15	YES	YES	YES	YES	YES	Exceptional
15.16	YES	NO	YES	YES	YES	Very Good
15.17	NO	NO	NO	YES	YES	Below Average
15.18	NO	NO	NO	NO	YES	Below Average
15.19	NO	NO	NO	NO	YES	Below Average
16.01	NO	NO	NO	YES	YES	Below Average
16.02	NO	NO	NO	YES	YES	Below Average
16.03	NO	NO	NO	YES	YES	Below Average
16.04	NO	NO	YES	YES	YES	Very Good
16.05	YES	YES	NO	YES	YES	Very Good
16.06	NO	YES	NO	YES	YES	Very Good
16.07	YES	YES	NO	YES	YES	Very Good
16.08	NO	YES	NO	YES	YES	Very Good
16.09	NO	YES	NO	YES	YES	Very Good
16.10	NO	YES	NO	YES	YES	Very Good
16.11	YES	YES	NO	YES	YES	Very Good
16.12	YES	YES	NO	YES	YES	Very Good
16.13	NO	YES	NO	YES	YES	Very Good
16.14	NO	YES	NO	YES	YES	Very Good
16.15	YES	YES	YES	YES	YES	Exceptional
16.16	YES	NO	YES	YES	YES	Very Good
16.17	NO	NO	NO	YES	YES	Below Average
16.18	NO	NO	NO	NO	YES	Below Average
16.19	NO	NO	NO	NO	YES	Below Average
17.01	NO	NO	NO	YES	YES	Below Average
17.02	NO	NO	NO	YES	YES	Below Average
17.03	NO	NO	NO	YES	YES	Below Average
17.04	NO	NO	YES	YES	YES	Very Good
17.05	YES	YES	NO	YES	YES	Very Good
17.06	NO	YES	NO	YES	YES	Very Good
17.07	YES	YES	NO	YES	YES	Very Good
17.08	NO	YES	NO	YES	YES	Very Good
17.09	NO	YES	NO	YES	YES	Very Good
17.10	NO	YES	NO	YES	YES	Very Good
17.11	YES	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
17.12	YES	YES	NO	YES	YES	Very Good
17.13	NO	YES	NO	YES	YES	Very Good
17.14	NO	YES	NO	YES	YES	Very Good
17.15	YES	YES	YES	YES	YES	Exceptional
17.16	YES	NO	YES	YES	YES	Very Good
17.17	NO	NO	NO	YES	YES	Below Average
17.18	NO	NO	NO	NO	YES	Below Average
17.19	NO	NO	NO	NO	YES	Below Average
18.01	NO	NO	NO	YES	YES	Below Average
18.02	NO	NO	NO	YES	YES	Below Average
18.03	NO	NO	NO	YES	YES	Below Average
18.04	NO	NO	YES	YES	YES	Very Good
18.05	YES	YES	NO	YES	YES	Very Good
18.06	NO	YES	NO	YES	YES	Very Good
18.07	YES	YES	NO	YES	YES	Very Good
18.08	NO	YES	NO	YES	YES	Very Good
18.09	NO	YES	NO	YES	YES	Very Good
18.10	NO	YES	NO	YES	YES	Very Good
18.11	YES	YES	NO	YES	YES	Very Good
18.12	YES	YES	NO	YES	YES	Very Good
18.13	NO	YES	NO	YES	YES	Very Good
18.14	NO	YES	NO	YES	YES	Very Good
18.15	YES	YES	YES	YES	YES	Exceptional
18.16	YES	NO	YES	YES	YES	Very Good
18.17	NO	NO	NO	YES	YES	Below Average
18.18	NO	NO	NO	NO	YES	Below Average
18.19	NO	NO	NO	NO	YES	Below Average
19.01	NO	NO	NO	YES	YES	Below Average
19.02	NO	NO	NO	YES	YES	Below Average
19.03	NO	NO	NO	YES	YES	Below Average
19.04	NO	NO	YES	YES	YES	Very Good
19.05	YES	YES	NO	YES	YES	Very Good
19.06	NO	YES	NO	YES	YES	Very Good
19.07	YES	YES	NO	YES	YES	Very Good
19.08	NO	YES	NO	YES	YES	Very Good
19.09	NO	YES	NO	YES	YES	Very Good
19.10	NO	YES	NO	YES	YES	Very Good
19.11	YES	YES	NO	YES	YES	Very Good
19.12	YES	YES	NO	YES	YES	Very Good
19.13	NO	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
19.14	NO	YES	NO	YES	YES	Very Good
19.15	YES	YES	YES	YES	YES	Exceptional
19.16	YES	NO	YES	YES	YES	Very Good
19.17	NO	NO	NO	YES	YES	Below Average
19.18	NO	NO	NO	NO	YES	Below Average
19.19	NO	NO	NO	NO	YES	Below Average
20.01	NO	NO	NO	YES	YES	Below Average
20.02	NO	NO	NO	YES	YES	Below Average
20.03	NO	NO	NO	YES	YES	Below Average
20.04	NO	NO	YES	YES	YES	Very Good
20.05	YES	YES	NO	YES	YES	Very Good
20.06	NO	YES	NO	YES	YES	Very Good
20.07	YES	YES	NO	YES	YES	Very Good
20.08	NO	YES	NO	YES	YES	Very Good
20.09	NO	YES	NO	YES	YES	Very Good
20.10	NO	YES	NO	YES	YES	Very Good
20.11	YES	YES	NO	YES	YES	Very Good
20.12	YES	YES	NO	YES	YES	Very Good
20.13	NO	YES	NO	YES	YES	Very Good
20.14	NO	YES	NO	YES	YES	Very Good
20.15	YES	YES	YES	YES	YES	Exceptional
20.16	YES	NO	YES	YES	YES	Very Good
20.17	NO	NO	NO	YES	YES	Below Average
20.18	NO	NO	NO	NO	YES	Below Average
20.19	NO	NO	NO	NO	YES	Below Average
21.01	NO	NO	NO	YES	YES	Below Average
21.02	NO	NO	NO	YES	YES	Below Average
21.03	NO	NO	NO	YES	YES	Below Average
21.04	YES	YES	NO	YES	YES	Very Good
21.05	NO	YES	NO	YES	YES	Very Good
21.06	YES	YES	NO	YES	YES	Very Good
21.07	NO	YES	NO	YES	YES	Very Good
21.08	NO	YES	NO	YES	YES	Very Good
21.09	YES	YES	NO	YES	YES	Very Good
21.10	YES	YES	NO	YES	YES	Very Good
21.11	NO	YES	NO	YES	YES	Very Good
21.12	NO	YES	NO	YES	YES	Very Good
21.13	YES	YES	YES	YES	YES	Exceptional
21.14	YES	NO	YES	YES	YES	Very Good
21.15	NO	NO	NO	YES	YES	Below Average

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
21.16	NO	NO	NO	NO	YES	Below Average
21.17	NO	NO	NO	NO	YES	Below Average
22.01	NO	NO	NO	YES	YES	Below Average
22.02	NO	NO	NO	YES	YES	Below Average
22.03	NO	NO	NO	YES	YES	Below Average
22.04	YES	YES	NO	YES	YES	Very Good
22.05	NO	YES	NO	YES	YES	Very Good
22.06	YES	YES	NO	YES	YES	Very Good
22.07	NO	YES	NO	YES	YES	Very Good
22.08	NO	YES	NO	YES	YES	Very Good
22.09	YES	YES	NO	YES	YES	Very Good
22.10	YES	YES	NO	YES	YES	Very Good
22.11	NO	YES	NO	YES	YES	Very Good
22.12	NO	YES	NO	YES	YES	Very Good
22.13	YES	YES	YES	YES	YES	Exceptional
22.14	YES	NO	YES	YES	YES	Very Good
22.15	NO	NO	NO	YES	YES	Below Average
22.16	NO	NO	NO	NO	YES	Below Average
22.17	NO	NO	NO	NO	YES	Below Average
23.01	NO	NO	NO	YES	YES	Below Average
23.02	NO	NO	NO	YES	YES	Below Average
23.03	NO	NO	NO	YES	YES	Below Average
23.04	YES	YES	NO	YES	YES	Very Good
23.05	NO	YES	NO	YES	YES	Very Good
23.06	YES	YES	NO	YES	YES	Very Good
23.07	NO	YES	NO	YES	YES	Very Good
23.08	NO	YES	NO	YES	YES	Very Good
23.09	YES	YES	NO	YES	YES	Very Good
23.10	YES	YES	NO	YES	YES	Very Good
23.11	NO	YES	NO	YES	YES	Very Good
23.12	NO	YES	NO	YES	YES	Very Good
23.13	YES	YES	YES	YES	YES	Exceptional
23.14	YES	NO	YES	YES	YES	Very Good
23.15	NO	NO	NO	YES	YES	Below Average
23.16	NO	NO	NO	NO	YES	Below Average
23.17	NO	NO	NO	NO	YES	Below Average
24.01	NO	NO	NO	YES	YES	Below Average
24.02	NO	NO	NO	YES	YES	Below Average
24.03	NO	NO	NO	YES	YES	Below Average
24.04	YES	YES	NO	YES	YES	Very Good

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
24.05	NO	YES	NO	YES	YES	Very Good
24.06	YES	YES	NO	YES	YES	Very Good
24.07	NO	YES	NO	YES	YES	Very Good
24.08	NO	YES	NO	YES	YES	Very Good
24.09	YES	YES	NO	YES	YES	Very Good
24.10	YES	YES	NO	YES	YES	Very Good
24.11	NO	YES	NO	YES	YES	Very Good
24.12	NO	YES	NO	YES	YES	Very Good
24.13	YES	YES	YES	YES	YES	Exceptional
24.14	YES	NO	YES	YES	YES	Very Good
24.15	NO	NO	NO	YES	YES	Below Average
24.16	NO	NO	NO	NO	YES	Below Average
24.17	NO	NO	NO	NO	YES	Below Average
25.01	NO	NO	NO	YES	YES	Below Average
25.02	NO	NO	NO	YES	YES	Below Average
25.03	NO	NO	NO	YES	YES	Below Average
25.04	YES	YES	NO	YES	YES	Very Good
25.05	NO	YES	NO	YES	YES	Very Good
25.06	YES	YES	NO	YES	YES	Very Good
25.07	NO	YES	NO	YES	YES	Very Good
25.08	NO	YES	NO	YES	YES	Very Good
25.09	YES	YES	NO	YES	YES	Very Good
25.10	YES	YES	NO	YES	YES	Very Good
25.11	NO	YES	NO	YES	YES	Very Good
25.12	NO	YES	NO	YES	YES	Very Good
25.13	YES	YES	YES	YES	YES	Exceptional
25.14	YES	NO	YES	YES	YES	Very Good
25.15	NO	NO	NO	YES	YES	Below Average
25.16	NO	NO	NO	NO	YES	Below Average
25.17	NO	NO	NO	NO	YES	Below Average
26.01	NO	NO	NO	NO	YES	Below Average
26.02	NO	NO	NO	NO	YES	Below Average
26.03	NO	NO	NO	NO	YES	Below Average
26.04	YES	YES	NO	YES	YES	Very Good
26.05	NO	YES	NO	YES	YES	Very Good
26.06	YES	YES	NO	YES	YES	Very Good
26.07	NO	YES	NO	YES	YES	Very Good
26.08	NO	YES	NO	NO	YES	Below Average
26.09	YES	YES	YES	NO	YES	Commendable
27.01	NO	NO	NO	NO	YES	Below Average

Unit Number	Satisfies Criteria					Natural Ventilation Rating
	Criterion (i)	Criterion (ii)	Criterion (iii)	Criterion (iv)	Criterion (v)	
27.02	NO	NO	NO	NO	YES	Below Average
27.03	NO	NO	NO	NO	YES	Below Average
27.04	YES	YES	NO	YES	YES	Very Good
27.05	NO	YES	NO	YES	YES	Very Good
27.06	YES	YES	NO	YES	YES	Very Good
27.07	NO	YES	NO	YES	YES	Very Good
27.08	NO	YES	NO	YES	YES	Very Good
27.09	YES	YES	YES	YES	YES	Exceptional

4.2 Summary of the Results

The results of the study into the natural ventilation performance of the residential units based on the SEPP65 requirements are tabulated in Table 3 below:

Table 3: Summary of Natural Ventilation Performance

No. Of Units	SEPP65 Compliance Deemed to Satisfy		Expected Compliance Using Alternative Path	
	Percentage of Complying Apartments	No. of Additional Apartments Required	Percentage of Complying Apartments	No. of Additional Apartments Required
504	32.9%	137	61.3%	-6

Due to the long natural of the subject site in the north-south direction, the availability for corner or cross-over apartments is somewhat limited. As such due to the large number of single aspect apartment, the design does not satisfy the rule of thumb for natural ventilation detailed within SEPP65.

A further assessment has been undertaken for the residential apartments based on our experience in the field of wind-driven natural ventilation including full-scale and wind tunnel modelling and comparisons, as well as the previous natural ventilation study undertaken for this site. Due to the effective use of façade detailing including a stepped façade for the apartments, and notches on the eastern and western aspects of the development, it is expected that development will satisfy the requirements for natural ventilation. This will be need to be verified via means of wind tunnel testing.

5 CONCLUSION

An assessment of the natural ventilation characteristics the various residential units of the proposed development known as V by Crown, located at 45 Macquarie Street, Parramatta has been undertaken. The conclusions of this report are drawn from our extensive experience in this field and are based the latest architectural drawings prepared by the project architect Allen Jack + Cottier, received 31st June, 2012. The results of the study have been compared against the wind-driven natural ventilation criteria detailed in the State Environmental Planning Policy No. 65 (SEPP65). This report addresses only the general wind effects and any localised effects that are identifiable by visual inspection.

The results of the assessment indicate that the subject development will not satisfy the SEPP65 requirement for natural ventilation due to the large number of single-aspect residential apartments. Hence the proposed development site is expected to satisfy the 60% SEPP65 requirement for natural ventilation.

A further assessment has been undertaken for the residential apartments based on our experience in the field of wind-driven natural ventilation including full-scale and wind tunnel modelling and comparisons, as well as the previous natural ventilation study undertaken for this site. Due to the effective use of façade detailing including a stepped façade for the apartments, and notches on the eastern and western aspects of the development, it is expected that development will satisfy the requirements for natural ventilation. This will be need to be verified via means of wind tunnel testing.

6 REFERENCES

ANSI/ASHRAE 55-2011, Thermal Environmental Conditions for Human Occupancy, Atlanta: American Society of Heating, Refrigeration and Air-conditioning Engineers.

ANSI/ASHRAE 62.1-2011, Ventilation for Acceptable Indoor Air Quality, Atlanta: American Society of Heating, Refrigeration and Air-conditioning Engineers.

AS1668.2-2002, The used of ventilation and air conditioning in buildings, Part 2: Ventilation design for indoor air contaminant control (excluding requirements for the health aspects of tobacco smoke exposure), Standards Australia

Aynsley R.M., Melbourne W. and Vickery B.J., (1977) Architectural Aerodynamics, Architectural Science Series, pp192-203.

Peddie K.M. and Rofail A.W., 2010, 'Designing for Natural Ventilation for Tall Residential Buildings', 2011 CTBUH World Conference, Seoul, Korea, October 10-12, 2011

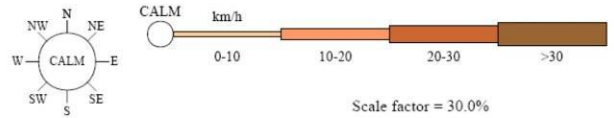
Peddie K.M. and Rofail A.W., 2010, 'Application of Natural Ventilation for Commercial Developments' 14th Australasian Wind Engineering Society Workshop, Canberra, August 5-6, 2010

APPENDIX A - WIND ROSES FOR THE SYDNEY REGION

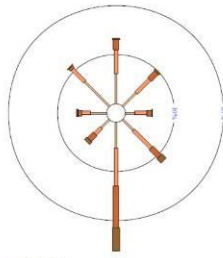
WIND FREQUENCY ANALYSIS (in km/h)

SYDNEY AIRPORT AMO STATION NUMBER 066037

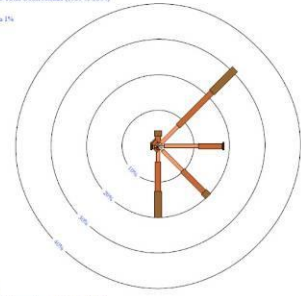
Latitude: -33.94 ° Longitude: 151.17 °



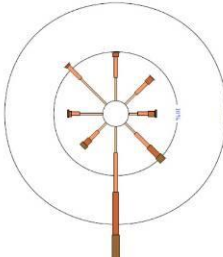
9 am Jan
1933 Total Observations (1939 to 2004)
Calm 1%



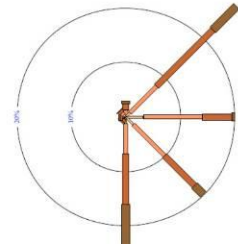
3 pm Jan
1941 Total Observations (1939 to 2004)
Calm 1%



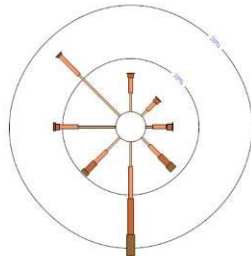
9 am Feb
1783 Total Observations (1939 to 2004)
Calm 13%



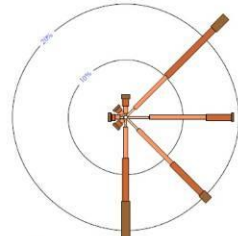
3 pm Feb
1776 Total Observations (1939 to 2004)
Calm 1%



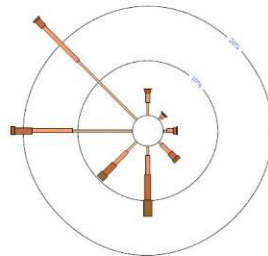
9 am Mar
1958 Total Observations (1939 to 2004)
Calm 14%



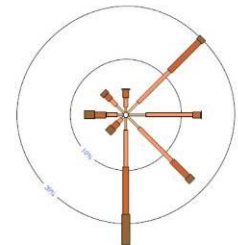
3 pm Mar
1973 Total Observations (1939 to 2004)
Calm 2%



9 am Apr
1963 Total Observations (1939 to 2004)
Calm 14%



3 pm Apr
1951 Total Observations (1939 to 2004)
Calm 2%



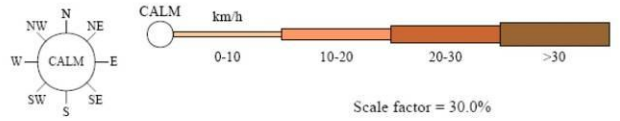
Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1%.

An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

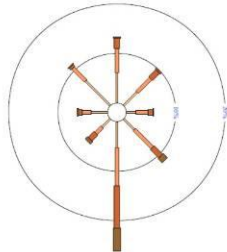


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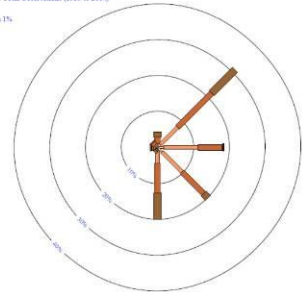
WIND FREQUENCY ANALYSIS (in km/h)
SYDNEY AIRPORT AMO STATION NUMBER 066037
Latitude: -33.94 ° Longitude: 151.17 °



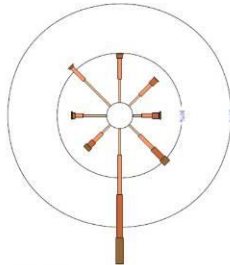
9 am Jan
1923 Total Observations (1939 to 2004)
Calm 3%



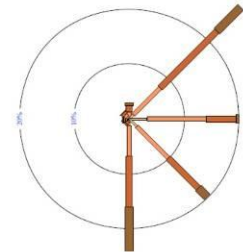
3 pm Jan
1941 Total Observations (1939 to 2004)
Calm 1%



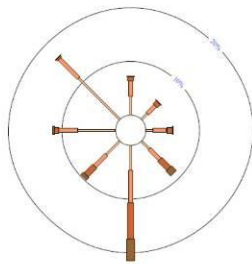
9 am Feb
1789 Total Observations (1939 to 2004)
Calm 13%



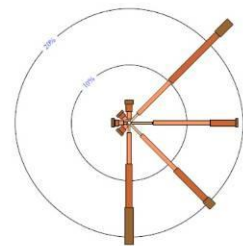
3 pm Feb
1776 Total Observations (1939 to 2004)
Calm 1%



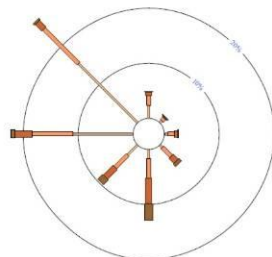
9 am Mar
1968 Total Observations (1939 to 2004)
Calm 14%



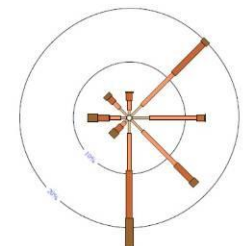
3 pm Mar
1776 Total Observations (1939 to 2004)
Calm 2%



9 am Apr
1963 Total Observations (1939 to 2004)
Calm 14%



3 pm Apr
1963 Total Observations (1939 to 2004)
Calm 2%

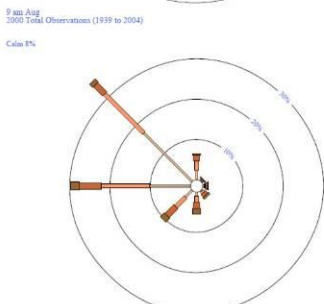
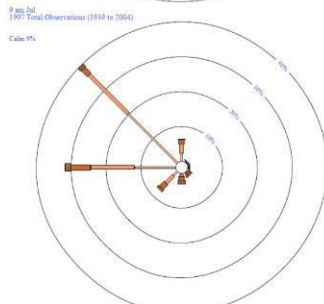
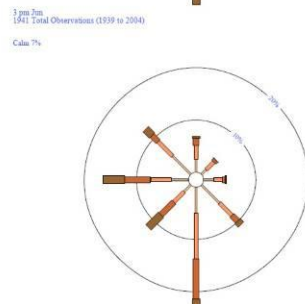
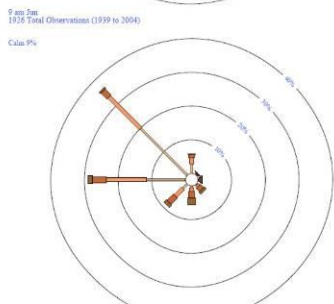
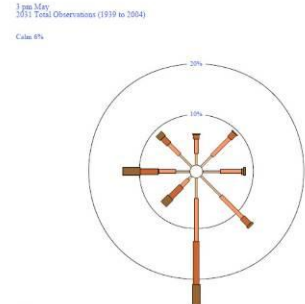
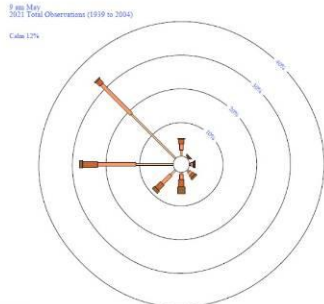
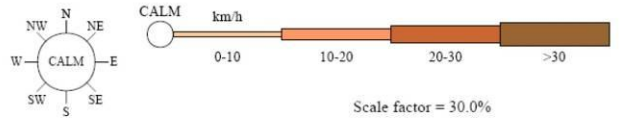


Wind directions are divided into eight compass directions. Calm has no direction.
 An asterisk (*) indicates that calm is less than 1%.
 An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.



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WIND FREQUENCY ANALYSIS (in km/h)
SYDNEY AIRPORT AMO STATION NUMBER 066037
Latitude: -33.94 ° Longitude: 151.17 °



Wind directions are divided into eight compass directions. Calm has no direction.
 An asterisk (*) indicates that calm is less than 1%.
 An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.



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