CONSULTANCY STUDY FOR AIR VENTILATION ASSESSMENT SERVICES

Cat. A1– Term Consultancy for Expert Evaluation on Air Ventilation Assessment (PLN AVA 2015)

Final Report

For Mong Kok Planning Area

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INSTITUTE OF Future Cities

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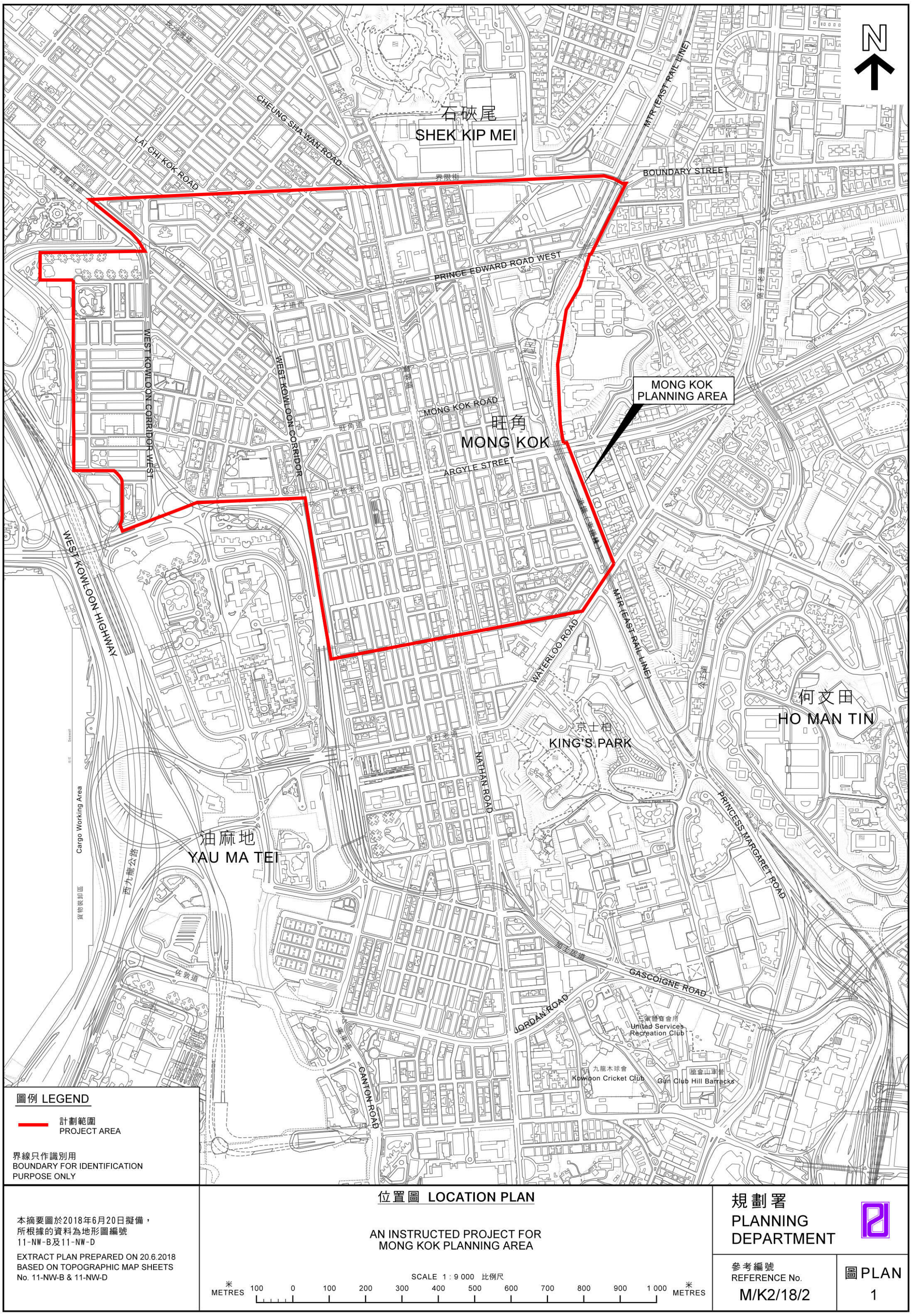
by Professor Edward Ng
School of Architecture, CUHK, Shatin, NT, Hong Kong
T: 39436515 F: 26035267
E: edwardng@cuhk.edu.hk W: www.edwardng.com

The Study Area (Mong Kok Planning Area)



Expert Evaluation Report

for the Initial Scenario for Mong Kok Planning Area

Executive summary

0.1 This Expert Evaluation (EE) on Air Ventilation Assessment (AVA) is conducted to review the development restrictions for the Mong Kok Planning Area (MK Area) with reference to the relevant court judgments on the judicial reviews and related appeals including that in respect of the draft Mong Kok Outline Zoning Plan (OZP) No. S/K3/28.

0.2 Regarding the wind environment, annual winds of MK Area mainly come from the east (E) and east-northeast (ENE), while summer winds mainly come from the southwest (SW) and east (E). Based on all available wind information and an understanding of the topography and land-sea breezes, it can be concluded that important wind directions for the MK Area fall along the ENE-WSW axis.

0.3 MK Area is one of the most densely built-up areas in Hong Kong. It is currently dominated by small residential sites, with most commercial sites located along Nathan Road and a large piece of open space in the northeastern corner of MK Area. The major roads/streets oriented roughly east-west serve as effective air paths.

0.4 The Baseline Scenario refers to the scenario under the draft Mong Kok OZP No. S/K3/30 with building height restrictions (BHRs), non-building areas (NBAs), building gaps (BGs), and building setbacks (SBs) requirements as imposed on the then draft Mong Kok OZP No. S/K3/28. In the Initial Scenario, changes in BHRs for different zonings ("C", "C(1)", "OU(B)", "OU(B)1", "R(A)", "R(A)3", "R(A)4", "R(E)", and "R(E)1" zones) have been proposed to increase the design flexibility and allow for the implementation of the Sustainable Building Design Guidelines (SBDG). The air ventilation performance of the Initial Scenario is expertly assessed against that of the Baseline Scenario.

0.5 An analysis on building frontage (BF) is used to evaluate the potential impacts on air ventilation in MK Area caused by the general increase of BH in the Initial Scenario. As a majority of sites in MK Area have a two-tier BHR (based on site area), assumptions are made for the proportion of sites with areas larger than $400m^2$ according to government information. The average increase in BF for the whole MK Area in the Initial Scenario compared to the Baseline Scenario is found to be at most 11.6%. This is unlikely to cause any statistically significant difference in air ventilation impacts.

0.6 When wind comes from the WSW and W, the NBA aligned with Li Tak Street, BGs above 20mPD aligned with Ka Shin Street and at the junction of Sycamore Street and Tai Kok Tsui Road allow the entry and penetration of sea breeze into MK Area. When wind comes from the ENE and E, the BG above 23mPD aligned with Mong Kok Road facilitates unobstructed wind flow into MK Area. When wind comes from the NE and SW, the diagonal BG along Nullah Road and Cheung Wong Street, and the SBs requirements along Maple Street are effective for facilitating air movements within MK Area. The SBs requirements along Sai Yeung Choi Street South and Portland Street reduce the canyon height-to-width (H/W) and length-to-width (L/W) ratios. As a result, both downwash effects and lateral flow induced by corner eddies may be enhanced to improve the wind environment at pedestrian level. Therefore, the NBAs, BGs, and SB requirements are all good features for air ventilation in MK Area as a whole and are necessary to be maintained.

0.7 The potential for implementation of the SB and building separation requirements in the SBDG are also evaluated for MK Area. The potential improvement on air ventilation caused by sites adopting SB can be quite significant for those streets which are currently less than 15m wide. However, only 34 individual building lots (assuming no site amalgamation upon redevelopment) are required to comply with the building separation requirement and the potential benefits on air ventilation are expected to be minor and localised. Therefore, site amalgamation should be encouraged to increase the implementation potential of the building separation requirements in the SBDG.

0.8 Three focus study areas are further evaluated to supplement the overall understanding of the air ventilation performance of MK Area under the Initial Scenario. A local improvement in air ventilation at pedestrian level is expected at the Government site at the junction of Sai Yee Street and Argyle Street and adjoining area for comprehensive development (with a tall tower of 320mPD). On the other hand, the large increase in BF at the sites sandwiched between Sham Mong Road and Kok Cheung Street and the sites sandwiched between Flower Market Road and Prince Edward Road West will likely hinder the entry of sea breeze and prevailing winds and worsen the air ventilation within MK Area as compared to the Baseline Scenario. Future developments at these focus areas are recommended to follow the design principles set out in the Hong Kong Planning Standards and Guidelines (HKPSG) at the detailed design stage as the prevailing effort for improvement in urban climate.

0.9 In particular for the sites sandwiched between Sham Mong Road and Kok Cheung Street, it is important to ensure sufficient permeability near the pedestrian level and that air paths are evenly distributed and align with existing streets to allow momentum-driven air flows to reach the inner parts of MK Area. Considering both the feasibility of disposition and the air ventilation performance around the “OU(B)1” site, an alternative of shifting the BG to the northern part of the subject site to facilitate wind penetration into Ka Shin Street is considered feasible.

0.10 In summary, the Initial Scenario is unlikely to cause any statistically significant difference in air ventilation impacts for the whole MK Area when compared to the Baseline Scenario and special attention should be given to the sites highlighted in the focus areas. It is also noted that in compact high-rise building areas, the increase in BH may cease to be the key factor affecting air ventilation at pedestrian level when the H/W ratio of street canyons exceed a certain point. Nevertheless, it should be acknowledged that MK Area is already suffering from poor environment conditions with weak wind and air pollution problems, and any future developments would inevitably worsen the existing conditions, thus good building design measures are important.

0.11 Future developments must be carefully planned and should follow the design principles set out in the HKPSG, especially those listed below:

- Introduce variations in BH across the area;
- Avoid long and continuous façades;
- Reduce site coverage at grade and minimise ground coverage of podia;
- Maintain “O” and “G/IC” sites as air spaces and connect breezeways; and
- Maximise planting of greenery in open spaces, preferably at grade.

0.12 The Government should also give more balanced considerations to S16 applications for building developments which require BH relaxation in order to incorporate more design features to improve air ventilation at pedestrian level. It is highly recommended that project proponents should conduct further assessments to demonstrate that the air ventilation performance of any future developments in MK Area would be no worse off than the evaluated scenarios.

旺角規劃區初步方案的空氣流通專家評估報告

行政摘要

0.1 本空氣流通專家評估報告(報告)旨在檢討旺角規劃區(旺角區)的發展限制以跟進旺角分區計劃大綱草圖圖則編號S/K3/28相關的司法覆核和上訴案件的法院判決。

0.2 就風環境而言，旺角區的全年盛行風主要來自東面和東北偏東面，而夏季的盛行風則主要來自西北面和東面。總結所有可用的風環境資料以及對地形和海陸風的了解，旺角區的重要風向為東北偏東－西北偏西走向。

0.3 旺角區是香港其中一個最密集的已建設區，主要為小型住宅用地，而大部分的商業用地則位於彌敦道兩旁，以及一大片位於旺角區東北面的休憩用地。大致上以東西為走向的主要道路/街道是旺角區有效的風道。

0.4 基準情況所指的是旺角分區計劃大綱草圖圖則編號S/K3/30上的所有要求，包括在圖則編號S/K3/28上所規定的建築物高度限制、非建築用地、建築物間距和建築物後移要求。為增加設計彈性並落實可持續建築設計指引，初步方案建議改變不同地帶(包括：「商業」、「商業1」、「其他指定用途(商貿)」、「其他指定用途(商貿1)」、「住宅(甲類)」、「住宅(甲類)3」、「住宅(甲類)4」、「住宅(戊類)」和「住宅(戊類)1」)的建築物高度限制。本報告就初步方案及基準情況兩者的空氣流通表現作出專業評估。

0.5 本報告先分析整體旺角區建築物的臨街面以評估在初步方案中建築物高度的整體上升對旺角區的空氣流通所造成的潛在影響。由於旺角區的大部分用地採用兩級建築物高度限制(根據地盤面積)，評估時按照政府資料中地盤面積大於400平方米的用地的比例作出相應假設。在初步方案中，整個旺角區的臨街面比起基準情況的平均增幅最高為11.6%。這在統計角度上不大可能對空氣流通影響造成明顯差異。

0.6 當風來自西南偏西面和西面時，與利得街並排的非建築用地、與嘉善街並排而且高度為主水平基準以上20米的建築物間距，以及詩歌舞街和大角咀道交界處的建築物間距，能讓海風進入和滲透旺角區。當風來自東北偏東面和東面時，與旺角道並排而且高度為主水平基準以上23米的建築物間距，讓風能暢通無阻地吹進旺角區。當風來自東北面和西南面時，沿水渠道和長旺道對角的建築物間距，以及沿楓樹街建築物後移的要求都有效促進旺角區的空氣流通。沿西洋菜南街和砵蘭街的建築物後移要求能減少街峽的高寬比及長寬比，有可能促進氣流下洗效應和增強由角隅渦流引起的橫向氣流流動，以改善行人水平的風環境。因此，非建築用地、樓宇間距和樓宇後移要求是對旺角區的整體空氣流通的良好元素，並應予以保留。

0.7 本報告同時就在旺角區實施可持續建築指引所列的建築物後移和建築物間隔要求的可能性進行評估。在闊度少於15米的窄街，建築物後移對空氣流通改善可以相當顯著。然而，現時只有34個地段(假設重建時沒有合併用地) 須遵守建築物間隔要求，

所以預期只會輕微及局部地改善空氣流通。因此，政府應鼓勵建議合併用地以增加落實可持續建築設計指引內有關樓宇間距要求的可行性。

0.8　此外，為更了解初步方案下旺角區的整體通風表現，本報告對三個重點研究區域作進一步評估。在洗衣街與亞皆老街交界的政府用地及毗鄰用地的綜合發展項目(主建築物高度為主水平基準以上320米)預期能局部改善行人水平的空氣流通。另一方面，在深旺道和角祥街之間的用地以及在花墟道和太子道西之間的用地，大幅增加臨街面有可能妨礙海風和盛行風的進入，使旺角區的空氣流通較基準情況為差。建議這些重點研究區域的未來發展應在詳細設計階段遵從香港規劃標準與準則所列的設計指引，致力改善目前的城市氣候。

0.9　針對深旺道和角祥道之間的用地，為確保便動量驅動的氣流能深入旺角區的內部，未來發展應確保在行人水平有足夠的滲透率，而且風道應平均分布及與現有街道並排。考慮到「其他指定用途(商貿)1」用地附近的布局彈性和空氣流通表現，作為替代方案考慮，可將建築物間距移至所屬地盤北部以增加對嘉善街的通風。

0.10　總結而言，與基準方案比較，除重點研究區域中所強調的一些用地外，初步方案從統計角度上不大可能對整個旺角區造成任何明顯的空氣流通影響。需要指出的是，在緊密的高層建築區域，當街峽的高寬比率超過某一水平，建築物高度的增加可能不再是影響行人水平的空氣流通的主要因素。然而，必須承認旺角區已經處於弱風和空氣污染問題的惡劣環境條件下，因此任何未來發展都無可避免地會使現時情況惡化，而良好的建築物設計措施更顯得重要。

0.11　未來發展都必須經過謹慎規劃，並應遵從「香港規劃標準與準則」所羅列的設計指引，尤其是以下幾點：

- 在整個地區引入建築物高度的變化；
- 避免連續/過長的外牆；
- 減少地面的上蓋面積，將平台的地面覆蓋減至最少；
- 維持「休憩用地」和「政府、機構及社區用地」作為空氣流通的空間並連接通風廊；以及
- 盡量在休憩用地種植綠化植物，以地面為佳。

0.12　如未來旺角區的個別建築項目因為引入更多設計元素來改善行人水平的空氣流通而需要根據《城市規劃條例》第16條提出規劃許可申請以進一步放寬建築物高度限制，政府應更平衡考慮該申請的理據。項目倡議者亦應提供進一步評估，以證明該發展不會使旺角區的空氣流通表現變得比該評估方案更差。

Expert Evaluation Report
for the Initial Scenario for Mong Kok Planning Area

1.0 The Assignment

1.1 The development restrictions for the Mong Kok Planning Area (MK Area) are being reviewed to take into account the relevant court judgment on the judicial review (JR) application including that in respect of the draft Mong Kok Outline Zoning Plan (OZP) No. S/K3/28. It is considered necessary to conduct an expert evaluation (EE) to assess the preliminary air ventilation impacts of the latest proposed development restrictions.

1.2 Two JR applications were filed by The Real Estate Developers Association of Hong Kong (REDA) (JR case HCAL No. 58 of 2011) and Lindenford Limited (Lindenford) (JR case HCAL No. 59 of 2011) against the Town Planning Board’s (the Board) decisions on their representations in respect of the draft Mong Kok OZP No. S/K3/28, in particular on the imposition of the building height restrictions (BHRs) and designation of non-building areas (NBAs), building gaps (BGs) and building setback (SBs) requirements for various development zones. In the judgment of JR case HCAL No. 58 of 2011, the Court of First Instance ruled that the Board’s decisions are quashed and have to be remitted to the Board for reconsideration. A review of the development restrictions on the draft Mong Kok OZP is therefore conducted.

1.3 This expert evaluation report is based on previous AVA studies, court judgments of JR cases concerned, and other materials provided by Planning Department (PlanD) including:

Site Plan of Project Area
Wind information from Hong Kong Observatory and PlanD
Baseline analysis (including existing building heights, street widths, land use, planning restrictions) of MK Area
Draft Mong Kok OZP Nos. S/K3/28 and S/K3/30 (Plan, Notes and Explanatory Statements)
Digital map (2D) of MK Area
Aerial photos of MK Area
Initial Scenario (with relaxed building height restrictions) of MK Area
EE on AVA for Mong Kok Area (September 2010)
EE and IS on AVA for Sai Yee Street and Mong Kok East Station (2017)
HCAL No. 58 of 2011 – The Real Estate Developers Association of Hong Kong v. Town Planning Board
HCAL No. 59 of 2011 – Lindenford Limited v. Town Planning Board
MPC Paper No. 19/10 dated 10.9.2010

TPB Paper No. 8809 dated 29.4.2011

1.4 Other reference materials include:

Hong Kong Buildings Department. (2016). Practice Note for Authorised Persons, Registered Structural Engineers and Registered Geotechnical Engineers: Sustainable Building Design Guidelines (APP-152)
Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG)
Hong Kong Town Planning Board. Application for Permission under Section 16 of the Town Planning Ordinance (CAP. 131) Guidance Notes
Ng, E., Yuan, C., Chen, L., Ren, C., Fung J.C.H. "Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: a study in Hong Kong." Landscape and Urban Planning 101.1 (2011): 59-74
Theurer, W. Typical building arrangements for urban air pollution modelling. Atmospheric Environment 33.24-25 (1999): 4057-4066
Yuan, C. and Ng, E. "Building porosity for better urban ventilation in high-density cities–A computational parametric study." Building and Environment 50 (2012): 176-189
Simpson, J.E. (1994). Sea breeze and local wind. Cambridge University Press
Oke, T. R. (1987). Boundary layer climates. Routledge
A. Kovar-Panskus, P. Louka, J.-F. Sini, E. Savory, M. Czech, A. Abdelqari, P. G. Mestayer and N. Toy, “Influence of geometry on the mean flow within urban street canyons – A comparison of wind tunnel experiments and numerical simulations”, Water, Air, and Soil Pollution: Focus 2: 365–380 (2002), Kluwer Academic Publishers
Yazid, A. W. M., Sidik, N. A. C., Salim, S. M., & Saqr, K. M. A review on the flow structure and pollutant dispersion in urban street canyons for urban planning strategies. Simulation 90.8 (2014): 892-916.
Hong Kong Green Building Council Limited. (2018). HKGBC Guidebook on Urban Microclimate Study

1.5 The consultant has studied the foregoing materials. During the preparation of the report, the consultant has visited the site and conducted working sessions with PlanD.

2.0 Background

2.1 PlanD's study: "Feasibility Study for Establishment of Air Ventilation Assessment System" (Feasibility Study) has recommended that it is important to allow adequate air ventilation through the built environment for pedestrian comfort.

2.2 Given Hong Kong's high density urban development, the Feasibility Study opines that: "more air ventilation, the better" is the useful design guideline.

2.3 The Feasibility Study summarises 10 qualitative guidelines for planners and designers. For the OZP level of consideration, breezeways/air paths, street grids and orientations, open spaces, NBAs, waterfront sites, scales of podium, building heights, building dispositions, and greeneries are all important strategic considerations.

2.4 The Feasibility Study also suggests that Air Ventilation Assessment (AVA) be conducted in three stages: Expert Evaluation, Initial Studies, and Detailed Studies. The suggestion has been adopted and incorporated into Housing Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB) Technical Circular no. 1/06. The key purposes of Expert Evaluation are to the following:

(a) Identify good design features.
(b) Identify obvious problem areas and propose some mitigation measures.
(c) Define "focuses" and methodologies of the Initial and/or Detailed studies.
(d) Determine if further study should be staged into Initial Study and Detailed Study, or Detailed Study alone.

2.5 To conduct the Expert Evaluation systematically and methodologically, it is necessary to undertake the following information analyses:

(a) Analyse relevant wind data as the input conditions to understand the wind environment of the Area.
(b) Analyse the topographical features of the study area, as well as the surrounding areas.
(c) Analyse the greenery/landscape characteristics of the study area, as well as the surrounding areas.
(d) Analyse the land use and built form of the study area, as well as the surrounding areas.

Based on the analyses of site context and topography:

(e) Estimate the characteristics of the input wind conditions of the study area.
(f) Identify the wind paths and wind flow characteristics of the study area through slopes, open spaces, streets, gaps and NBAs between buildings, and low rise buildings; also identify stagnant/problem areas, if any.
(g) Estimate the need of wind for pedestrian comfort.

Based on the analyses of the existing urban conditions:

(h) Evaluate the strategic role of the study area in air ventilation term.
(i) Identify problematic areas which warrant attention.
(j) Identify existing "good features" that needs to be kept or strengthened.

Based on an understanding of the existing urban conditions:

(k) Compare the prima facie impact, merits or demerits of the different development restrictions as proposed by PlanD on air ventilation.

(l) Highlight problem areas, if any. Recommend improvements and mitigation measures if possible.

(m) Identify focus areas or issues that may need further studies. Recommend appropriate technical methodologies for the study if needed.

2.6 In this particular AVA EE, the focus is put to assess the air ventilation performance of the proposed Initial Scenario against that of the Baseline Scenario, which refers to the scenario under the draft Mong Kok OZP No. S/K3/30 with BHRs, NBAs, BGs, and SB as imposed on the then draft Mong Kok OZP No. S/K3/28.

2.7 Three focus study areas, namely the (i) the government site at the junction of Sai Yee Street and Argyle Street and adjoining area for comprehensive development (the Sai Yee Street Redevelopment Site); (ii) the street blocks sandwiched between Sham Mong Road and Kok Cheung Street; and (iii) the two street blocks sandwiched between Flower Market Road and Prince Edward Road West, have been selected where a further evaluation will be conducted to supplement the overall understanding of the air ventilation performance of MK Area under the Initial Scenario.

2.8 The Sai Yee Street Redevelopment Site is selected as it is a comprehensive development with a substantial increase in BH, while the other two areas are selected as they are areas important for wind entry but with a relatively large increase in BHR in the Initial Scenario.

3.0 The Wind Environment

3.1 Hong Kong Observatory (HKO) stations provide useful and reliable data on the wind environment in Hong Kong (Figure 3.1). There are some 46 stations operated by HKO in Hong Kong. Together, these stations allow for a good general understanding of the wind environment especially near ground level.

Figure 3.1 Some of the HKO stations in Hong Kong. This is a screen capture at 12:00 on 25 Oct 2017 from the HKO website. The arrows show the wind directions and speeds at the given time.

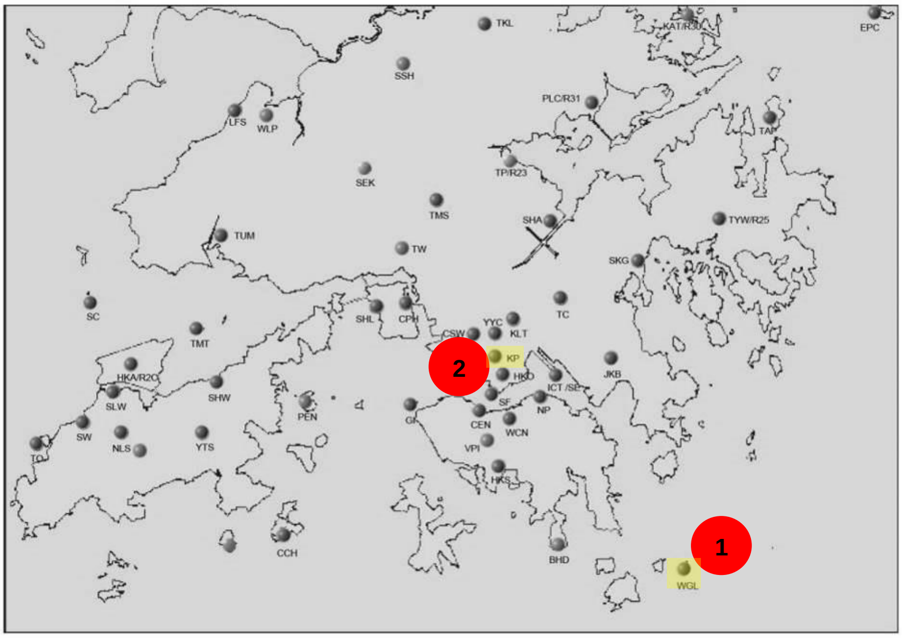


Figure 3.2 The HKO stations at 1: Waglan Island (WGL), 2: King's Park (KP).

3.2 The HKO station at Waglan Island (WGL) is normally regarded by wind engineers as the reference station for wind related studies (Location 1 in Figure 3.2). The station has a very long measurement record, and is unaffected by Hong Kong's complex topography. However it is known not to be able to capture the thermally induced local wind circulation like sea breezes very well. Based on WGL wind data, AVA studies are typically employed to estimate the site wind availability taking into account the topographical features around the site.

3.3 Based on the annual wind rose of WGL (Figure 3.3), it is apparent that the annual prevailing wind in Hong Kong is from the east. A major component of wind also comes from the northeast; and there is a minor, but nonetheless observable component from the southwest. WGL has weak to moderate wind (0.1m/s to 8.2 m/s) approximately 70% of the time.

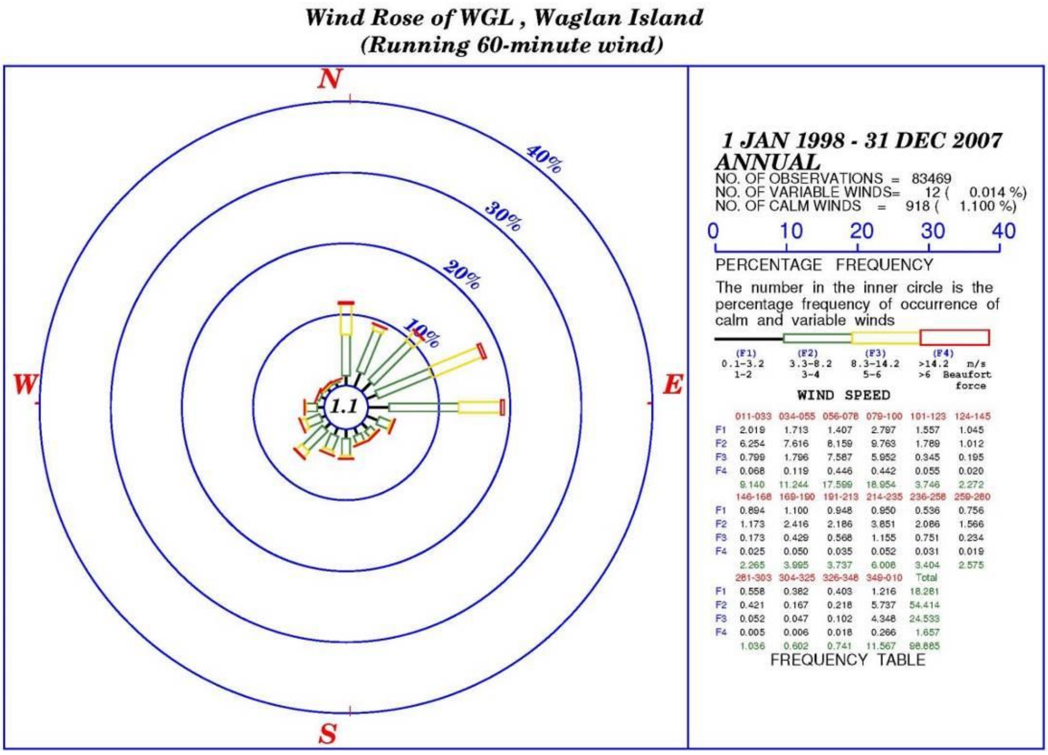


Figure 3.3 Wind rose of WGL from 1998 to 2007[1] (annual).

3.4 For the AVA study, seasonal or monthly wind environment should be understood (Figures 3.4 and 3.5). During winter, the prevailing wind comes from the northeast, whereas during summer, it comes from the southwest. As far as AVA is concerned, in Hong Kong, the summer wind is very important and beneficial for thermal comfort. Hence, based on WGL data, it is very important to plan our city, on the one hand, to capture the annual wind characteristics, and on the other hand, to maximise the penetration of the summer winds (mainly from the southwest) into the urban fabric.

[1] Wind data from 1998 to 2007 are the latest available 10-year data from HKO to the consultant.

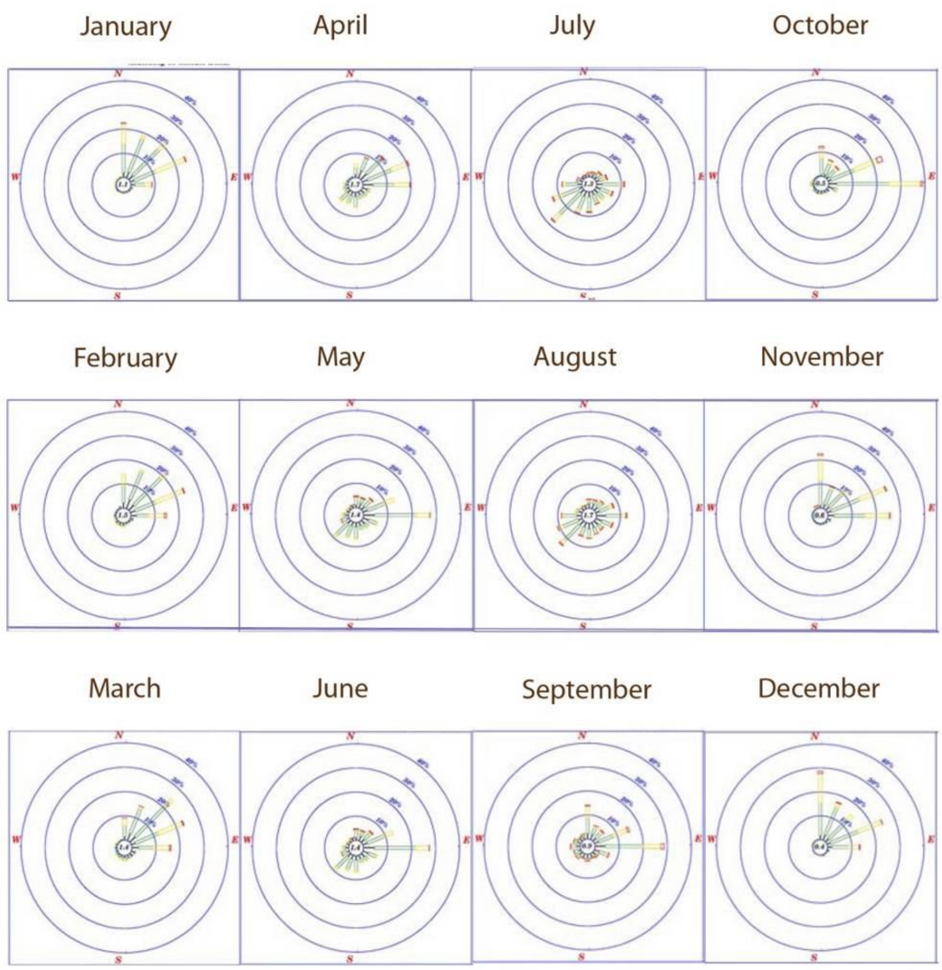


Figure 3.4 Monthly wind roses of WGL from 1998 to 2007.

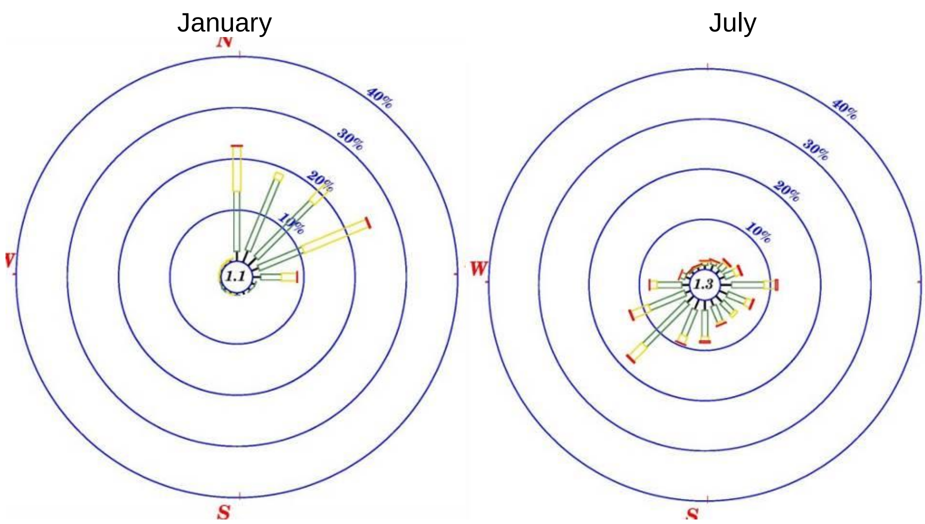


Figure 3.5 Wind roses of WGL from 1998 to 2007 (Jan and July).

3.5 Apart from WGL, the wind data of King's Park have also been extracted from HKO for reference (Figure 3.6 to Figure 3.9) as the nearest station measuring wind environment for the MK Area. The measurement data at King's Park (with ground elevation of 65mPD) is affected by both building landscape and topography as it is situated within the building canopy and also lower than the higher ground elevation of Ho Man Tin district (up to around 100mPD) to the east. It can be observed that the annual prevailing winds are mainly from the east and east-southeast, with also significant wind components from the north and west. The summer prevailing winds are mainly from the east, west, and southerly quarters.

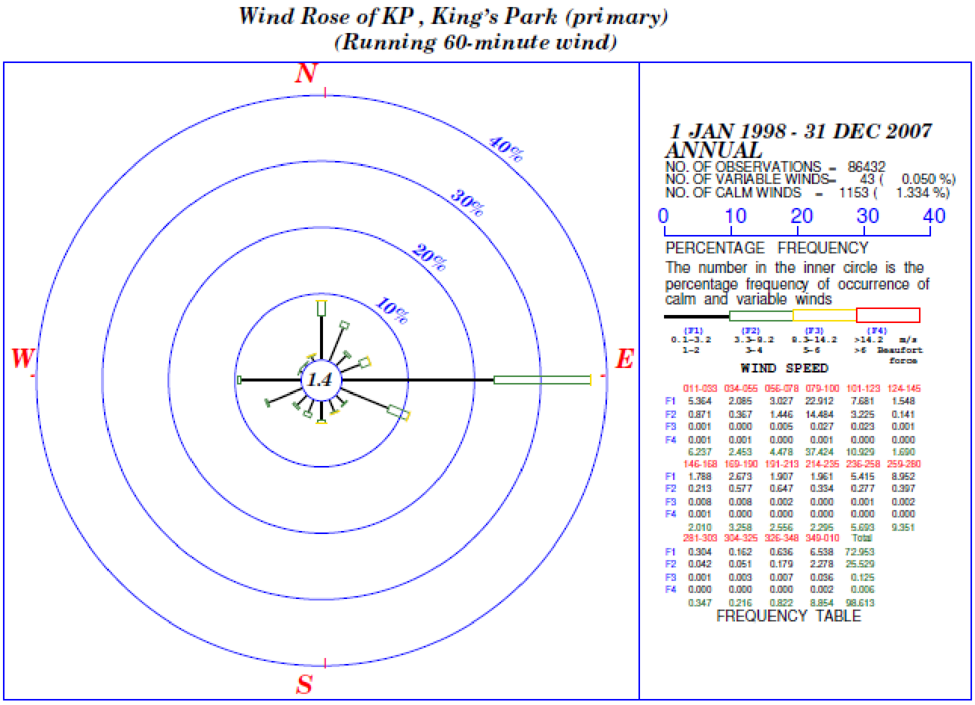


Figure 3.6 Wind rose of King's Park from 1998 to 2007 (annual).

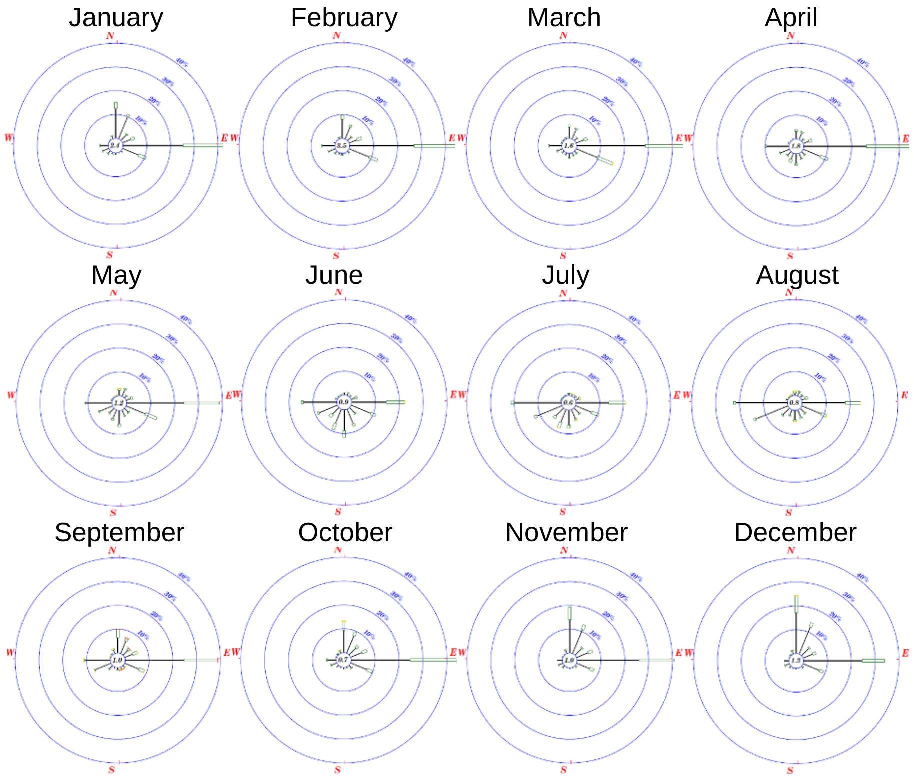


Figure 3.7 Monthly wind roses of King's Park from 1998 to 2007.

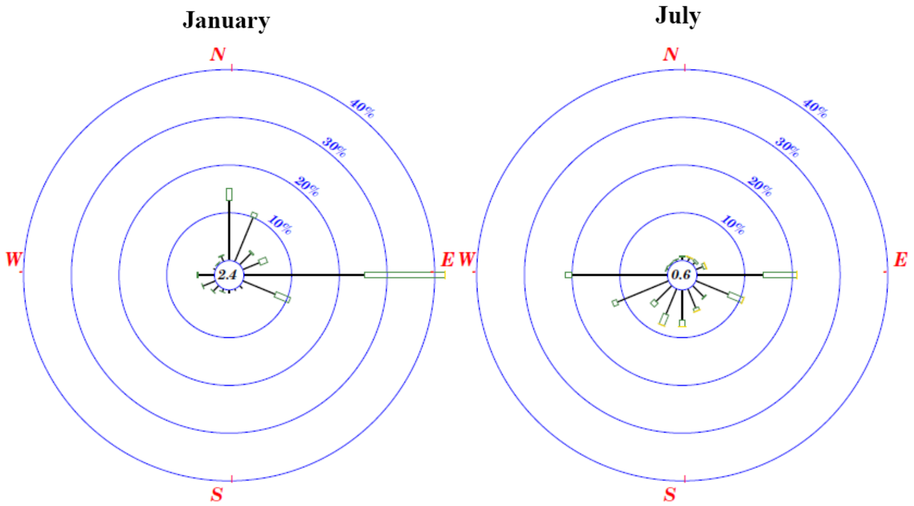


Figure 3.8 Wind roses of King's Park from 1998 to 2007 (Jan and July).

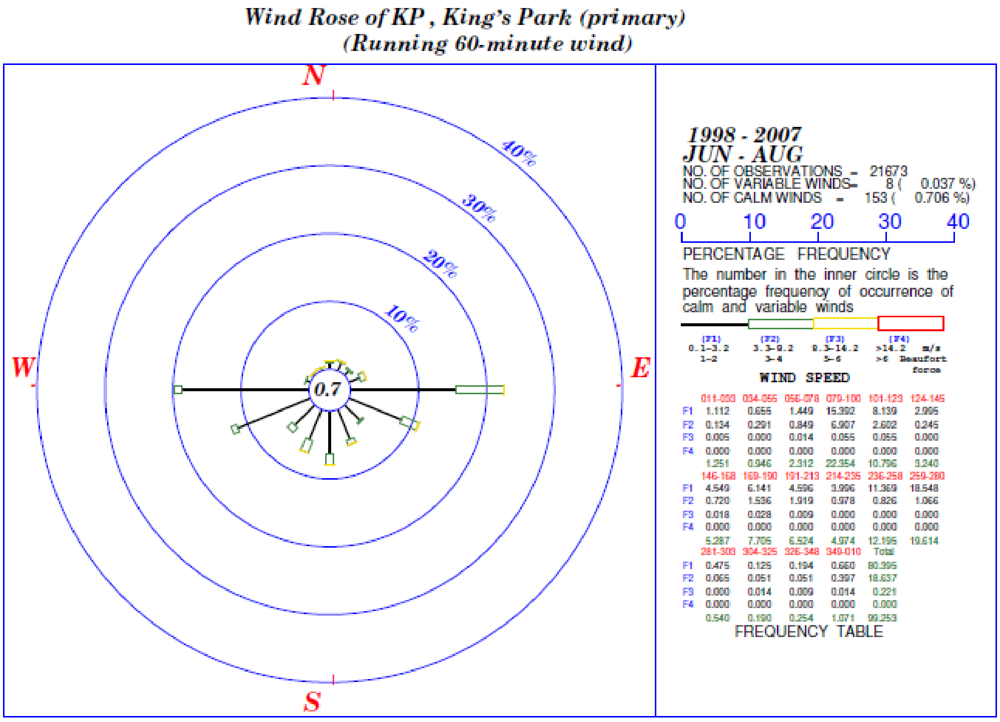


Figure 3.9 Wind rose of King's Park from 1998 to 2007 (Jun to Aug, summer).

3.6 Noting the limitation of the data of Waglan Island mentioned in para. 3.2, wind characteristics from the web-based database system provided by PlanD has also been referenced[1]. Data from five locations (x:077 y:043, x:078 y:043, x:079 y:043, x:078 y:042, x:079 y:042), which covers the MK Area, were simulated at 200m, 300m and 500m above the ground (Figures 3.10 to 3.14). These locations, according to the application of Regional Atmospheric Modeling System (RAMS), were selected to reflect the general wind patterns within the MK Area induced by topography. All five locations show similar wind availability. Annual and summer prevailing wind directions are summarised in Table 1. In general, the RAMS wind data from PlanD's website are consistent with that measured by HKO stations, but the RAMS data is limited to reflect the wind availability at higher elevations at or above 200m.

[1] http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/index.html

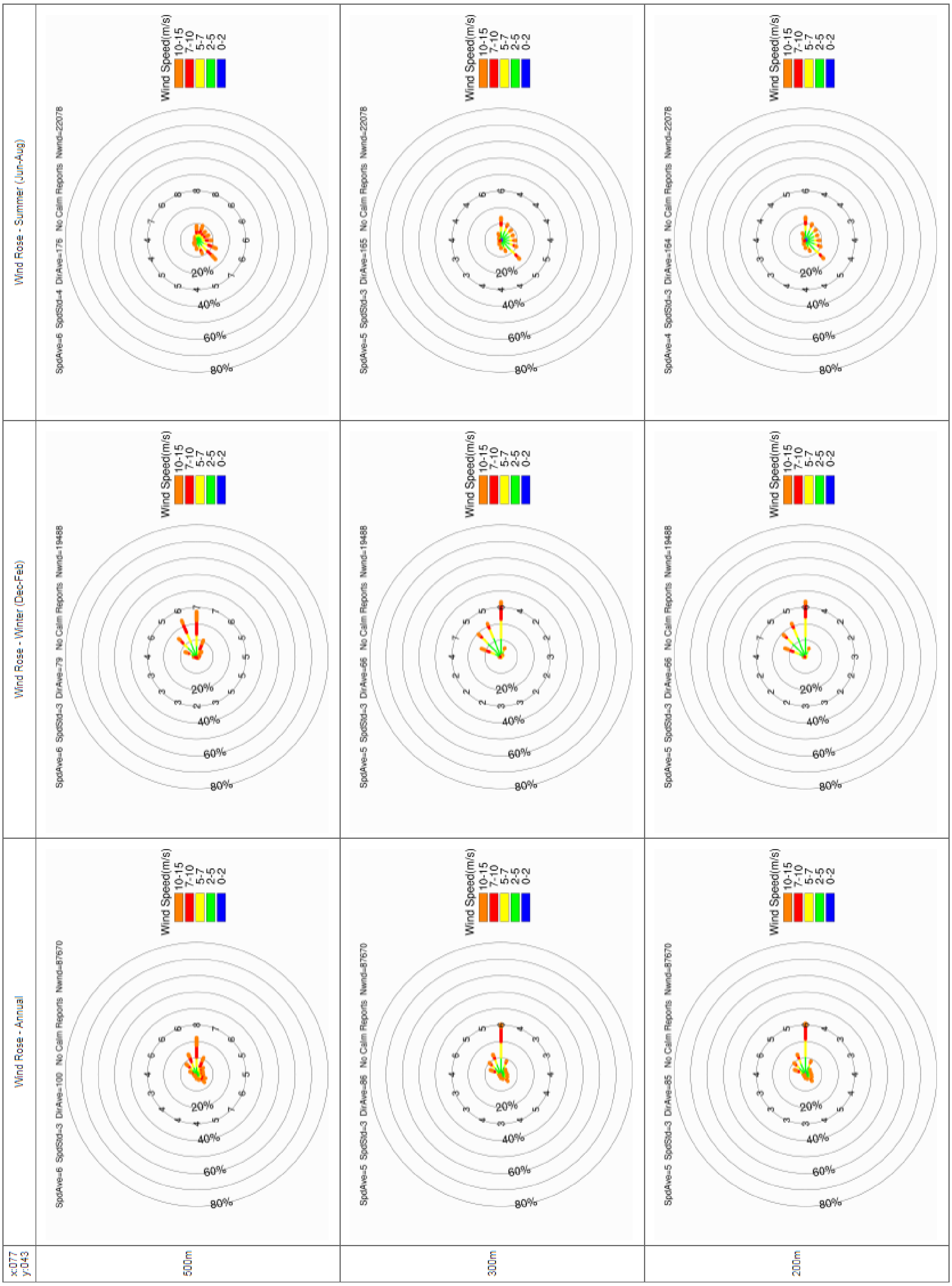


Figure 3.10 The wind data provided by PlanD for the MK Area (x:077 y:043).

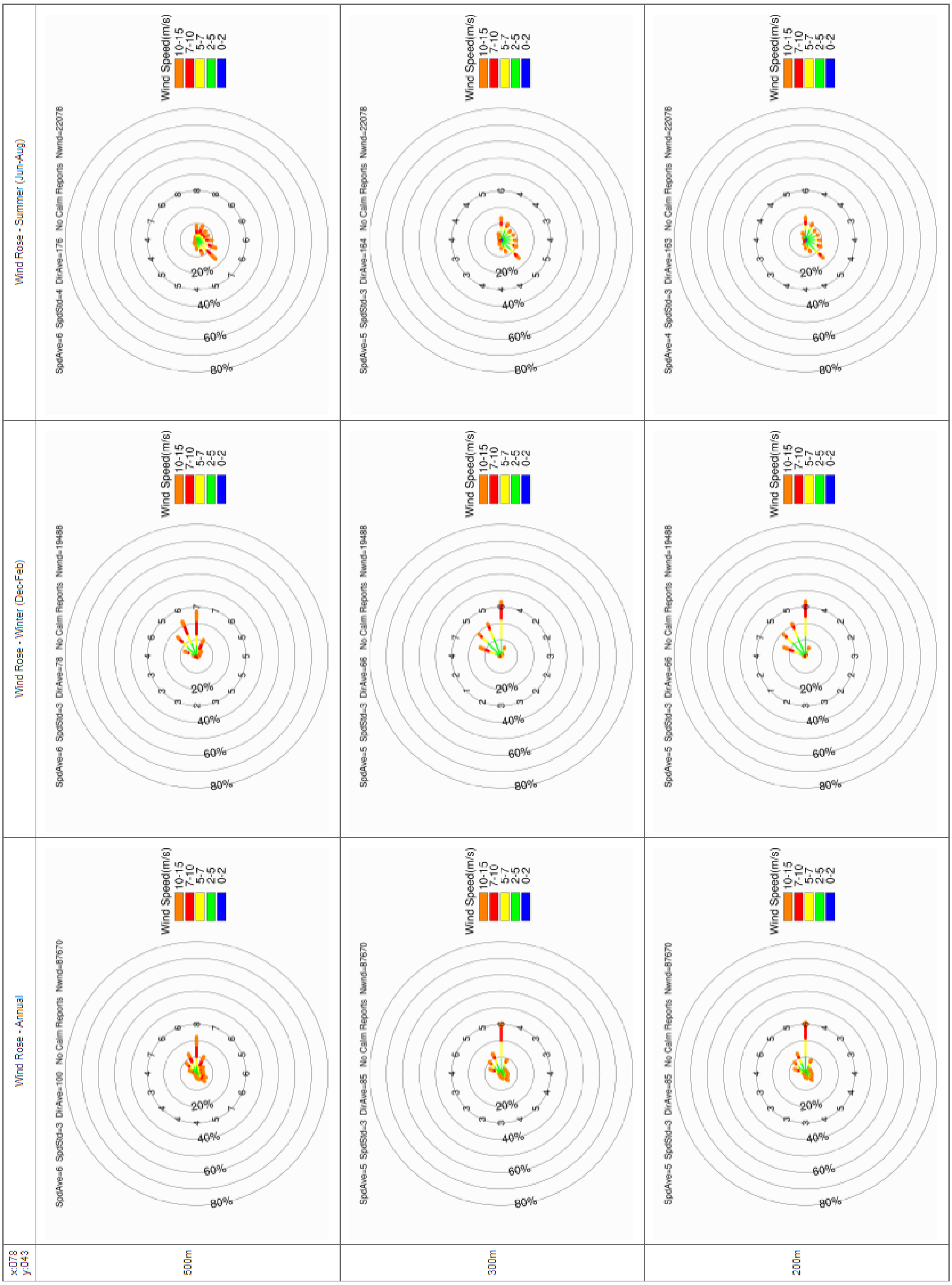


Figure 3.11 The wind data provided by PlanD for the MK Area (x:078 y:043).

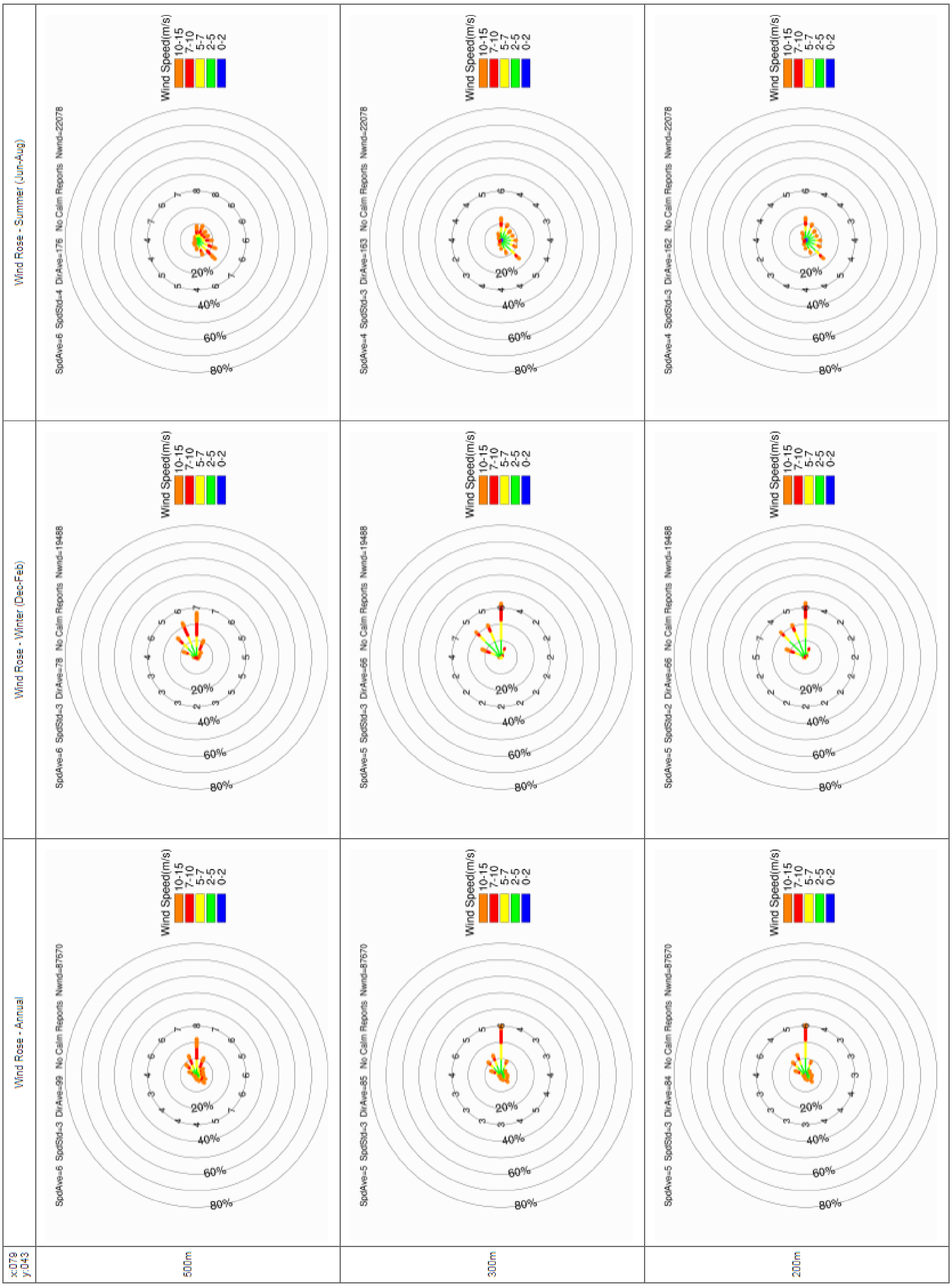


Figure 3.12 The wind data provided by PlanD for the MK Area (x:079 y:043).

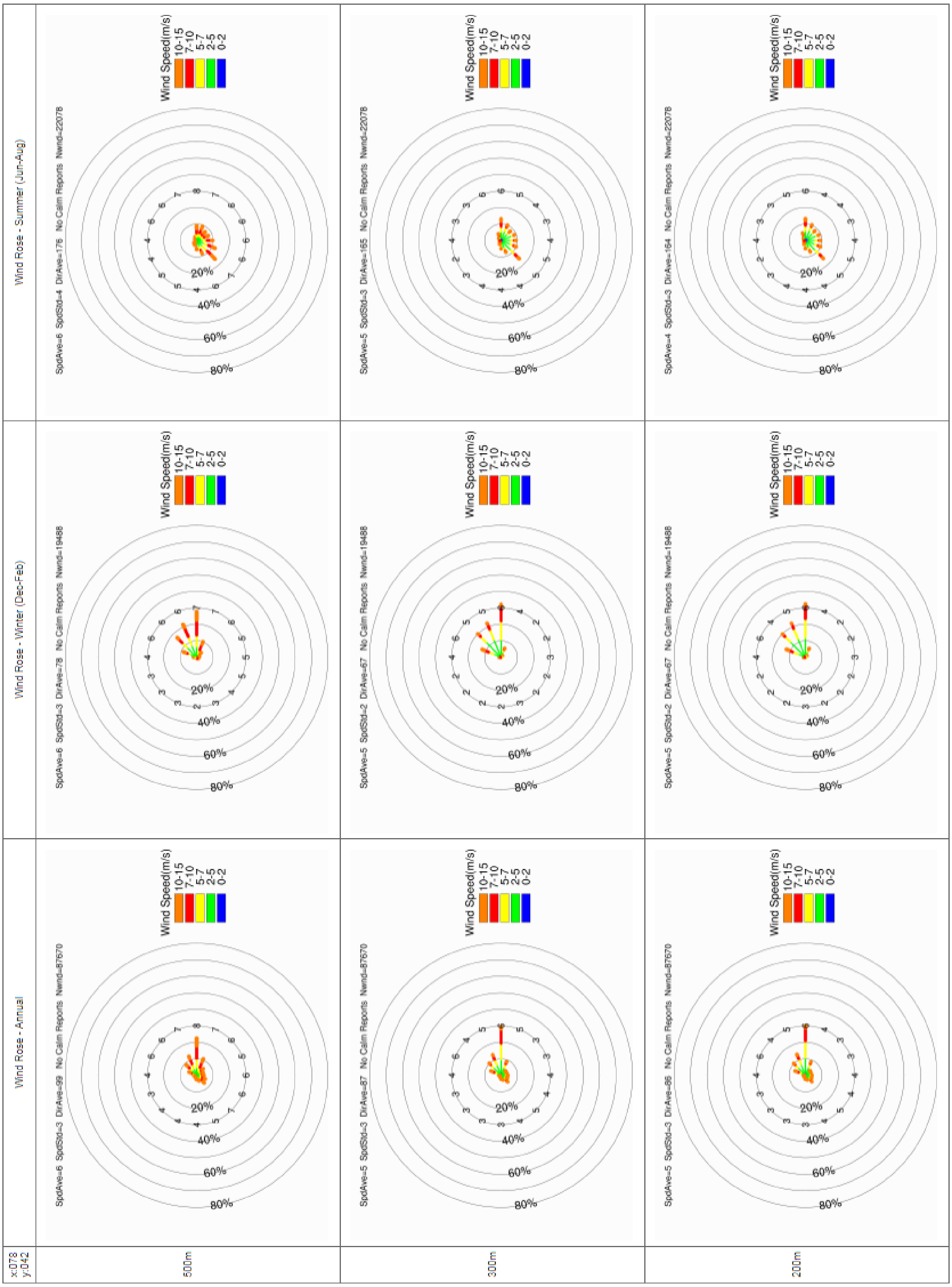


Figure 3.13 The wind data provided by PlanD for the MK Area (x:078 y:042).

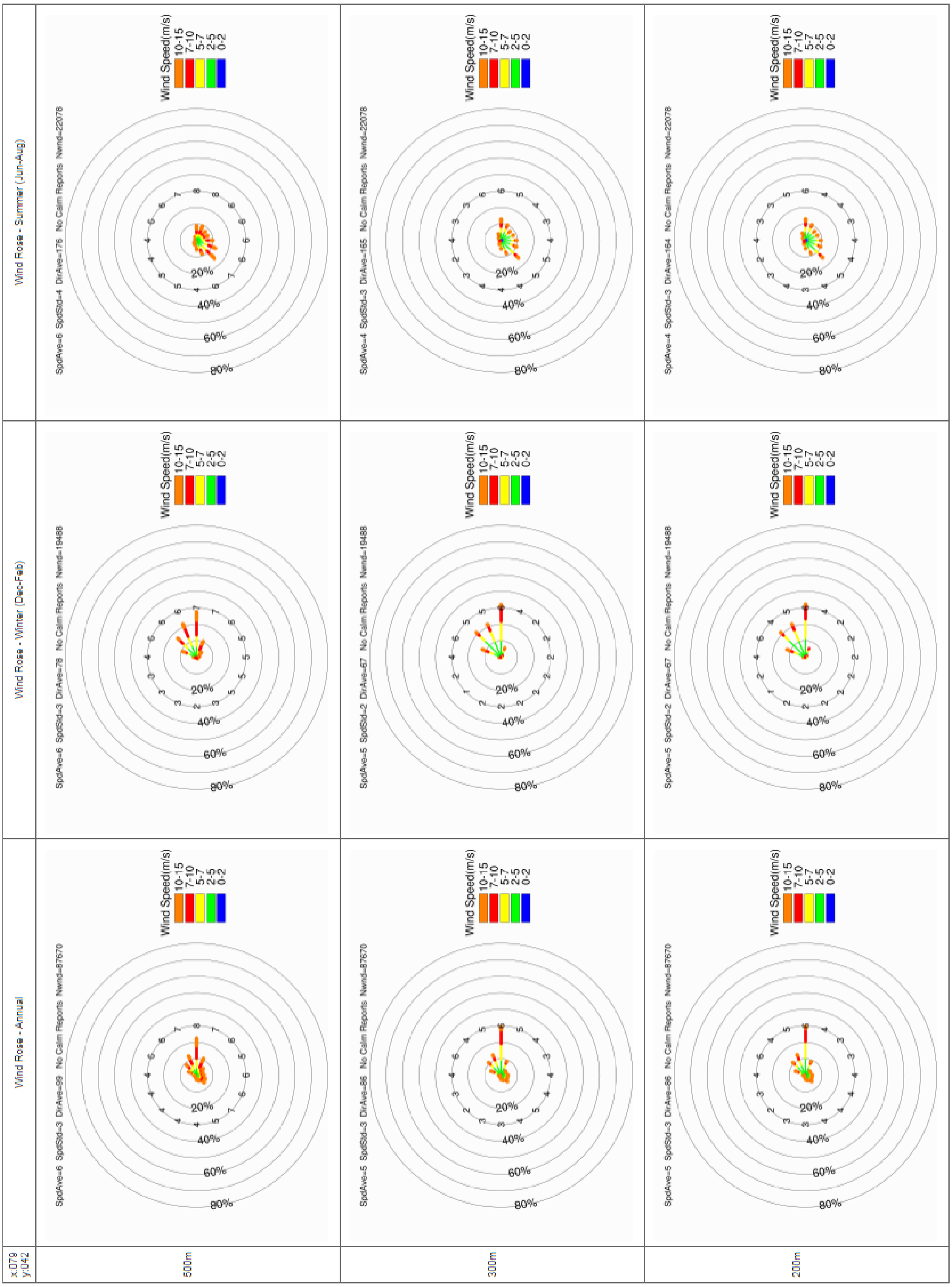


Figure 3.14 The wind data provided by PlanD for the MK Area (x:079 y:042).

3.7 With reference to the previous AVA study for MK area in September 2010[1], wind availability data were also obtained from MM5 simulation performed by HKUST and wind tunnel experiment conducted at the CLP Power Wind/Wave Tunnel Facility (WWTF). Based on simulated wind availability data, annual prevailing winds are identified from the northeast and east, while summer prevailing winds are identified from the east, southwest, southeast and the southerly quarters (Figure 3.15 and 3.16). Based on experimental wind data, annual prevailing winds are identified from the northeast quadrant, north and east, while summer prevailing winds are identified from the east, south and southwest quadrant (Figure 3.17 and 3.18).

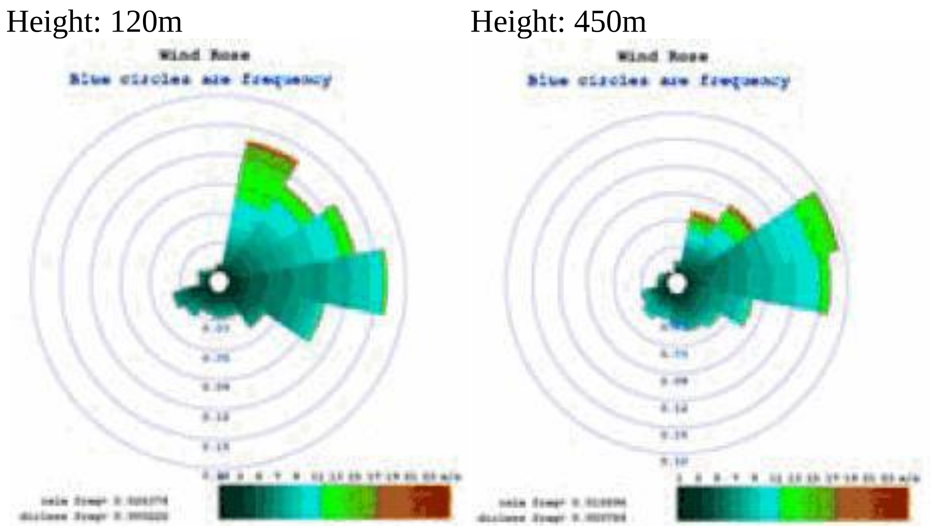


Figure 3.15 Annual wind rose based on MM5 simulation (taken from AVA EE 2010).

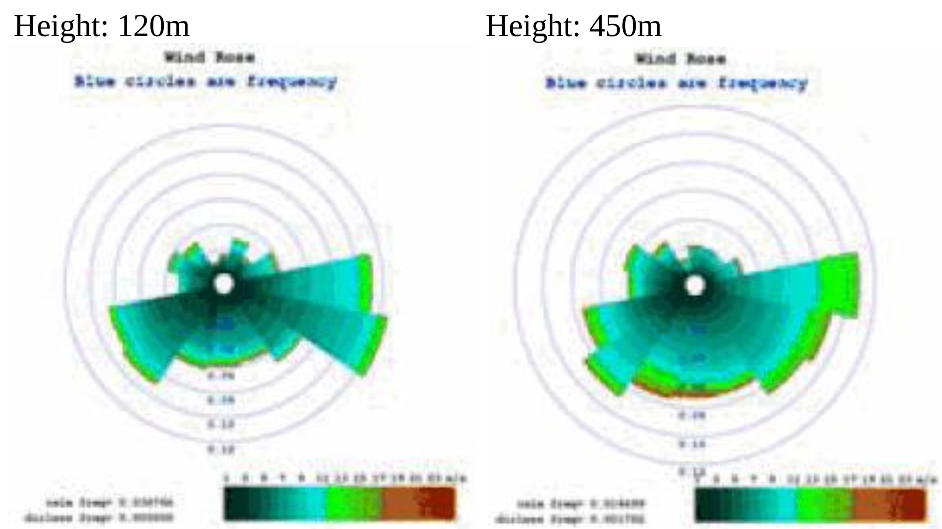


Figure 3.16 Summer wind rose based on MM5 simulation (taken from AVA EE 2010).

[1] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG52_AVA_FinalReport.pdf

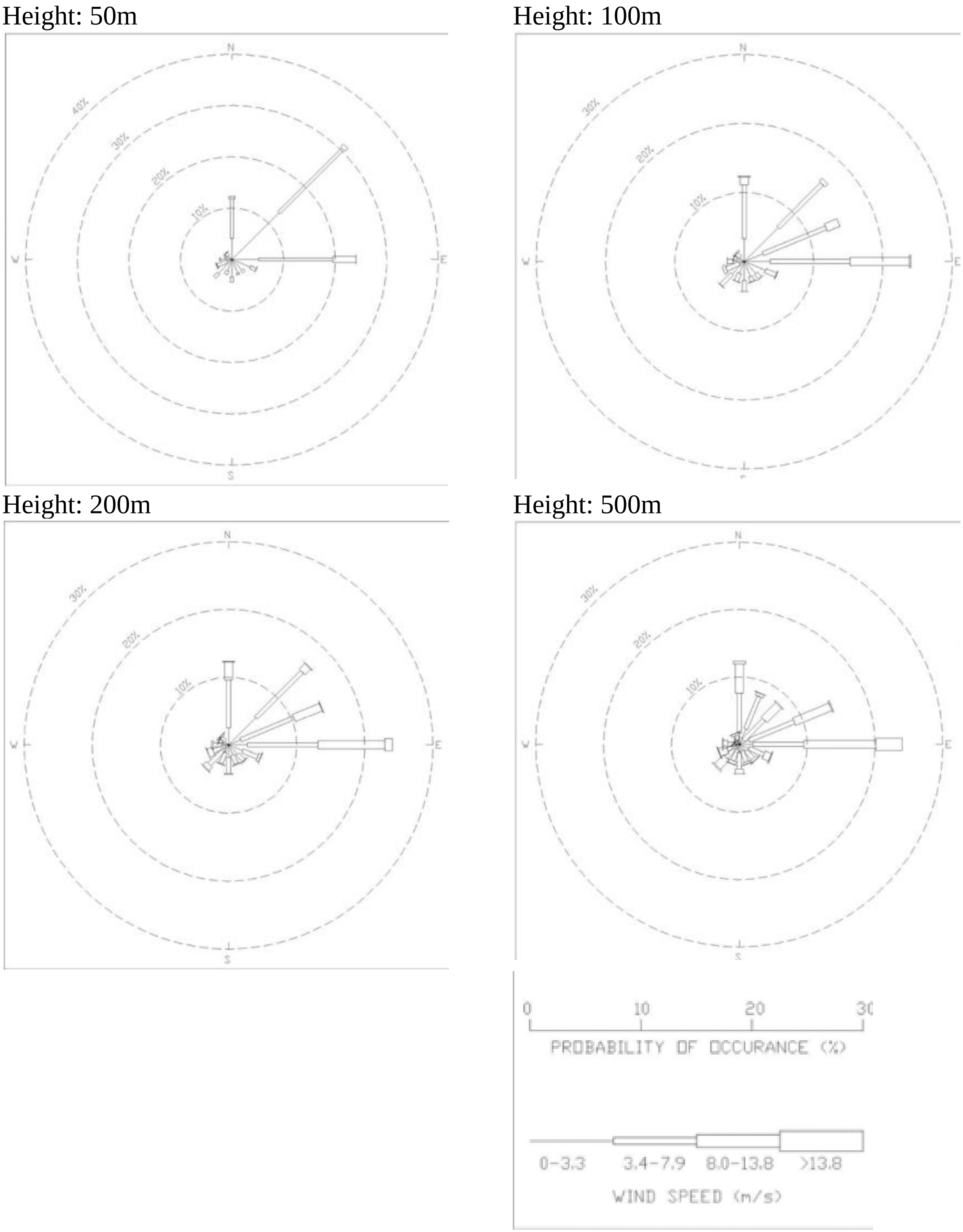


Figure 3.17 Annual wind rose based on wind tunnel experiment (taken from AVA EE 2010).

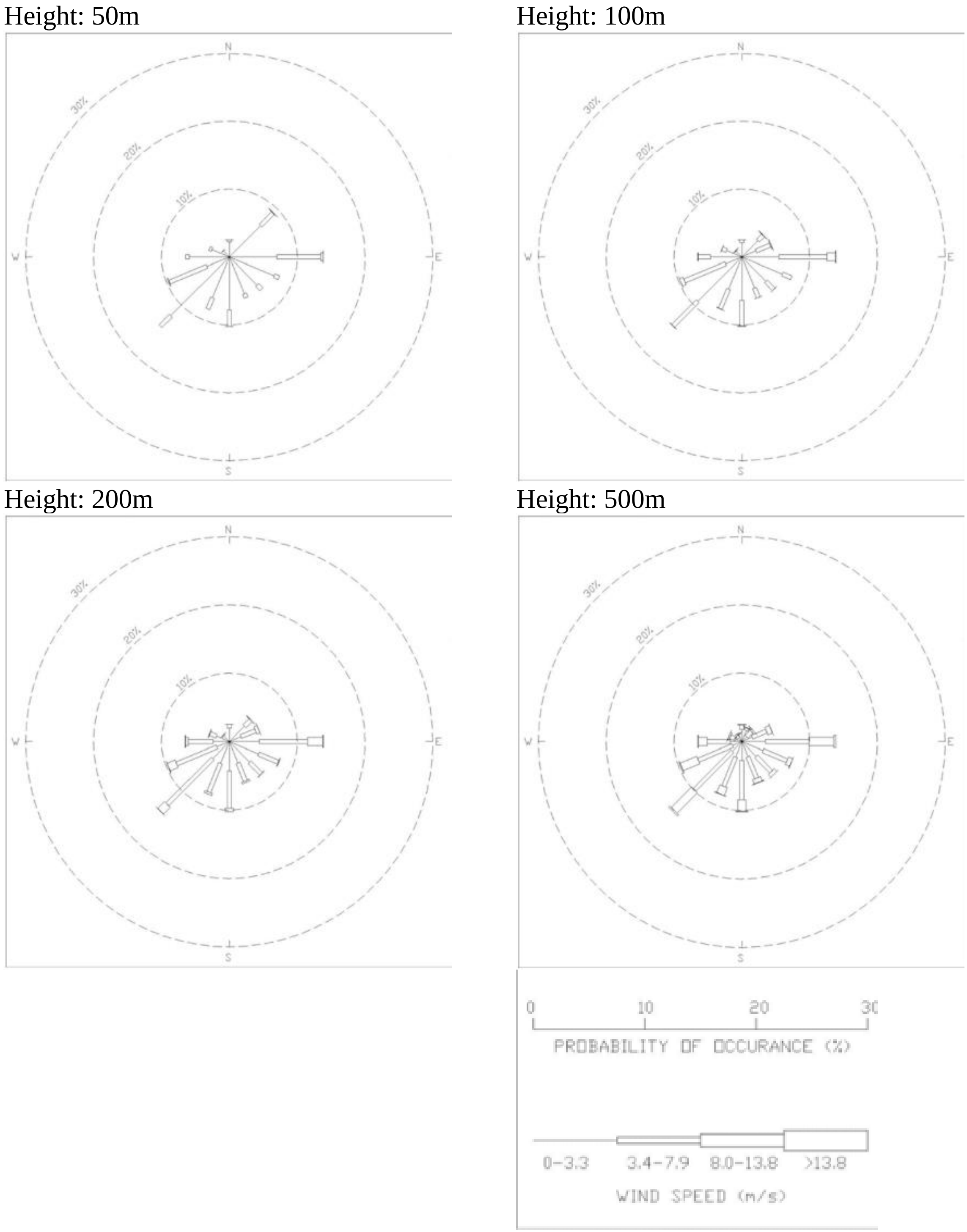


Figure 3.18 Summer wind rose based on wind tunnel experiment (taken from AVA EE 2010).

3.8 In summary, based on all available wind data (Table 1), it can be concluded that the prevailing annual winds mainly come from the E and ENE. Prevailing summer winds mainly come from the SW and E, with significant wind components from the southerly quarters (Figure 3.19). This is in agreement with the important wind directions identified during the previous AVA study of the MK Area in 2010[1].

Table 1 Summary of Prevailing Wind Directions (the three most frequent directions, listed in the order of prevalence).

<table>
<tr><th>Data</th><th>Location</th><th>Height (m)</th><th>Annual wind</th><th>Summer wind</th></tr>
<tr><td>HKO station</td><td>King's Park (KP)</td><td>65</td><td>E, ESE, W</td><td>E, W, WSW</td></tr>
<tr><td rowspan="15">RAMS (from PlanD)</td><td rowspan="3">x:077 y:043</td><td>200</td><td>E, ENE, NE</td><td>SW, E, SSW</td></tr>
<tr><td>300</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, ENE, ESE</td><td>SW, SSW, ESE</td></tr>
<tr><td rowspan="3">x:078 y:043</td><td>200</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>300</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, ENE, ESE</td><td>SW, SSW, ESE</td></tr>
<tr><td rowspan="3">x:079 y:043</td><td>200</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>300</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, ENE, ESE</td><td>SW, SSW, S</td></tr>
<tr><td rowspan="3">x:078 y:042</td><td>200</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>300</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, ENE, ESE</td><td>SW, SSW, S</td></tr>
<tr><td rowspan="3">x:079 y:042</td><td>200</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>300</td><td>E, ENE, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, ENE, ESE</td><td>SW, SSW, S</td></tr>
<tr><td colspan="2" rowspan="2">MM5 simulation (from AVA EE 2010)</td><td>120</td><td>E, NE, ENE</td><td>ESE, E, SW</td></tr>
<tr><td>450</td><td>ENE, E, NE</td><td>E, SW, SE</td></tr>
<tr><td colspan="2" rowspan="4">Wind tunnel experiment (from AVA EE 2010)</td><td>50</td><td>NE, E, N</td><td>SW, E, S</td></tr>
<tr><td>100</td><td>E, NE, N</td><td>SW, E, S</td></tr>
<tr><td>200</td><td>E, N, NE</td><td>SW, E, S</td></tr>
<tr><td>500</td><td>E, N, ENE</td><td>SW, E, S</td></tr>
</table>

[1] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG52_AVA_FinalReport.pdf

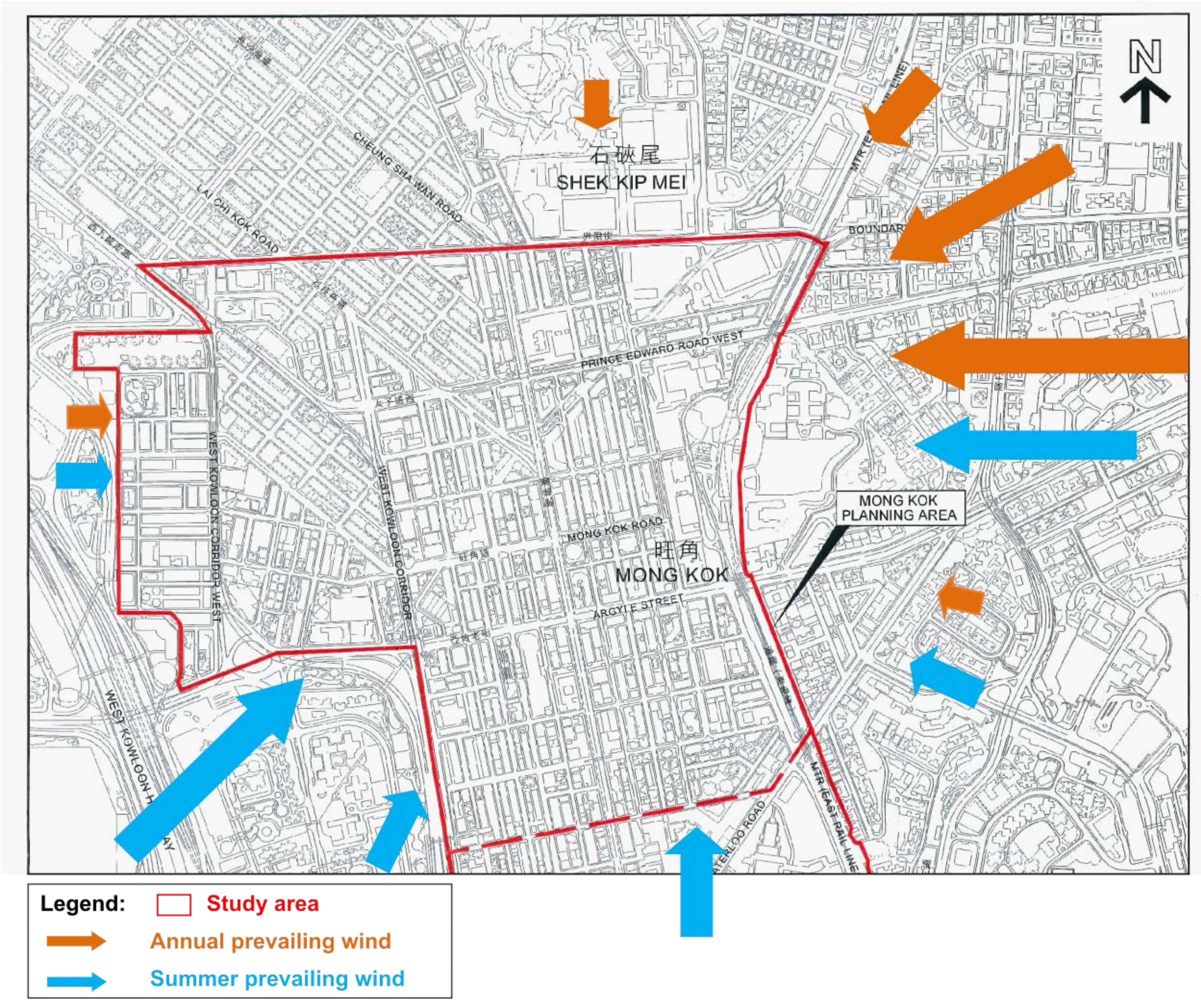


Figure 3.19 A summary of the prevailing winds in the MK Area (arrow sizes indicate the probabilities of corresponding wind directions).

4.0 Topography, Land-Sea Breezes and the Wind Environment

4.1 MK Area is located on relatively flat grounds with low elevation (up to 30m) in the Kowloon Peninsula. There are hilly areas rather far around 2km north of MK Area, including Beacon Hill (ground elevation of around 150m), Eagle’s Nest (ground elevation of around 150m) and Lion Rock (ground elevation of over 300m). To the southeast of the MK Area, Ho Man Tin is slightly higher, reaching ground elevation of around 100m. To the southwest, MK Area is within 750m from the New Yau Ma Tei Typhoon Shelter and the sea to the west of the Victoria Harbour (Figure 4.1).

4.2 MK Area is generally unaffected by katabatic (downhill) air movements from neighbouring topography. The annual and summer prevailing winds can reach the MK Area unobstructed by topography and the hilly areas are not in the immediate surroundings of the MK Area to create complicated local flow patterns at the site.

4.3 The MK Area is subjected to thermally-induced weak air movements caused by the land-sea component at the coastline to the west and southwest of the MK Area. Coupled MM5/CALMET simulations of the Hong Kong wind field show convergence over the Kowloon Peninsula (Figure 4.2). Observed winds also confirm wind flow from the SW and WSW into the western Kowloon Peninsula. These sea breezes may penetrate further inland via the east-west streets in MK Area. With reference to the land-sea breeze formation mechanism (see Figure A-1 in Appendix A), the influence of sea breezes is expected to be more significant in the afternoon, especially under weak wind conditions.

4.4 Based on all available wind information and an understanding of the topography and land-sea breezes, it can be concluded that important wind directions for the MK Area fall along the ENE-WSW axis (Figure 4.3). Major roads/streets parallel or within 30 degrees from this direction, including Prince Edward Road West and Argyle Street, can therefore form effective air paths in the area.

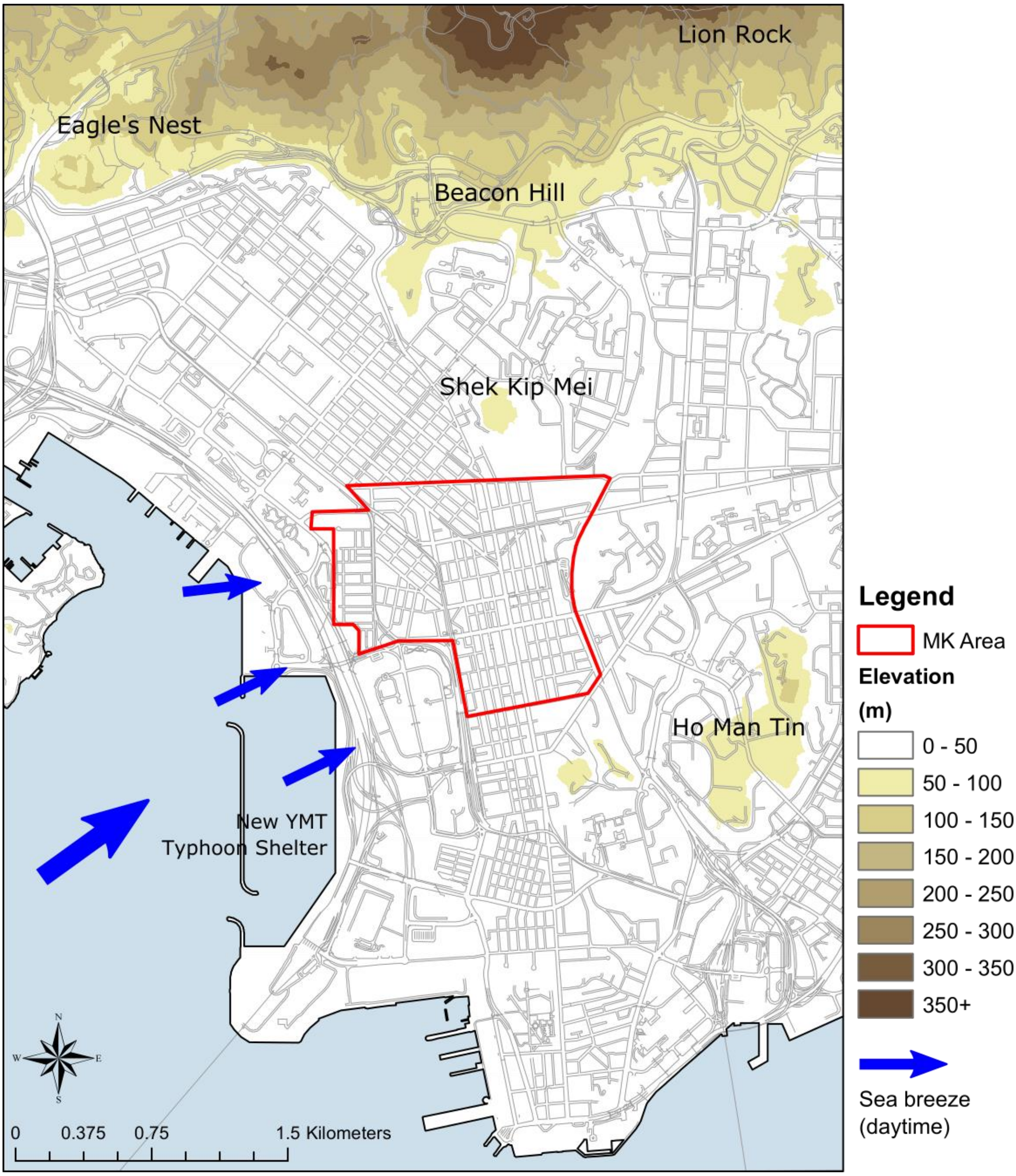


Figure 4.1 Topography surrounding the MK Area and sea breezes from the southwest.

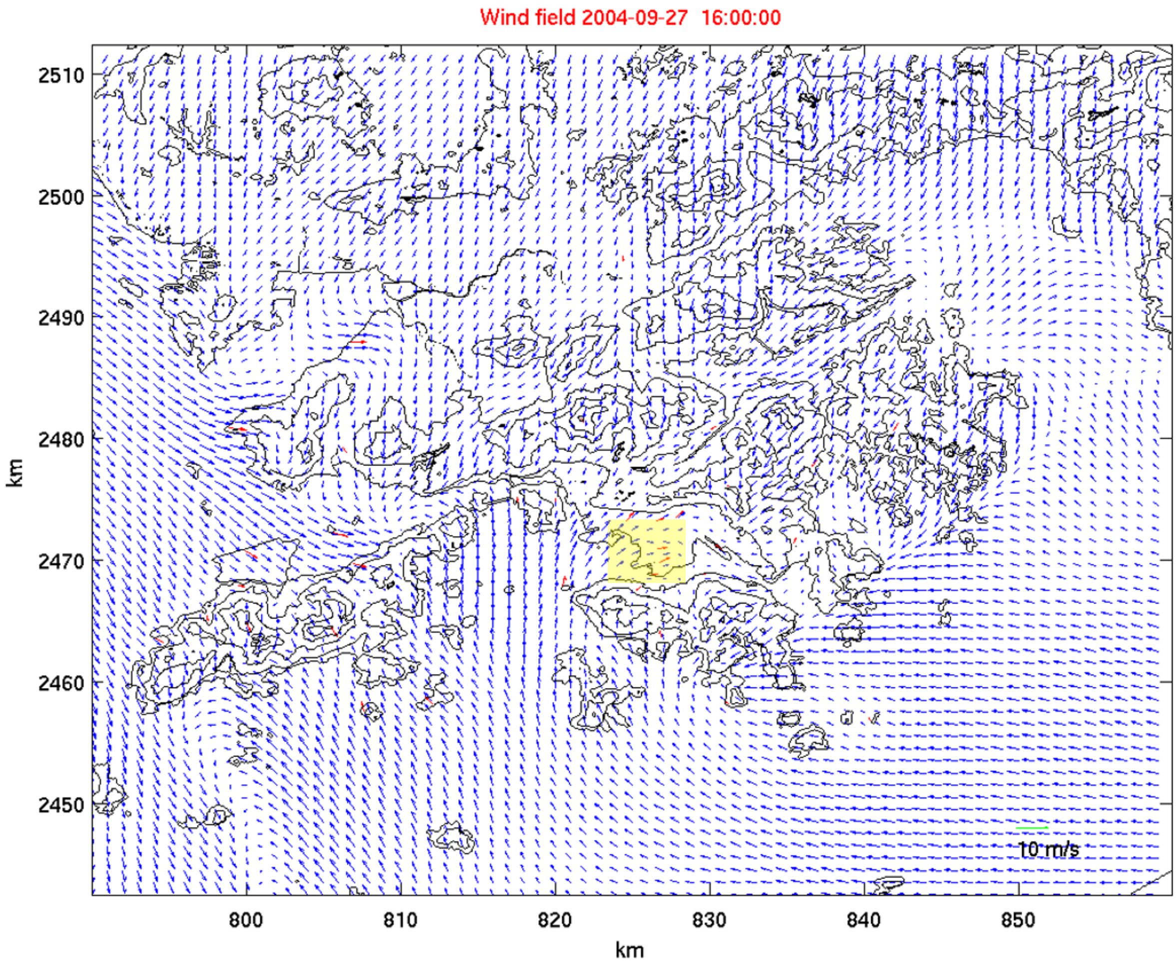


Figure 4.2 Observed winds (red arrows) vs. coupled MM5/CALMET simulated winds with 100m x 100m resolution at 10m above ground, following the contours (area of interest highlighted in yellow).

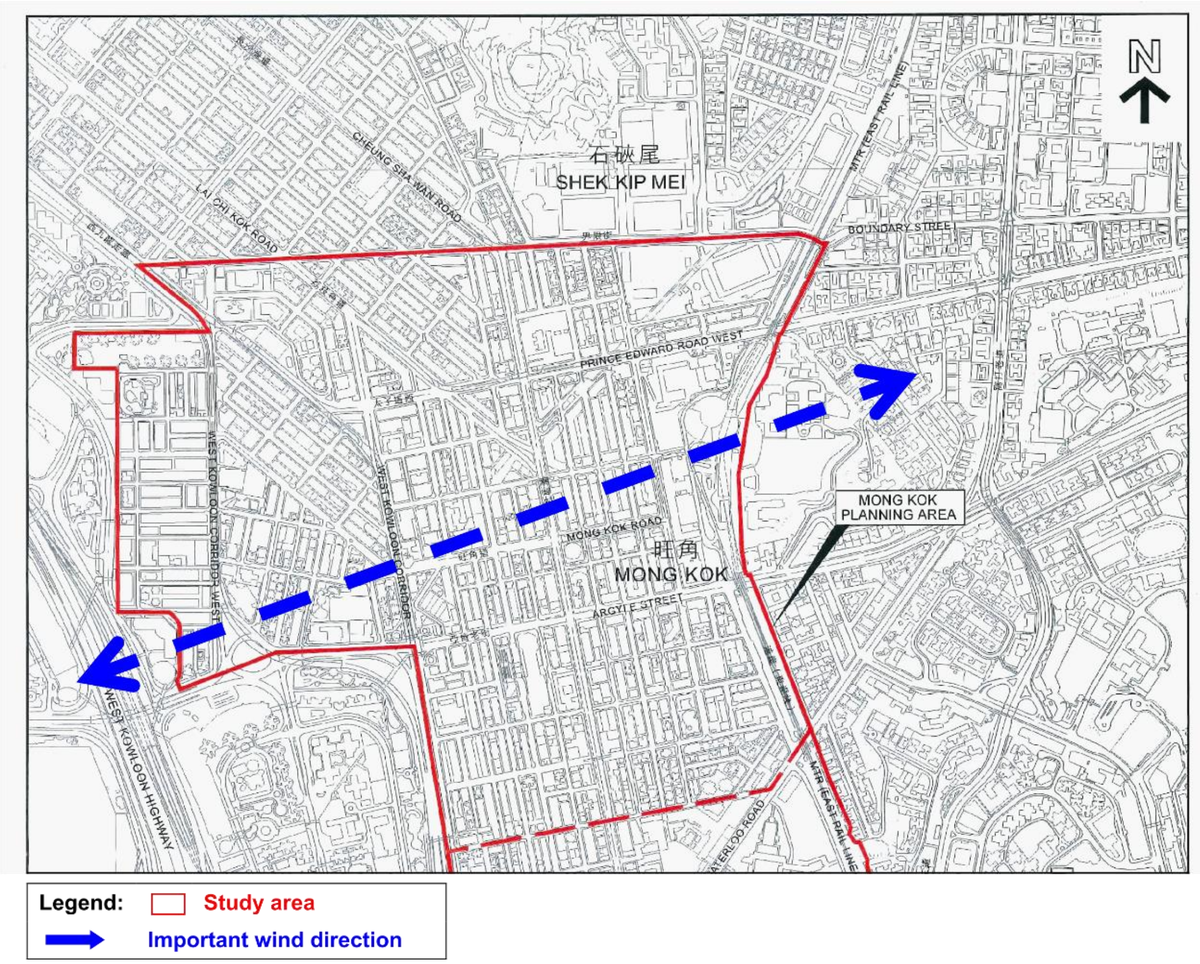


Figure 4.3 A conclusive understanding of the wind environment of the MK Area.

Urban Morphology and Major Ventilation Pathways

4.5 MK area is one of the most densely built-up areas in Hong Kong. There is a mix of ageing tenements and newly developed high-rise buildings. Most of the buildings are for residential use, with commercial developments mainly along Nathan Road. The majority of building lots are small (site areas smaller than 400m^2).

4.6 Open spaces occupy around 6% of the whole MK Area. There is a large piece of open area comprising Mong Kok Stadium and Boundary Street Recreation Ground in the northeastern corner of MK Area. Other open spaces include Anchor Street Playground, Mong Kok Road Playground, Lok Kwan Street Park, Sycamore Playground, Macpherson Playground, Sai Yee Street Garden etc. (Figure 4.4).

4.7 Urban area relies on major roads, open space and low-rise building areas (provided by “Open Space” (“O”) sites and most “Government, Institution or Community” (“G/IC”) sites) to form breezeways and air paths. Roads connecting open spaces and low-rise building areas are important to facilitate air movement within the urban environment. Roads/streets parallel or within 30 degrees from the prevailing wind directions also form effective air paths. With consideration of the immediate surrounding built environment of MK Area and the important wind directions (along ENE-WSW axis), the major breezeways and air paths are identified and shown in Figure 4.4.

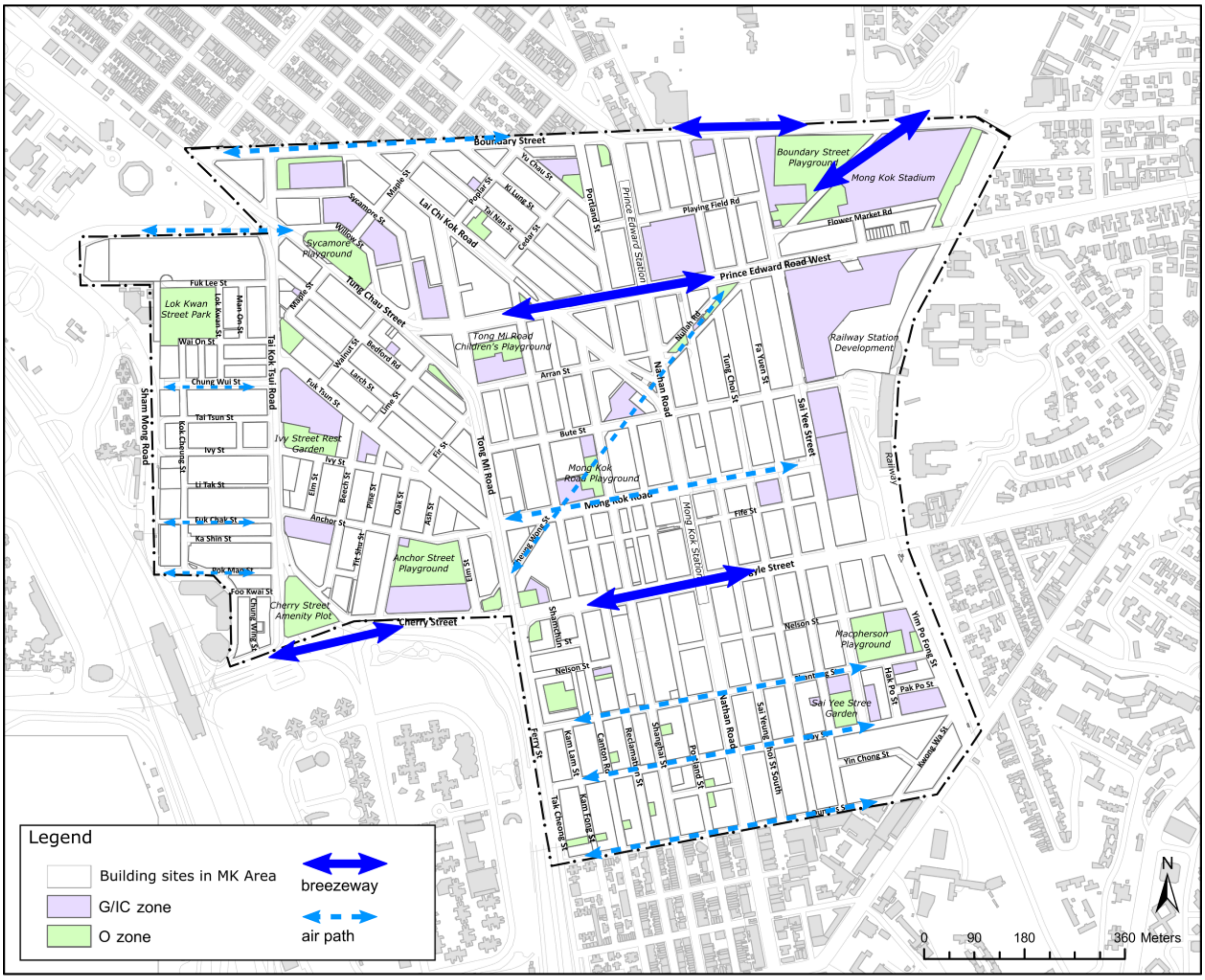


Figure 4.4 Major ventilation pathways identified in MK Area.

4.8 When wind comes from the WSW and W, it enters through the narrow streets in the western part of MK Area. There may be some blockage of air movement by the immediate neighbouring developments to the west of Tai Tsun Street, Ivy Street, and Foo Kwai Street. The diagonal street blocks between Tai Kok Tsui Road and Tong Mi Road also hinder the penetration of air flow into the central part of MK Area. The wider Argyle Street, connecting relatively open areas on the two sides of MK Area, serves as another major pathway for air to flow through MK Area. Other streets with a roughly E-W orientation are also effective in facilitating air movements through MK Area (Figure 4.5).

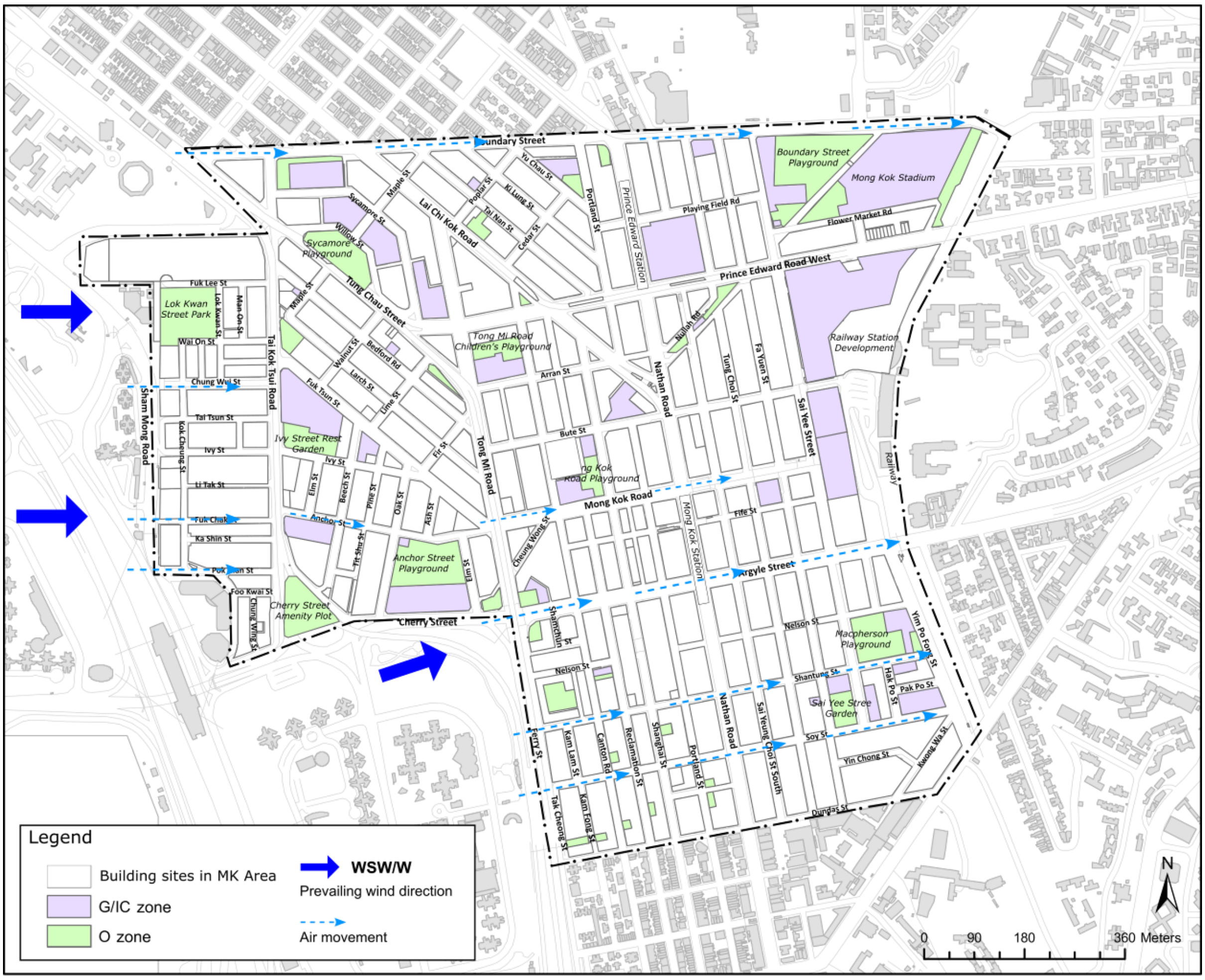


Figure 4.5 Air movement in MK Area when wind comes from the WSW and W.

4.9 When wind comes from the ENE and E, it flows along the streets orientated roughly E-W and without blockage by buildings, including Boundary Street, Prince Edward Road West, Bute Street, Argyle Street, Soy Street, Dundas Street etc.. The air movement may, however, be hindered by the street blocks perpendicular to the ENE and E to the west of Tong Mi Road (Figure 4.6).

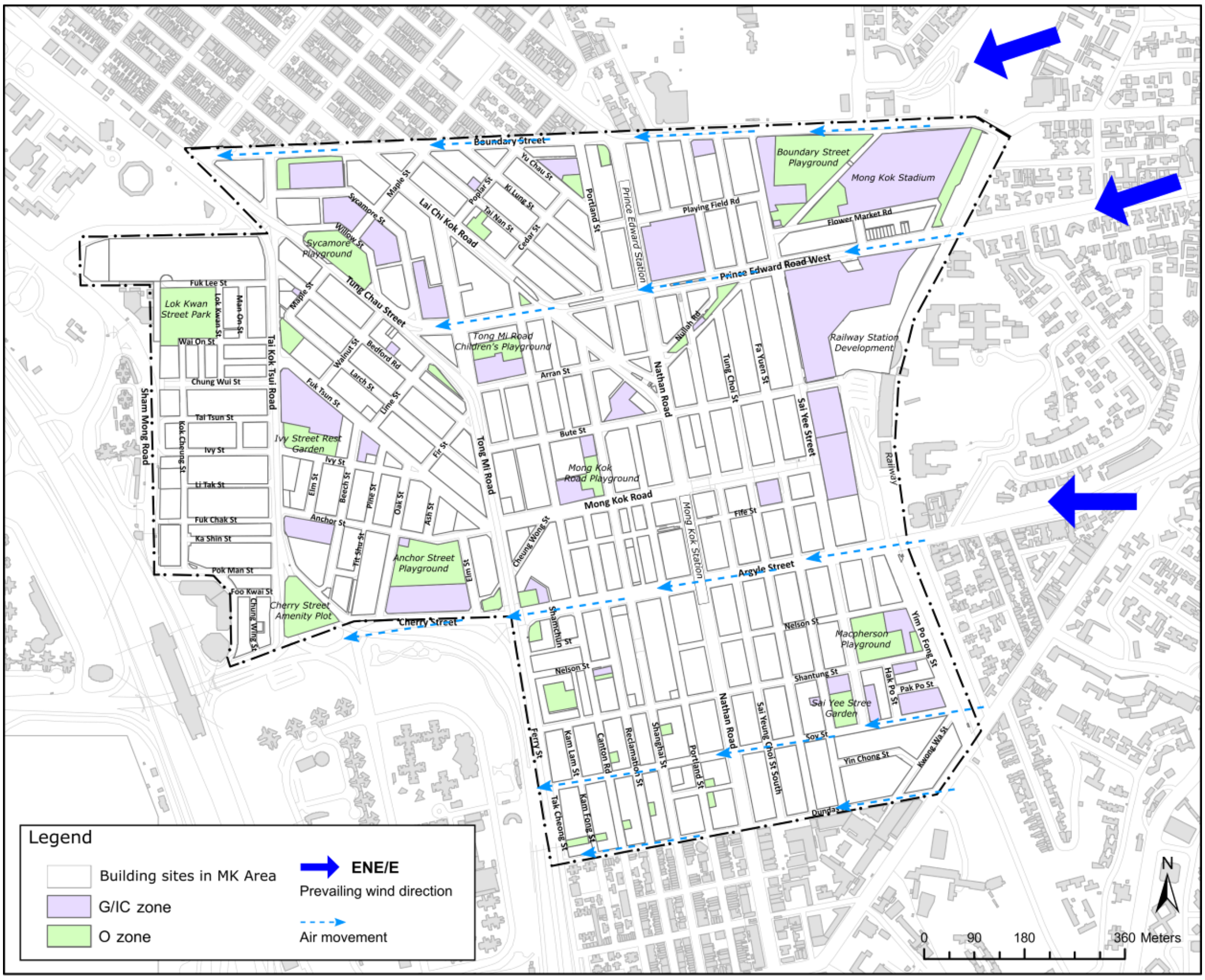


Figure 4.6 Air movement in MK Area when wind comes from the ENE and E.

4.10 When wind comes from the NE and SW, it flows along Nullah Road and Cheung Wong Road, which are parallel to this direction, to penetrate into MK Area. Maple Street is also aligned to the NE-SW orientation. There may be slight air movement from the NE along Maple Street though wind reaching Maple Street is greatly reduced by the densely built-up areas in Sham Shui Po to the immediate north of MK Area. The large piece of open area in the northeastern corner of MK Area plays an important role in allowing the entry of wind from the NE (Figure 4.7).

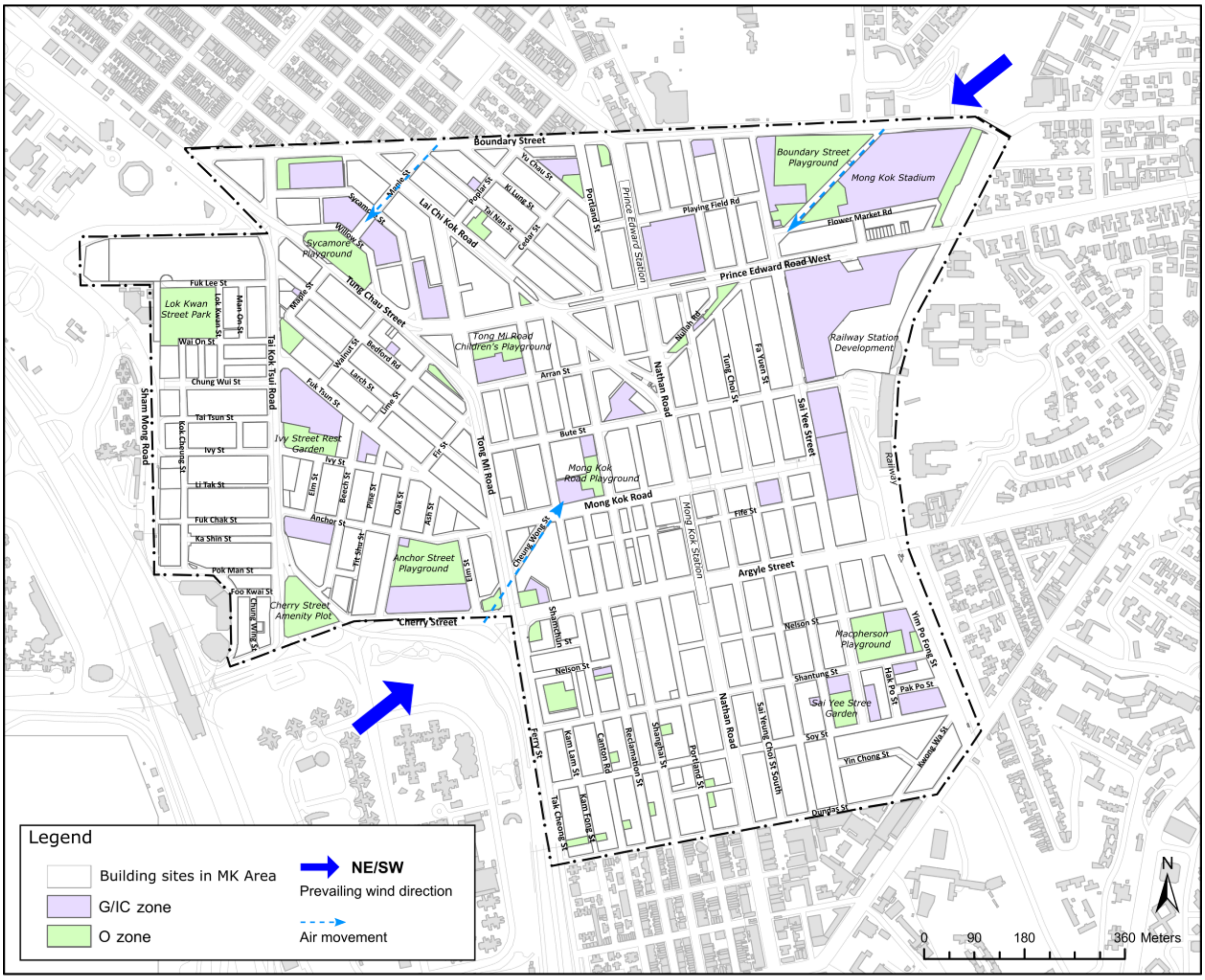


Figure 4.7 Air movement in MK Area when wind comes from the NE and SW.

4.11 Available wind data also show some wind components from the S for MK Area. Although wind flows reaching MK Area from the S are greatly reduced by the densely built-up areas in Yau Ma Tei to the immediate south of MK Area, major roads/streets along the N-S orientation, especially Nathan Road (width of around 30m), provide permeability for air movements by diffusion within MK Area. Air movements along Sham Mong Road, Tai Kok Tsui Road, and Tong Mi Road, as well as along the east rail line are further facilitated by their relatively open upwind areas (Figure 4.8).

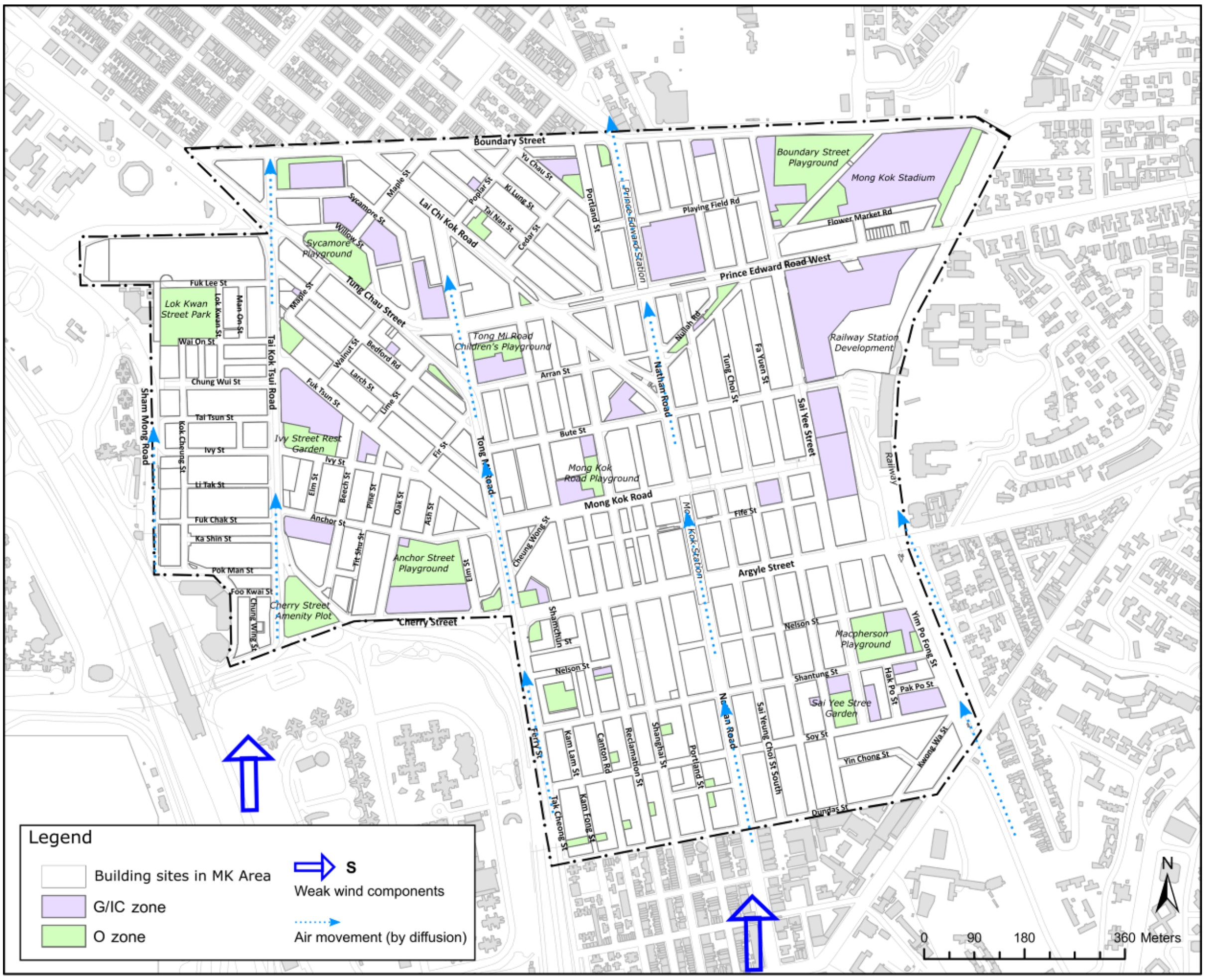


Figure 4.8 Air movement in MK Area when weak wind comes from the S.

5.0 Baseline Scenario

5.1 The Baseline Scenario refers to the scenario under the draft Mong Kok OZP No. S/K3/30 with BHRs, NBAs, BGs, and SBs requirements as imposed on the then draft Mong Kok OZP No. S/K3/28.

General characteristics of MK Area

5.2 MK Area is located on flat grounds in the Kowloon Peninsula. It is subjected to thermally-induced weak air movements caused by the land-sea component at the coastline to the west and southwest of the area. Important wind directions for MK Area fall along the ENE-WSW axis, with minor annual and summer wind components from the north and southerly quarters. The wind environment of MK Area is detailed in Sections 3 and 4.

5.3 MK Area has a largely regular street grid with major roads/streets oriented roughly north-south (e.g. Sai Yee Street, Nathan Road, Tong Mi Road, Tai Kok Tsui Road) and east-west (e.g. Boundary Street, Prince Edward Road West, Mong Kok Road, Argyle Street). These roads/streets are roughly perpendicular and parallel to the important wind directions (along the ENE-WSW axis), respectively. Nullah Road and Cheung Wong Road cut through MK Area diagonally from NE to SW. There are also a few other diagonal roads/streets (e.g. Fuk Tsun Street, Tung Chau Street, Lai Chi Kok Road) oriented roughly NW-SE in the northwestern part of MK Area.

5.4 When wind comes from the E, ENE, W, WSW, roads/streets parallel or within 30 degrees from these directions (i.e. the roads/streets oriented roughly east-west) can serve as effective air paths in MK Area. When wind comes from the NE and SW, Nullah Road and Cheung Wong Street form the only potential air path for wind to flow through MK Area. When wind comes from the N and S, wind flows reaching MK Area are greatly reduced by the densely built-up areas in Sham Shui Po/Shek Kip Mei and Yau Ma Tei to the immediate north and south of MK Area, respectively.

5.5 MK Area is one of the most densely built-up areas in Hong Kong. It is characterised by high H/W ratios, high building frontage and narrow streets. It is currently dominated by residential sites with areas smaller than $400m^2$. Most commercial sites are located along Nathan Road. A large piece of open space comprising Mong Kok Stadium and Boundary Street Recreation Ground is located at the northeastern corner of MK Area. There are also some other isolated “G/IC” and “O” sites within MK Area.

5.6 In recent years, based on the available information provided by the Government, at least half of the newly approved building plans in the past 5 years have site areas larger than $400m^2$.

Building Height Restrictions

5.7 Existing BHRs are as shown in Figure 5.1. According to the information provided by PlanD, although the development restrictions including BHRs for all “C”, “R(A)”, “R(E)”, “OU”, “Comprehensive Development Area (1)” (“CDA(1)”) and “G/IC” zones on the OZP have been reviewed, revised BHRs are only proposed for the “C”, “C(1)”, “OU(B)”, “OU(B)1”, “R(A)”, “R(A)3”, “R(A)4”, “R(E)”, and “R(E)1” zones in MK Area. Moreover, the Sai Yee Street Redevelopment Site (in white) will be evaluated separately as a focus area (see Section 7).

5.8 For “C(2)”, “C(3)”, “R(A)1”, “R(A)2”, “CDA(1)” and “G/IC” zones as well as “OU” zones except “OU(B)” and “OU(B)1” zones, upon completion of the review of development restriction, it is recommended that their BH will remain unchanged. In addition, areas zoned “Open Space” (“O”) which aims to provide spatial and visual relief amidst the densely built environment are not the subject of the current review of development restrictions. These sites are indicated in grey in Figure 5.1.

5.9 All “R(A)”, “R(A)4”, and “R(E)” sites in MK Area have a two tier BHR of 80/100mPD (100mPD is allowed for site with an area larger than 400m^2).

5.10 “C” sites on the two sides of Nathan Road generally have a BHR of 100mPD, except for seven street blocks between Argyle Street and Mong Kok Road as well as those between Boundary Street and Prince Edward Road West, where a BHR of 120mPD is imposed for creating downwash effect onto pedestrian areas.

5.11 The four “OU(B)” sites abutting Maple Street and Walnut Street have a BHR of 80mPD, while the other “OU(B)” sites (two abutting Tong Mi Road and Mong Kok Road, and one at the junction of Tai Kok Tsui Road and Ivy Street) have a BHR of 100mPD.

5.12 Sites sandwiched between Sham Mong Road and Kok Cheung Street (including a mix of “R(A)3”, “R(E)1” and “OU(B)1” sites) and sites sandwiched between Flower Market Road and Prince Edward Road West (zoned as “R(A)3”) have a two tier BHR of 60/80mPD (80mPD is allowed for site with an area larger than 400m^2). A “C(1)” site at the junction of Tai Kok Tsui Road and Cherry Street is specified to have a BHR of 60mPD.

5.13 The “G/IC” and “O” sites with varied BHRs aim to provide spatial and visual relief amidst the densely built environment and/or to reflect the BH of the existing buildings. These sites, together with the “C(2)”, “C(3)”, “R(A)1”, “R(A)2” and “CDA(1)” zones as well as “OU” zones except “OU(B)” and “OU(B)1” zones, are coloured in grey on Figure 5.1 as their BHRs will remain unchanged.

Non-building areas, Building Gaps, and Building Setbacks

5.14 NBAs, BGs, and SB requirements specified in the Baseline Scenario of MK Area are summarised in Figure 5.1.

5.15 A NBA of 13m wide aligned with Li Tak Street is located between the two existing buildings abutting Kok Cheung Street to allow the entry of westerly winds. No structure is allowed from ground level.

5.16 BGs are defined within the "OU(B)1" site abutting Kok Cheung Street aligned with Ka Shin Street (20mPD), at the junction of Sycamore Street and Tai Kok Tsui Road (20mPD), within the Sai Yee Street Redevelopment Site aligned with Mong Kok Road (23mPD), and located diagonally aligned with Nullah Road and Cheung Wong Street (20mPD).

5.17 SB requirements are imposed for buildings along Portland Street and Sai Yeung Choi Street South, as well as for three "OU(B)" sites on the two sides of Maple Street between Tung Chau Street and Larch Street. A minimum SB of 3m from the lot boundary above 15m measured from mean street level is required for tower developments at these sites.

5.18 The potential impacts on air ventilation of the above BHRs, NBAs, BGs, and SB requirements have been evaluated in the previous EE on AVA for Mong Kok Area[1]. This forms the Baseline Scenario of the current AVA EE. In subsequent sections, the Initial Scenario will be compared and evaluated against this Baseline Scenario.

[1] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG52_AVA_FinalReport.pdf

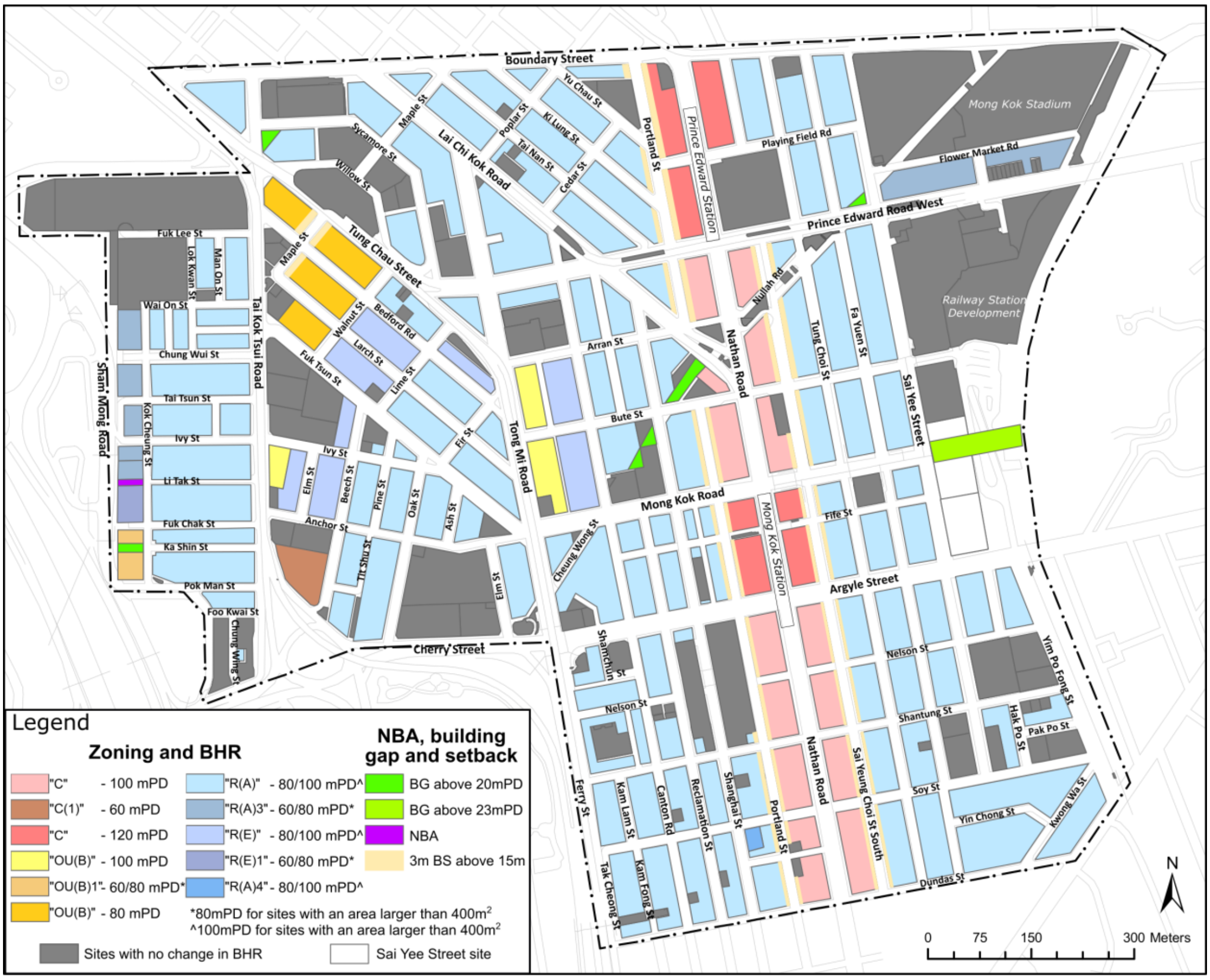


Figure 5.1 BHRs, NBAs, BGs and SB requirements of the Baseline Scenario for MK Area.

6.0 Expert Evaluation of the Initial Scenario

6.1 To follow up on the court judgments, PlanD has reviewed the development restrictions (including relevant BHRs and other ventilation measures such as NBAs and BGs) on the current OZP and come up with the Initial Scenario.

6.2 Compared to the Baseline Scenario (described in Section 5), the following aspects of the Initial Scenario are expertly assessed in this AVA EE:

- Changes in BHRs for different zonings to increase the design flexibility in building developments;
- The requirements on NBAs, BGs and SBs;
- The potential for the implementation of key building design elements (in particular, building separation and SB) set out in the Sustainable Building Design Guidelines (SBDG)[1].

Key Characteristics of the Initial Scenario

6.3 For residential sites (“R(A)”, “R(A)3”, “R(A)4”, “R(E)”, “R(E)1” zones), the BHR is proposed to be increased to 100mPD for all sites, based on the modern building design standard for composite development (which assumes 20% GFA concession, 4m podium floor height and 3m typical floor height), and to allow for the implementation of the SBDG. Sharing the same development restriction, PlanD also proposed to rezone the “R(A)3” and “R(E)1” zones into “R(A)” and “R(E)” zone. Moreover, subsequent to the above, PlanD also proposes to rezone the “R(A)4” zone to “R(A)3” zone.

6.4 For “C”, “C(1)”, “OU(B)”, and OU(B)1” sites, the BHR is proposed to be increased to 110mPD in general, based on the modern building design standard for commercial development (which assumes 25% GFA concession, 5m podium floor height and 4m typical floor height), the requirement for the provision of refugee floor, and to allow for the implementation of the SBDG. For the seven street blocks between Argyle Street and Mong Kok Road as well as those between Boundary Street and Prince Edward Road West on both sides of Nathan Road with an original BHR of 120mPD, the BHR is proposed to be increased to 130mPD. Sharing the same development restriction, PlanD also proposed to rezone the “OU(B)1” zone to “OU(B)” zone.

6.5 Figure 6.1 shows the proposed BHRs in the Initial Scenario. There is no change in BHRs for the sites in grey.

6.6 The Initial Scenario maintains the NBAs, BGs and SB requirements (see Figure 5.1) defined in the Baseline Scenario.

[1] Hong Kong Buildings Department. (2016). Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers: Sustainable Building Design Guidelines (APP-152).

6.7 A redevelopment of the government site at Sai Yee Street is proposed. The maximum BH will be 320mPD. A quantitative Air Ventilation Assessment has been conducted. This site will be evaluated as a focus area in this AVA EE (see Section 7).

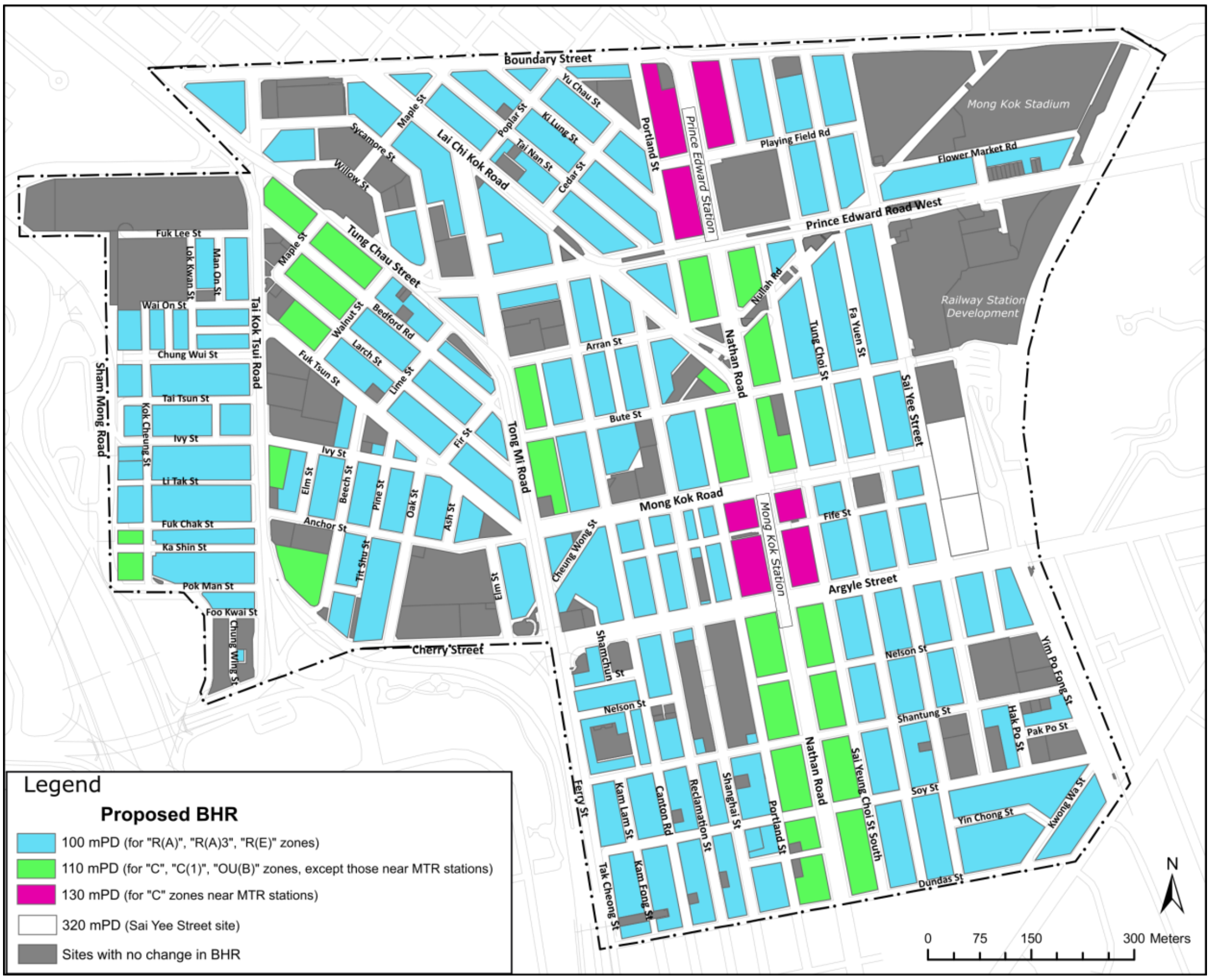


Figure 6.1 Initial Scenario with proposed building height restrictions for MK Area.

Analysis of Building Frontage

6.8 On the whole, the proposed BHRs in the Initial Scenario of MK Area are taller than the heights of the existing majority of buildings as well as the baseline BHRs. The proposed BHs for "C" and "OU(B)" sites are generally increased by 10m (with a few sites increased by 30-50m), while the proposed BHs for residential sites are increased by 0-20m (with a few sites increased by 40m). In general, taller buildings increase surface roughness, and thus reduce wind flow over the urban canopy. A scientific understanding of building heights for city planning can be found in Appendix B.

6.9 To facilitate the evaluation of the difference in potential impact on air ventilation between the Baseline and Initial Scenarios, the concept of building frontage (BF) needs to be introduced.

6.10 BF can be understood as the vertical surface area of a building façade as a percentage of the maximum possible surface area of that building façade (i.e. full façade length fronting a street x tallest BHR). It is dependent on the height, ground coverage, and permeability of a building façade. A graphical description of BF can be found in Appendix C (Figure C-1). Reducing BF effectively reduces the bulkiness of buildings and improves wind penetration within the city. It is a simplified representation of the frontal area density, which is widely used by researchers in urban canopy communities to help quantify drag effect caused by the built environment[1]. Therefore, the difference in BF between the Baseline and Initial Scenarios can serve as a good estimation of the difference in their potential impacts on air ventilation within MK Area.

6.11 The change in BF between the Baseline and Initial Scenarios is calculated for the major façade (i.e. the longest side fronting a street) of each OZP zone in MK Area. Detailed results can be found in Appendix C (Table C-1).

6.12 As residential sites ("R(A)", "R(A)3", "R(A)4", "R(E)", "R(E)1" zones) and the "OU(B)1" site have a two-tier BHR (60/80 mPD or 80/100 mPD based on site area) in the Baseline Scenario, assumptions are made for the proportion of sites with areas larger than 400m^2. According to Government information, at least half (in terms of number of sites) of the newly approved building plans in the past 5 years have site areas larger than 400m^2. Based on this information, it can be assumed that the proportion of sites with areas larger than 400m^2 is likely greater than 50% in terms of site area. Therefore, the analysis on BF has been carried out for three cases, where 50%, 75%, and 100% (in terms of area) of the residential and "OU(B)1" sites are assumed to have site areas larger than 400m^2, and thus are allowed the taller of the two BHRs.

6.13 There is generally an increase in BF in the Initial Scenario compared to the Baseline Scenario. The average increase in BF for the whole MK Area is shown in Table 2.

Table 2 Average increase in building frontage (BF) in the Initial Scenario compared to the Baseline Scenario for the three cases, where 50% (Case 1), 75% (Case 2), and 100% (Case 3) (in terms of area) of the residential and "OU(B)1" sites are assumed to have site areas larger than 400m^2.

Case 1 (50% large sites)	Case 2 (75% large sites)	Case 3 (100% large sites)
11.6%	7.5%	3.4%

6.14 Note that Case 1 (50% large sites, in terms of area) is a very conservative assumption regarding the proportion of sites with areas larger than 400m^2 upon redevelopment of MK Area. Therefore, the average increase in BF in the Initial

[1] Ng, E., Yuan, C., Chen, L., Ren, C., Fung J.C.H. "Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: a study in Hong Kong." Landscape and Urban Planning 101.1 (2011): 59-74.

Scenario compared to the Baseline Scenario for the whole MK Area is very likely to be less than 11.6%.

6.15 The slight average increase in BF for the whole MK Area (between 3.4% and 11.6%) in the Initial Scenario is unlikely to have any statistically significant difference[1] in air ventilation impacts when compared to the Baseline Scenario.

Review of Non-building Areas, Building Gaps, and Building Setbacks

6.16 NBAs, BGs, and SB requirements have been defined in the Baseline Scenario (see Figure 5.1). They are reviewed with respect to the prevailing wind directions to evaluate their roles under the Initial Scenario.

6.17 As discussed in Sections 3 (summarised in Table 1) and 4, the most important wind for MK Area lies on the ENE-WSW axis. Annual prevailing wind are mainly from the E and NE, while summer prevailing winds are from the E, SW, and the southerly quarters. However, effects of wind from the N and S are dominated by the densely built-up neighbourhood of MK Area and very little wind can reach MK Area from these directions.

6.18 Major ventilation pathways in MK Area have been identified in Sections 4.5 to 4.11. While there are air movements along most of the streets oriented roughly E-W and N-S under different wind conditions, the NW-SE diagonal street blocks bounded by Fuk Tsun Street and Yu Chau Street do not receive much air movements and are relatively stagnant areas, as similarly identified during the previous AVA study of the MK Area in 2010[2].

6.19 When wind comes from the WSW and W, it is important to allow the entry and penetration of sea breeze through the westernmost street blocks and into MK Area. Unobstructed streets parallel to the wind directions are effective in facilitating momentum-drive air movements through MK Area. The NBA aligned with Li Tak Street and BG above 20mPD aligned with Ka Shin Street prevent wind blockage by upwind building blocks and allow sea breeze entry (Figure 6.2). The BG aligned with Ka Shin Street also serves to compensate for the significant increase in BHR at the "OU(B)" site sandwiched between Sham Mong Road and Kok Cheung Street by providing building permeability in the middle zone. More discussion regarding this BG can be found in Section 7 as part of the sites sandwiched between Sham Mong Road and Kok Cheung Street, which is one of the focus areas.

6.20 When wind comes from the WSW and W, the BG above 20mPD at the junction of Sycamore Street and Tai Kok Tsui Road is also important as it welcomes air flow from Tung Chau Street Park into the relatively stagnant areas with street

[1] Ng, E., Yuan, C., Chen, L., Ren, C., Fung J.C.H. "Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: a study in Hong Kong." Landscape and Urban Planning 101.1 (2011): 59-74.
[2] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG52_AVA_FinalReport.pdf

blocks oriented NW-SE. It prevents the creation of a bottleneck that would restrict the air flow from the west into Sycamore Street.

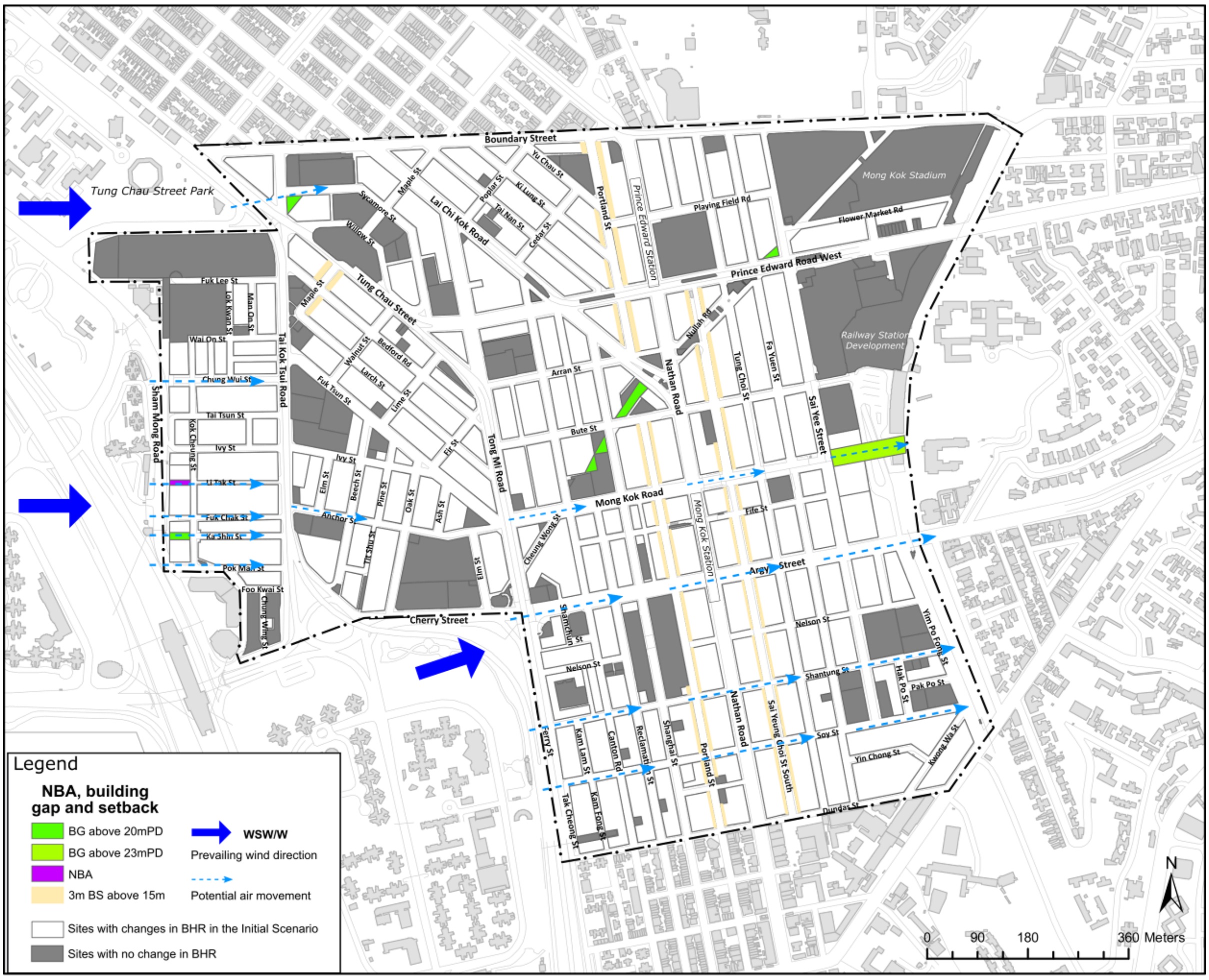


Figure 6.2 Potential air movement in MK Area under the Initial Scenario when wind comes from the WSW and W.

6.21 Wind from the WSW and W flows perpendicular to the N-S street canyons in the central part of MK Area. Deep street canyons create skimming flows over the top of buildings and cause stagnant conditions at pedestrian level (see Figure A-2 in Appendix A). With a height difference between buildings along Portland Street (BHR of 100mPD) and Nathan Road (BHR of 110mPD or 130mPD), there could be downwashes (see Figure A-3 in Appendix A). SB of 3m on each side of Portland Street reduces the H/W ratio from 6:1 to 4.5:1. Although this is still far from the ideal H/W ratio of 2:1 for pedestrian level wind environment, this may slightly improve the ventilation along Portland Street.

6.22 The SB of 3m on each side of Portland Street can also aid the lateral flow induced by corner eddies (see Figure A-4 in Appendix A) to enter into the street canyon above 15m. For long street canyons, air ventilation effects by corner vortices fade with increasing length-to-width (L/W) ratios of streets[1]. Due to the tall height of buildings along Portland Street, the downwashes mentioned in 6.21 are likely to be weak. Therefore, lateral flow induced by horizontal vortices at lower levels become important for the penetration of air movement into the N-S street canyons.

6.23 When wind comes from the ENE and E, open areas (e.g. Mong Kok Stadium) and streets parallel to the wind directions in the easternmost part of MK Area facilitate wind flow into MK Area. The BG above 23mPD at the Sai Yee Street site aligned with Mong Kok Road links up open space in Kadoorie Hill and Mong Kok Road, which is a major road in MK Area. It is important for facilitating unobstructed wind flow from the east into MK Area (Figure 6.3).

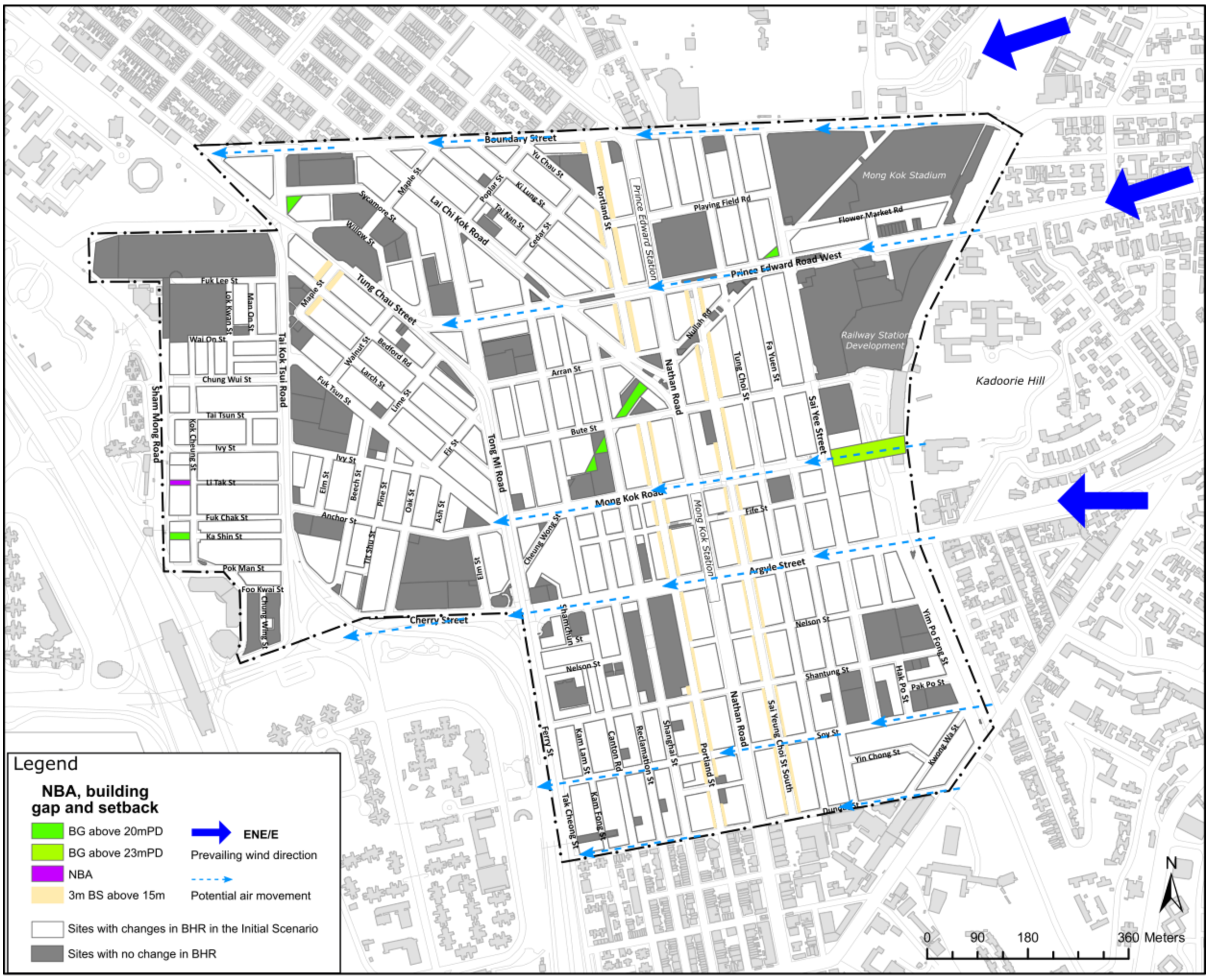


Figure 6.3 Potential air movement in MK Area under the Initial Scenario when wind comes from the ENE and E.

6.24 Wind from the ENE and E flows perpendicular to the N-S street canyons in the central part of MK Area. Similar to the discussion in Section 6.21, the height difference between buildings along Sai Yeung Choi Street South (BHR of 100mPD)

[1] Theurer, W. Typical building arrangements for urban air pollution modelling. Atmospheric Environment 33.24-25 (1999): 4057-4066.

and Nathan Road (BHR of 110mPD or 130mPD) could help create downwashes (see Figure A-3 in Appendix A). SB of 3m on each side of Sai Yeung Choi Street South reduces the H/W ratio from 5:1 to 4:1. Although this is still far from the ideal H/W ratio of 2:1 for pedestrian level wind environment, this could slightly improve the ventilation along Sai Yeung Choi Street South.

6.25 Similar to the discussion in Section 6.22, the SB of 3m on each side of Sai Yeung Choi Street South also aid the lateral flow induced by corner eddies (see Figure A-4 in Appendix A) to enter into the street canyon above 15m. Due to the tall height of buildings along Sai Yeung Choi Street South, the downwashes mentioned in 6.24 are likely to be weak. Therefore, lateral flow induced by horizontal vortices at lower levels become important for the penetration of air movement into the N-S street canyons.

6.26 When wind comes from the NE and SW, Nullah Road and Cheung Wong Street are parallel to this direction and together they form the only potential air path for wind to flow through MK Area. The BGs located diagonally from Mong Kok Road to Flower Market Road help connect the relatively open areas in the northeastern corner of MK Area (comprising Mong Kok Stadium and Boundary Street Recreation Ground) and Nullah Road and Cheung Wong Street. As a result, wind could be able to enter from the NE and SW and flow through MK Area (Figure 6.4). This also complements the existing NE-SW air path between Cherry Street and Boundary Street.

6.27 When wind comes from the NE and SW, the SB requirement along Maple Street also enhances air movement parallel to this direction. Air flow is more able to cross Sycamore Playground and reach the relatively stagnant areas with street blocks oriented NW-SE. Although the diagonal street blocks hinder wind flow from the prevailing directions, any increase in urban permeability can facilitate air movement by diffusion within the urban canyon.

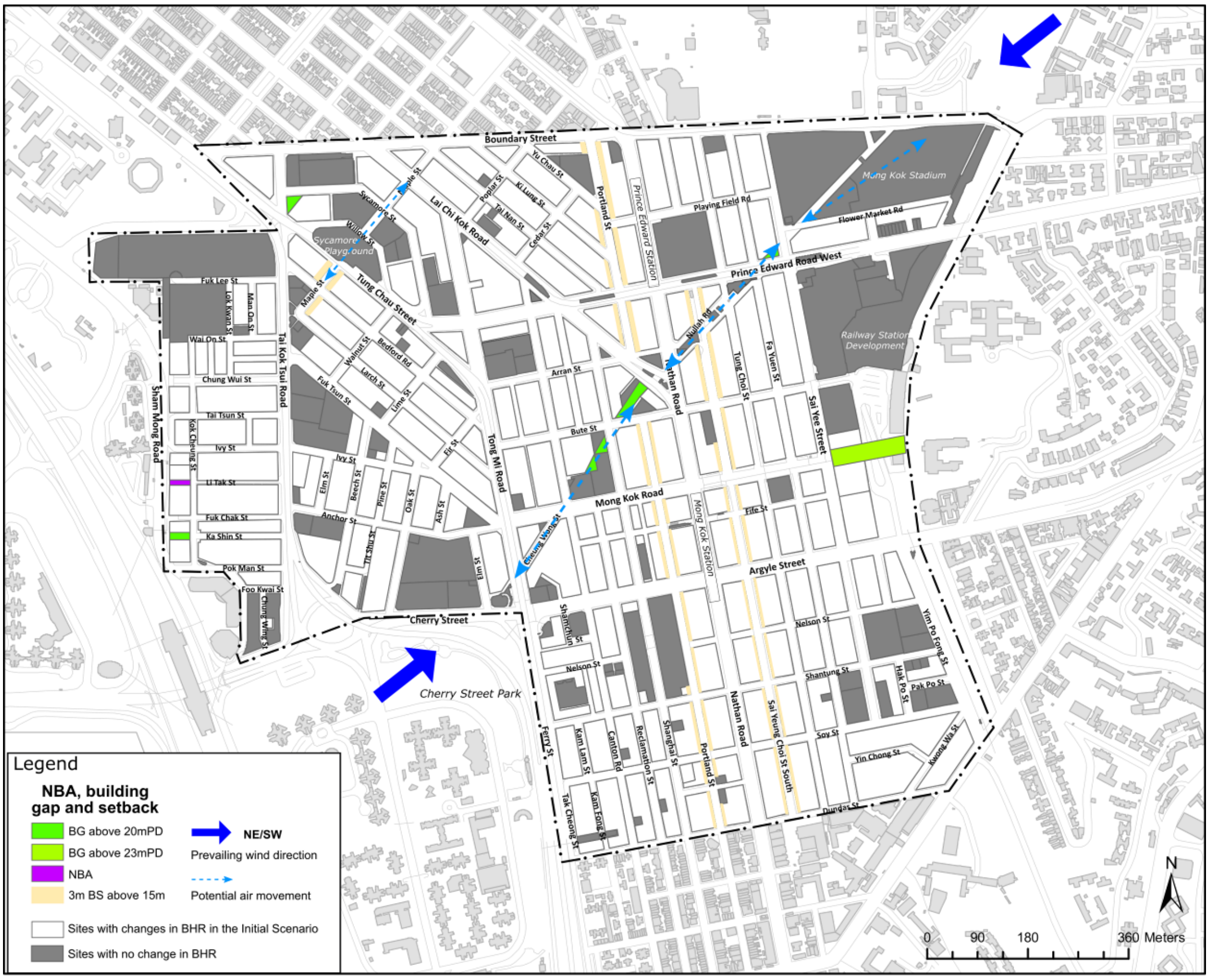


Figure 6.4 Potential air movement in MK Area under the Initial Scenario when wind comes from the NE and SW.

6.28 Available wind data also show some wind components from the S for MK Area. Although wind flows reaching MK Area from the S are greatly reduced by the densely built-up areas in Yau Ma Tei to the immediate south of MK Area, major roads/streets along the N-S orientation provide permeability for air movements by diffusion within MK Area. The 3m SB requirements along Portland Street and Sai Yeung Choi Street South further increases urban permeability for air movements within the street canyons of MK Area (Figure 6.5).

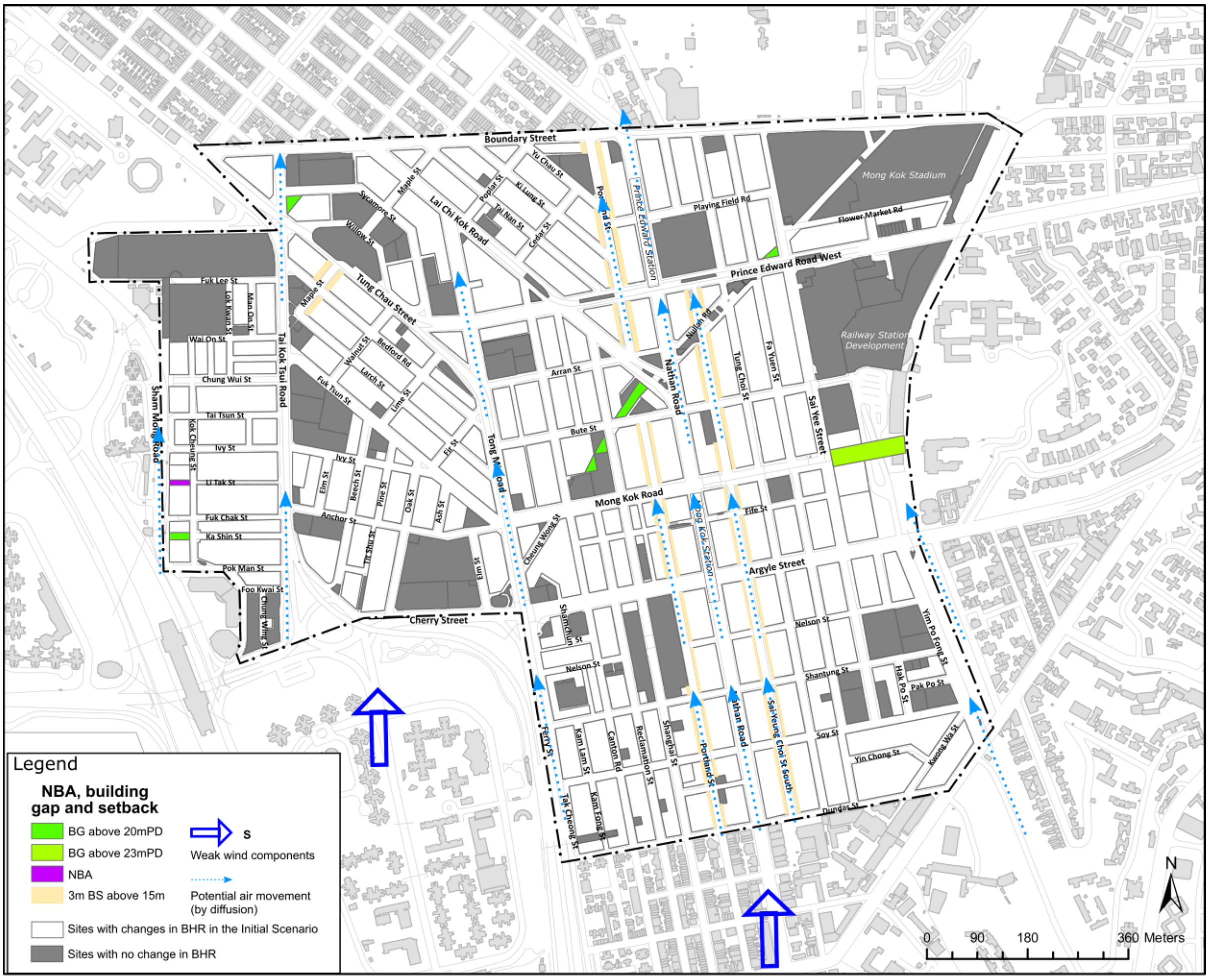


Figure 6.5 Potential air movement in MK Area under the Initial Scenario when weak wind comes from the S.

6.29 In summary, the NBAs, BGs, and SB requirements are all good features for air ventilation in MK Area and are therefore necessary to be maintained in the Initial Scenario.

Implementation of the Sustainable Building Design Guidelines

6.30 The SBDG[1] aims to enhance the quality and sustainability of the built environment in Hong Kong by granting GFA concessions for new building developments that comply with the SBDG. It establishes three key building design elements, namely building separation, SB, and site coverage of greenery, to achieve better air ventilation, mitigate the heat island effect, and enhance the environmental quality of our living space.

6.31 The proposed changes in BHRs in the Initial Scenario increase design flexibility in building developments and allow for the implementation of the SBDG (in

[1] Hong Kong Buildings Department. (2016). Practice Note for Authorised Persons, Registered Structural Engineers and Registered Geotechnical Engineers: Sustainable Building Design Guidelines (APP-152).

particular, the building separation and SB requirements) to improve air ventilation at pedestrian level.

6.32 SB benefits the pedestrian wind environment by widening streets to prevent the development of deep street canyons (see Figure A-5 in Appendix A). According to the SBDG, buildings fronting a street less than 15m wide should be set back so that no part of the building up to a level of 15m above the street level should be within 7.5m from the centreline of the street. Building lots that need to comply with the SB requirement are marked in Figure 6.6. The potential improvement on air ventilation caused by sites adopting SB can be quite significant for those streets which are currently less than 15m wide.

Figure 6.6 Building sites fronting narrow streets < 15m wide which should adopt SB as required by the SBDG in MK Area.

6.33 Building separation increases permeability within the urban built environment to mitigate heat island effects arising from the undesirable screening effect of long buildings. Incorporating building porosity into building design promotes air movements amongst developments and enhances the diffusion and mixing of air (see Figure A-6 in Appendix A). Permeability in the low zone is particularly important for improving air ventilation at pedestrian level[1].

6.34 According to the SBDG, building sites that are (a) 20,000m^2 or above, or (b) less than 20,000m^2 and proposed with buildings having a continuous projected façade length (L_p) of 60m or above, should comply with the building separation requirements (see Figure A-7 in Appendix A). The maximum permissible L_p for such building sites should not exceed five times the mean width of street canyon (U) (see Figure A-8 in Appendix A). A minimum permeability (P) of 20% is required for each plane in each assessment zone (see Figure A-9 in Appendix A).

6.35 As discussed in Section 5.5, most existing building sites in MK Area are smaller than 400m^2. There are currently no building lots in MK Area exceeding 20,000m^2. For sites less than 20,000m^2, only 34 individual building lots have L_p of 60m or above. Assuming there is to be no site amalgamation upon redevelopment of MK Area, Figure 6.7 shows the building lots that are required to comply with the building separation requirement of the SBDG.

6.36 When there is no site amalgamation, the sites that are required to comply with the building separation requirement of the SBDG are very few and isolated. The potential benefits on air ventilation are expected to be very minor and localised (mainly in the western part of MK Area).

6.37 As discussed in Section 5.6, at least half of the newly approved building plans in the past 5 years have site areas larger than 400m^2.

6.38 There is an increasing potential for the implementation of building separation of the SBDG when sites amalgamate. If all sites in MK Area amalgamate within the same street block, nearly all amalgamated building sites (except the row of sites west of Kok Cheung Street, the row of sites south of Mong Kok Road, and a few other smaller sites) are required to comply with the building separation requirement of the SBDG. In this case, although the proposed BHRs in the Initial Scenario are taller, the pedestrian level wind environment may be improved by the potential benefits brought by building permeability, especially at the low zone.

[1] Yuan, C. and Ng, E. "Building porosity for better urban ventilation in high-density cities–A computational parametric study." Building and Environment 50 (2012): 176-189.

Figure 6.7 Existing building lots with ≥ 60m which should adopt building separation as required by the SBDG in MK Area.

7.0 Focus Study Areas

7.1 The three focus study areas are namely the Sai Yee Street site (Figure 7.1), the row of sites west of Kok Cheung Street, and sites near the Flower Market area (Figure 7.2).

Sai Yee Street Redevelopment Site

7.2 Figure 7.1 shows the Recommended Development Scheme (RDS) for the planned redevelopment of the government sites at Sai Yee Street. With reference to the separate AVA Initial Study conducted for this particular site, its potential impacts on air ventilation in MK Area under the Initial Scenario is evaluated.

7.3 Three towers sit above a podium of 23mPD at the Sai Yee Street site. The height profile is provided by a tall tower of 320mPD in the central part and lower building heights (~40mPD) in the northern and southern parts. A BG with a width of around 30m above 23mPD aligned with Mong Kok Road has been stipulated. Another building separation of around 20m above the podium aligned with Fife Street is proposed in the RDS.

7.4 The tall and slender tower in the central part of Sai Yee Street site is expected to improve the local air ventilation around the footprint of the high-rise building by two ways. First, the large façade area of the tall tower can induce a downwash effect to ventilate the pedestrian level. Secondly, the wind can be captured by the tall tower and spiral down at the downwind side of the tower onto the pedestrian level. The downward air flows are subsequently redistributed along the BGs on the two side of the tall tower and into the urban canyons in MK Area. The potential local benefits are confirmed by simulation results in the AVA Initial Study.

7.5 However, air flow reaching areas further downwind of the Sai Yee Street site may be weakened due to the tall tower development, and thus an increase in overall surface roughness. Since there is only one tall tower development amongst other buildings of around 100mPD, its effect on the overall air ventilation performance in MK Area is not expected to be significant. Simulation results in the AVA Initial Study show similar ventilation performance between the RDS and existing scheme.

7.6 When wind comes from the E, the two BGs to the immediate north and south of the tall tower allow the entry and penetration of wind flow from the open space in Kadoorie Hill into MK Area along Mong Kok Road and Fife Street. They allow unobstructed air movement parallel to the prevailing wind directions and are good air ventilation features.

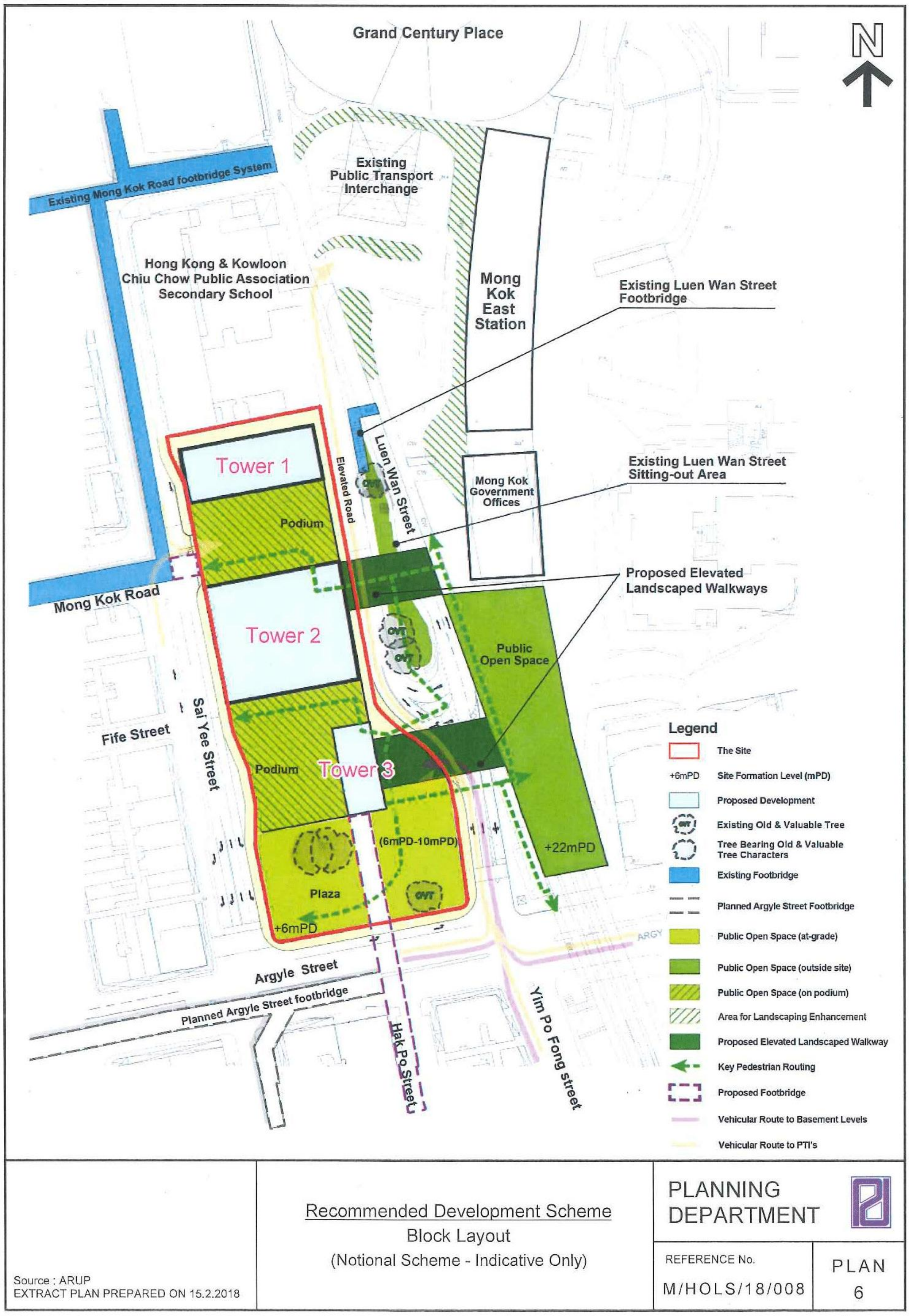


Figure 7.1 Recommended development scheme at the Sai Yee Street site.

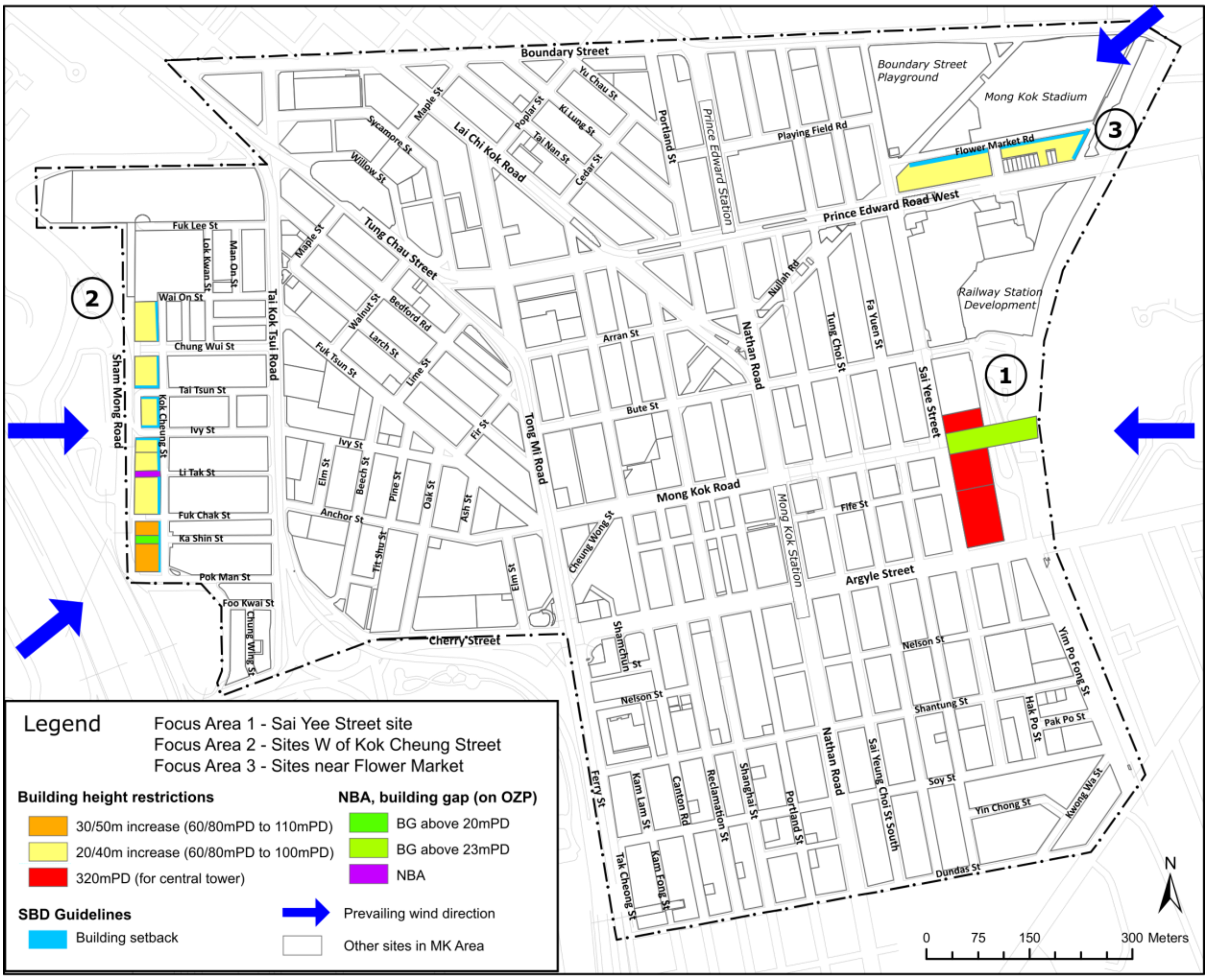


Figure 7.2 Focus study areas in MK Area and their BHRs, NBAs and BGs, and SBs as required by the SBDG.

Sites Sandwiched between Sham Mong Road and Kok Cheung Street

7.7 Sites sandwiched between Sham Mong Road and Kok Cheung Street form the westernmost row of buildings in MK Area and are the closest to the western coast of Kowloon Peninsula. Although there are some existing high-rise buildings (e.g. Harbour Green, Island Harbourview, The Long Beach) between the harbour front and the western boundary of MK Area that may slightly reduce the wind flow reaching these sites, they are particularly important for welcoming the entry of sea breeze from the W and summer prevailing winds from the SW.

7.8 Tall buildings forming a high wall-like structure facing the prevailing wind or along the waterfront should generally be avoided. In the Baseline Scenario, the BHRs of these sites are lowered to 60/80mPD (two-tier based on site area) so as to create a slightly stepped building height profile with lower buildings in the windward direction.

7.9 In the Initial Scenario, the BHRs are increased to 100mPD for the residential sites ("R(A)" and "R(E)" zones) and 110mPD for the "OU(B)" site in this focus area. This induces a building height increase of 20m to 50m for these sites (Figure 7.2). Using the same approach for BF analysis and adopting the same assumptions for site areas (refer to Sections 6.9 to 6.16), the average increase in BF for the row of sites to the west of Kok Cheung Street is shown in Table 3 for the three cases.

Table 3 Average increase in building frontage (BF) for the sites sandwiched between Sham Mong Road and Kok Cheung Street in the Initial Scenario compared to the Baseline Scenario for the three cases, where 50% (Case 1), 75% (Case 2), and 100% (Case 3) (in terms of area) of the residential and "OU(B)1" sites are assumed to have site areas larger than 400m^2.

Case 1 (50% large sites)	Case 2 (75% large sites)	Case 3 (100% large sites)
31.6%	26.7%	21.8%

7.10 There is a large increase in BF for the row of sites to the west of Kok Cheung Street. Even when all the sites are assumed to have a site area larger than 400m^2, the increase in BF is more than 20%. Therefore, the air ventilation performance of the Initial Scenario is expected to be worse than that of the Baseline Scenario for this focus study area.

7.11 The NBA aligned with Li Tak Street and BG above 20mPD aligned with Ka Shin Street are essential for allowing the entry of westerly sea breeze into the central part of MK Area. The SB requirement of the SBDG also helps widen streets and reduce ground coverage to enhance air movement at pedestrian level (Figure 7.2).

7.12 Nevertheless, the row of sites sandwiched between Sham Mong Road and Kok Cheung Street is an area of concern for air ventilation in MK Area, especially due to its windward location. Any future developments at this focus area are recommended to follow the design principles set out in the Hong Kong Planning Standards and Guidelines (HKPSG)[1] at the detailed design stage as the prevailing effort for improvement in urban climate.

7.13 To ensure the impacts on air ventilation are no worse off than in the Baseline Scenario, the increase in BF in the high zone should be compensated by building permeability provided in the low/middle zones. The BG above 20mPD aligned with Ka Shin Street is therefore needed to compensate for the taller BHR of sites, especially for the "OU(B)" site, in the Initial Scenario.

7.14 It is understood that air ventilation is provided by both momentum-driven wind flow along air paths and air movement by diffusion through building porosity. Generally, momentum-driven wind flow is able to penetrate further along streets and benefit a larger area extent. Although the BG aligned with Ka Shin Street may not be directly aligned with E-W roads further to the east, momentum-driven wind flow

[1] Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG).

through Ka Shin Street will be able to reach Tai Kok Tsui Road and enhance air movement near the residential sites to the east of Tai Kok Tsui Road by diffusion.

7.15 At a district level consideration, it is important to ensure that air paths are carefully placed to connect and align with existing street grids such that ventilation corridors can be formed to further enhance wind penetration into inner parts of urbanised areas[1]. The incorporation of the SB and building separation requirements of the SBDG[2] may achieve similar effects as the imposed BG. However, such requirements cannot control the desirable positioning and orientation of the permeability to be provided within the "OU(B)" site in this focus area.

7.16 Moreover, air paths should be distributed evenly along the wind entrance. Without the BG at the "OU(B)" site, there will be a continuous façade of around 73m perpendicular to the prevailing wind direction[3] which is not desirable for urban ventilation as stated in the SBDG (see Figure A-8 in Appendix A).

7.17 In order to strike a balance between design flexibility and air ventilation at the "OU(B)" site, different alternative scenarios could also be considered to break down the continuous façade and increase the permeability of future developments at the site in order to allow the westerly winds to enter Ka Shin Street. One of the possible alternative scenarios is a wider BG above 20mPD located in the northern part of the "OU(B)" site in this focus area that lies within 30 degrees from Ka Shin Street. The BG could ensure that wind can flow into and along both Ka Shin Street and Fuk Chak Street, forming a wider air path at the middle zone for further wind penetration to the inner part of MK Area.

7.18 This alternative scenario, together with the height increase from 60/80mPD to 110mPD, may be more feasible for the disposition of future developments at the "OU(B)" site in this focus area as it allows greater design flexibility for the tall building towers at the subject site instead of twin towers separated by a BG as stipulated in the current OZP. This way, there is also a higher potential and feasibility for future developments to incorporate design principles set out in the HKPSG and SBDG.

Sites Sandwiched between Flower Market Road and Prince Edward Road West

7.19 Sites sandwiched between Flower Market Road and Prince Edward Road West are located in the northeastern corner of MK Area and in the downwind direction of the large piece of open area comprising Mong Kok Stadium and Boundary Street Recreation Ground. If not carefully planned and designed, they may form a wall-like structure and block the wind flow across the open areas from entering MK Area from the NE.

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[1] Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG).
[2] Hong Kong Buildings Department. (2016). Practice Note for Authorised Persons, Registered Structural Engineers and Registered Geotechnical Engineers: Sustainable Building Design Guidelines (APP-152).
[3] The continuous façade exceeds five times the mean width of street (around 14m before SB) of which the site abuts

7.20 In the Baseline Scenario, the BHRs of these sites are specified at 60/80mPD (two-tier BHR based on site area) so as to create a slightly stepped building height profile with lower buildings in the windward direction. It is aimed to minimise the blockage of northeasterly wind and allow easier wind penetration into Prince Edward Road West and Sai Yee Street.

7.21 In the Initial Scenario, the BHRs are increased to 100mPD for these residential sites. This induces a building height increase of 20m to 40m for these sites (Figure 7.2). Using the same approach for BF analysis and adopting the same assumptions for site areas (refer to Sections 6.9 to 6.16), the average increase in BF for the row of sites sandwiched between Flower Market Road and Prince Edward Road West is shown in Table 5 for the three cases.

Table 5 Average increase in building frontage (BF) for the sites sandwiched between Flower Market Road and Prince Edward Road West in the Initial Scenario compared to the Baseline Scenario for the three cases, where 50% (Case 1), 75% (Case 2), and 100% (Case 3) (in terms of area) of the residential and “OU(B)1” sites are assumed to have site areas larger than 400m^2.

Case 1 (50% large sites)	Case 2 (75% large sites)	Case 3 (100% large sites)
30.0%	25.0%	20.0%

7.22 There is a large increase in BF for the row of sites sandwiched between Flower Market Road and Prince Edward Road West. Even when all the sites are assumed to have a site area larger than 400m^2, the increase in BF is 20%. Therefore, the air ventilation performance of the Initial Scenario is expected to be worse than that of the Baseline Scenario for this focus study area.

7.23 The SB requirement of the SBDG helps widen Flower Market Road and reduce ground coverage to enhance air movement at pedestrian level (Figure 7.2).

7.24 E and ENE winds are also important annual prevailing wind directions. Fortunately, as the longer continuous façade of the row of sites near the Flower Market is oriented parallel or within 30 degrees from these wind directions, the potential impact of the height increment on the entry of E wind is less significant compared to the NE wind.

7.25 Nevertheless, the row of sites sandwiched between Flower Market Road and Prince Edward Road West is an area of concern for air ventilation in MK Area, especially due to its windward location. Any future developments at this focus area are recommended to follow the design principles set out in the Hong Kong Planning Standards and Guidelines (HKPSG)[1] at the detailed design stage as the prevailing effort for improvement in urban climate.

[1] Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG).

8.0 Recommendations and Further Work

8.1 The Initial Scenario has been expertly evaluated in Section 6. The proposed changes in BHR cause a general increase in BH within MK Area, but the slight average increase in BF for the whole MK Area in the Initial Scenario is unlikely to have any statistically significant difference in air ventilation impacts when compared to the Baseline Scenario, and special attention should be given to the row of sites sandwiched between Sham Mong Road and Kok Cheung Street and sites sandwiched between Flower Market Road and Prince Edward Road West, as pointed out in Section 7.

8.2 It should be noted that in compact high-rise building areas, skimming flow regime is often found over the top of buildings (see Figure A-2 in Appendix A), causing stagnant conditions at pedestrian level. When the H/W ratio of street canyons exceed a certain point, the increase in BH ceases to be the key factor affecting air ventilation at pedestrian level. Instead, focus should be put on district-wide measures such as NBAs, BGs and SB requirements, as well as enhancing air movements amongst developments by improving building design.

8.3 From the district point of view, the NBAs, BGs, and SB requirements in the Initial Scenario are all important features for air ventilation in MK Area and should be maintained.

8.4 From the building design point of view, the SBDG establish key building design elements to increase urban permeability and improve the wind environment at pedestrian level. Site amalgamation should be encouraged to increase the potential of the implementation of the SBDG (in particular, the building separation requirements).

8.5 Nevertheless, with reference to the expert witness statement[1] of the judicial review case HCAL No. 58 of 2011, MK Area is now characterised by high average H/W ratio, high FAD, and is one of Hong Kong's most severe urban heat islands due to intensive developments in the narrow streets of Mong Kok in the past years. As a result, MK Area suffers from poor environmental conditions with weak wind and air pollution problems.

8.6 Any future developments/redevelopments would inevitably add stress to the already poor existing conditions in MK Area. Therefore, developments must be carefully planned and should follow the design principles set out in the Hong Kong Planning Standards and Guidelines (HKPSG)[2] at the detailed design stage as the prevailing effort for improvement in urban climate. The five most important design principles are highlighted below (Paragraphs 8.7 to 8.11).

[1] NG Yan Yung. Witness Statement – REDA HCAL 58/2011. for Town Planning Board & Department of Justice HKSAR. 28 pgs. Hong Kong, 2011.11. <P118673> (see extract in Appendix D)
[2] Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG).

Further Design Principles

8.7 Variations in BH should be introduced across MK Area to help instigate wind flow throughout the district by encouraging downwashes and mixing of air due to pressure differences (see Figure A-10 in Appendix A). Low-rise buildings and open spaces should be located in the windward direction to allow the entry and penetration of prevailing winds. Tall buildings of uniform heights forming deep urban canyons should be avoided as they create skimming flows over the top of buildings and stagnant conditions at pedestrian level (see Figures A-2 and A-3 in Appendix A).

8.8 Long and continuous façades should be avoided, especially perpendicular to the prevailing wind direction and at street level. Suitable building disposition could help effective air flows around building in desirable directions (see Figure A-11 in Appendix A). Ground coverage for buildings, including any podium structures, should be minimised to no more than 65% of the site.

8.9 To increase the permeability of the urban fabric at street level, site coverage of the podia should be reduced to allow more open space at grade (see Figure A-12 in Appendix A). A terraced podium design should be adopted to direct downward airflow to the pedestrian level (see Figure A-13 in Appendix A).

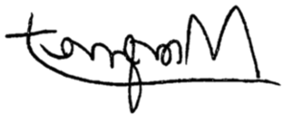
8.10 Existing "O" and "G/IC" sites should be maintained as "air spaces" where air ventilation can be relieved within the dense urban morphology. Open spaces, amenity areas, NBAs, SBs, and low-rise building corridors are important in providing urban permeability, moderating the city climate, and connecting breezeways and air paths (see Figures A-14 and A-15 in Appendix A).

8.11 Planting in open spaces should be maximised. Greenery (preferably tree planting) should cover no less than 30% for sites larger than 1 ha and 20% for sites below 1 ha at lower levels, preferably at grade.

8.12 When considering planning applications involving minor relaxation of BHR, the Government should also give more balanced considerations to S16[1] applications for building developments which require BH relaxation in order to incorporate more design features (such as those recommended in the HKPSG[2]) to improve air ventilation at pedestrian level. For such cases, it is highly recommended that project proponents should conduct further assessments to evaluate the potential air ventilation impacts on MK Area and demonstrate that the performance of any future developments would be no worse off than the evaluated scenarios.

[1] Hong Kong Town Planning Board. Application for Permission under Section 16 of the Town Planning Ordinance (CAP. 131) Guidance Notes.
[2] Hong Kong Planning Department. (2011). Hong Kong Planning Standards and Guidelines (HKPSG).

Prepared by



Date: 19 June 2018

Kwok Yu Ting

Endorsed by

Date: 19 June 2018

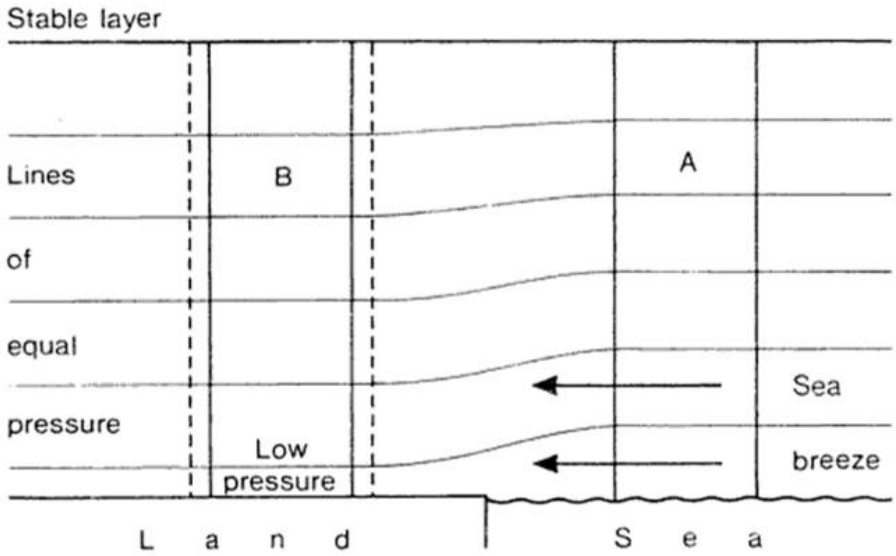
Professor Edward Ng
On behalf of technical experts in the term consultant term

The Chinese University of Hong Kong,
Shatin, NT, Hong Kong
T: 39436515 F: 26035267
E: edwardng@cuhk.edu.hk

Consultant team

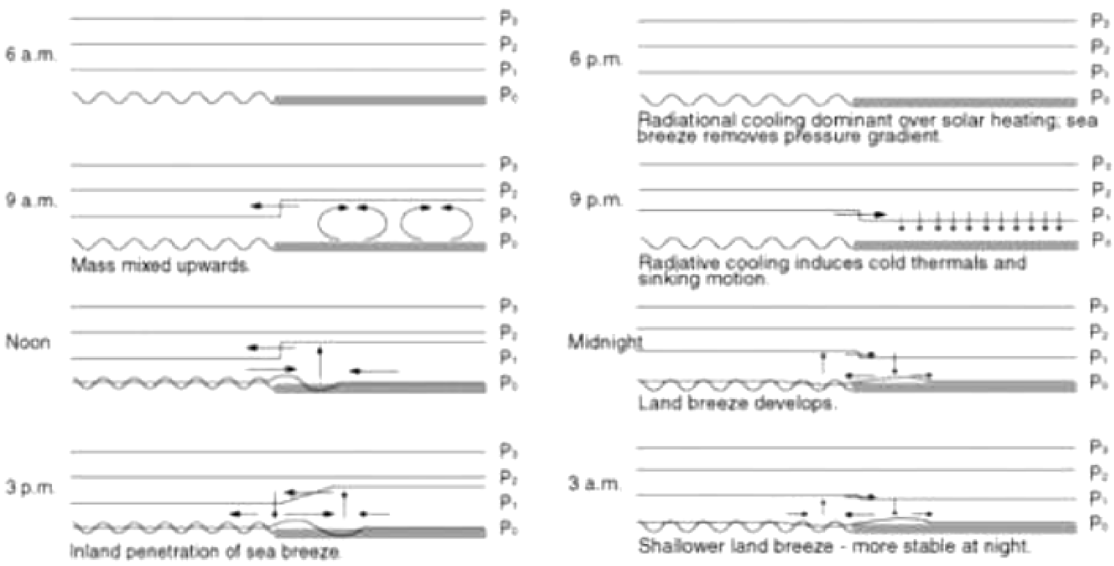
	Expertise
Professor Edward Ng CUHK, Hong Kong	Coordinator, Architect, Environmental scientist, AVA methodology
Professor Kevin Ka-Lun Lau CUHK, Hong Kong	Urban Climatologist, Environmental Scientist
Professor Jimmy Chi-Hung Fung HKUST, Hong Kong	Mathematician, Mesoscale wind simulation, Climatic studies
Professor Chao Ren CUHK, Hong Kong	Architect, Urban Climatologist
Miss Yu-Ting Kwok CUHK, Hong Kong	Environmental Scientist

Appendix A



(a) Formation of sea breezes.

Note: A column of air above the land (B) is heated by the sun and expands sideways, while a column of air above the sea (A) is unaltered. This causes a pressure difference at low levels which gives rise to sea breeze.



(b) The daily mechanism of land and sea breezes.

Figure A-1 Land and sea breezes.

[Reference: Simpson, J.E. 1994. Sea breeze and local wind. Cambridge University Press.]

Appendix A (Cont'd)

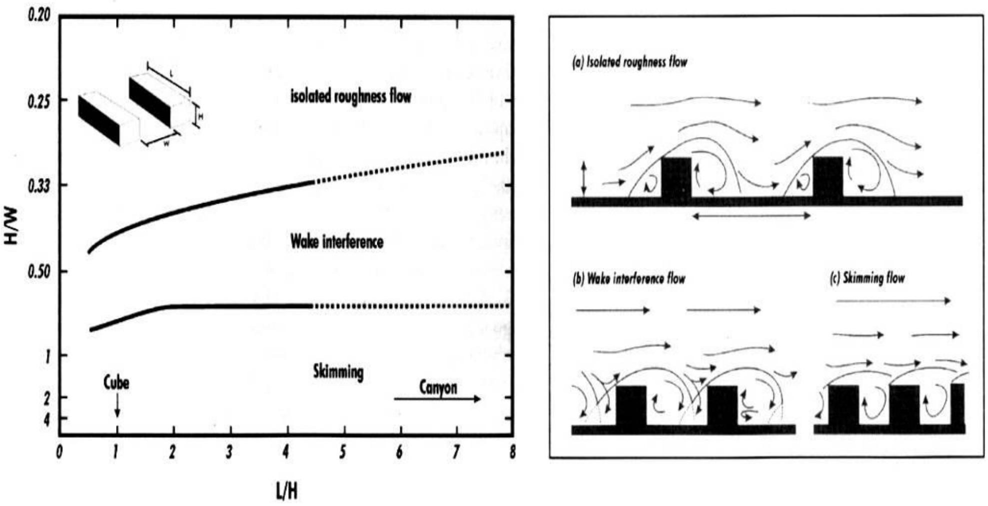


Figure A-2 The relationship between building height and street width ratio and the possible flow regimes.

[Reference: Oke, T. R. (1987). *Boundary layer climates*. Routledge.]

Appendix A (Cont'd)

With wind from directions perpendicular to the canyons, downwashes due to the differentials in building heights is occasionally likely when building heights are very different. Otherwise, with smaller building height differences, this is unlikely. It is known that for long and deep canyons with an H/W ratio of 2 and above, a double vortex phenomenon will be observed. However, beyond a H/W ratio of 2:1, the ground level of canyons, even with the so call downwash effects, will have very weak eddies and air ventilation.

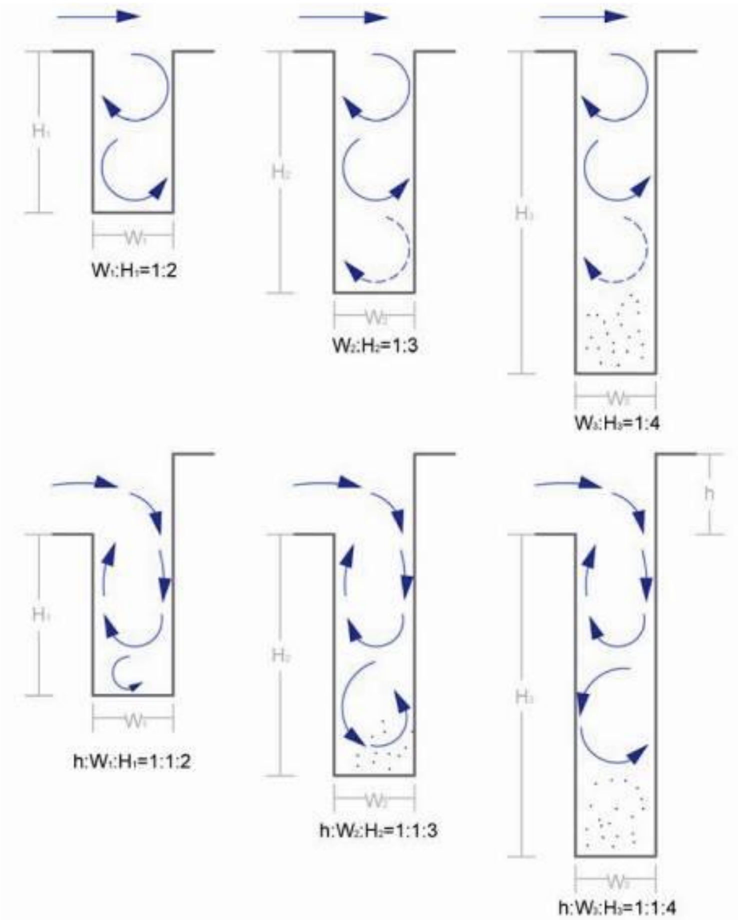


Figure A-3 The figure shows a generic understanding of the wind regimes in canyons, and canyons with downwashes.

[Reference: A. Kovar-Panskus, P. Louka, J.-F. Sini, E. Savory, M. Czech, A. Abdelqari, P. G. Mestayer and N. Toy, Influence of geometry on the mean flow within urban street canyons – A comparison of wind tunnel experiments and numerical simulations, Water, Air, and Soil Pollution: Focus 2: 365–380, 2002, Kluwer Academic Publishers.]

Appendix A (Cont'd)

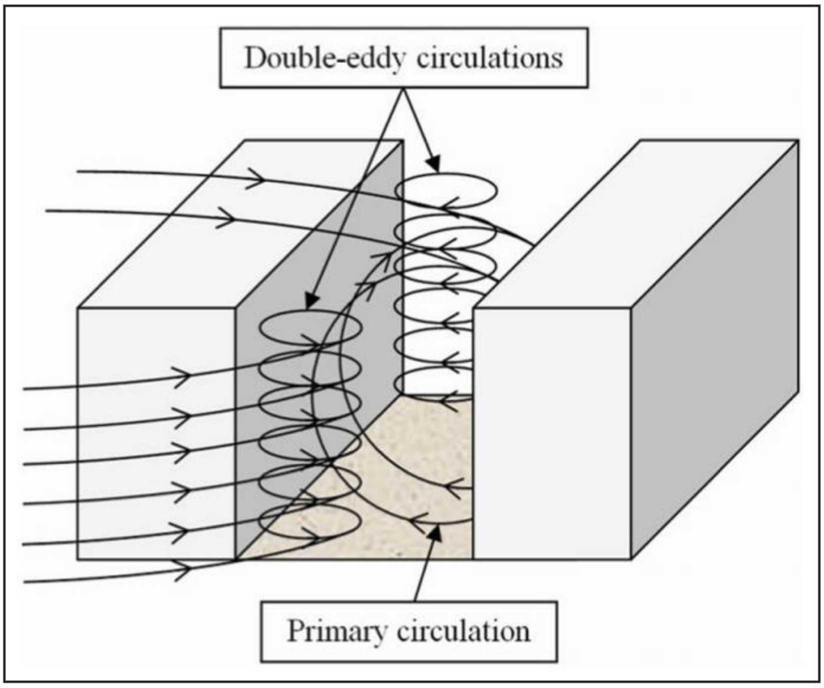
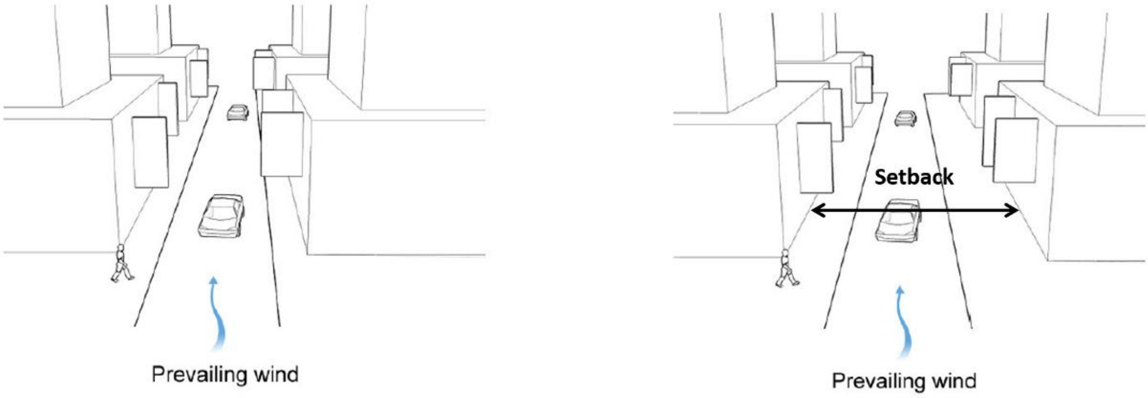


Figure A-4 Flow structures in an isolated street canyon with perpendicular air flow.

[Reference: Yazid, A. W. M., Sidik, N. A. C., Salim, S. M., & Saqr, K. M. A review on the flow structure and pollutant dispersion in urban street canyons for urban planning strategies. Simulation 90.8 (2014): 892-916.]

Appendix A (Cont'd)



To improve the air ventilation in the urban areas, the widening of streets along the prevailing wind direction is considered of high effectiveness. Especially for large sites facing narrow urban canyon as typically found in old urban district like Mong Kok, the building setback on each side of the street should be provided upon redevelopment or urban renewal.

Figure A-5. Street widening/ Building setback.

[Reference: Hong Kong Planning Standard and Guidelines]

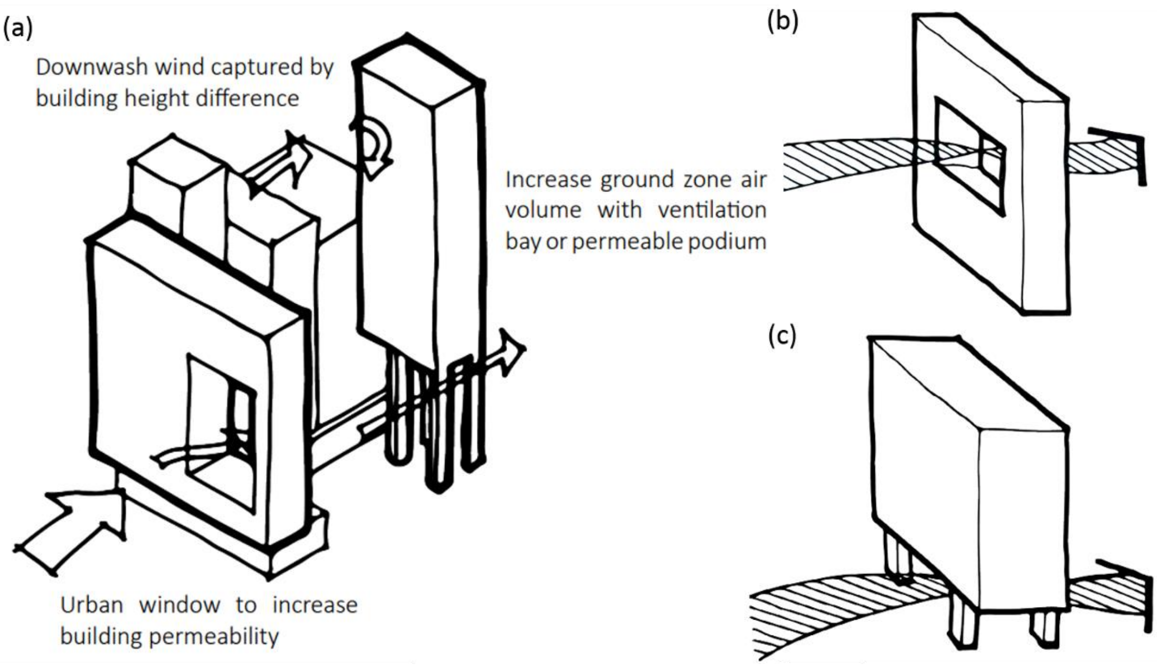


Figure A-6 (a) Increase ventilation with building design, (b) increase building permeability, and (c) increase ground zone air volume by permeable podium.

[Reference: HKGBC Guidebook on Urban Microclimate Study]

Appendix A (Cont'd)

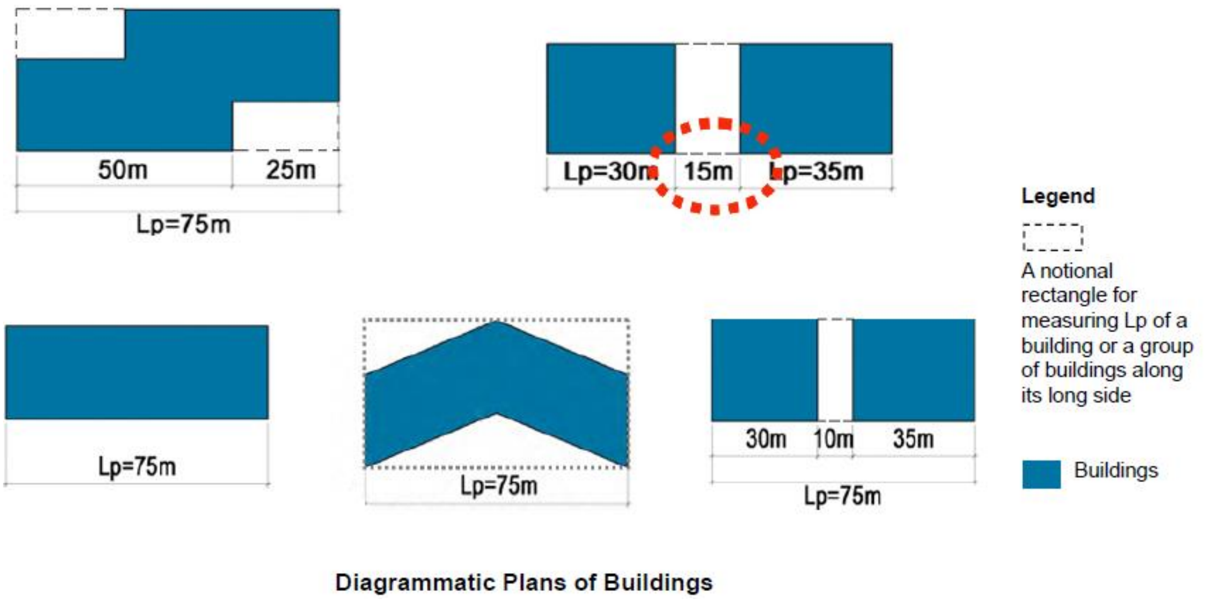


Figure A-7 Determining L_p, i.e. the total projected length of façade of a building or a group of buildings if separation between them is less than 15m. Building portions at low zone of height ≤6.67m are disregarded in L_p.

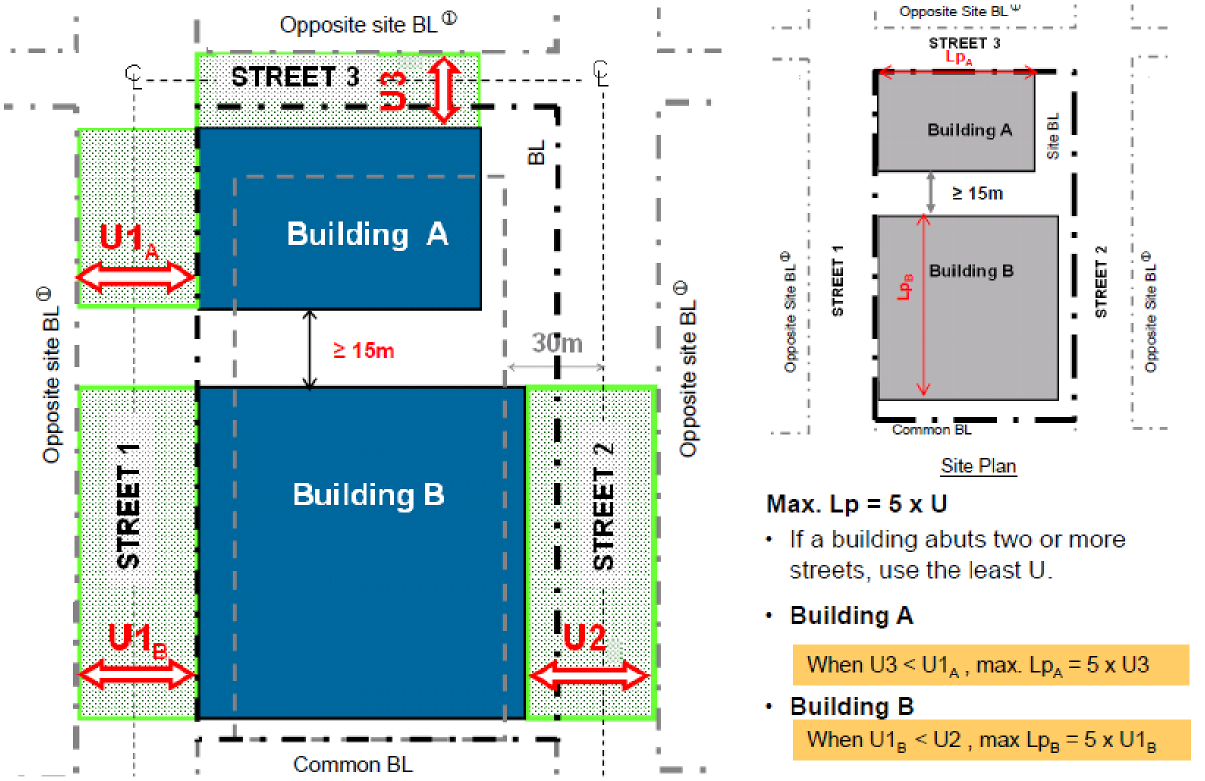


Figure A-8 Defining the mean width of street canyon (U) and the maximum permissible continuous projected façade length (L_p).

Appendix A (Cont'd)

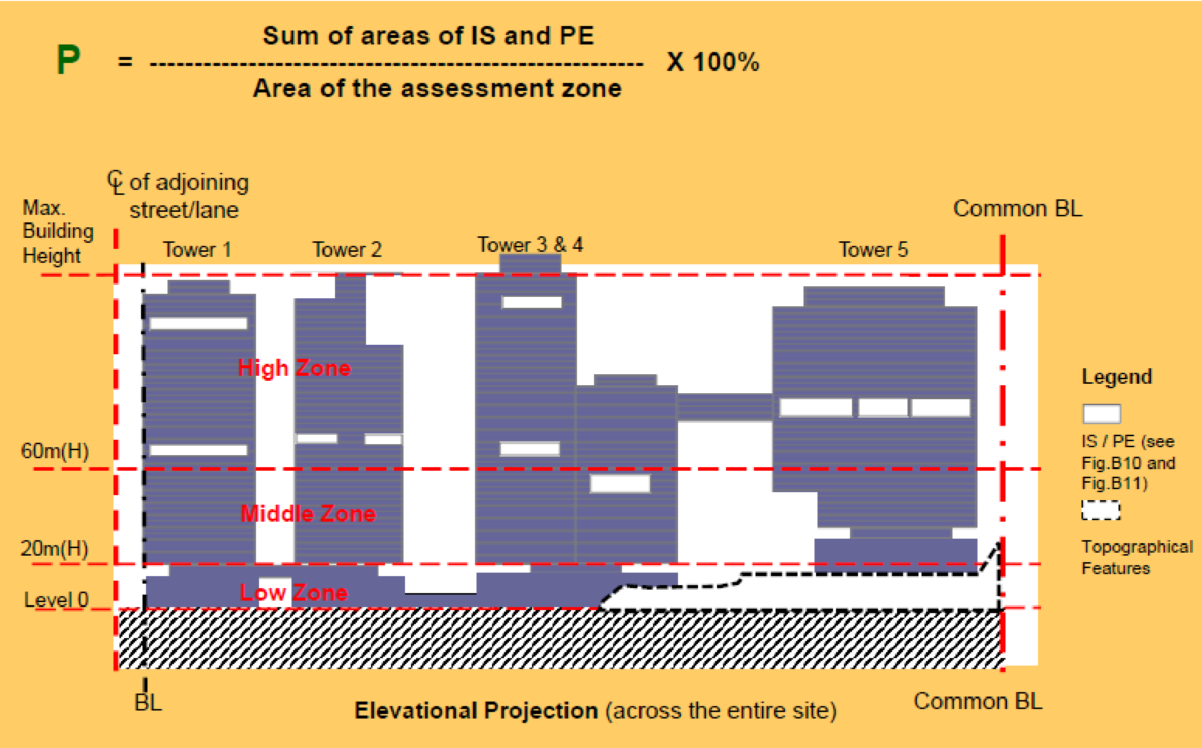
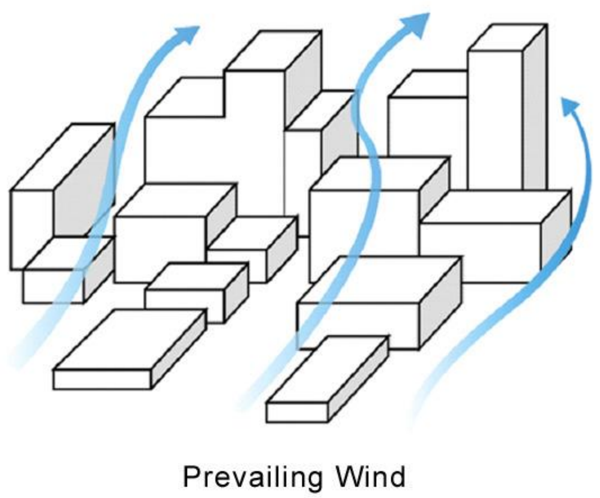


Figure A-9 Assessment of Permeability (P).

[Reference: Sustainable Building Design Guidelines (PNAP APP-152)]

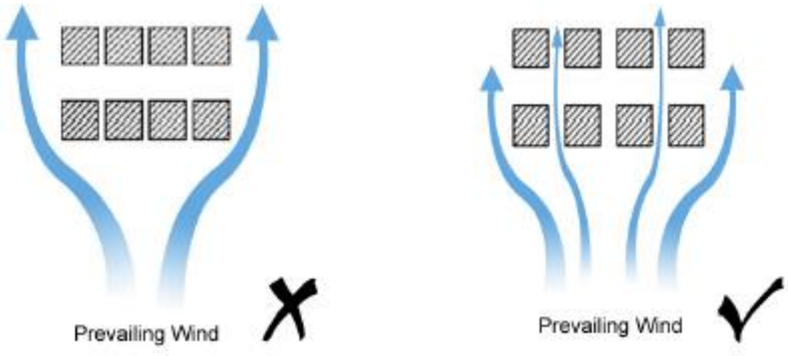


In general, gradation of building heights would help wind deflection and avoid air stagnation. Where appropriate, height variation across the district with decreasing heights towards the direction where the prevailing wind comes from should be adopted to promote air movements.

Figure A-10 Varying height profile to promote air movements.

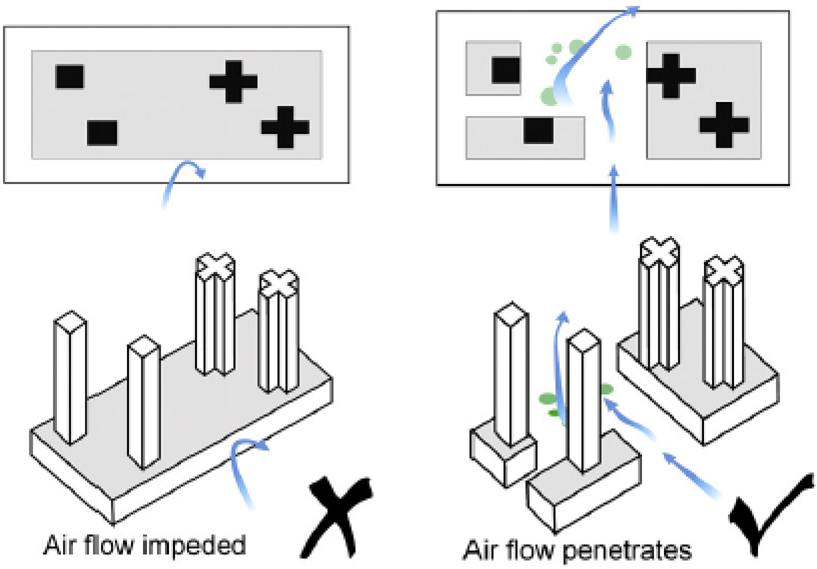
[Reference: Hong Kong Planning Standard and Guidelines]

Appendix A (Cont'd)



Where practicable, adequately wide gaps should be provided between building blocks to maximize the air permeability of development and minimize its impact on wind capturing potential of adjacent developments. The gaps for enhancing air permeability should be at a face perpendicular to the prevailing wind.

Figure A-11 Gaps between Building Blocks to Enhance Air Permeability.

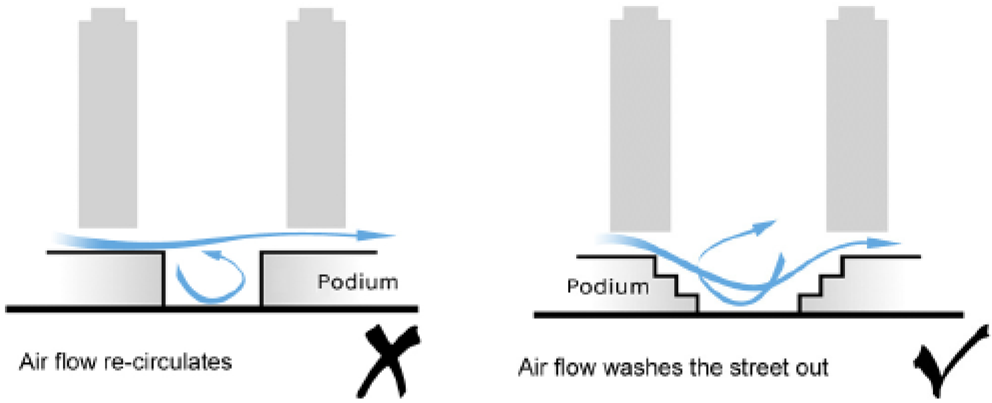


Compact integrated developments and podium structures with full or large ground coverage on extensive sites typically found in Hong Kong are particularly impeding air movement and should be avoided where practicable.

Figure A-12 Reducing Site Coverage of the Podia to Allow More Open Space at Grade.

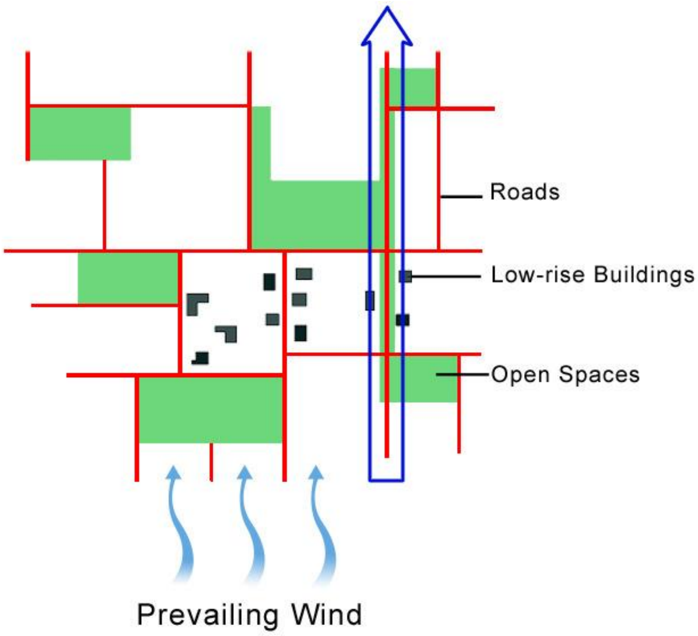
[Reference: Hong Kong Planning Standard and Guidelines]

Appendix A (Cont'd)



Where appropriate, a terraced podium design should be adopted to direct downward airflow to the pedestrian level.

Figure A-13 Terraced Podium Design.



Breezeways should be created in forms of major open ways, such as principal roads, inter-linked open spaces, amenity areas, non-building areas, building setbacks and low-rise building corridors, through the high-density/high-rise urban form. They should be aligned primarily along the prevailing wind direction routes, and as far as possible, to also preserve and funnel other natural air flows including sea and land breezes and valley winds, to the developed area.

Figure A-14 Linkage of Roads, Open Spaces and Low-rise Buildings to Form Breezeways.

[Reference: Hong Kong Planning Standard and Guidelines]

Appendix A (Cont'd)

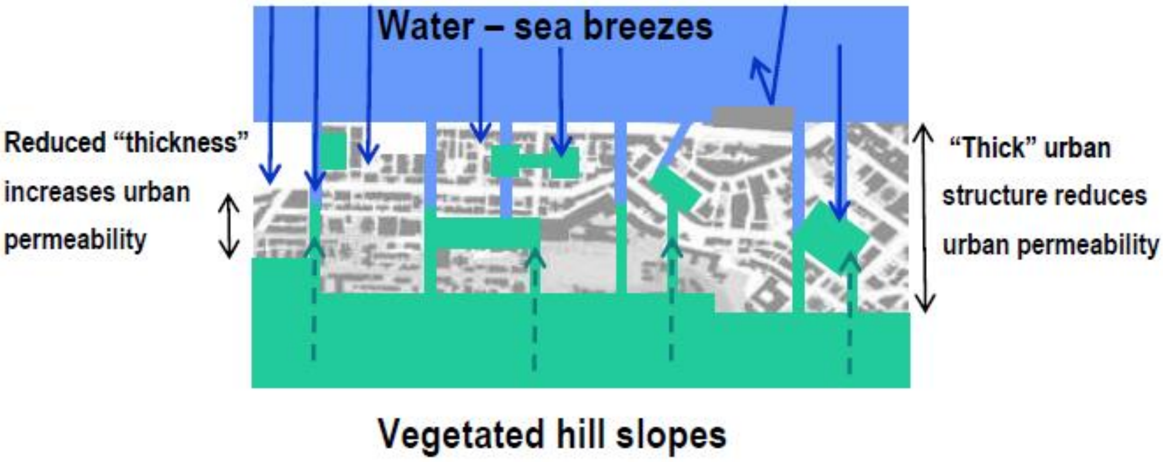


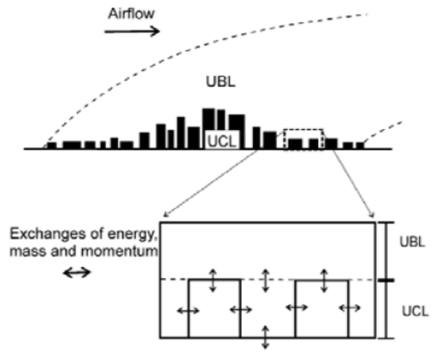
Figure A-15 Ways to create breezeways and air paths in the urban fabric to facilitate air ventilation connectivity.

[Reference: Hong Kong Planning Department. (2012). "Urban Climatic Map and Standards for Wind Environment - Feasibility Study" Final Report.]

Appendix B

A scientific understanding of building heights for City Planning

The air mass exchange of an urban area can be understood based on the Urban Boundary Layer (UBL) and the Urban Canopy Layer (UCL) interaction.



To optimize air ventilation of the UCL, which is the layer of human occupation including pedestrian at ground level, it is useful to maximize the energy, mass and momentum exchange between UBL and UCL. The vertical exchange is denoted by U_E and can be expressed with the following equations:

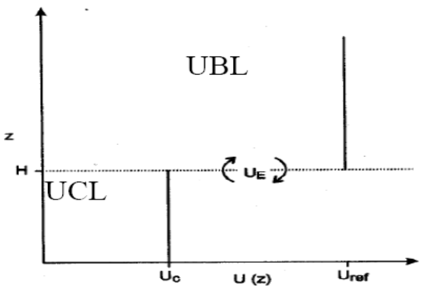
$$\frac{U_E}{u^*} = \left[\frac{1}{k}\ln\left(\frac{z_{ref}-d}{z_o}\right) - \frac{U_C}{u^*}\right]^{-1}$$

where

$$\frac{U_C}{u^*} = \left[\frac{\lambda_f}{2}\right]^{-0.5} \quad \text{for } \lambda_f > 0.2$$

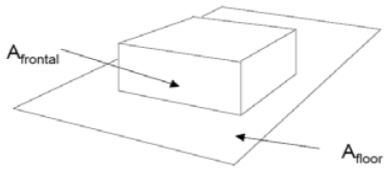
$$\frac{U_C}{u^*} = \left[\frac{z_o}{2H}\right]^{-0.5} \quad \text{for } \lambda_f < 0.2$$

Uc	the average flow within the canopy
U*	friction velocity
Zo	roughness length
d	displacement height
λf	frontal area density
H	average building height
K	von Karman constant = 0.4



λf frontal area density :-

$$\lambda_f = \left(\frac{\sum_{obstacles} A_{frontal}}{A_{floor}}\right)$$



Hence, to increase U_E , it is important to lower the displacement height (which is normally taken as 0.7*UCL, and UCL is commonly taken as 1.2*H). It is also important to increase the roughness length (Zo) by optimizing λf to around 0.1 to 0.3.

All else being equal, this means a collection of <u>tall buildings</u> in an urban area resulting in high UCL and high λf, and therefore higher displacement height, can lead to lower U_E. Lowering building heights can be a solution.

Furthermore, this also means that closely packed buildings of <u>uniform building height</u> (or small building height variation) can result in lower Zo and can lead to lower U_E. Creating large building height variations can be a solution. Having a building height to street width (H/W) ratio of less than 1.5 to 2 in order to avoid a skimming flow regime developing can also be a solution.

Professor Edward Ng, CUHK, 2009.

Appendix C

Details on the Analysis of Building Frontage

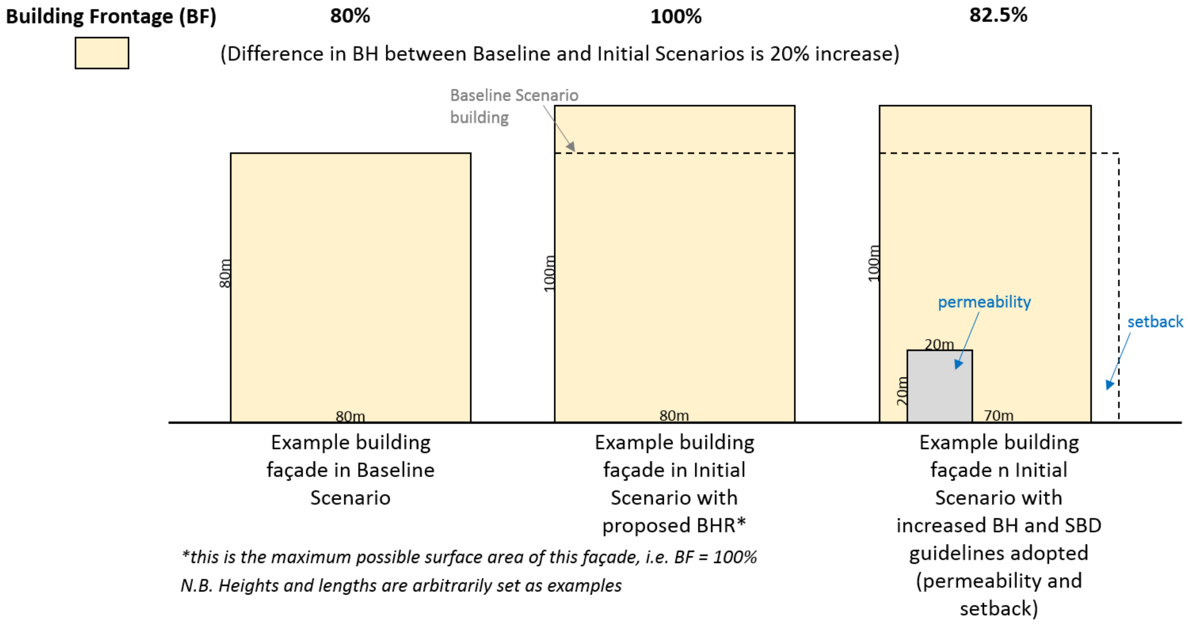


Figure C-1 Graphical description of building frontage.

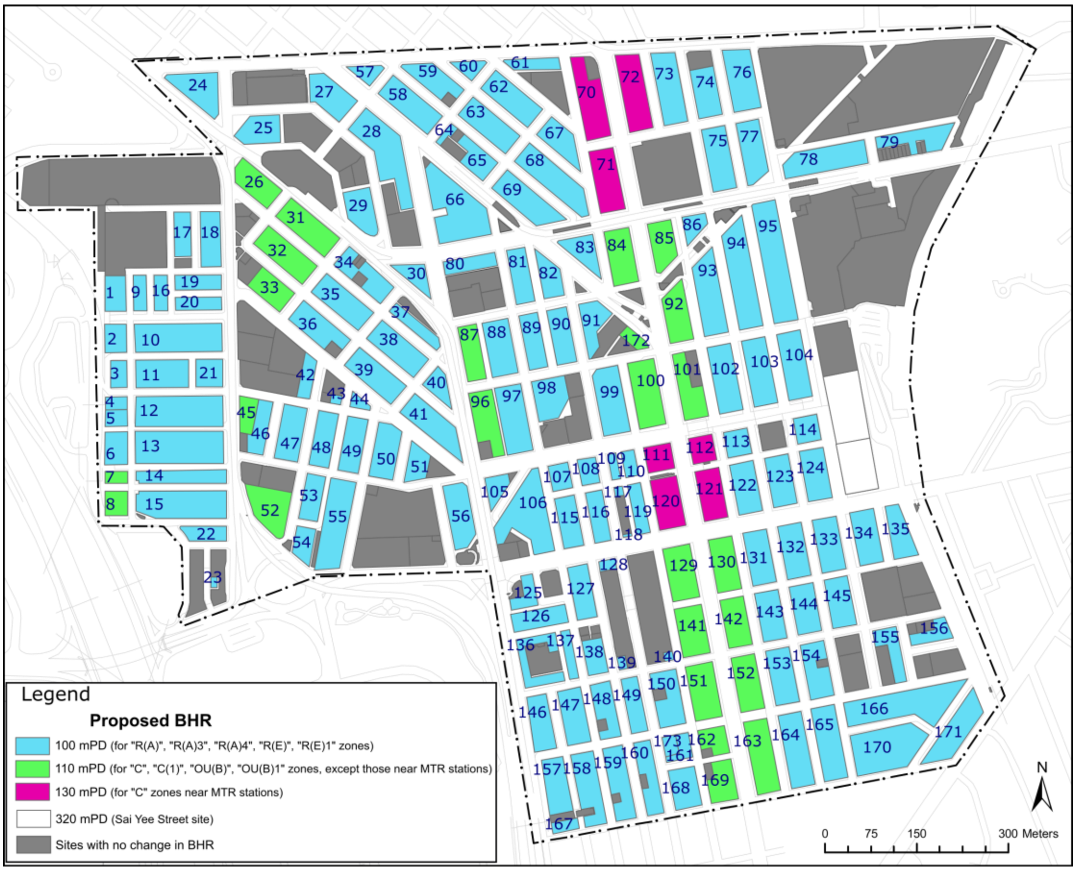


Figure C-2 Numbered OZP zones for the analysis of building frontage shown in Table C-1.

Appendix C (Cont'd)

Table C-1 Difference in building frontage between the Baseline and Initial Scenarios for each OZP zone (numbered as in Figure C-2). Analysis has been carried out for three cases, where 50% (Case 1), 75% (Case 2), and 100% (Case 3) (in terms of area) of the residential and "OU(B)1" sites are assumed to have site areas larger than 400m^2.

Zone no.	Difference in building frontage		
	Case 1 (50% large sites)	Case 2 (75% large sites)	Case 3 (100% large sites)
1	30%	25%	20%
2	30%	25%	20%
3	30%	25%	20%
4	30%	25%	20%
5	30%	25%	20%
6	30%	25%	20%
7	36%	32%	27%
8	36%	32%	27%
9	10%	5%	0%
10	10%	5%	0%
11	10%	5%	0%
12	10%	5%	0%
13	10%	5%	0%
14	10%	5%	0%
15	10%	5%	0%
16	10%	5%	0%
17	10%	5%	0%
18	10%	5%	0%
19	10%	5%	0%
20	10%	5%	0%
21	10%	5%	0%
22	10%	5%	0%
23	10%	5%	0%
24	10%	5%	0%
25	10%	5%	0%
26	27%	27%	27%
27	10%	5%	0%
28	10%	5%	0%
29	10%	5%	0%
30	10%	5%	0%
31	27%	27%	27%
32	27%	27%	27%
33	27%	27%	27%
34	10%	5%	0%
35	10%	5%	0%

Appendix C (Cont'd)

Table C-1 (cont'd)

36	10%	5%	0%
37	10%	5%	0%
38	10%	5%	0%
39	10%	5%	0%
40	10%	5%	0%
41	10%	5%	0%
42	10%	5%	0%
43	10%	5%	0%
44	10%	5%	0%
45	9%	9%	9%
46	10%	5%	0%
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69	10%	5%	0%
70	8%	8%	8%
71	8%	8%	8%
72	8%	8%	8%
73	10%	5%	0%
74	10%	5%	0%
75	10%	5%	0%
76	10%	5%	0%

Appendix C (Cont'd)

Table C-1 (cont'd)

77	10%	5%	0%
78	30%	25%	20%
79	30%	25%	20%
80	10%	5%	0%
81	10%	5%	0%
82	10%	5%	0%
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111	8%	8%	8%
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117	10%	5%	0%

Appendix C (Cont'd)

Table C-1 (cont'd)

118	10%	5%	0%
119	10%	5%	0%
120	8%	8%	8%
121	8%	8%	8%
122	10%	5%	0%
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157	10%	5%	0%
158	10%	5%	0%

Appendix C (Cont'd)

Table C-1 (cont'd)

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160	10%	5%	0%
161	10%	5%	0%
162	9%	9%	9%
163	9%	9%	9%
164	10%	5%	0%
165	10%	5%	0%
166	10%	5%	0%
167	10%	5%	0%
168	10%	5%	0%
169	9%	9%	9%
170	10%	5%	0%
171	10%	5%	0%
172	9%	9%	9%
173	10%	5%	0%
average	**11.6%**	**7.5%**	**3.4%**

Appendix D

Extracts from Witness Statement of Ng Yan Yung
– REDA HCAL 58/2011. for Town Planning Board & Department of Justice HKSAR.

4.4 I have read the Applicant's representation submitted to the Board on 18 November 2010 **[LL-1:A6/12]**, and consider the arguments it contains invalid. The Applicant quoted the recommendations of the EE report out of context and in a piecemeal manner. It advocated taller buildings by increasing the height bands "…*by, say 10m to 20m to permit buildings of around 40 storeys, would provide for better urban design* ...' (§3.1.4) and asked for deletion of all the NBAs and setbacks (§4.6 to 4.7), which were much needed to improve urban air ventilation of the area. The major justifications against the NBAs and setbacks are mainly related to whether such designation is permissible under the Ordinance, i.e. the spot restriction issue, and whether the Draft OZP is the most appropriate means to achieve the purpose. There is little substance on air ventilation aspect to justify its proposal.

4.5 In a nutshell, the Applicant's representation wished that neither the BH nor how the building sits on the site should be controlled hoping that *"good development design that benefits the public*" (§5.1) might come about if, and only if, "*incentive*" are given. However, in the absence of proper planning control, there is no guarantee that measures to improve air ventilation would be voluntarily incorporated in the private developments. The allowance for design flexibility, encouragement or incentive would simply turn into a quest for maximization of BH for better view and high profitability. The need to improve air ventilation for the public good will not be safeguarded.

4.6 In the EE report **[LL-1:A3/9(11)/493; §7.3]** the following is stated in this regard: "*All in all, given practical constraints and the need to respect 'development rights' of the land owner, the proposed mitigation measures have noted and responded to some of the major concerns we expressed on the Initial Planned Scenario. However, the overall need to reduce the Ground Coverage, Building Volume Density and building height has not been addressed. Besides, more non-building areas and greeneries are still highly encouraged to include. We regard this represents a small but important step towards creating a quality urban environment for the general public of Hong Kong.*"

Mong Kok and its urban air ventilation environment

4.12 When the narrow streets of Mong Kok were laid out by Sir Patrick Abercrombie during the postwar years, it was never meant for the kind of tall buildings we are seeing nowadays. A H/W ratio in the order of 1:1 was the norm at that time. Today, like Wan Chai area, the area has high average H/W ratio, high FAD, and one of Hong Kong's more severe UHII. The wind condition in the Mong Kok area is weak. The relentless pursuit of maximising development intensity without due consideration of our built environment in the area in the past many years is one of the main causes of the poor-environment that we are now suffering from.

Appendix D (Cont'd)

4.13 Like its neighbouring Yau Ma Tei area, apart from human thermal consideration, the lack of urban air ventilation in Mong Kok also means that anthropogenic wastes may not be properly and rapidly dissipated. Again, I believe that it is important that we review the urban planning and building design of the area to improve, among other environmental factors, the air ventilation performance of the area.

4.14 With reference to Environmental Protection Department's roadside monitoring station record, Mong Kok suffers bad air pollution problems, exceeding the Air Quality Objectives[1] on the maximum annual pollution concentration of Nitrogen Dioxide, Total Suspended Particulars and Respirable Suspended Particulates[2] for the past 5 years. To improve urban air ventilation in the area is an effective measure towards mitigating the problem.

4.15 The background of the review of the Mong Kok OZP and consideration of the Applicant's representation by the Board are set out in the Affirmation of Chan Wai Shun. To recap, PlanD commissioned ENVIRON Hong Kong Limited to conduct an AVA by EE for the area. Taking into account the recommendations of the EE report **[LL-1:B3/9(3)]** as well as other planning considerations, PlanD proposed amendments to the Mong Kok OZP to impose BHRs, NBAs, setbacks and building gaps, and the amendments were adopted by the Board and exhibited for public inspection under the Ordinance on 17 September 2010. The Applicant submitted a representation to the Board against most of the amendments to the OZP on 17 November 2010. After consideration of the representations on 29 April 2011, the Board decided not to uphold the Applicant's representation.

4.16 I have read the Applicant's similar representation submitted to the Board on 17 November 2010 **[LL-1:B4/11]**. I consider the arguments it contains invalid. My views in Section 4.4 to 4.6 apply to the present situation.

4.17 Regarding the objection to the "*Lack of Flexibility for Innovative and Quality Design*" (5.1), I must add that the public sentiment against wall and bulky buildings has a lot to do with the practice of allowing uncontrolled design flexibility, which from my observation of Hong Kong's urban development from an air ventilation perspective quickly turns into design "maxi-bility". By design "maxi-bility" I mean that, in the absence of proper planning control for the area, the allowance for design flexibility would simply turn into a quest for maximization of BH for better view and high profitability rather than the improvement of air ventilation. The poor air ventilation we have now in Mong Kok is a witness of that practice.

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[1] Air Quality Objectives for seven widespread air pollutants were established in 1987 under the Air Pollution Control Ordinance based on international standards as yardsticks for air quality management. These Air Quality Objectives derived from scientific analyses of the relationship between pollutant concentrations in the air and the associated adverse effects of the polluted air on the health of the public.

[2] Total suspended particulates are small airborne particles such as dust, fume and smoke with diameters less than 100 micrometres. Respirable suspended particulates refer to those airborne particles with diameters of 10 micrometres or less.

Appendix D (Cont'd)

4.18 All in all, I consider the Board's decision not to uphold the Applicant's representation reasonable from air ventilation viewpoint.

In summary

4.23 In sum, due to dense and tall urban developments and narrow streets, the built-up areas covered by these four OZPs are generally subject to poor air ventilation. Taking into account my views of the four OZP areas as outlined above, I verily believe that, all in all, the reviews of these OZPs for imposition of appropriate BHRs, NBAs, setbacks and building gaps are positives step towards the direction of providing a more livable built environment for the community.

4.24 I have read the Final Reports of the EE ("the EE Reports") prepared by myself [LL-1:A3/9(11)], CO2nnsulting Limited [LL-1:D2/7(4)] and ENVIRON Hong Kong Limited [LL-1:B3/9(3) & C2/7(3)]. The EEs were all conducted in accordance with the requirements of the Technical Guide. The EE Study process was iterative in its nature. They all started with an evaluation of the topography, urban morphology and local wind environment in the concerned areas with a view to identifying areas of air ventilation concern. With this in mind, the consultants then assessed the air ventilation impact of an initial planned scenario prepared by PlanD with the BHRs imposed. Various recommendations, e.g. adjustments to BHRs, provision of NBAs, setbacks and building gaps, were made by the consultants in order to improve the air ventilation performance of the areas, and there was discussion between PlanD and AVA consultants. In making the recommendations, apart from their expertise/experience and understanding of the local wind environment and urban morphology in the area, the consultants made reference to the established guidelines and quantitative indicators. Some examples are quoted below:

(b) in the Mong Kok EE, similarly, there is a detailed assessment on the air ventilation performance with reference to the H/W ratio of different streets (§4.2.18 and 4.2.19). The consultant has used the H/W ratio to indicate the improvement brought about by the building setbacks introduced upon redevelopment (§4.3.8 to 4.3.12). Referring to the qualitative air ventilation guidelines in HKPSG (§11.2.11) which states "height variation across the district with decreasing heights towards the direction where the prevailing wind comes from should be adopted to promote air movements", the consultant recommends a lower BHR for the sites on the front row of the area facing the prevailing north-easterly and westerly wind in order to allow the incoming of prevailing wind as well as to form a decreasing BH profile in accordance with guidelines, and a higher BH of 120mPD at some of the "Commercial" sites along Nathan Road adjacent to the MTR Mong Kok Station and Prince Edward Station to create or amplify downwash of wind to the pedestrian area around the buildings (§4.3.2, 4.3.15 and 4.3.19);

Appendix D (Cont'd)

4.25 Upon the recommendations of the consultants, PlanD incorporated various air paths, NBAs, building setbacks and/or BHRs (for the purpose of creating air paths). A couple of dimensions for the NBAs, setbacks and building gaps had been worked out based on the professional advice of the consultants with due regard to the practicality of the proposal (e.g. site constraint, and the impact on the development potential of the site as assessed by PlanD). The consultants then re-examined and confirmed whether the measures would improve air ventilation performance in the Area as compared with the initial scenario.

4.26 All in all, I consider that the EE Reports have provided a reasonable and sound basis to assist planners with their planning decisions. My reservation is that the recommendations that PlanD has incorporated into these Draft OZPs can only be considered as efforts to "slow down" the worsening air ventilation problem of the areas knowing that even with the BHRs, a lot of taller-and-bulkier buildings, compared to the existing buildings, will eventually be constructed. In my opinion, even more can and should be done.