TERM CONSULTANCY FOR AIR VENTILATION ASSESSMENT SERVICES

Cat. A – Term Consultancy for Expert Evaluation and Advisory Services on Air Ventilation Assessment (PLNQ 37/2007)

Final Report - Pak Shek Kok

September 2008

……

by Professor Edward Ng
Department of Architecture, CUHK, Shatin, NT, Hong Kong
T: 26096515 F:26035267
E: edwardng@cuhk.edu.hk W: www.edwardng.com

List of Abbreviations

ABL – Atmospheric Boundary Layer
AVA – Air Ventilation Assessment
AWS – Automatic Weather Station
B(P)R – Building (Planning) Regulations
ETWB – Environment, Transport and Works Bureau
G/IC – Government, Institution or Community
HKO – Hong Kong Observatory
HKUST – Hong Kong University of Science and Technology
HPLB – Housing, Planning and Lands Bureau
m/s – meters per second
NBA – Non-Building Area
O – Open Space
OU – Other Specified Uses
OZP – Oultine Zoning Plan
R(B)1 – Residential (Group B) 1
R(B)2 – Residential (Group B) 2
R(B)3 – Residential (Group B) 3
R(B)4 – Residential (Group B) 4
REC – Recreation
TPTL – Tai Po Town Lot
UCL – Urban Canopy Layer
WGL – Waglan Island

Expert Evaluation Report
of Pak Shek Kok Development Area Phase 2, Site D

Executive summary

Wind Availability:
(a) The prevailing summer wind of the Project Area comes from the East and the southerly quarters including South West, South and South East. In winter, the wind comes also from the East and North East. In sum, the prevailing annual wind of the Project Area comes from the East and North East.

(b) The Project Area is on the Tolo Harbour waterfront. When the prevailing wind comes from the East over the water, it is unobstructed. The Project Area benefits greatly from the prevailing East wind over the water.

(c) When the wind comes from the southerly quarters (mostly South West) in summer times, it is also reaching the Project Area unobstructed over the "Recreation" zone to its south. It is hence well ventilated in its present setting.

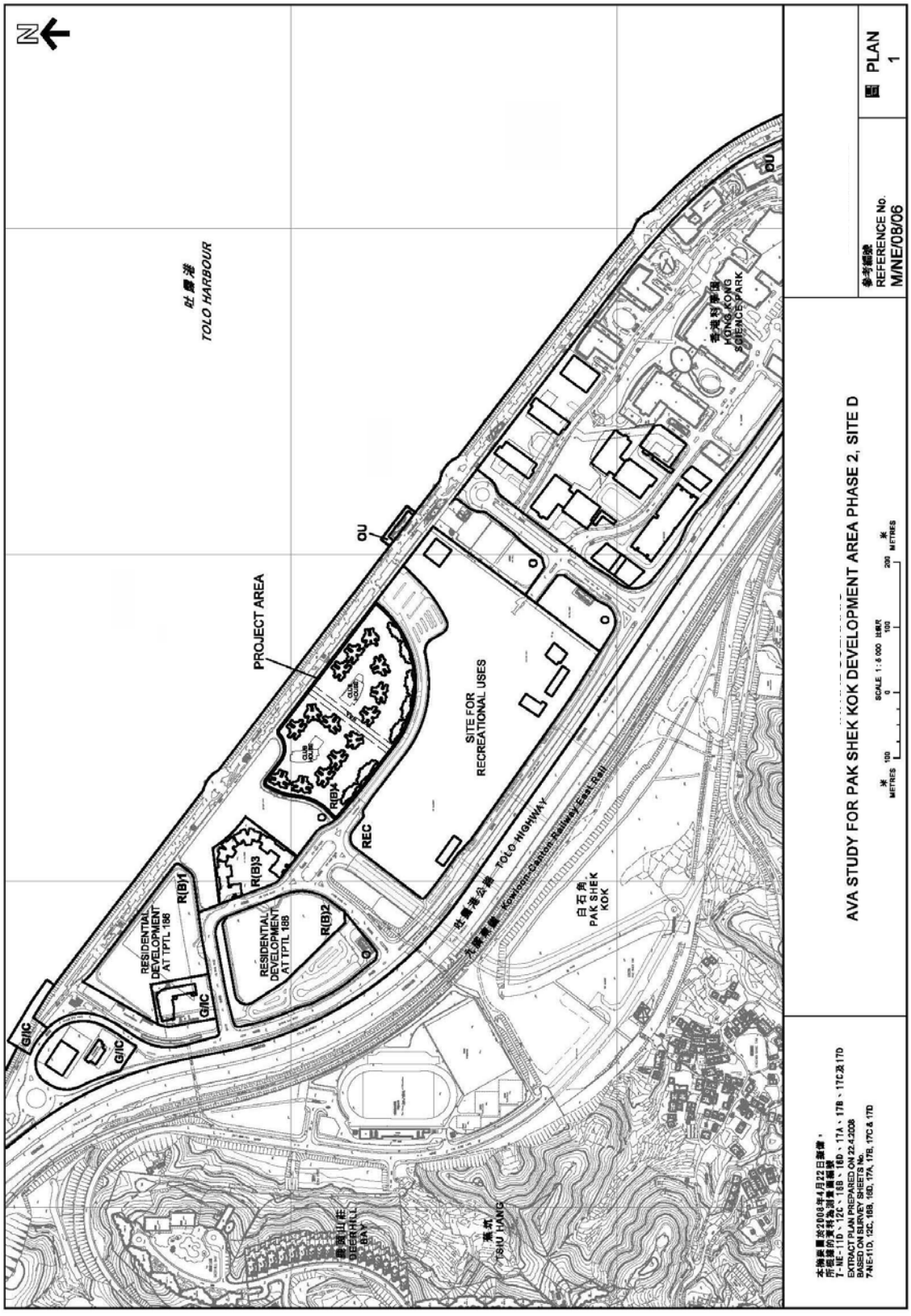
Assessment
(a) The Project Area has a planned development potential with a domestic plot ratio of 3 and a non-domestic plot ratio of 0.2. The development intensity is low and there should be plenty of flexibilities for designers to design the buildings with adequate open areas around them. This should allow air ventilation to enter, penetrate and exit the Project Area through the open areas within the Project Area.

(b) There is a building height restriction of 45m. When buildings of 45m are positioned along the boundary, they will, based on empirical results, create a wind wake of about 45m from the Project Area boundary. It is unlikely that the wind-wake will adversely impact the surrounding wind environment, as the surrounding development is more than 45m away.

Key Recommendation
(a) To maintain wind penetrating the Project Area, it is recommended that an air path (Non-Building Area (NBA) of 15m) be incorporated roughly in the middle of the Project Area in a North East to South West alignment to cater for the North East to South West winds which are most significant in most times of the year.

Further Studies
(a) Based on the assessment and if the above recommendations are incorporated, there should be no major air ventilation issues. Further study is not necessary.

RECOMMENDED SCENARIO WITH 15M WIDE NON BUILDING AREA (NBA)



Expert Evaluation Report
of Pak Shek Kok Development Area Phase 2, Site D

1.0 Background

1.1 The Project Area is located at the northern part of the Pak Shek Kok Reclamation Area with an area of about 4.18ha. It is currently zoned "Residential (Group B)4" ("R(B)4") on the approved Pak Shek Kok (East) Outline Zoning Plan (OZP) No. S/PSK/9 with a maximum permitted domestic plot ratio of 3, non-domestic plot ratio of 0.2 and a maximum permitted building height of 45m. It is bounded by promenade zoned "O" in the North, local road L5 to the South and East (with a transport terminus). To the West and North West of the Area are three private residential sites (namely TPTL 186,187 and 188) which have been sold by public auction in 2007. A large vacant site designated "Recreation" ("REC") is located to the immediate South of the Area. To the further South East of the Project Area is the Hong Kong Science Park zoned "Other Specified Uses (Science Park)" on the OZP. The Project Area is required to incorporate noise mitigation measures similar to those required under the information statements for the land auction held for Tai Po Town Lots (TPTLs) 186,187 and 188 because of the noise impact of Tolo Highway.

1.2 Taken into account the unique setting and environmental constraints of the general area, the layout for the Initial Scenario assessment is formulated with the following features:

(a) The Initial Scenario presents development of the Project Area up to a maximum plot ratio and building height permitted under the OZP;

(b) Within the Project Area, single-aspect design is adopted for residential buildings facing the Tolo Highway. No openings of the noise sensitive rooms shall have a line-of-sight of Tolo Highway;

(c) Based on the draft lease, the Project Area is split into 2 portions with approximately equal area and sea frontage (See Fig. 1.1 for the boundary line between the two portions of the Project Area);

(d) There is a residential development at the "R(B)3" site (TPTL 187) with a maximum domestic plot ratio of 3, non-domestic plot ratio of 0.2 and building height of 30m as allowed under the Pak Shek Kok OZP;

(e) For the "REC" site, according to the Notes and Explanation Statement of the Pak Shek Kok OZP, the "REC" zone is intended primarily for recreational developments and its definite use is subject to further study. Potential uses of the site include China ecology centre, ocean dome, aquatic centre, sports stadium, sports complex, event-based recreation ground and other passive recreation uses. A plot ratio of 0.2 and building height of 2 storeys are assumed for the "REC" site in the Initial Scenario;

(f) The "O" zone in front of the Project Area has been completed. The other "O"

zones are under various stage of development;

(g) Phases 1 and 2 of the Hong Kong Science Park have already been completed in 2004 and 2007 respectively. Although there is no firm timetable for Phase 3 development at the moment, the Initial Scenario assumes it to be in place with a development intensity similar to that of Phases 1 and 2;

(h) Other existing buildings, G/IC and utility facilities in the vicinity of the Project Area include the Pak Shek Kok electricity substation and sewage pumping station; and

(i) Developments across Tolo Highway and the East Rail are not considered as they are remote from the Project Area.

The development features of the Initial Scenario assessment is at Figure 1.1.

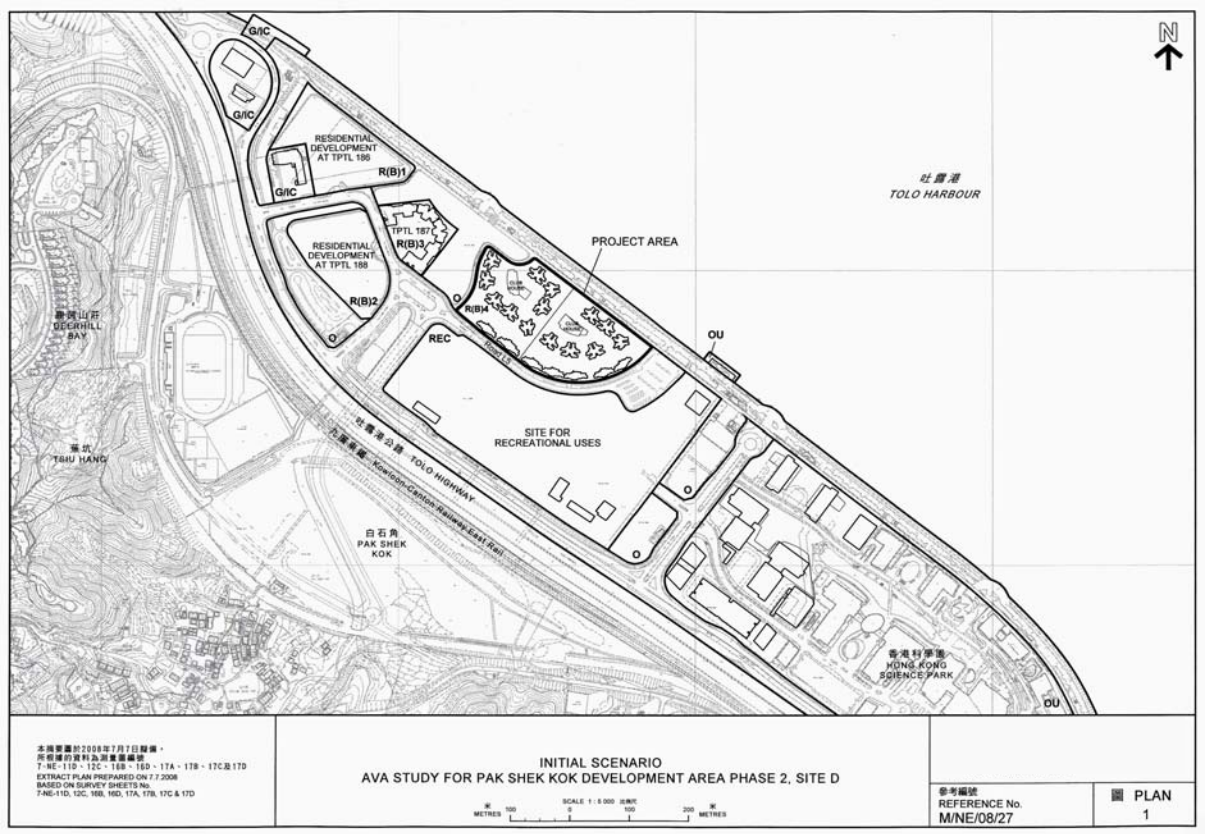


Figure 1.1 The Development Features of the Initial Scenario

2.0 The Assignment

2.1 The objective of the assignment is to carry out expert evaluation for the Project Area for a broad understanding of the likely impacts on air ventilation upon its full development with a view, if required, to deriving an optional development scenario with recommended major improvements in the design for a better pedestrian level air ventilation environment.

Figure 2.1 Aerial Photo showing the Project Area

3.0 The wind environment

3.1 Hong Kong Observatory (HKO) stations provide useful and reliable data of the wind environment in Hong Kong. There are some 46 stations operated by HKO in Hong Kong. Together, they allow a very good general understanding of the wind environment especially close to ground level.

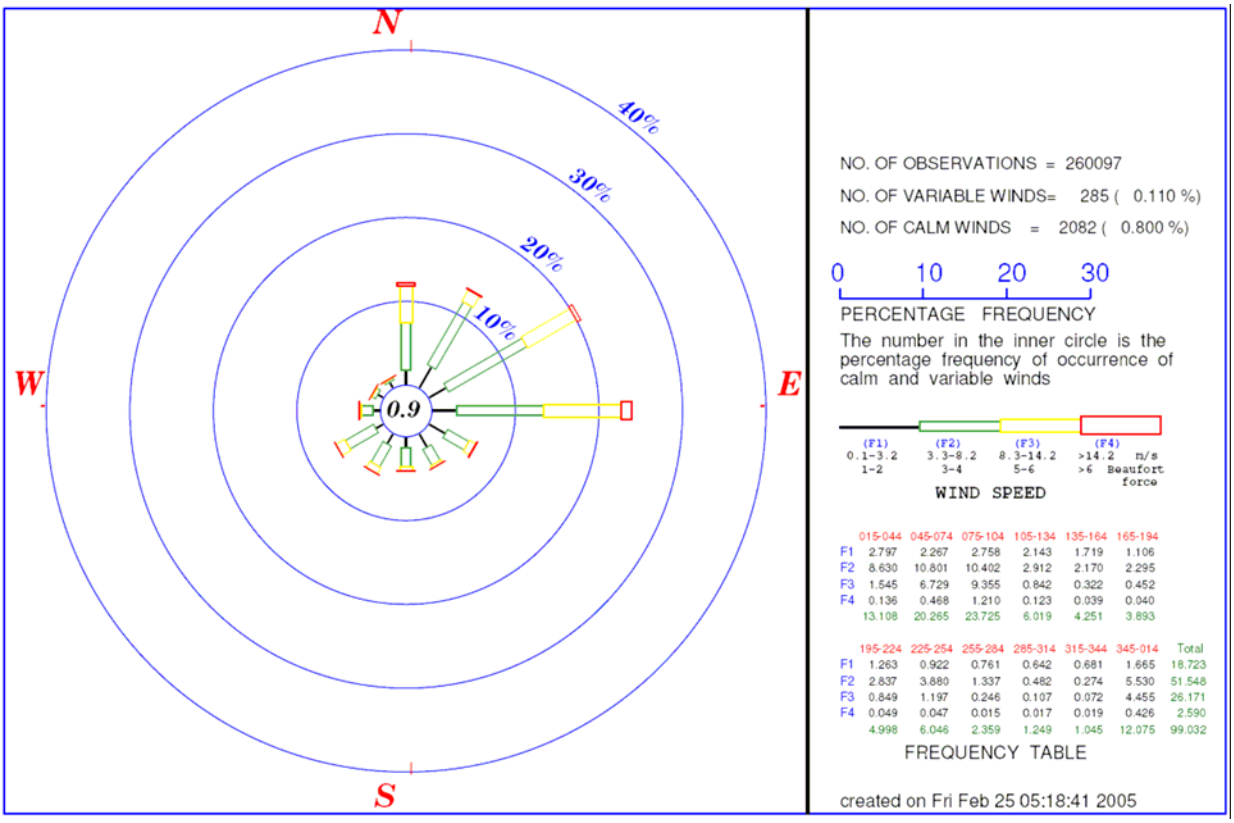


Figure 3.1 Wind rose of WGL

3.2 The HKO station at Waglan Island (WGL) is normally regarded by wind engineers as the reference station for wind related studies. The station has a very long measuring record, and it is unaffected by Hong Kong's complex topography. Based on WGL wind data, studies are typically employed to estimate the site wind availability taking into account the topographical features around the site. Examining the annual wind rose of WGL (Figure 3.1), it is apparent that the annual prevailing wind in Hong Kong is from the East. There is also a major component of wind coming from the North East; and there is a minor, but nonetheless observable component from the South West. Around 70% of the time, WGL has weak to moderate wind (0.1m/s to 8.2 m/s).

3.3 For the study, it is important to also understand the wind environment seasonally or monthly (Figure 3.2 and 3.3). In the winter months of Hong Kong, the prevailing wind comes from the North East. In the summer months, they come from

the South West. As far as AVA is concerned, in Hong Kong, the summer wind is very important and beneficial to thermal comfort. Hence, based on WGL data, it is very important for more penetration of the summer winds (mainly from the South West) into developments.

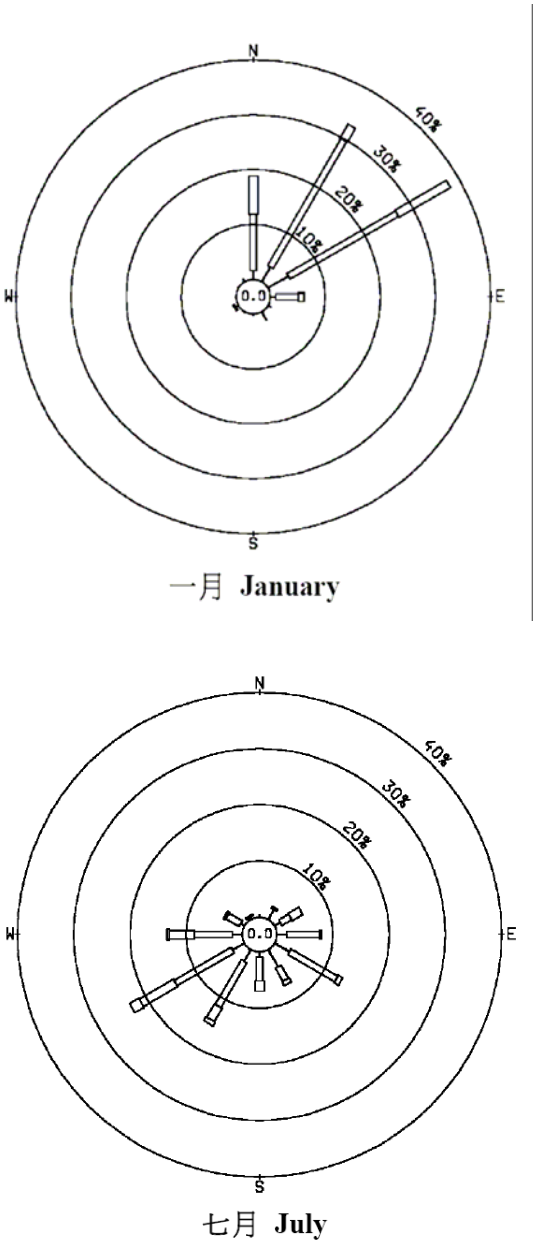


Figure 3.2 Wind roses of WGL 2006
(Jan and July, i.e. Winter and Summer) (as an example)

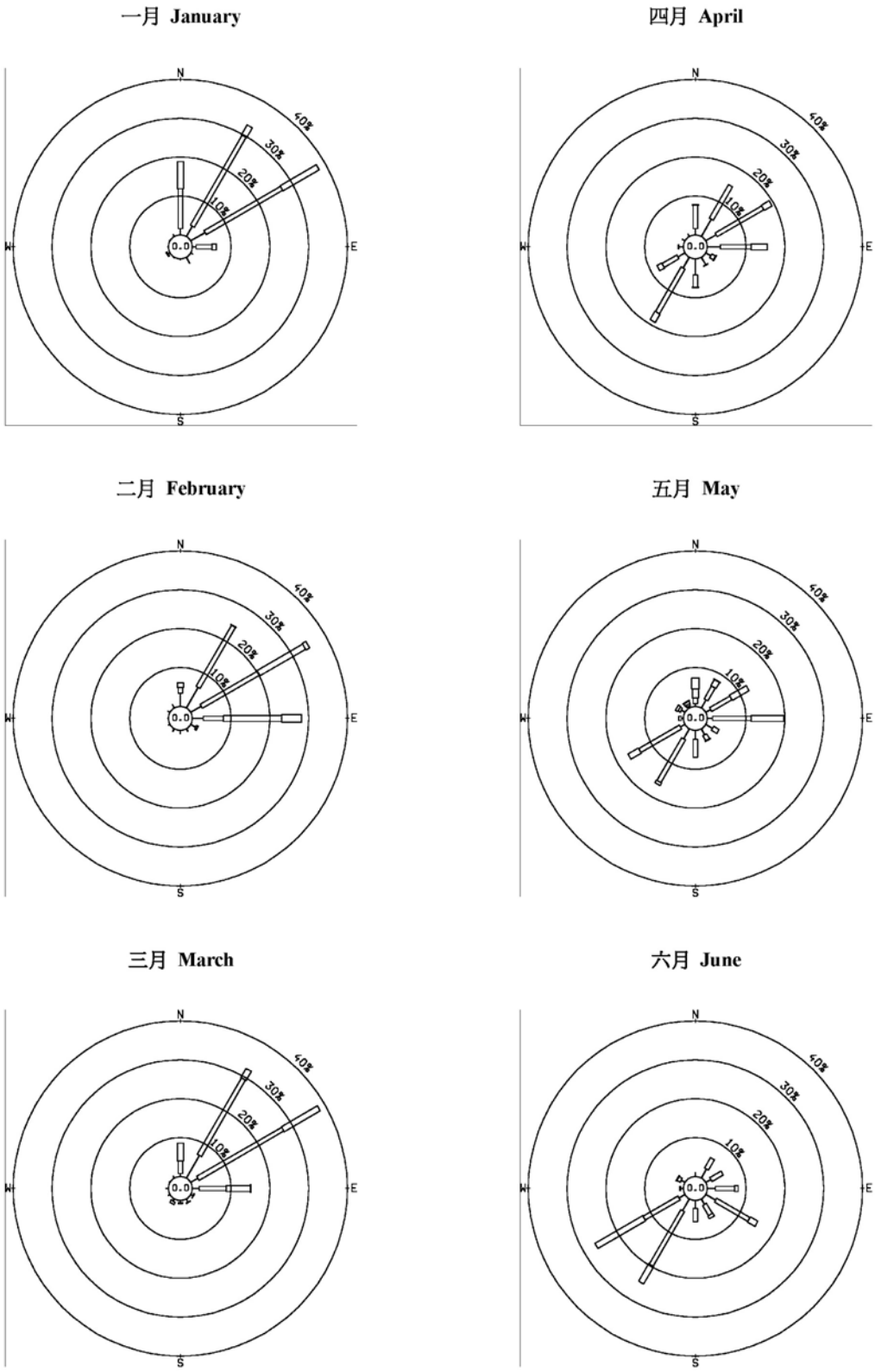


Figure 3.3a monthly wind roses of WGL 2006 (as an example).

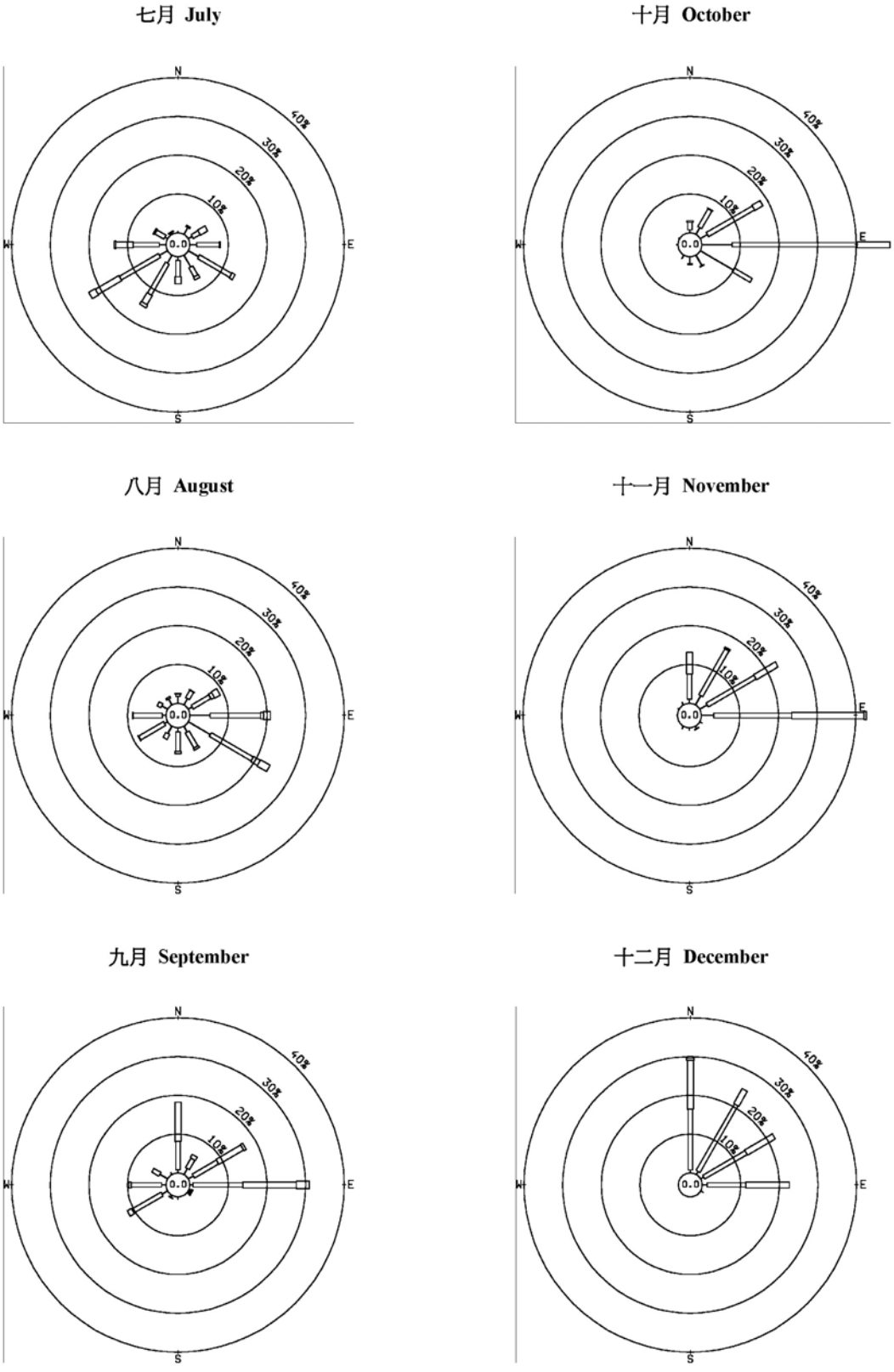


Figure 3.3b monthly wind roses of WGL 2006 (as an example).

3.4 Despite the above, the wind environment for the Project Area can be affected by topography and sea breezes. It is useful to look closer at the site locations. The Project Area is located at Pak Shek Kok. The nearest HKO stations are Tai Po and Shatin. Their annual wind roses are shown in Figure 3.4 and Figure 3.5.

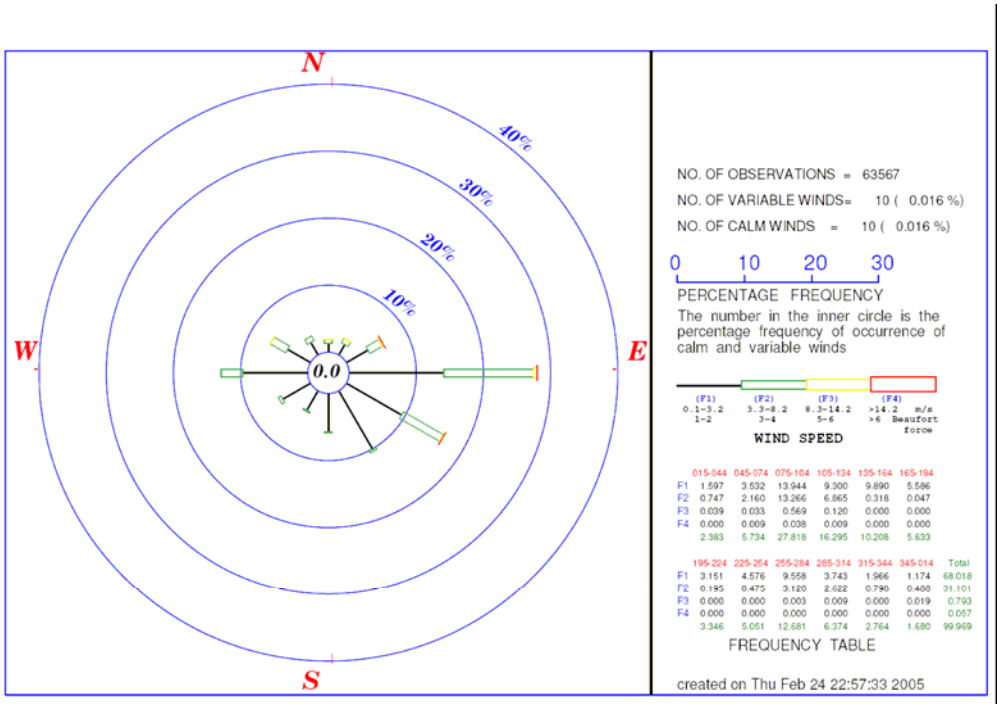


Figure 3.4 1989-2004 wind rose of HKO Tai Po station

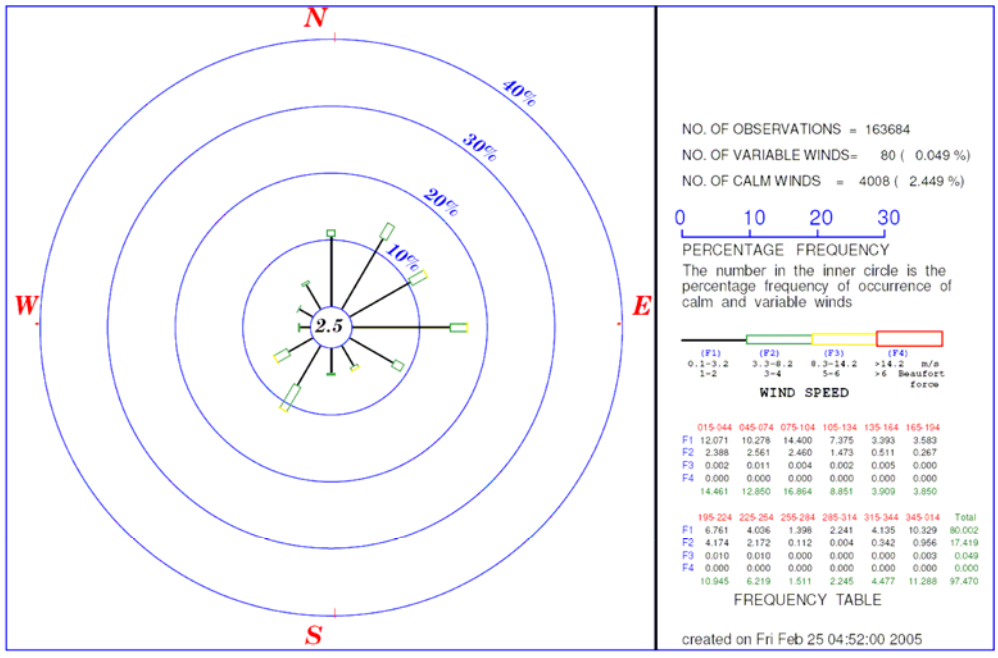
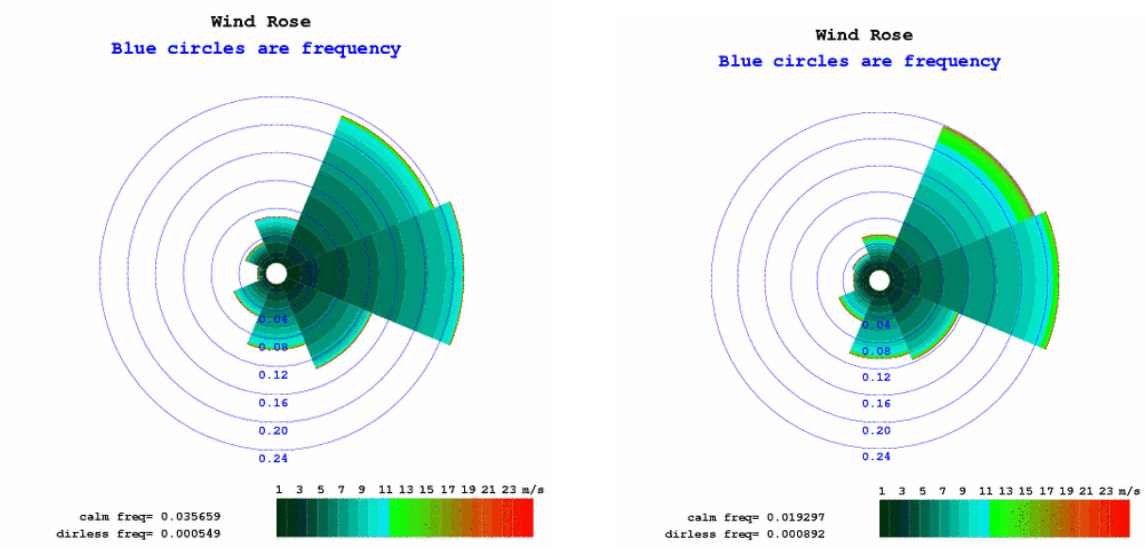


Figure 3.5 1989-2004 wind rose of HKO Shatin station

3.5 Researchers at Hong Kong University of Science and Technology (HKUST), Prof Alexis Lau and Prof Jimmy Fung, have simulated a set of wind data using MM5. [See note at the end of section 3] The data period cover the whole year of 2004. The data for the Project Area are extracted at 120m and 450m above ground (Figures 3.6 and 3.7). The altitude of 450m can be assumed to represent the atmospheric boundary layer (ABL) wind characteristics which gives good indication of the free wind of the area. On the other hand, the 120m height can represent urban canopy layer (UCL) wind characteristics and the UCL data is useful to account for topographical effects.

Figure 3.6 The location of MM5 extracted data.



120m (Annual) 450m (Annual)

Figure 3.7 MM5 generated wind roses

3.6 Using the simulated MM5 data, the annual prevailing wind directions and speeds of the Project Area and the surroundings are indicated in Figure 3.8.

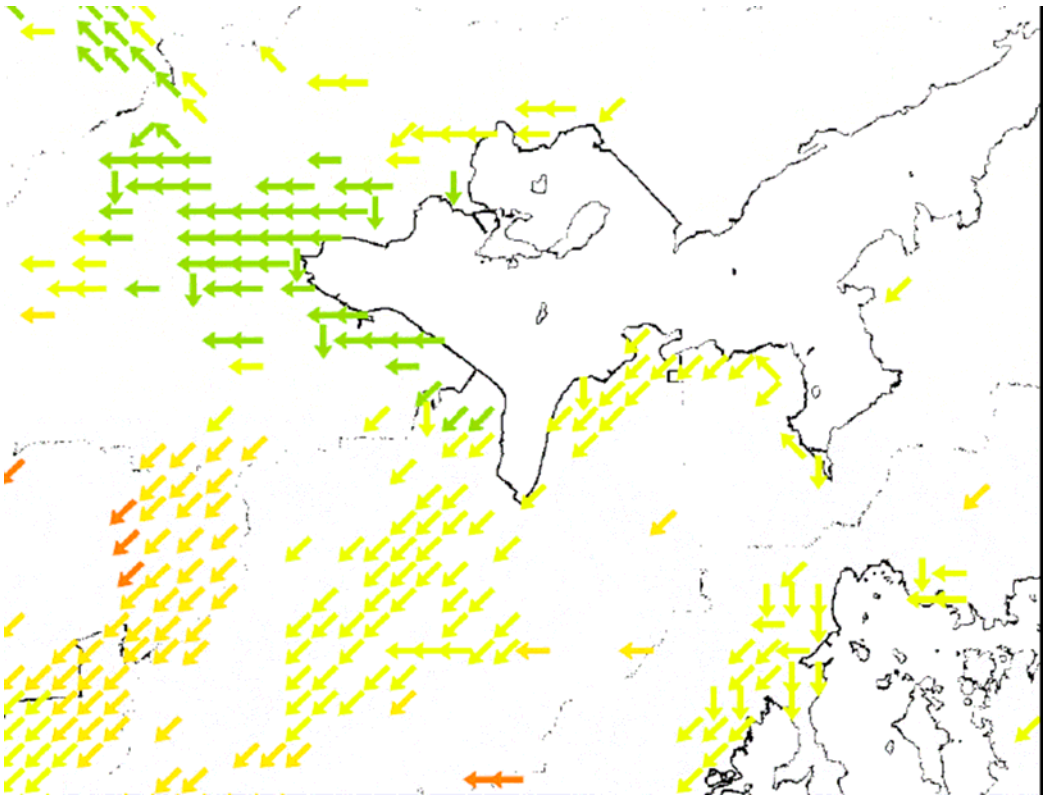
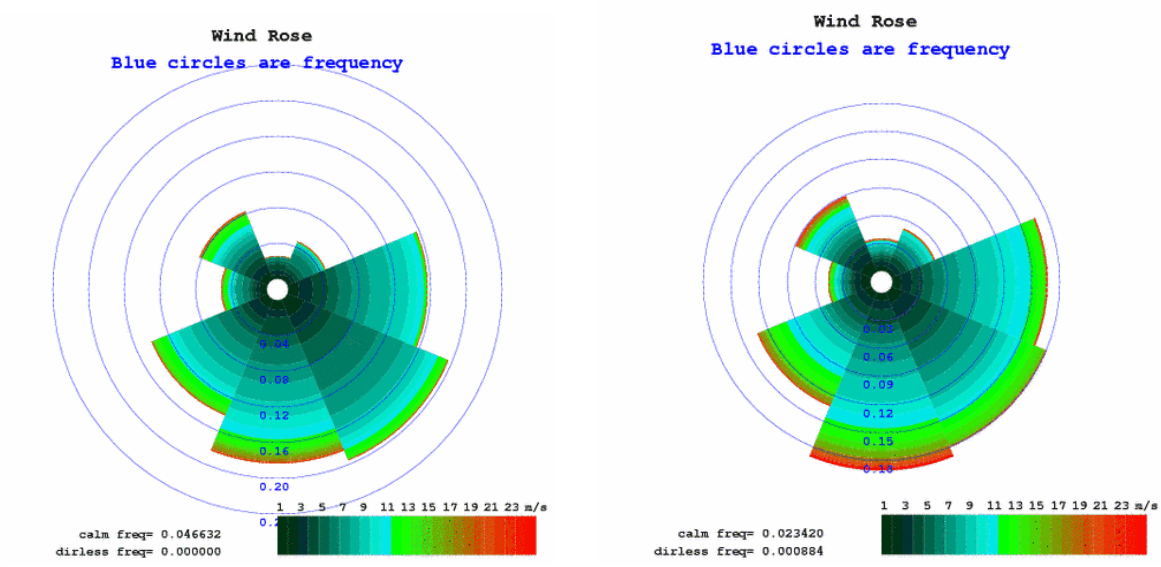


Figure 3.8 Annual prevailing wind directions (annual 2004) based on MM5.
(Arrows of various normalized wind speeds are colour coded –
RED (higher wind speed),
ORANGE, LIGHT GREEN and DARK GREEN (lower wind speed).

3.7 Because of the importance of the summer wind to thermal comfort, the MM5 generated wind rose and prevailing wind directions for the Projected Area in summer times are highlighted in Figures 3.9 and 3.10.



120m (Summer) 450m (Summer)

Figure 3.9 MM5 generated wind roses

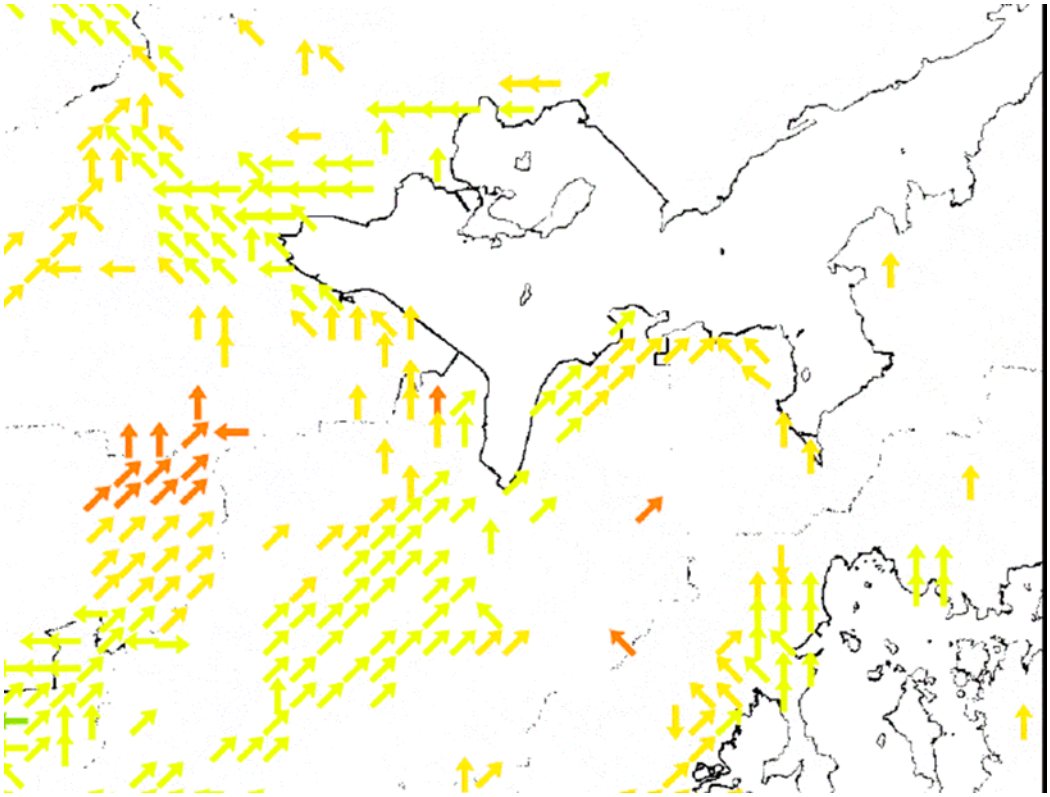


Figure 3.10 Prevailing wind directions of the summer months (Jun-Aug 2004) based on MM5. (Arrows of various normalized wind speeds are colour coded – RED (higher wind speed), ORANGE, LIGHT GREEN and DARK GREEN (lower wind speed).

3.8 In summary, based on the available wind data from the HKO and HKUST-MM5, one may conclude that the prevailing annual wind of the Project Area comes from the East and North East (Figures 3.7 and 3.8). For summer time, the prevailing wind of the Project Area comes from the East and the southerly quarters including South West, South and South East (Figures 3.9 and 3.10).

Note:

The Penn State University and National Center for Atmospheric Research Mesoscale Model (MM) is a limited-area, terrain-following sigma-coordinate model designed to simulate or predict mesoscale and regional-scale atmospheric circulation. It has been developed as a community model and is continuously being improved by contributions from users at several universities and government laboratories.

The Fifth-Generation Mesoscale Model (MM5) is the latest in a series that have been developed from a mesoscale model used by Anthes at Penn State University in the early 70's and later documented by Anthes and Warner (1978). Since that time, it has undergone many changes designed to broaden its usage. These include (i) a multiple-nest capability, (ii) nonhydrostatic dynamics, which allows the model to be used at a few-kilometer scale, (iii) multitasking capability on shared- and distributed-memory machines, (iv) a four-dimensional data-assimilation capability, and (v) more physics options.

The MM5 model is supported by several auxiliary programs, which are referred to collectively as the MM5 modeling system.

4.0 Assessment

4.1 The Project Area has a planned development potential with a domestic plot ratio of 3 and a non-domestic plot ratio of 0.2. The development intensity is low and there should be plenty of flexibilities for designers to design the buildings with adequate open area around them.

4.2 Based on the Technical Guide for Air Ventilation Assessment for Developments in Hong Kong jointly issued by the then Housing, Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB), the assessment area of a Project Area should be H from boundary of the Project Area, with H being the tallest building in the Project Area. It is understood that a building of height H can cause a wind wake area of approximately H from the building. The wake area is basically the “wind shadow” of the building with weaker and more turbulent winds (Figure 4.1).

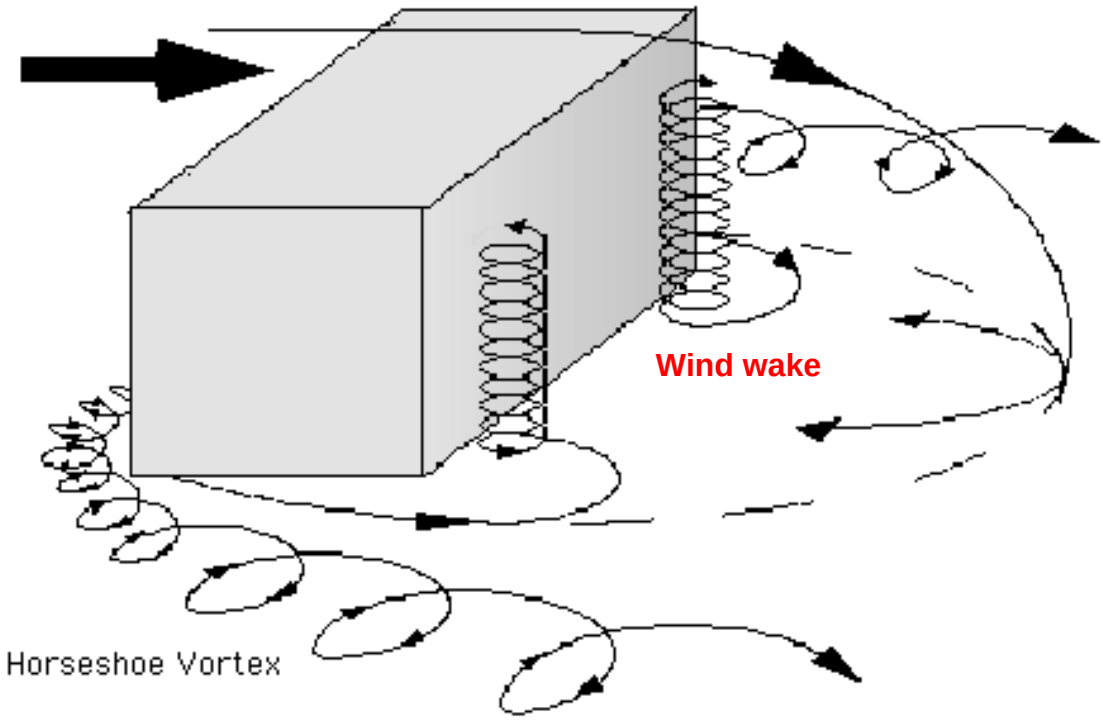


Figure 4.1a Building aerodynamics and Wind Wake

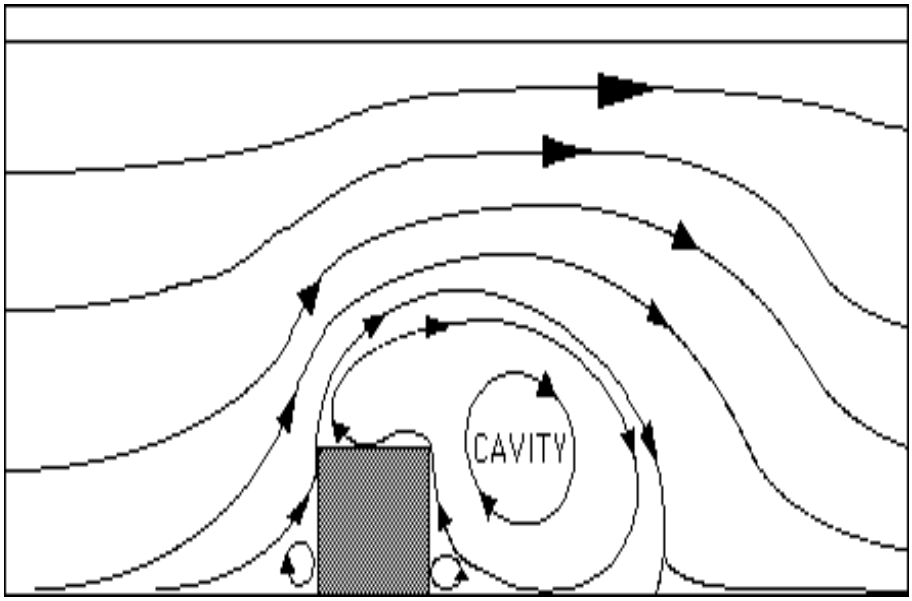


Figure 4.1b Building aerodynamics and Wind Wake

4.3 As the buildings within the Project Area are to be 45m high, the extent of the wake under prevailing wind directions can be estimated to be around 45m from the base of the buildings as illustrated in Figure 4.2.

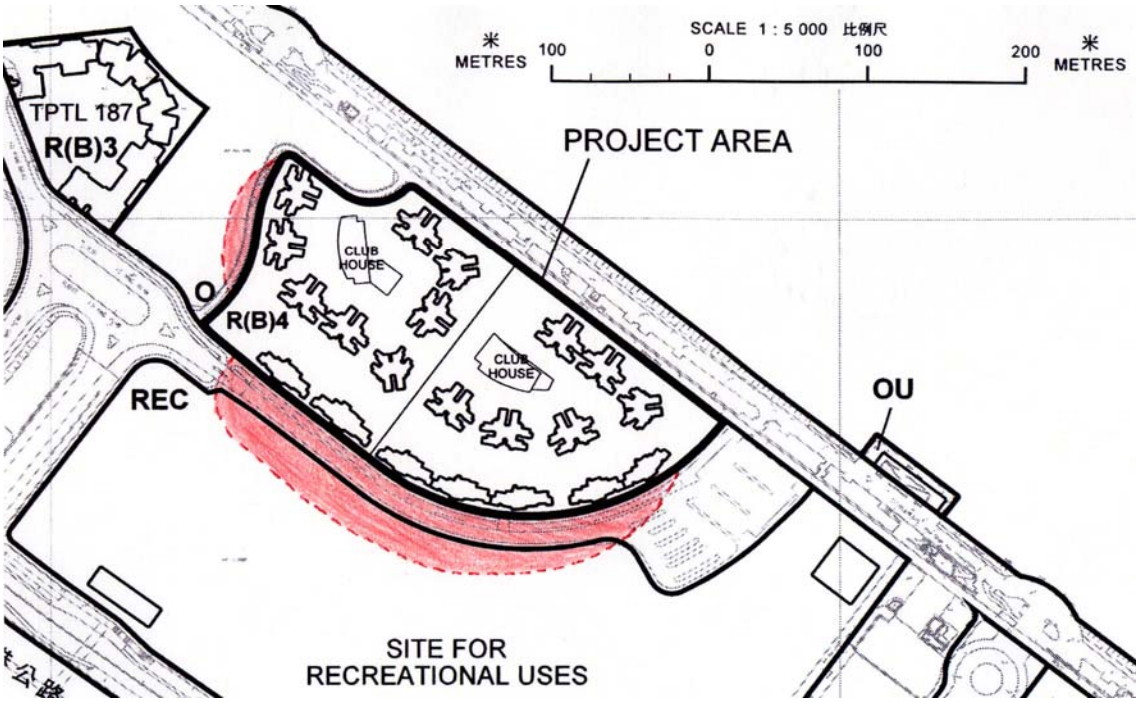


Figure 4.2 Wind Wakes under annual prevailing wind. (Showing only wakes beyond the Project Area boundary)

4.4 Again, because of the importance of the summer wind, the situation under wind wakes in summer is highlighted in Figure 4.3.

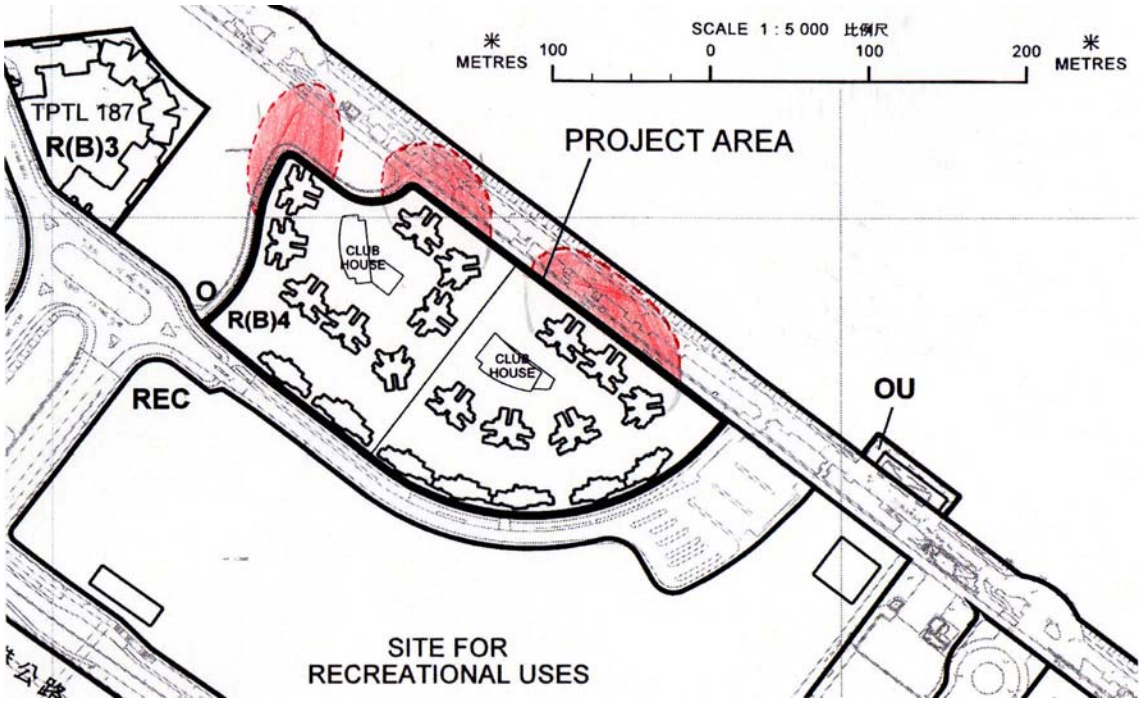


Figure 4.3 Wind Wakes in summer time. (Showing only wakes beyond the Project Area boundary)

4.5 Based on Figures 4.2 and 4.3, it can be concluded that the possible impact of the wind wakes to the surroundings due to the buildings in the Project Area is insignificant. Wind wake areas are Road L5, “Open Space” and “Recreation” zones and the promenade where there are unlikely to have air ventilation problem. Adjacent residential zones are generally not affected by the wind wakes.

4.6 In spite of the above, the splitting of the Project Area into 2 portions creates an opportunity for reducing the long wind wakes on Road L5 thereby further reducing the ventilation impact on the local road. This can be achieved by employing the common practice of designating a non-building area in the land sales condition for the 2 portions of the Project Area. Under Building (Planning) Regulation, residential buildings are required to be set back from site boundaries (B(P)R25) and the buildings within the Project Area are also subject to site coverage restriction under the same regulation. Imposition of the non-building area, along the boundary line of the 2 portions of the Project Area, would not affect the development potential of the Project Area and would not have significant impact on the disposition of the buildings. It will simply require a slightly wider separation between buildings on opposite sides of the boundary line, which will, on the other hand, as shown in Figure 4.4, reduce the wind wakes that could be created along local road L5. Air ventilation in a North South direction will be enhanced under both annual and summer prevailing wind. At the same time, the non-building area facilitates more privacy and reduces

overlooking problem. It is hence recommended that a non-building area be designated in the Project Area (see paragraph 5 for width).

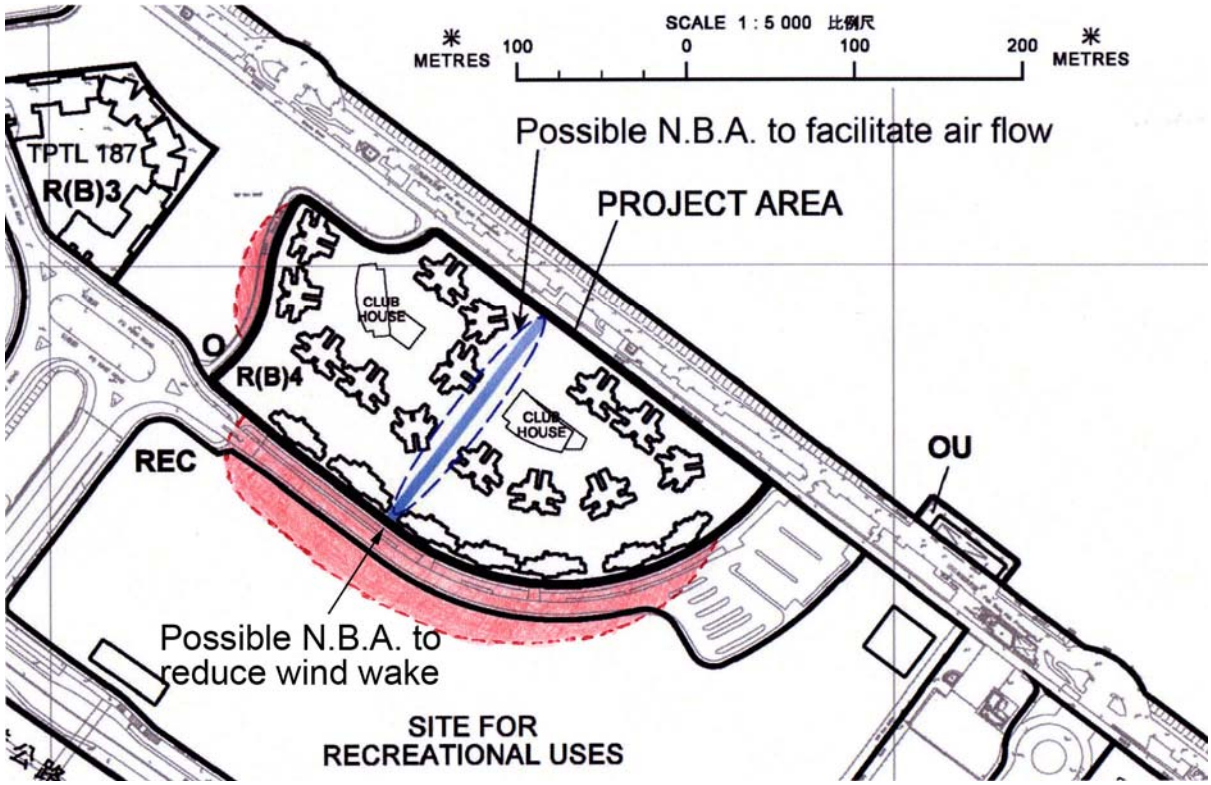


Figure 4.4 Wind Wakes under prevailing wind, without NBA and with a continuous row of buildings. (Showing only wakes beyond the site boundary)

5.0 Recommendation

5.1 Based on the assessment above, on the whole, given the building height restriction of 45m and a low development intensity of a domestic plot ratio of 3 and a non-domestic plot ratio of 0.2, there should be little air ventilation issues.

5.2 As the Project Area is to be split into 2 portions, there is an opportunity to make further enhancement of air ventilation by mitigating the possible long wind wake under the North East prevailing wind. A non-building area along the boundary of the 2 split portions can function as an air path in the middle of the Project Area. To be effective, the air path is suggested to be around 15m wide (as shown in Figures 5.1 and 5.2). The suggested width is based on an expert assessment taking into account the heights of buildings on both sides of the NBA, as well as the orientation and length of the NBA.

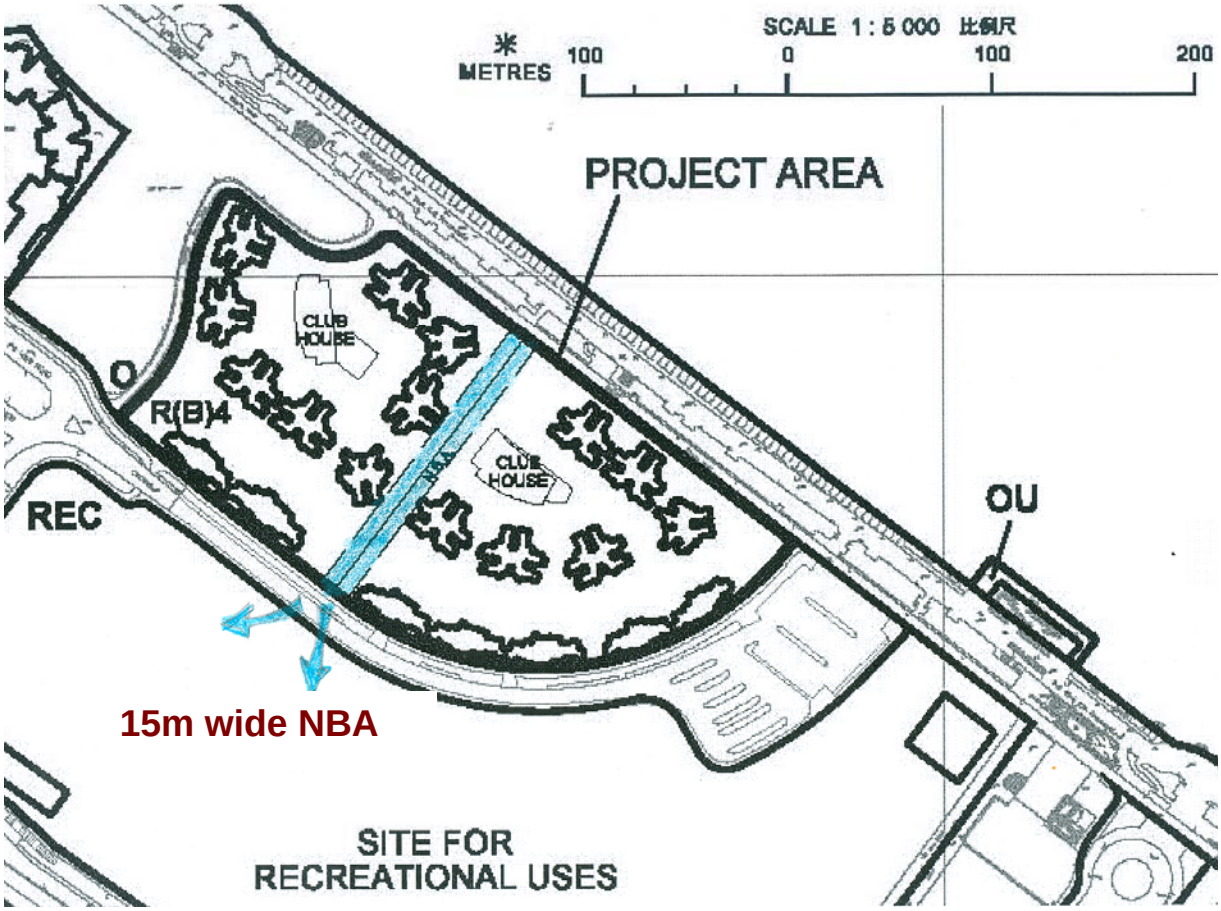


Figure 5.1 Non-building area (NBA) recommended

5.3 Also, to facilitate air flow within the air path, it is suggested that only minor structures such as boundary walls of height not more than 2m will be allowed within

the NBA. Higher or bulkier structures and obstacles will increase roughness and reduces the efficacy of the NBA as an air path.

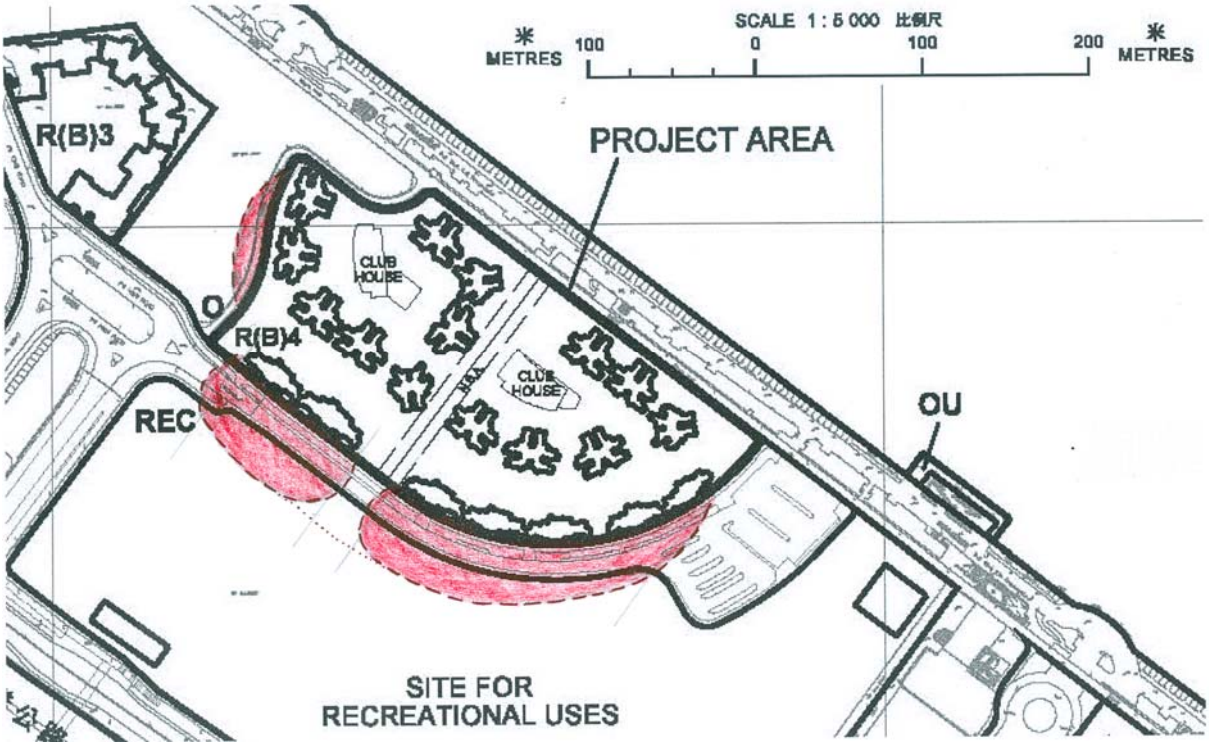
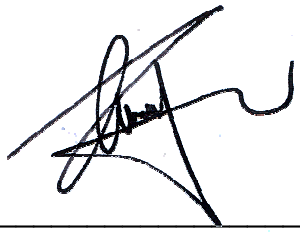


Figure 5.2 Wind Wakes under prevailing wind, with NBA. (Showing only wakes beyond the site boundary)

6.0 Further Studies

6.1 Based on the expert assessment, there should be no major air ventilation issues from the Project Area. Further study is not necessary.



Date: 27 Aug 2008

Professor Edward Ng
On behalf of technical experts in the term consultant team

Department of Architecture, CUHK,
Shatin, NT, Hong Kong
T: 26096515 F:26035267
E: edwardng@cuhk.edu.hk

Consultant team

	Expertise
Professor Edward Ng (Coordinator) CUHK, Hong Kong	Architect, Environmental and sustainable studies
Miss Betty Ho	Planner,
Mr K S Wong	Architect,
Professor Jimmy Chi-Hung Fung HKUST, Hong Kong	Mathematician, Meso-scale wind field modeling, CFD