TERM CONSULTANCY FOR AIR VENTILATION ASSESSMENT SERVICES

Cat. A1– Term Consultancy for Expert Evaluation and Advisory Services on Air Ventilation Assessment (PLNQ 35/2009)

Revised Final Report

Chai Wan Area

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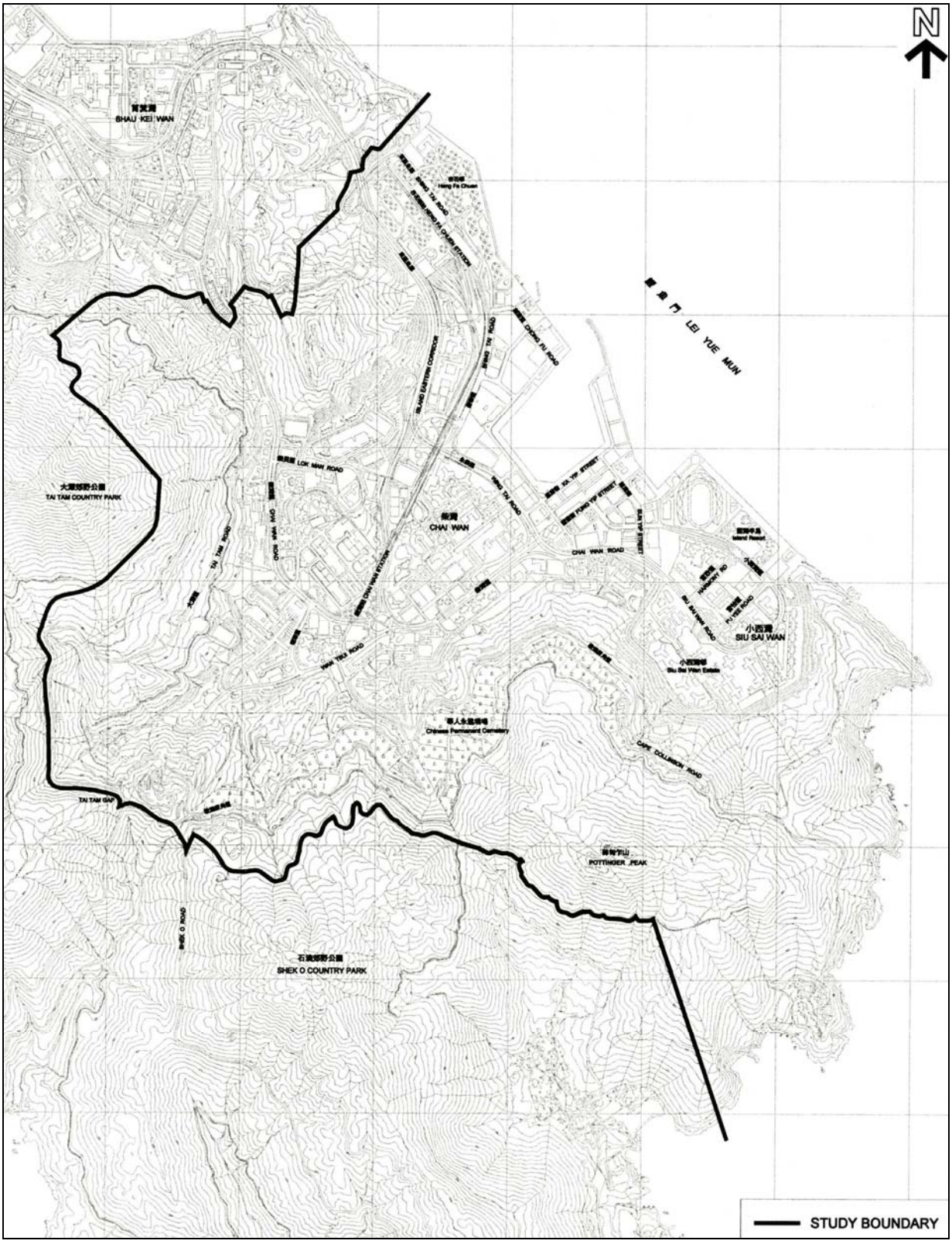
The Study Area



Expert Evaluation Report
of Chai Wan Area

Executive Summary

0.1 Wind Availability

(a) Based on the available wind data, one may conclude that the annual wind of the study area is mainly from North-East and East. The directions of the summer winds are ranging from southwest, south, southeast to east. There are strong northeast-southwest and east-southwest channeling effects at/near ground level due to the surrounding topography and the area's proximity to the waterfront.

0.2 Topography

(a) The Area is at the east of Hong Kong Island. Most of the developments in the area are on a flat reclamation land. The Area is, on the whole, exposed to the sea in the northeast and partially enclosed by Mount Collinson (348mPD) in the south, Mount Parker (507mPD) in the west and also Pottinger Peak (312mPD) in the southeast.

(b) While the mountains will weaken the background wind from the west, winds from the southerly quarters will find its ways through the two mountain passes and penetrate through the valleys into the Area (see the two red arrows in Figure 4.1).

0.3 Existing Conditions

(a) Many of the residential buildings are owned by the Housing Authority. They vary in absolute heights. Some of the taller blocks in Hing Wah (II) Estate are perpendicular to the prevailing wind and thus may weaken the important valley winds from the southwest.

(b) The long row of north-south orientated blocks of Fullview Garden restricts some of the easterly winds into Siu Sai Wan area. Fortunately, the promenade provides useful relief especially to the schools at Fu Yee Road and Harmony Road. Its nearby residential developments Kai Tsui Court and Siu Sai Wan Estate are not closely packed together and wind from the east can penetrate into the Area.

(c) It is a pity that the bulky Island Resort and its extensive podium are blocking the sea winds into Harmony Road, which should ideally be extended to the waterfront. However, there is prevailing east wind blowing between the building gaps. In future, it is very important to assess developments on the waterfront that may cause air ventilation issues to its neighbours – this and other sites.

(d) Along the north waterfront, the area is not over-developed. There are some undeveloped lands reserved for open space or Government, Institution or Community (G/IC) use along Sheung On Street and Chong Fu Road. Care must be

exercised that future developments respect the important southwest-northeast channeling wind of the area by introducing non-building areas and gaps between buildings. Illustrations are given in Figures 7.5 and 7.6.

(e) The undeveloped open space at the junction of Sheung On Street/Sheung Ping Street on the waterfront is an important air ventilation entrance to the Area. It has the potential to link across Tsui Wan Estate to Chai Wan Park, thus greatly benefits the air ventilation of the Area.

(f) There are also more than a few G/IC sites in the Area, such as stadium, parks, gardens, community centre, college and schools. Together with other open spaces and connected with roads, these G/IC sites provide useful relief and air spaces which would enhance the efficacy of the air paths. Care must be exercised when they are further developed with taller or bulkier buildings or re-zoned for larger developments.

(g) Ground Coverage in developed areas is overall medium, with some clusters of high-value pixels. Some clusters of high-value pixels are found in locations A, B and C (Figure 5.4). Location A is at the centre of the Area, occupied by larger industrial buildings and narrower streets. However, this location is just on an important air path in the direction of northeast-southwest of the area. Locations B and C cause less noticeable air ventilation issues.

(h) On the whole the building volume density of the Area is medium. The clustered cells of medium value are industrial buildings around Cheung Lee Street, residential buildings on the east of Siu Sai Wan Road and buildings of and around Island Resort. Evaluated together with the above paragraphs, special care must be exercised when these areas are developed with more extensive ground coverage and higher building heights in future developments.

0.4 The Existing Conditions with Committed Developments

(a) There are a few committed developments scattered in the Area (Figure 6.1). The developments near Lee Chung Street and Lin Shing Road are not extensive in size.

(b) There are also a few potential redevelopments in the Area (Figure 6.2). One cluster is the industrial buildings to the west of the MTR Chai Wan Station. As mentioned above, special care must be exercised when developments are made in this area so that the southwest-northeast air path is respected. Another cluster is industrial and residential buildings on both sides of Chai Wan Road. They are not extensive in size.

0.5 Expert Evaluation and Recommendations of the Initial Planned Scenario

(a) It must be stressed that given Hong Kong's tall building urban morphology, on the whole, building height restriction (or minor changes of building heights) is not the most effective method for maintaining and/or improving air ventilation. Breezeways,

air paths, open spaces, gaps between buildings and building permeability – especially at the near ground level, are more effective.

(b) The initial planned scenario keeps most of the existing "G/IC" sites (Figure 7.2) as low-rise buildings and "Open Space" ("O") sites, and also rezone some "G/IC" sites to "Green Belt" ("GB") and "O". "G/IC" sites connected to or next to the main air paths are particularly useful. Further greening on these sites is recommended.

(c) It is good to rezone some of the development zones to zones of much less intensive developments, such as "G/IC", "O" and "Road" (Figure 7.1). The proposed rezoning of Sites 1a to 1d, 3 and 5 (Figure 7.1) to "G/IC" and "O"will enhance air permeability around these areas.

(d) The proposed rezoning of the existing open-air bus terminus to the west of the MTR Chai Wan Station to area shown as 'Road' (Figure 7.1) will also facilitate air ventilation around the existing industrial area to its west.

(e) Apart from the rezoning proposals, it is also highly recommended to designate non-building areas in Tsui Wan Estate, Hing Man Estate/Hing Wah (II) Estate and the industrial area to the west of the MTR Chai Wan Station, as illustrated in Figure 7.3. The non-building areas are suggested to connect roads, open spaces and G/IC sites to form least-blocked air paths in the Area. The width of non-building areas is taken as 20-30m, in light of the width of 100m – 150m of the frontage area of the buildings. Moreover, building gaps in the existing Chai Wan Flatted Factory site, and between two existing industrial buildings namely the Chai Wan Industrial Centre and Minico Building are suggested. With wind channeling through the existing G/IC site and roads, the proposed building gap will facilitate the air ventilation along the major southwest-northeast air path via the proposed gap.

(f) In addition to the recommended non-building areas/building gaps, it is expected that Housing Department will conduct its own detailed air ventilation assessment to further optimize their local air ventilation designs upon redevelopment, particularly for those with site areas larger than 2 ha, viz, Hing Man Estate, Hing Wah (I) Estate, Hing Wah (II) Estate, Yue Wan Estate, Tsui Wan Estate and Siu Sai Wan Estate.

0.6 The Revised Scenario

(a) In response to the expert evaluation of the initial planned scenario in section 7, a revised scenario for the proposed non-building areas is proposed by the Planning Department as illustrated in Figures 8.1 to 8.3. Three non-building areas and two building gaps are proposed to respect the air paths as shown in Figure 5.6. They are generally in line with the recommendations in the expert evaluation and thus considered acceptable.

0.7 Further work

(a) Based on the expert assessment, there should be no major air ventilation issues if the suggestions can be followed. Further study is not necessary.

(b) There is no focus of concern in the study area due to the generally medium-rise and medium building volume density characteristics of the Area.

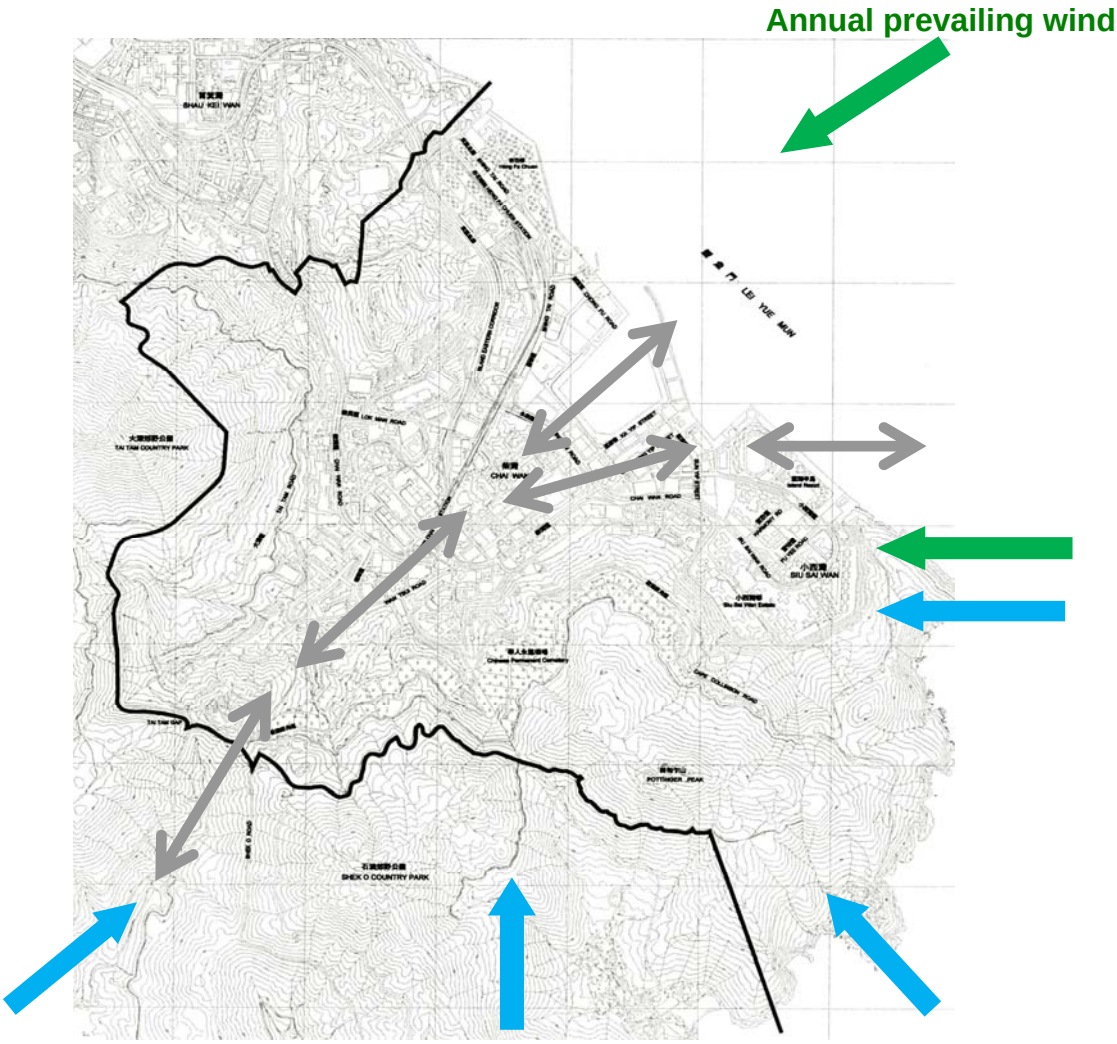


Figure 0.1 A summary of the prevailing winds of the Area (Green arrows indicate the annual prevailing wind; Blue arrows indicate summer prevailing wind; Grey arrows indicate the channeling effect area)

Expert Evaluation Report
of Chai Wan Area

1.0 The Assignment

1.1 In order to provide better planning control on the building height upon development/redevelopment, the draft Chai Wan Area Outline Zoning plan (OZP) No. S/H20/19 (the Plan) is being reviewed with a view to incorporating appropriate development restrictions for various development zones of the OZP to guide future development/redevelopment. It is considered necessary to conduct an expert evaluation to assess the preliminary Air Ventilation impacts of the proposed building height restrictions.

1.2 This expert evaluation report is based on the materials given by Planning Department to the Consultant including:

- existing building height (in mPD and storeys) for Chai Wan Area
- committed projects and planned projects (in mPD and absolute height) for Chai Wan Area
- proposed building height restrictions (in mPD) for Chai Wan Area
- site photos of Chai Wan Area
- aerial photos of Chai Wan Area
- survey sheets covering Chai Wan Area

1.3 During the writing of the report, the consultant has working sessions with colleagues at Planning Department on 30th March 2010, 3 May 2010 and 30 June 2010. The Consultant has studied the above mentioned materials, and has conducted site inspection on 18th April 2010.

2.0 Background

2.1 Planning Department's study: "Feasibility Study for Establishment of Air Ventilation Assessment System" 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 study opines that: "more air ventilation, the better" is the useful design guideline.

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

2.4 The study also suggests that Air Ventilation Assessment (AVA) be conducted in 3 stages: Expert Evaluation, Initial Studies, and Detailed Studies. The suggestion have been adopted and incorporated into HPLB and ETWB Technical Circular no. 1/06. The key purposes of Expert Evaluation are to:

(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 Area, as well as the surrounding areas.
(c) Analyse the greenery/landscape characteristics of the Area, as well as the surrounding areas.
(d) Analyse the land use and built form of the Area, as well as the surrounding areas.

Based on the analyses:
(e) Estimate the characteristics of the input wind conditions of the Area.
(f) Identify the wind paths and wind flow characteristics of the Area through slopes, open spaces, streets, gaps and non-building areas 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 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 building height restrictions as proposed by Planning Department 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.

3.0 The Wind Environment

3.1 Hong Kong Observatory (HKO) stations provide useful and reliable data of the wind environment in Hong Kong (Figure 3.1). There are some 46 stations operated

by HKO in Hong Kong. Together, they allow a very good general understanding of the wind environment especially close to ground level.

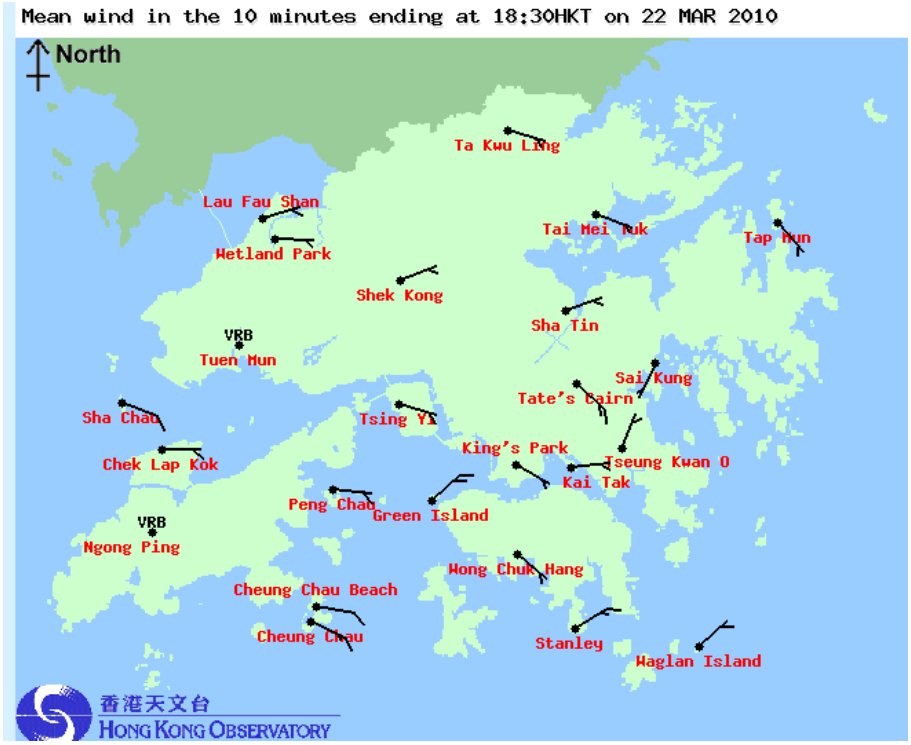


Figure 3.1 Some of the HKO stations in Hong Kong. This is a screen capture at 18:30 on 22 Mar 2010 from the HKO website. The arrows show the wind directions and speeds of the time.

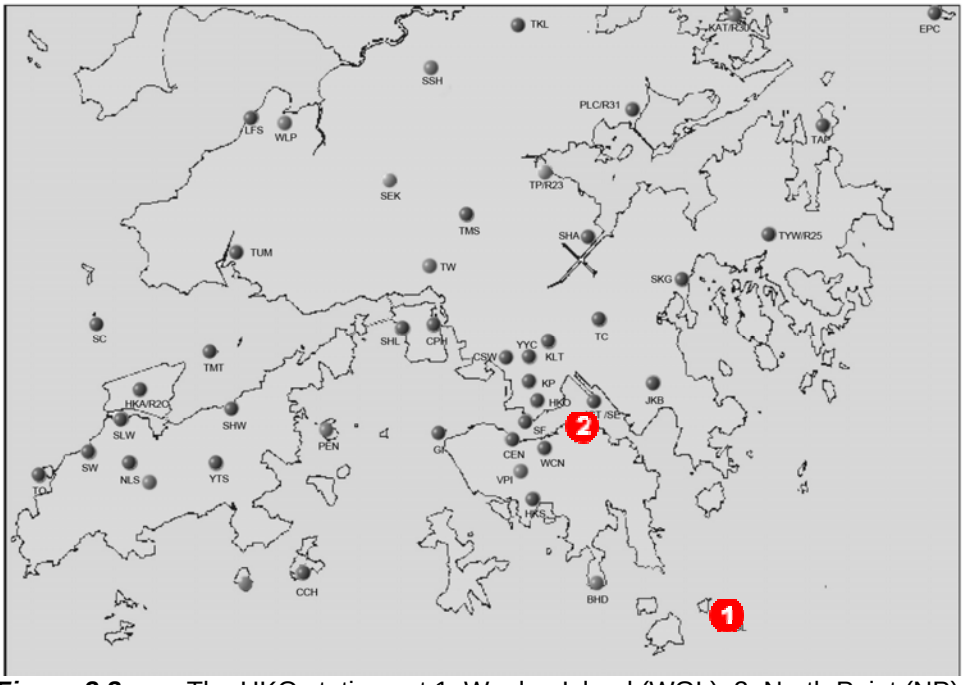


Figure 3.2 The HKO stations at 1: Waglan Island (WGL), 2: North Point (NP),

3.2 The HKO station at Waglan Island (WGL) is normally regarded by wind engineers as the reference station for wind related studies (Figure 3.3). The station has a very long measuring record, and it is unaffected by Hong Kong's complex topography [unfortunately, it is known not to be able to capture the thermally induced local wind circulation like sea breezes too well]. Based on WGL wind data, studies

are typically employed to estimate the site wind availability taking into account the topographical features around the site.

3.3 Examining the annual wind rose of WGL, it is apparent that the annual prevailing wind in Hong Kong is from the East. There is also a major component of wind coming from the North-East; and there is a minor, but nonetheless observable component from the South-West. Around 70% of the time, WGL has weak to moderate wind (0.1m/s to 8.2 m/s).

3.4 For the study, it is useful to understand the wind environment seasonally or monthly (Figures 3.4 and 3.5). In the winter months of Hong Kong, the prevailing wind comes from the North-East. In the summer months, they come from the South-West. As far as AVA is concerned, in Hong Kong, the summer wind is very important and beneficial to thermal comfort. Hence, based on WGL data, it is very important to plan our city, on the one hand, to capture the annual wind characteristics, and on the other hand, to maximize the penetration of the summer winds (mainly from the South-West) into the urban fabric.

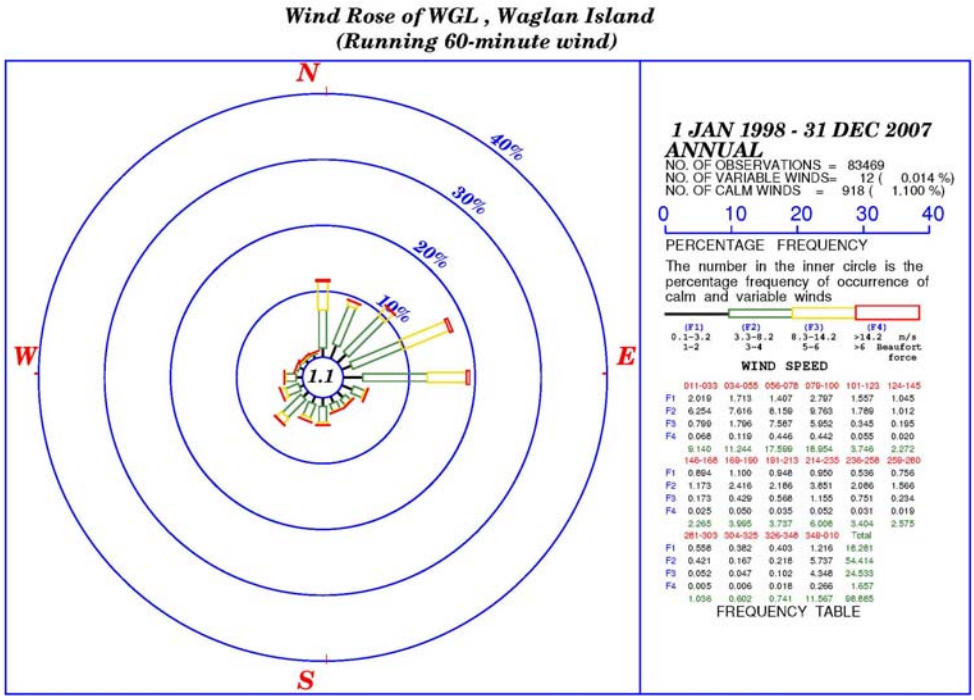


Figure 3.3 Wind rose of WGL 1998 – 2007 (annual) [Wind data in 1998 – 2007 are the latest available 10-year data from HKO to the consultant.]

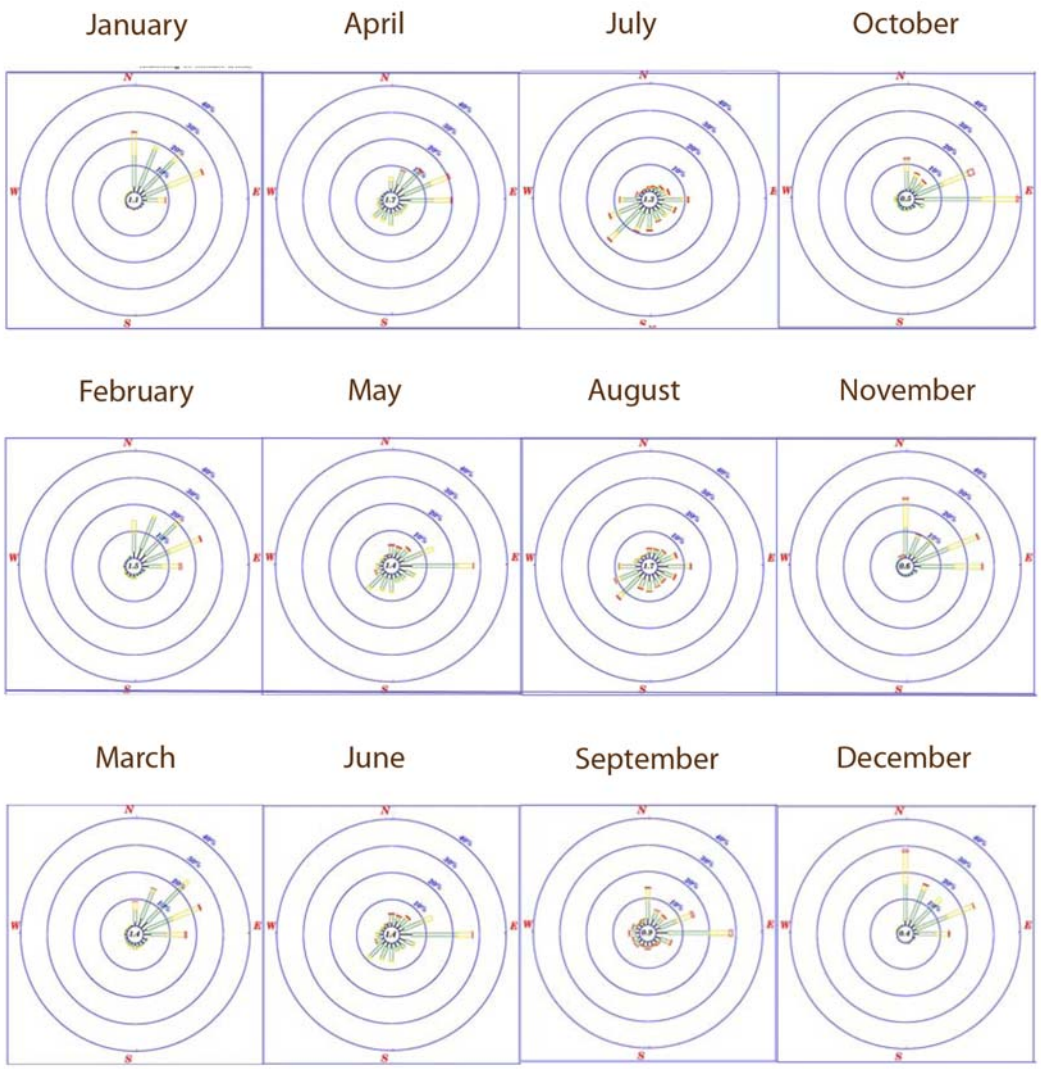


Figure 3.4 monthly wind roses of WGL 1998 – 2007

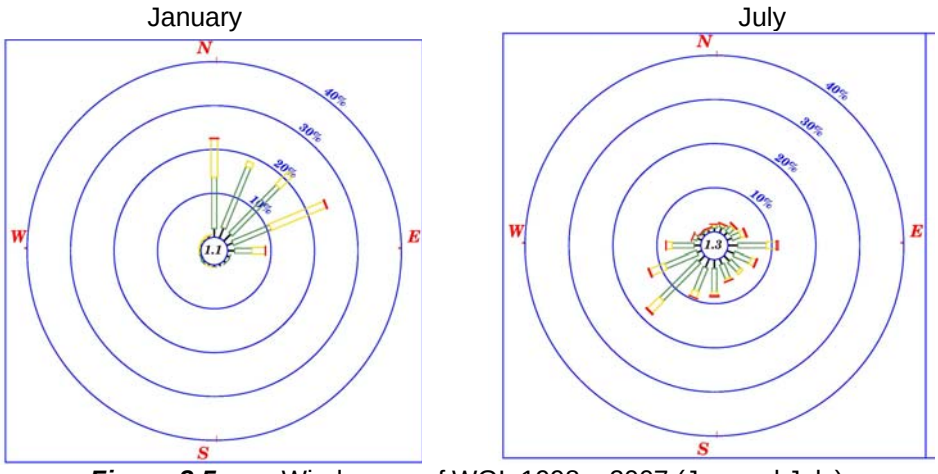


Figure 3.5 Wind roses of WGL 1998 – 2007 (Jan and July)

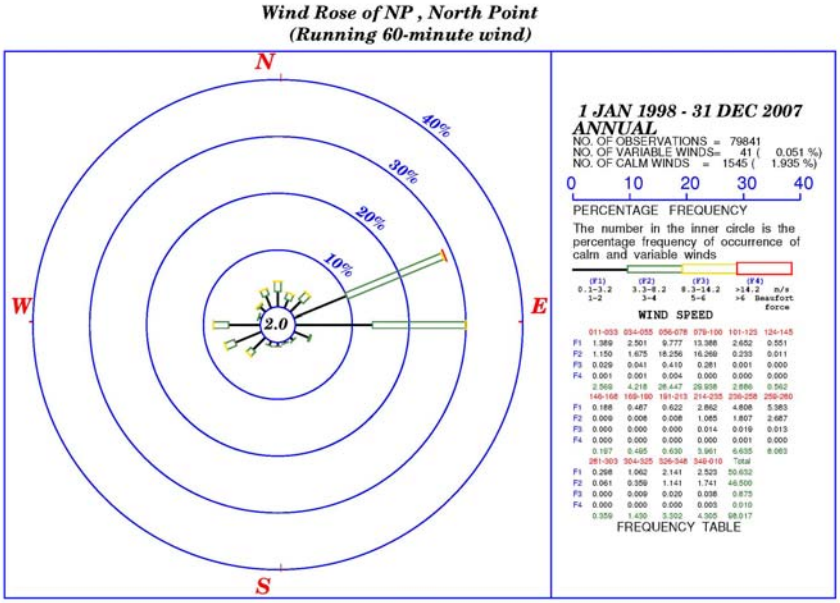


Figure 3.6 Wind rose of North Point 1998-2007 (annual)

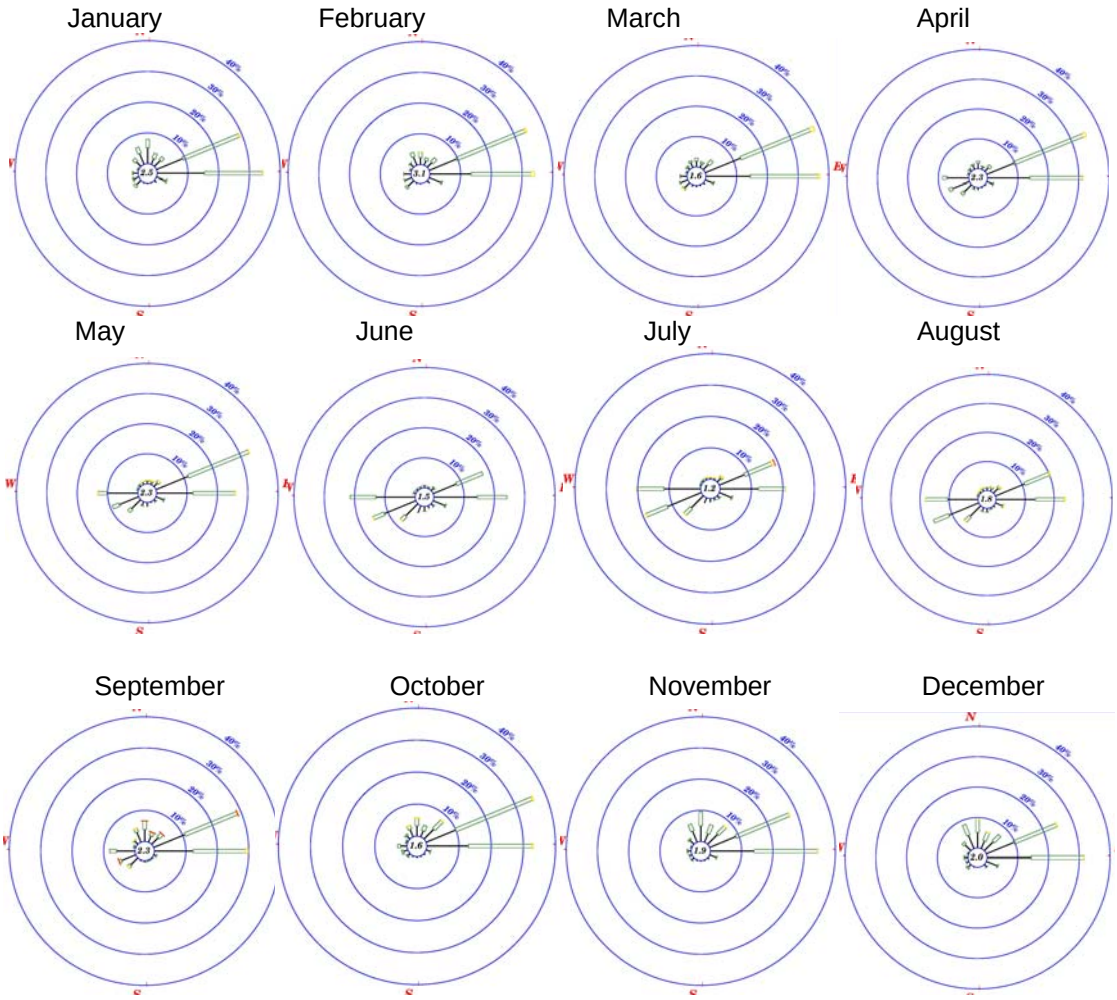


Figure 3.7 monthly wind roses North Point 1998 – 2007

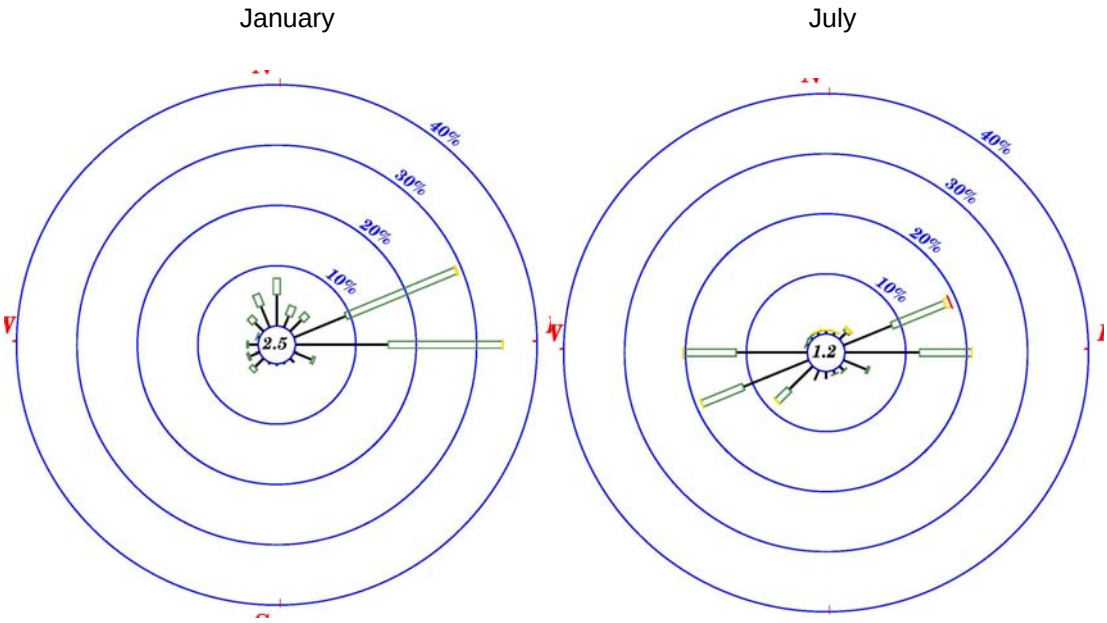


Figure 3.8 Wind roses of North Point 1998 – 2007 (Jan and July)

3.5 The HKO station at North Point is the nearest station to the study area (Figures 3.6 to 3.8). Its measurements show that east wind dominates the annual wind direction complemented with a smaller component of northeast wind. In the summer months, strong east-west and southwest–northeast channeling winds can be observed. This is because North Point is exposed to the sea in the northerly quarters from the east to the west and background winds from southerly quarters are shielded by massive mountains.

3.6 Researchers at the Hong Kong University of Science and Technology (HKUST), Prof Alexis Lau and Prof Jimmy Fung, have simulated a set of wind data using MM5. The data period cover the whole year of 2004. Based on this dataset, 3 locations of the Area are extracted at 120m and 450m above ground (Figures 3.9 to 3.15).

Figure 3.9 The 3 locations of MM5 extracted data

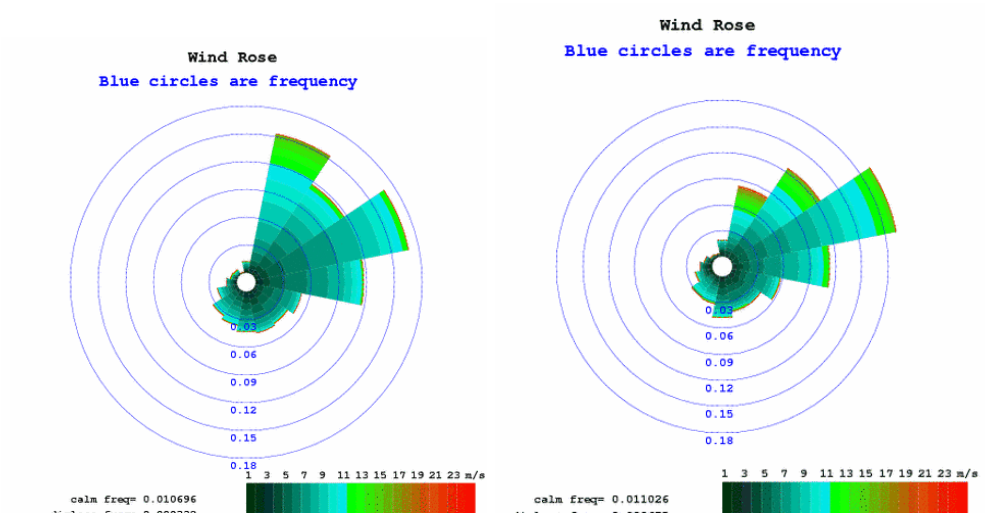


Figure 3.10 Wind roses (annual) at A (120m; 450m)

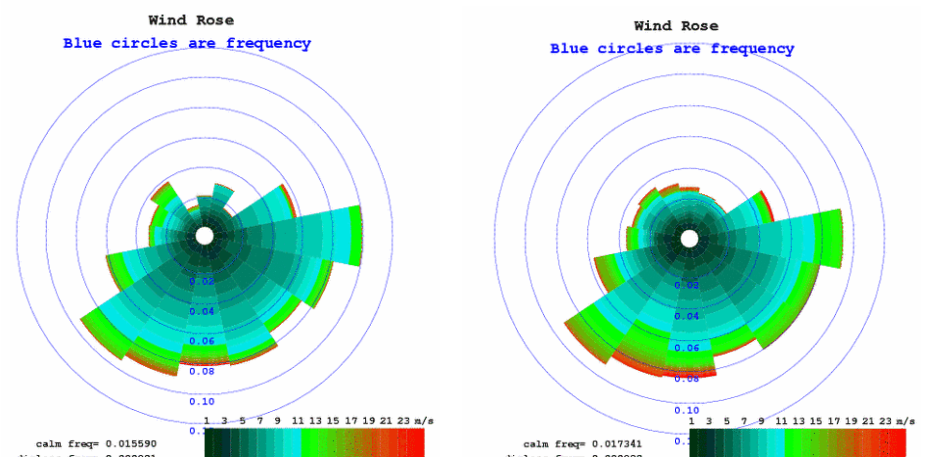


Figure 3.11 Wind roses (summer) at A (120m; 450m)

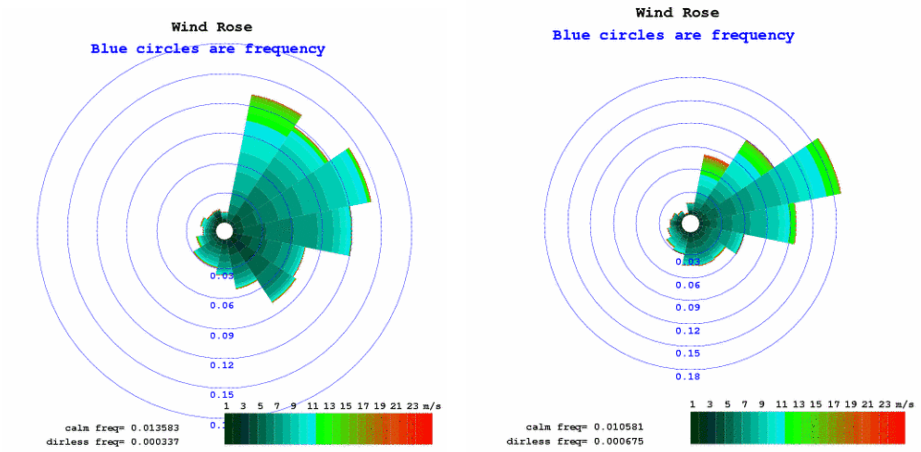


Figure 3.12 Wind roses (annual) at B (120m; 450m)

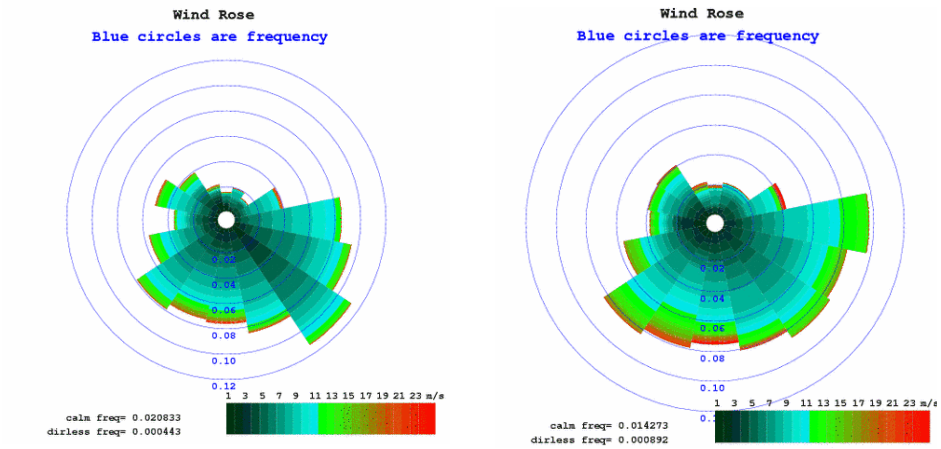


Figure 3.13 Wind roses (summer) at B (120m; 450m)

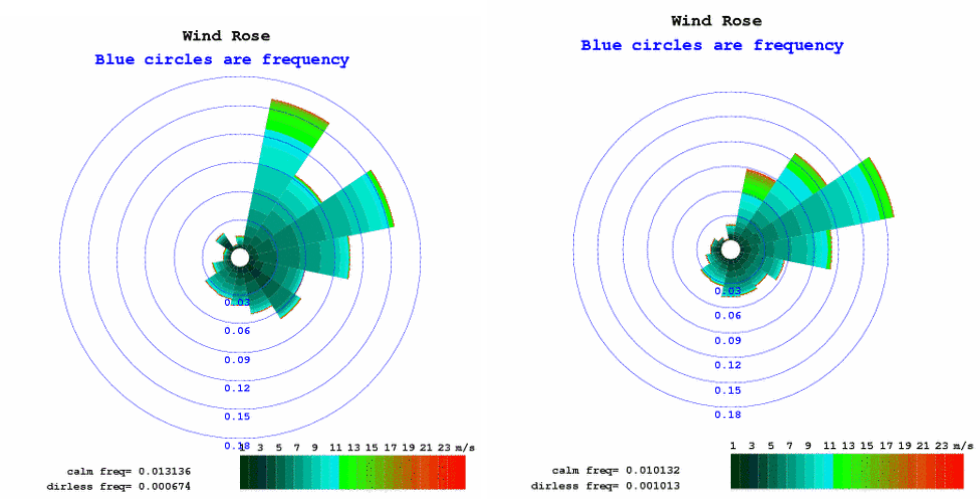


Figure 3.14 Wind roses (annual) at C (120m; 450m)

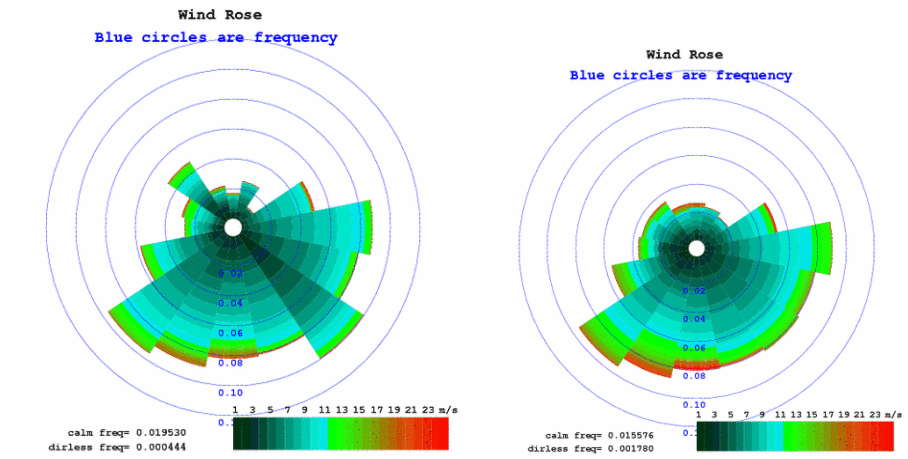


Figure 3.15 Wind roses (summer) at C (120m; 450m)

3.7 Using the simulated MM5 data, the annual and the summer prevailing wind directions of the study Area and the surroundings can be evaluated as in Figures 3.16 and 3.17.

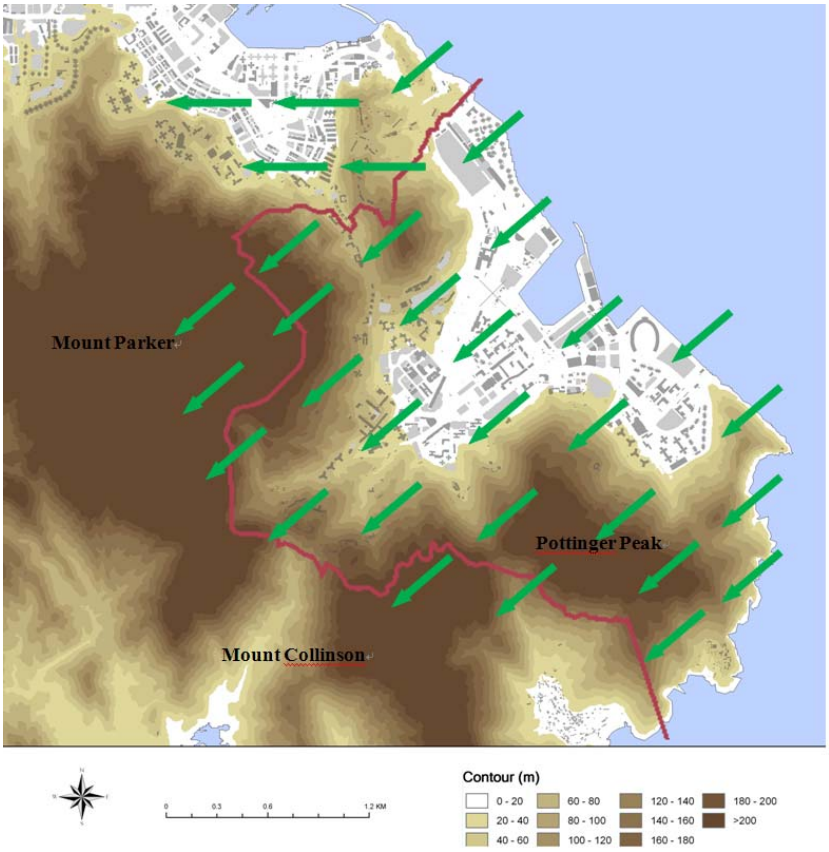


Figure 3.16 Prevailing wind directions (annual) based on MM5

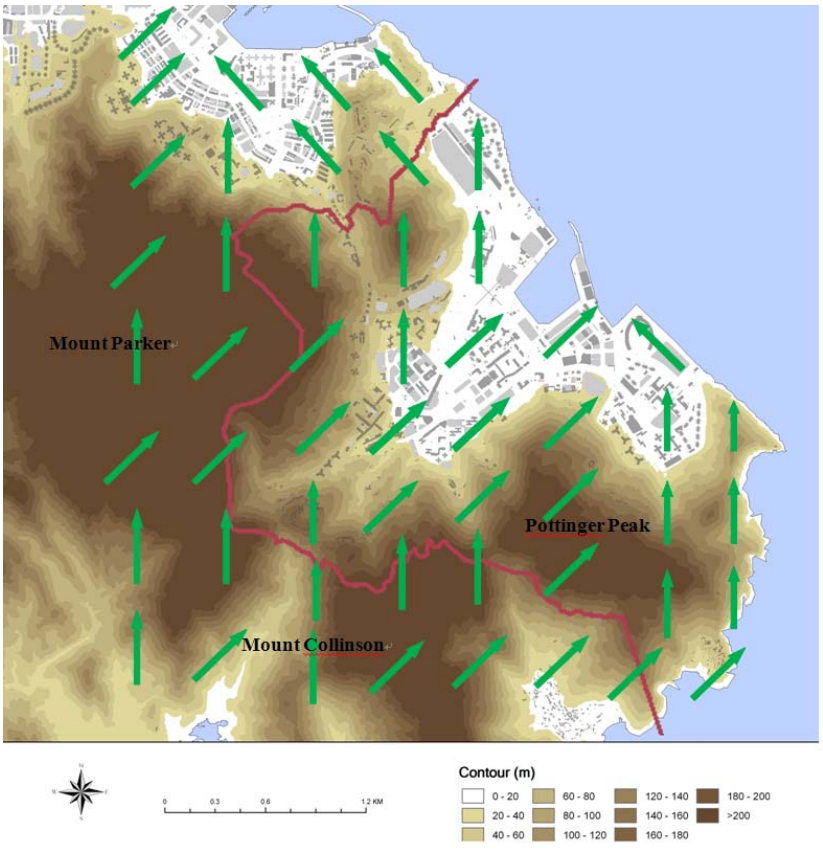


Figure 3.17 Prevailing wind directions of the summer months (Jun-Aug) based on MM5.

3.8 Based on the MM5 simulated wind roses of the 3 locations extracted, one can evaluate that there are little differences among them (Table 1) in terms of the prevailing wind directions.

Table 1 Evaluated prevailing directions of the 4 locations

	Annual	Summer
A	NE, E	SW, E, S, SE
B	NE, E	SE, E, SW ,S
C	NE, E	SE, SW, E ,S

3.9 In summary, based on the available wind data, one may conclude that the annual wind of the study area is mainly from North-East and East. The directions of the summer winds range from southwest, south, southeast to east. There is a strong northeast-southwest and east-southwest channeling effect (grey arrows in Figure 3.18) at/near ground level due to the surrounding topography and the area's proximity to the waterfront.

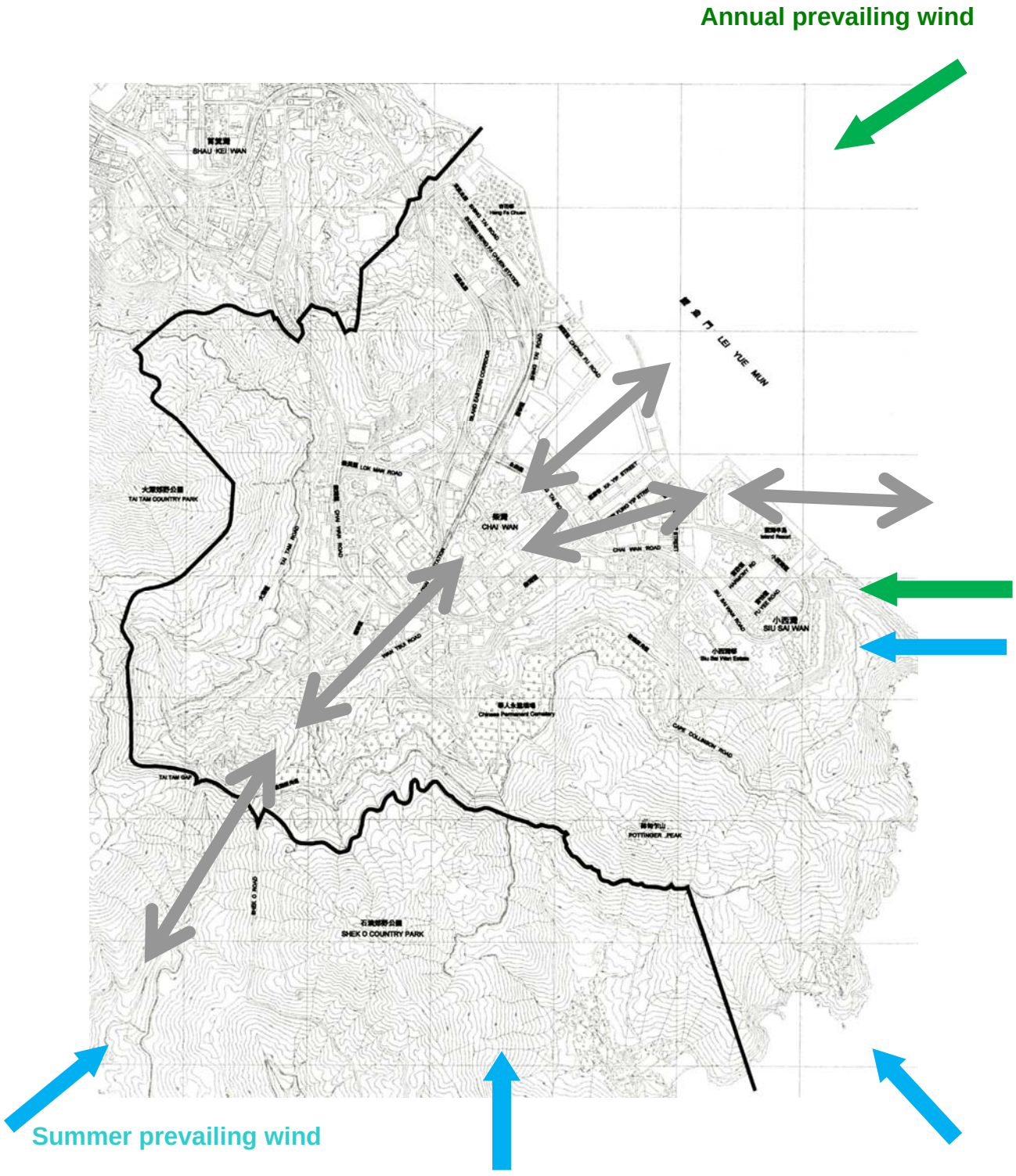


Figure 3.18 A summary of the prevailing winds of the Area (Green arrows indicate the annual prevailing wind; Blue arrows indicate summer prevailing wing; Grey arrows indicate the channeling effect area)

4.0 Topography, Land-Sea Breezes and the Urban Wind Environment

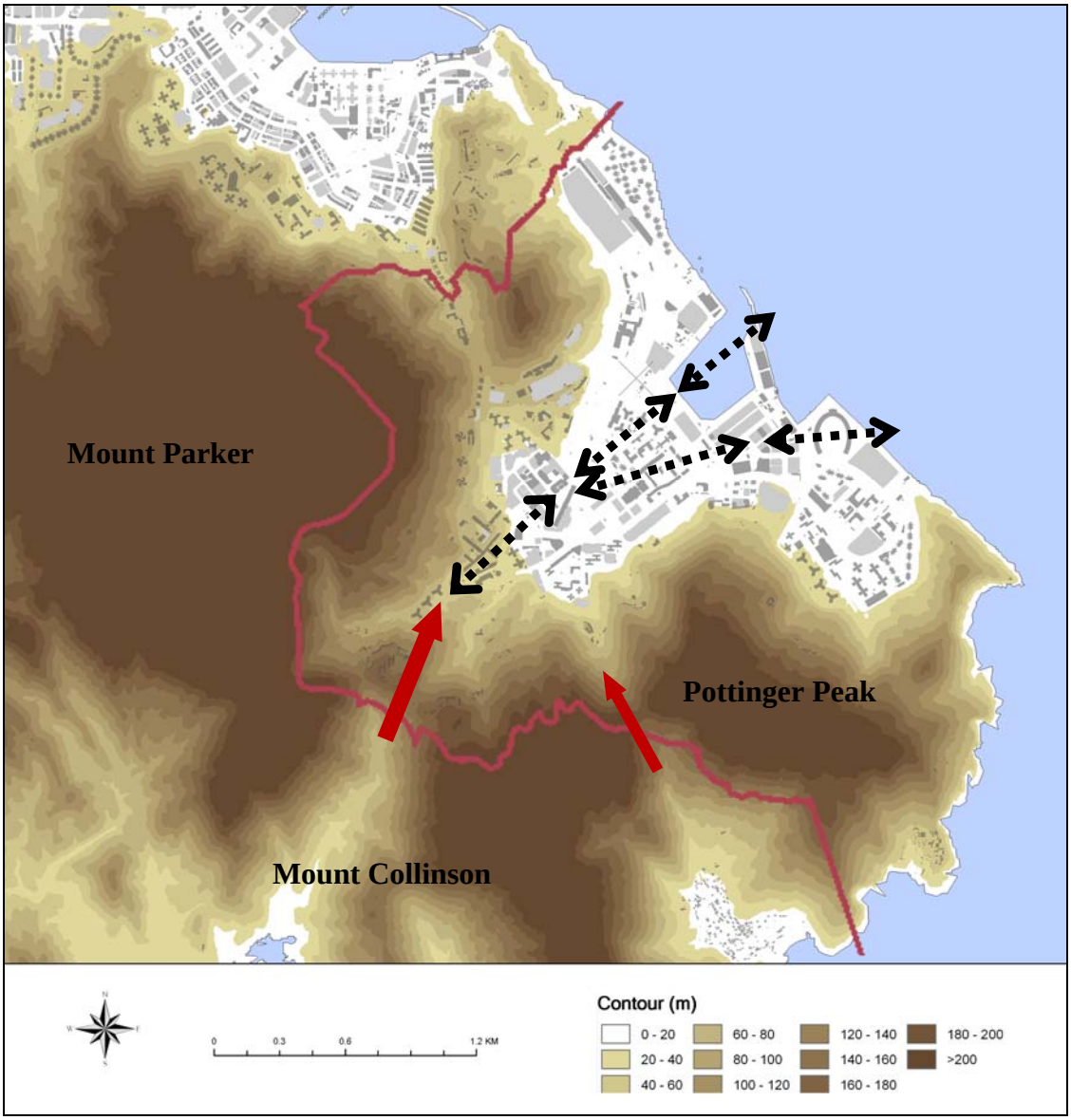


Figure 4.1 A digital elevation map of the Area (Red arrows indicate the valley wind system; Black arrows indicate northeast-southwest and east-southwest winds)

4.1 The Area is at the east of Hong Kong Island. Most of the developments in the area are on flat reclamation land. The Area is, on the whole, exposed to the sea in the northeast and partially enclosed by Mount Collinson (348mPD) in the south, Mount Parker (507mPD) in the west and Pottinger Peak (312mPD) in the southeast.

4.2 While the mountains will weaken the background wind from the west (an illustration is given in Figure 4.2 and Appendix A), winds from the southerly quarters will find its ways through two mountain passes and penetrate through the valleys into the Area (see the two red arrows in Figure 4.1).

4.3 Minor katabatic (downhill) air movement can be expected from the vegetated hill slopes surrounding the study area.

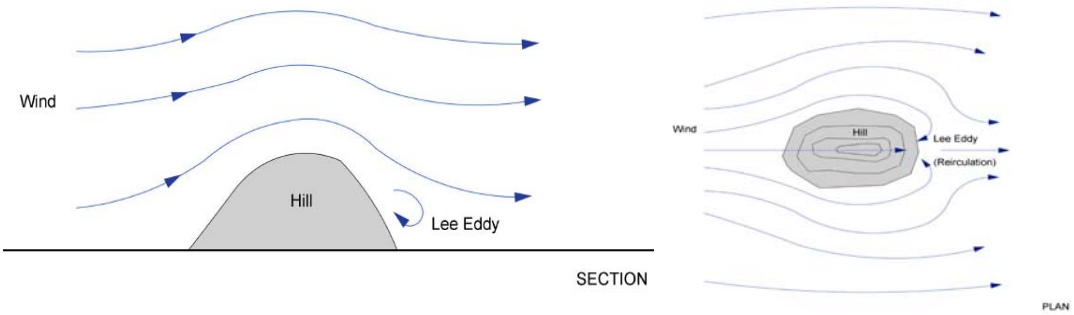


Figure 4.2 An example of wind flow across hills under moderate wind.

4.4 Due to the channeling effects induced by the surrounding mountain ranges, winds of the northeast-southwest and east-southwest are the most dominant wind directions to be respected for air ventilation (black arrows in Figure 4.1). It is important to respect this ventilation corridor.

5.0 The Existing Conditions

5.0.1 The existing building heights in terms of metres above Principal Datum and absolute heights in metres are shown in Figures 5.1 and 5.2 respectively.

5.0.2 As shown in Figure 5.2, most of the existing buildings have absolute heights not higher than 90m. Apart from a few very high private residential buildings near the east waterfront, other buildings with absolute heights more than 90m include the industrial-office buildings at Sun Yip Street and residential buildings in the southern/western foothill areas.

5.0.3 Many of the residential buildings are owned by the Housing Authority. They vary in absolute heights: Yue Wan Estate is lower than 30m; Wan Tsui Estate, Siu Sai Wan Estate, Tsui Wan Estate, Hing Wah (II) Estate and Tsui Lok Estate are lower than 90m; Hing Wah (I) Estate, Siu Sai Wan Estate, Fung Wah Estate and Hing Man Estate are lower than 120m (Figure 5.2). Some of the taller blocks in Hing Wah (II) Estate are perpendicular to the prevailing wind and thus may weaken the important valley winds from the southwest.

5.0.4 Heng Fa Chuen, with closely packed buildings, is on the waterfront. The buildings are not tall. It is not causing any noticeable air ventilation issues to the inland area.

5.0.5 The long row of north-south orientated blocks of Fullview Garden at Siu Sai Wan Road restricts some of the easterly winds into Siu Sai Wan area. Fortunately, the Siu Sai Wan Promenade provides useful relief especially to the schools at Fu Yee Street and Harmony Road. Buildings within the adjoining residential developments Kai Tsui Court and Siu Sai Wan Estate are not closely packed together and wind from the east can penetrate into the Area.

5.0.6 It is a pity that the bulky Island Resort and its extensive podium are blocking the sea winds into Harmony Road, which should ideally be extended to the waterfront. However, there is prevailing east wind blowing between the building

gaps. In future, it is very important to assess developments on the waterfront that may cause air ventilation issues to its neighbours – this and other sites.

5.0.7 Along the northern waterfront, the area is not over-developed. There are some undeveloped lands reserved for open space or G/IC uses along Sheung On Street and Chong Fu Road. Care must be exercised that future developments respect the important southwest and northeast channeling wind of the area by introducing non-building areas and gaps between buildings. Illustrations are given in Figures 7.5 and 7.6.

5.0.8 The current undeveloped open space at the junction of Sheung On Street/Sheung Ping Street on the waterfront is an important air ventilation entrance to the Area. It has the potential to link across Tsui Wan Estate to Chai Wan Park, thus greatly benefits the air ventilation of the Area. Further suggestions of non-building areas in Tsui Wan Estate will be discussed in section 7 and illustrated in Figure 7.3.

5.0.9 There are also more than a few G/IC sites in the Area, such as stadium, parks, gardens, community centre, college and schools. Together with other open spaces (Section 5.1 below refers) and connected with roads, these G/IC sites provide useful relief and air spaces which would enhance the efficacy of the air paths. Care must be exercised when they are further developed with taller or bulkier buildings or re-zoned for larger developments.

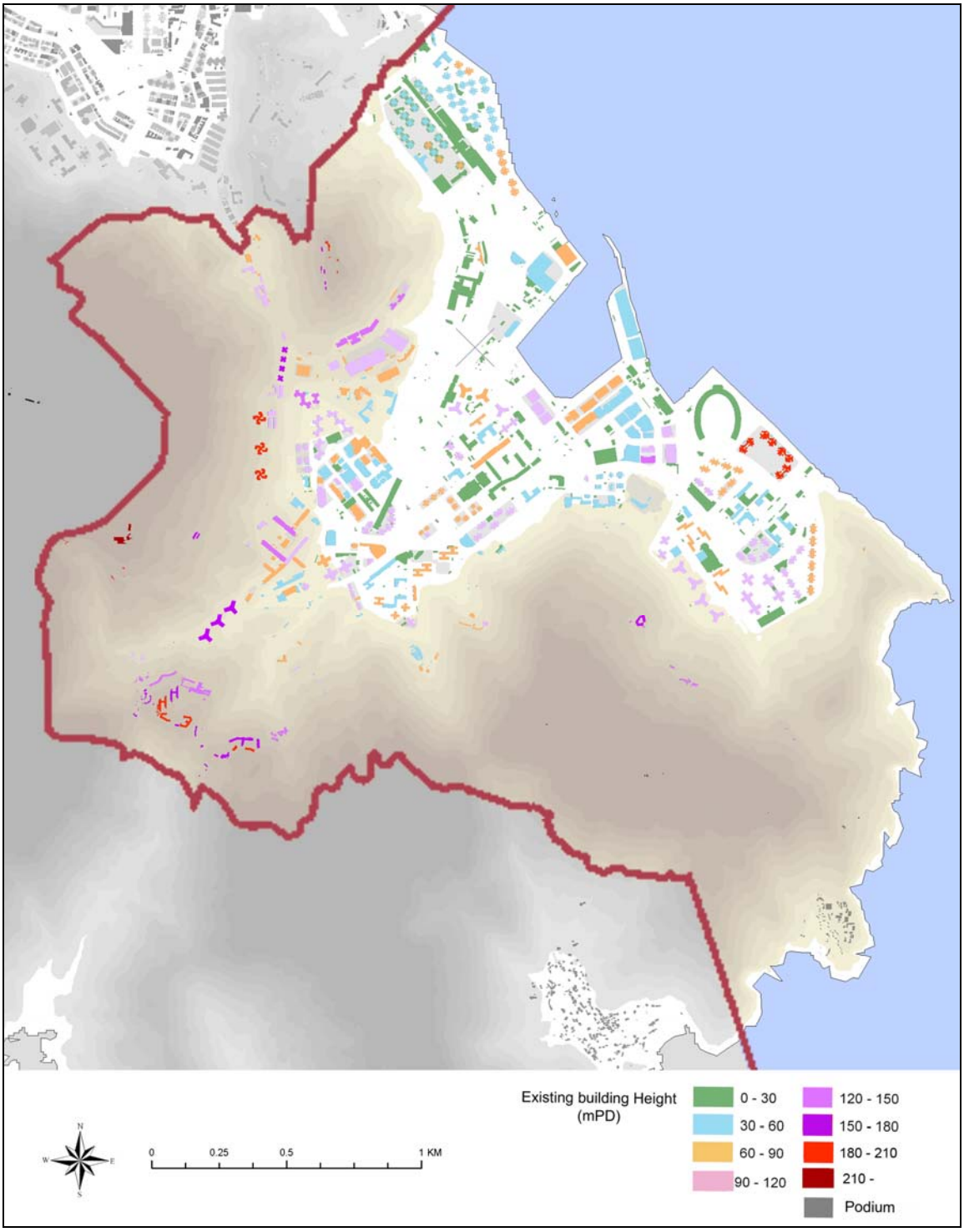


Figure 5.1 Existing building height in mPD

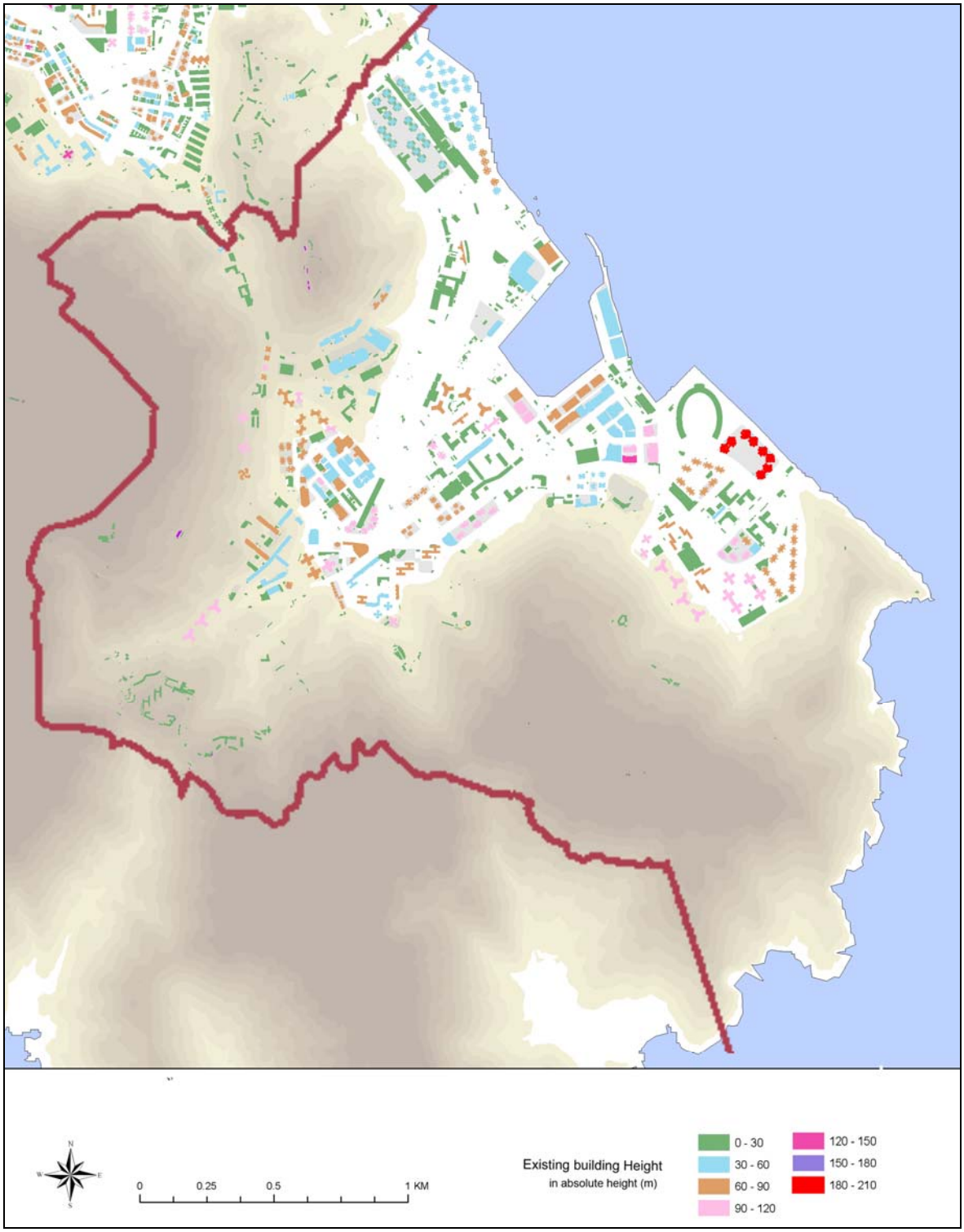


Figure 5.2 Existing building height in absolute height

5.1 Greenery, Open Spaces and Landscaping

5.1.1 Based on land-use map, the study area has extensive green coverage (Figure 5.3), mainly on the slopes of the surrounding hills and open spaces near the MTR Chai Wan Station aligned in the direction of southwest-northeast. They are useful in terms of generating cool and fresh air. Utilizing these green areas appropriately for provision of air paths is recommended. Care must be exercised when they are further developed with taller or bulkier buildings or re-zoned for larger developments.

5.1.2 The Area has quite a few open spaces as "air spaces" where air ventilation can be relieved given the dense urban morphology (Figure 5.3). They include Siu Sai Wan Stadium, Siu Sai Wan Promenade, Chai Wan Pool Side Garden, Wan Tsui Estate Park, Chai Wan Park, Sheung On Street Playground, Wing Tai Road Garden, Heng Fa Chuen Playground. Being connected to waterfront and with each other, they are very useful to the Area in terms of air ventilation.

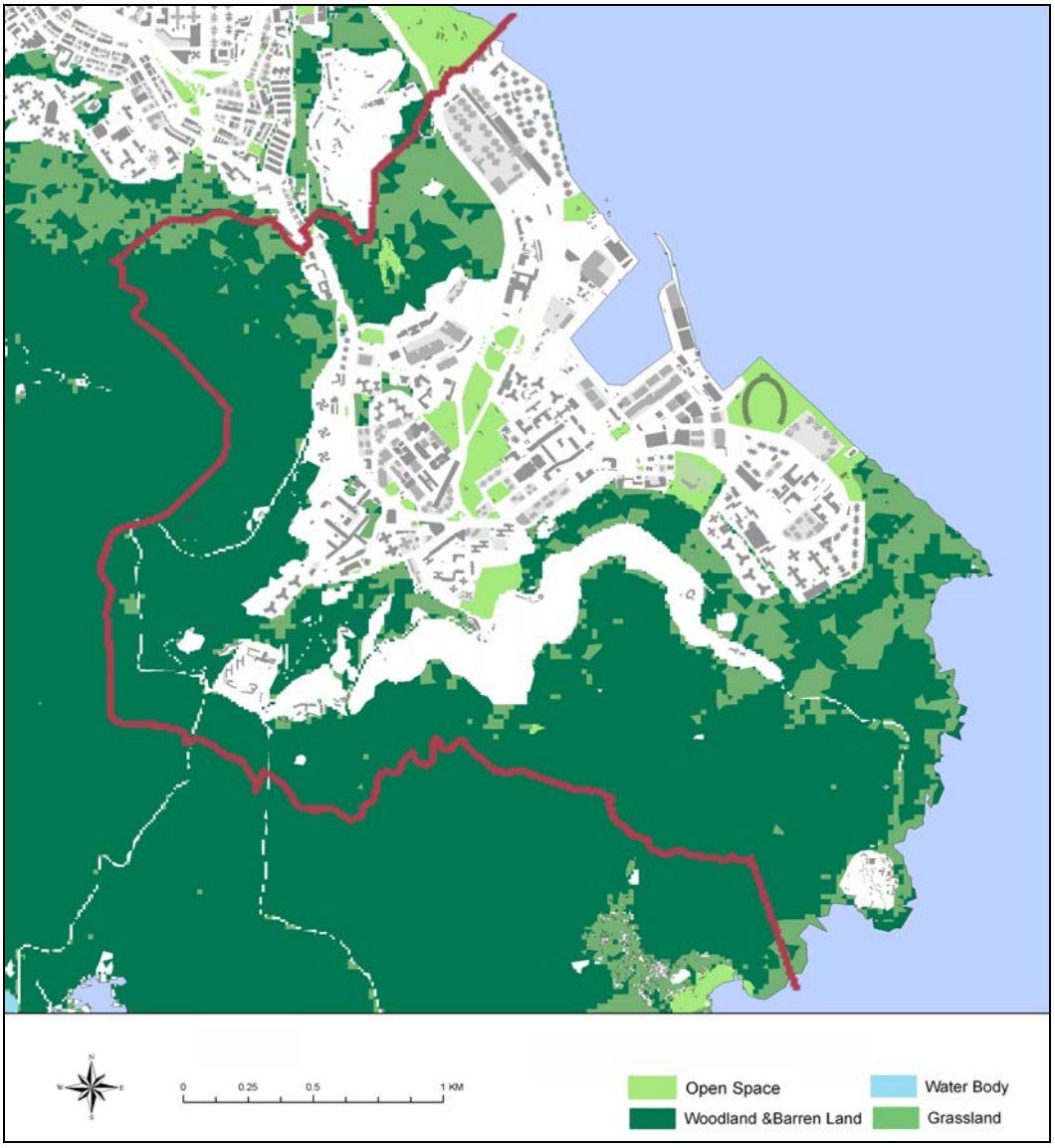


Figure 5.3 A greenery map of the Area based on land use data provided by PlanD

5.2 Land Use and Urban Morphology

5.2.1 Based on Figures 5.3 and 5.4, the greenery and open coverage of the Area are high in undeveloped areas and scattered in developed areas; the corresponding Ground Coverage in developed areas is overall medium, with some clusters of high-value pixels.

5.2.2 Some clusters of high-value pixels are found in locations A, B and C (Figure 5.4). Location A is at the centre of the Area, occupied by larger industrial buildings and narrower streets. However, this location is just on an important air path in the direction of northeast-southwest of the area, which is discussed and indicated in section 5.3. Location B is on a private residential development site, Heng Fa Chuen. Its proximity to the waterfront and isolation from other development areas makes it less critical. Location C has more dispersed developments.

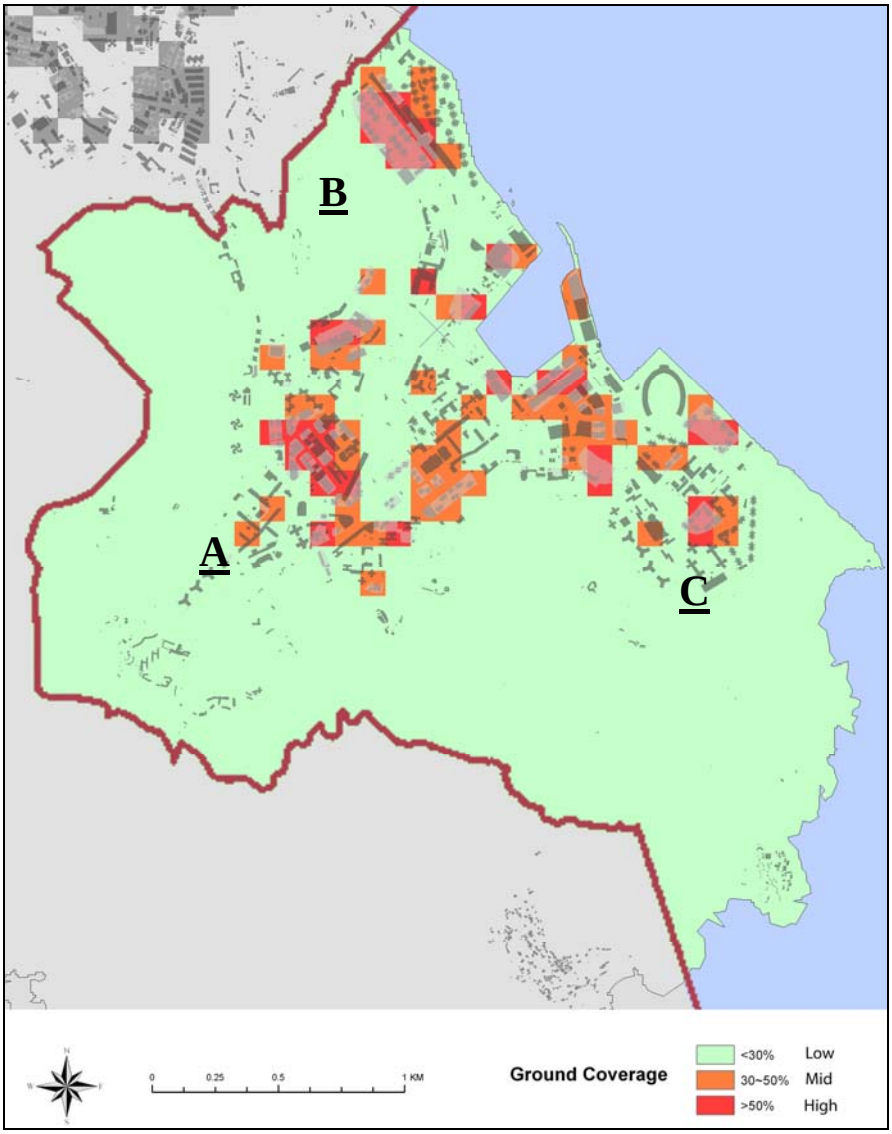


Figure 5.4 Ground Coverage Ratio map of the Area resolved to 100mx100m cell area (include roads, open spaces and ground area covered by buildings and podiums) [Ground Coverage Ratio is the ratio of total ground area (include roads and open spaces) and ground area covered by buildings and podiums in a 100m x 100m grid.]

5.2.3 Higher building volume increases the urban thermal capacity and reduces urban Sky View Factor (SVF), which reduces long wave radiation back to the sky causing urban heat island. This creates higher thermal stress in the summer months and the need for higher air ventilation to mitigate the negative thermal effects. Researchers at CUHK have earlier resolved a set of Building Volume Density (BVD) which is as shown at Figure 5.5. On the whole the building volume density of the Area is medium. The clustered cells of medium value are industrial buildings around Cheung Lee Street, residential buildings in the east of Siu Sai Wan Road and buildings of and around Island Resort.

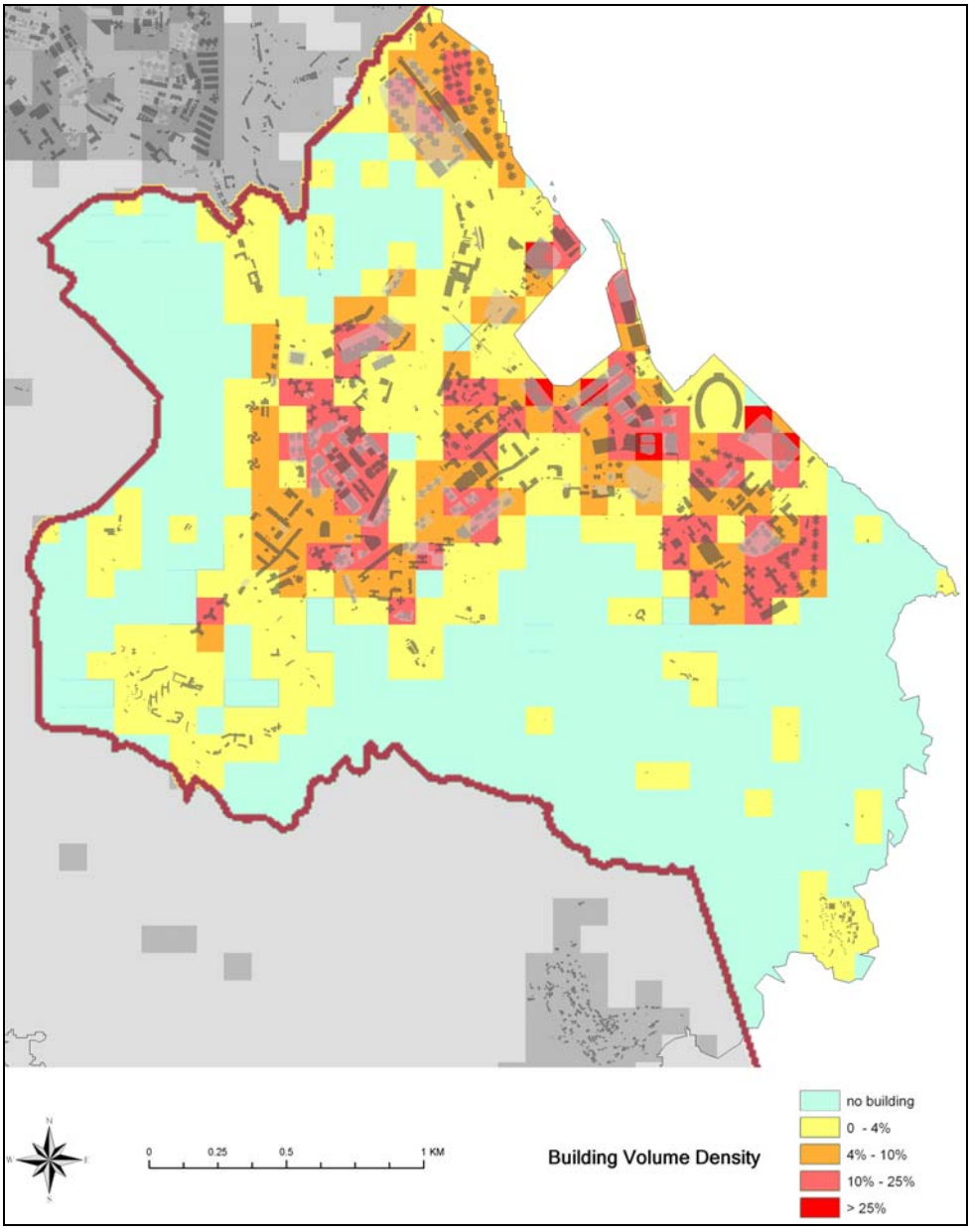


Figure 5.5 Building Volume Ratio map of the Area resolved to 100m x 100m grid. [For a site that occupies 100m x 100m, with a plot ratio of say 5, the building volume of the site will be about 150,000m^3. Building Volume Density in % (BVD) is building volume in m^3 of a 100m x 100m grid of land divided by a datum value of 1,200,000 m^3]

5.3 Air Paths

Figure 5.6 Air Paths of the Study Area

5.3.1 Based on an understanding of the Area's background wind, topography and existing building morphology, the air paths of the Area can be evaluated in following paragraphs.

5.3.2 Currently, a major air path (thick orange double arrows in Figure 5.6) in the Area is formed by channeling effects from the sea and mountain valleys as shown in Figure 4.1. The direction is either northeast-southwest or east-southwest. This air path is mainly connected by open spaces and roads. However, it may be weakened in the middle by the building blocks of Hing Wah (II) Estate positioned perpendicular to wind direction and the dense industrial developments to the west of MTR Chai Wan Station.

5.3.3 There are other two air paths in the Area including the southwest-north air corridor along Hong Man Street, Wing Tai Road Garden, Shing Tai Road and Heng Fa Chuen Playground, and the southwest-east air corridor along Wan Tsui Road, Chai Wan Road, Sheung On Street Playground and Fung Yip Street. These two air paths are illustrated in Figure 5.6 by small orange double arrows.

6.0 The Existing Conditions with Committed Projects

6.1 There are a number of committed developments (Figure 6.1) scattered in the Area. Among them, the office building at Lee Chung Street and the residential development at Lin Shing Road are not extensive in size. These projects will not adversely affect the existing surroundings in terms of air ventilation.

6.2 There are also a few potential redevelopments in the Area (Figure 6.2). The redevelopment at the ex-China Motor Bus depot at Chai Wan Road may weaken the important southwest-northeast channeling winds from the waterfront to Chai Wan Estate. It is noted that a maximum building height of 140mPD would be imposed for the site. To ensure better ventilation at the pedestrian level, permeable podium design should be adopted for the site.

6.3 In addition, there is a cluster of industrial buildings near the MTR Chai Wan Station. As mentioned in sections 5.2.2 and 5.2.3, special care must be exercised when developments are made in this area so that the southwest-northeast air path is respected. Another cluster is the industrial buildings near the junction of Fung Yip Street and On Yip Street, and the residential buildings at Chai Wan Road. They are not extensive in size.

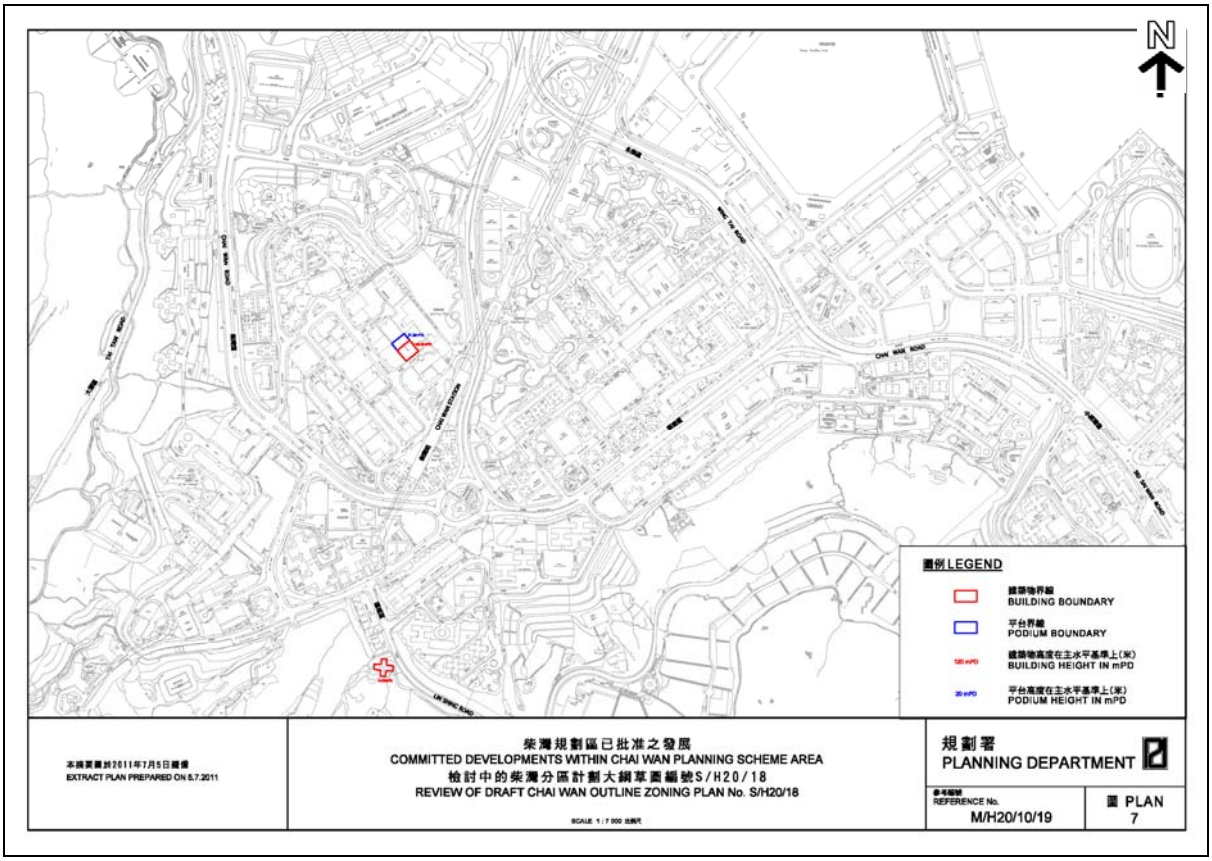


Figure 6.1 Committed Developments in the Area (indicating their locations and sizes)

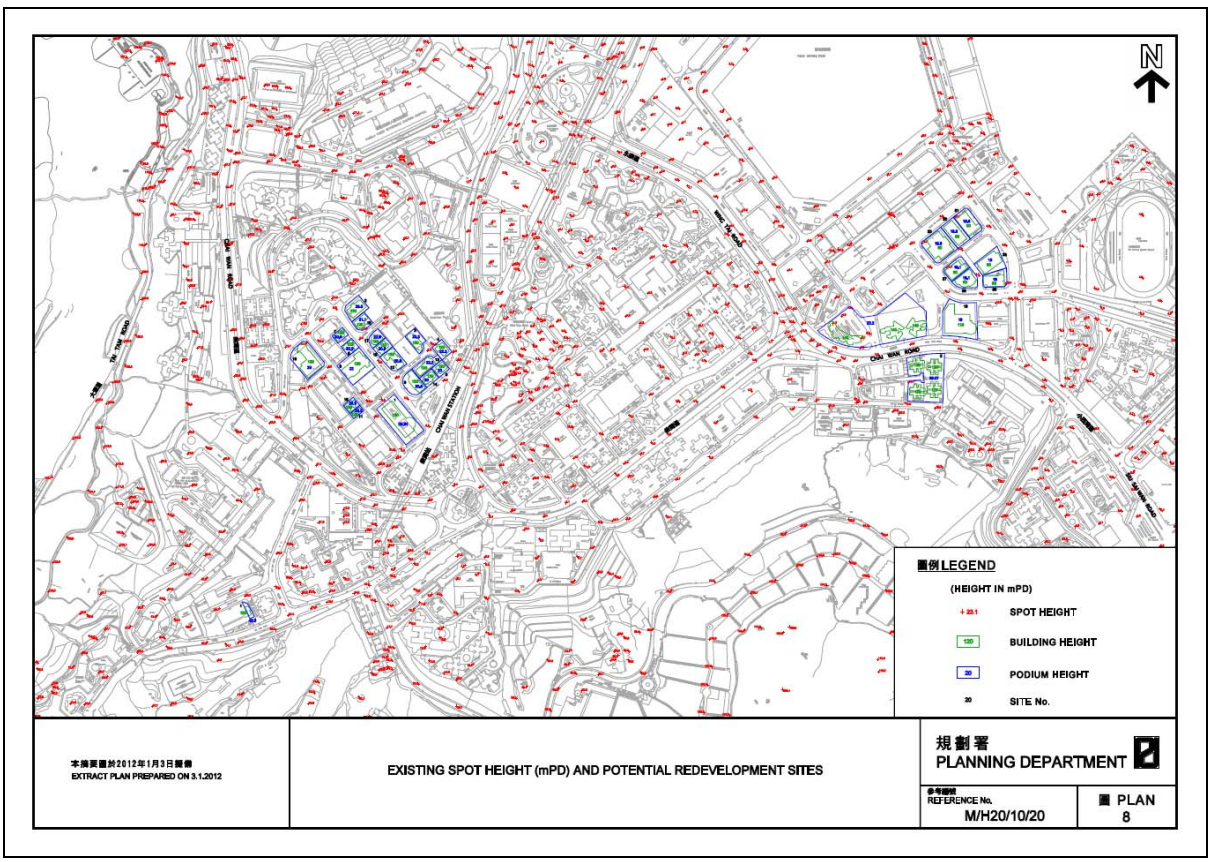


Figure 6.2 Potential Developments in the Area (indicating their locations and sizes)

7.0 Expert Evaluation and Recommendations of the Initial Planned Scenario

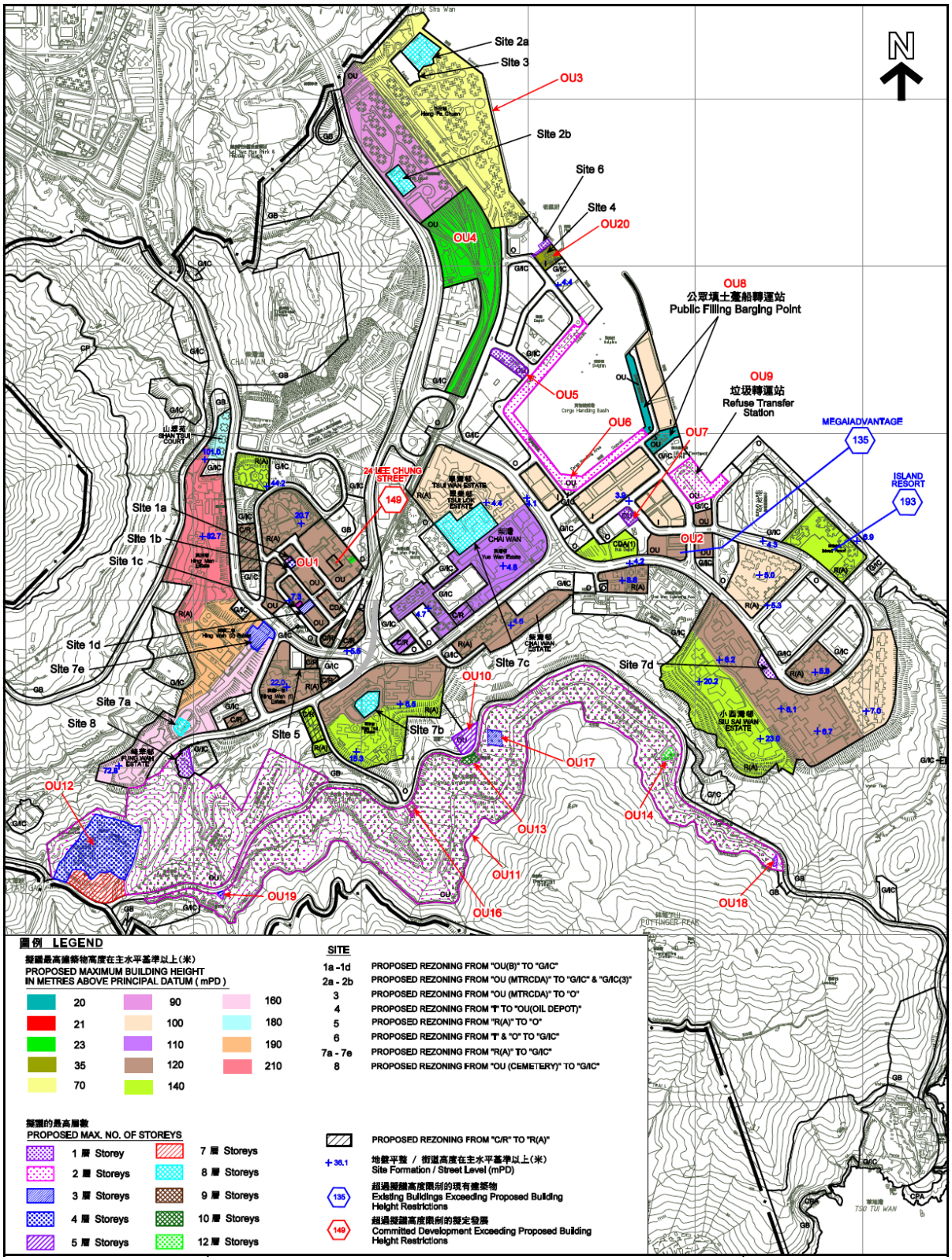


Figure 7.1 The Initial Planned Scenario of the Area (proposed building height restrictions in mPD for "CDA", "R(A)", "I", and "OU")

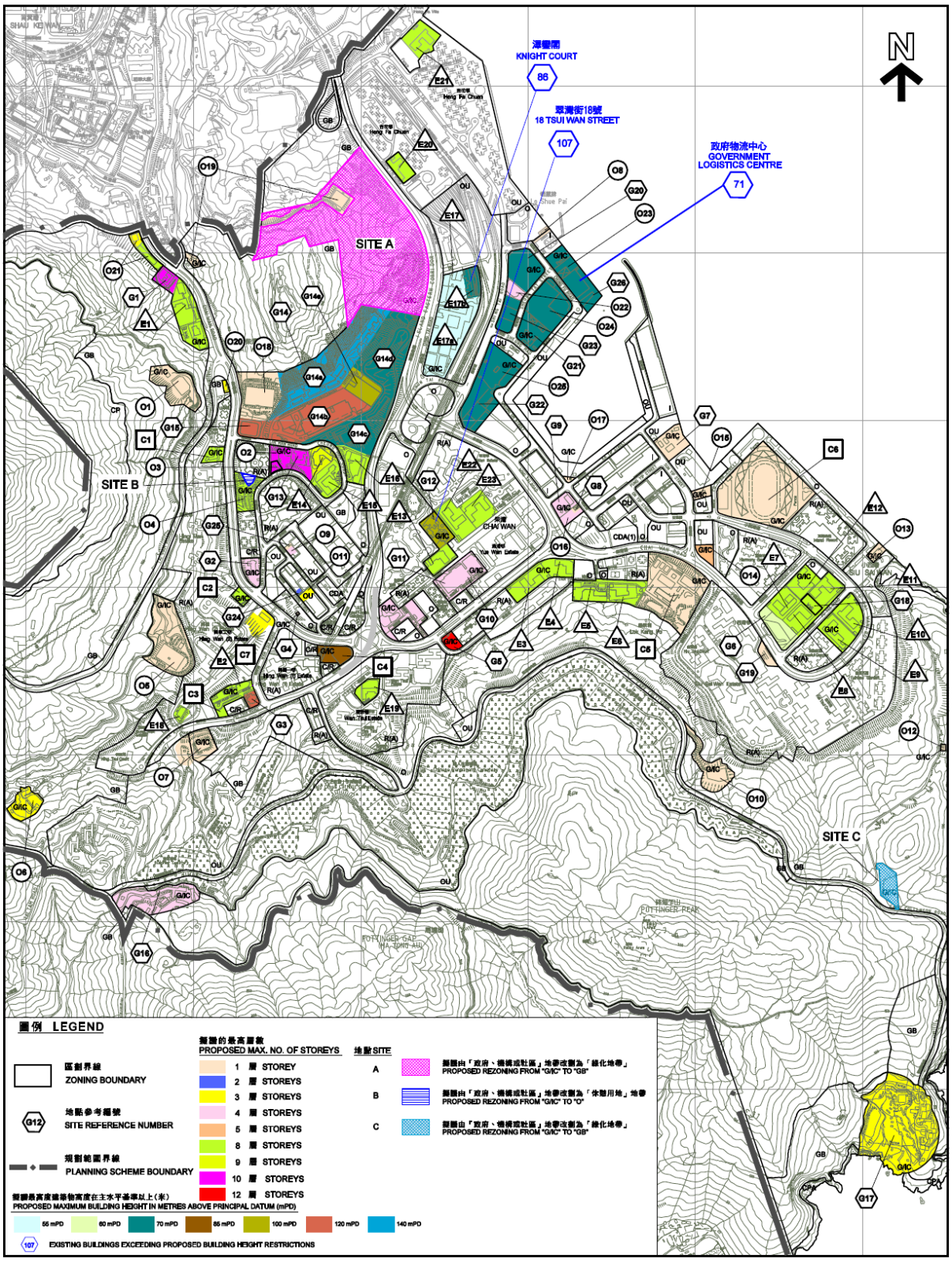


Figure 7.2 The Initial Planned Scenario of the Area (proposed building height restrictions in mPD for "G/IC"

7.1 It must be stressed that given Hong Kong's tall building urban morphology, on the whole, building height restriction (or minor changes of building heights) is not the most effective method for maintaining and/or improving air ventilation. Breezeways,

air paths, open spaces, gaps between buildings and building permeability – especially near ground level, are more effective.

7.2 Where stated, the proposed building height restrictions (Figures 7.1 and 7.2), largely reflect the heights of existing buildings. Overall, the stepped profile of building heights is adopted from 70mPD near the waterfront to 210mPD near the hillside slope. A good variety of building heights will facilitate the air ventilation in the Area. Chapter 11 of Hong Kong Planning Standards and Guidelines (HKPSG) can be referred to illustrate the effect (Figure 7.7).

7.3 The initial planned scenario keeps most of the existing "G/IC" sites (Figure 7.2) as low-rise buildings and "O" sites, and include proposals to rezone some "G/IC" sites to "GB" and "O". "G/IC" sites connected to or next to the air paths are particularly useful. Further greening on these sites is recommended.

7.4 It is good to rezone some of the development zones to zones of much less intensive developments, such as "G/IC", "O" and "Road" (Figure 7.1). The proposed rezoning of Sites 1a to 1d, 3 and 5 (Figure 7.1) to "G/IC" and "O" will enhance air permeability around these areas.

7.5 The proposal to rezone the existing open-air bus terminus to the west of the MTR Chai Wan Station to area shown as 'Road' (Figure 7.1) will also facilitate air ventilation around the existing industrial area to its west.

7.6 Apart from the proposals mentioned above, it is highly recommended that non-building areas and building gaps should be designated in appropriate locations to align along the wind direction of southwest-northeast. As illustrated in Figure 7.3, non-building areas are suggested to connect roads, open spaces and G/IC sites to form least-blocked air paths in the Area. The width of non-building areas is taken as 20-30m, in light of the width of 100m – 150m of the frontage area of the buildings[1]. The proposed non-building areas, which would encroach upon the sites of Tsui Wan Estate, Greenwood Terrace, Hing Wah (II) Estate, and the industrial developments to the west of the MTR Chai Wan Station, will form continuous air paths with least obstruction. The proposed building gaps, in the existing Chai Wan Flatted Factory site as well as between the Chai Wan Industrial Centre and Minico Building, will facilitate the air ventilation along the major southwest-northeast air path via the proposed gap.

7.7 Besides the above recommended non-building areas/building gaps, it is expected that Housing Department will conduct its own detail air ventilation assessment to further optimize their local air ventilation designs upon redevelopment, particularly for those with site areas larger than 2 ha, viz, Hing Man Estate, Hing Wah (I) Estate, Hing Wah (II) Estate, Yue Wan Estate, Tsui Wan Estate and Siu Sai Wan Estate.

[1] Please refer to the guidelines on required Building Separation Distance, indicated in the section of 5.2.5, of the published "Building Design to Foster a Quality and Sustainable Built Environment" by the Council for Sustainable Development in early 2009. In the guideline, it is proposed that for site areas greater than two hectares or with continuous building width of greater than 60 meters, an intervening space equivalent to 20% - 33% of the total frontage area of the building or buildings would be required.

7.8 Moreover, reference should be made to Chapter 11 of HKPSG on recommended urban design guidelines for air ventilation which cover podium design and waterfront building design among other site level considerations. Adequately wide gaps should be provided between building blocks to maximize the air permeability of the development and minimize its impact on wind capturing potential of adjacent developments, as illustrated in Figures 7.5 and 7.6.

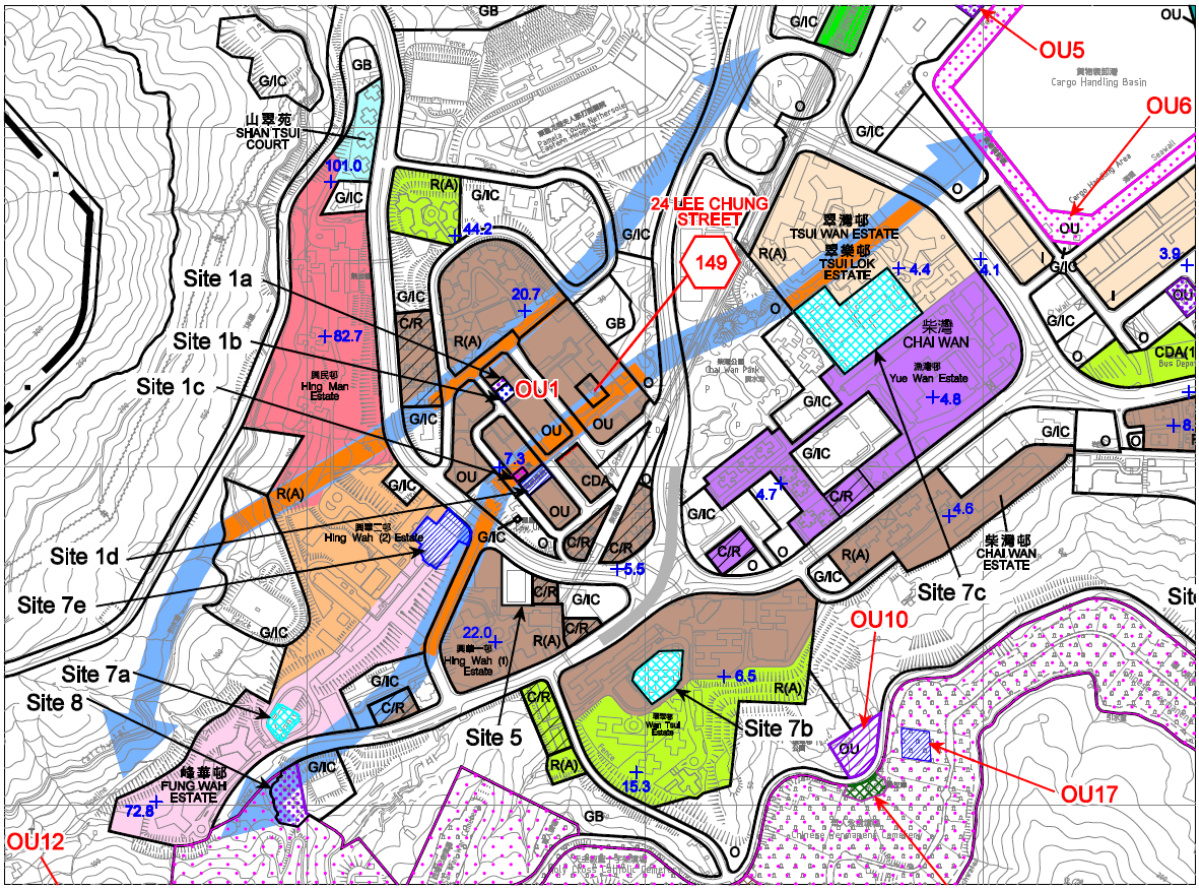


Figure 7.3 The suggested non-building areas/building gaps in the Area

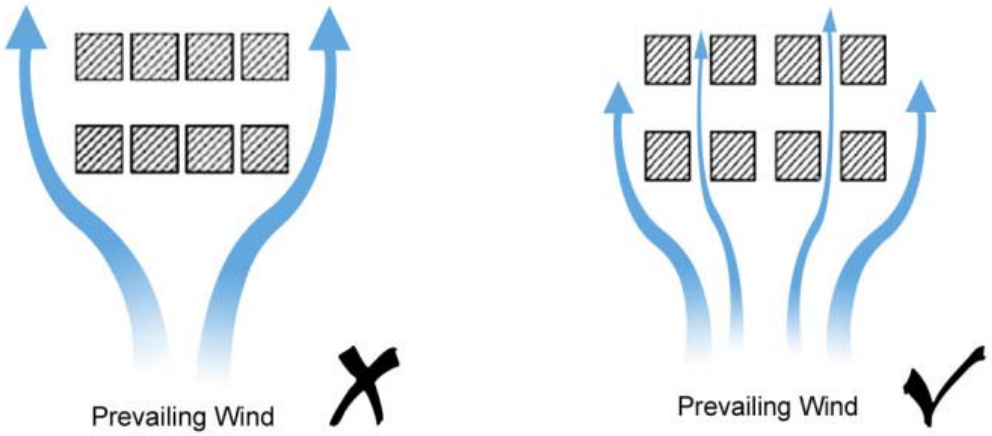


Figure 7.5 Guideline on building disposition for better air ventilation

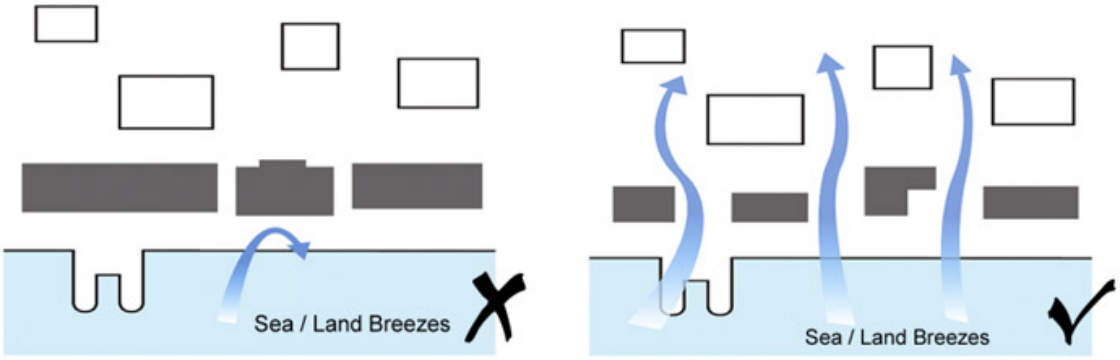


Figure 7.6 Guideline on waterfront building designs to avoid wind blockage

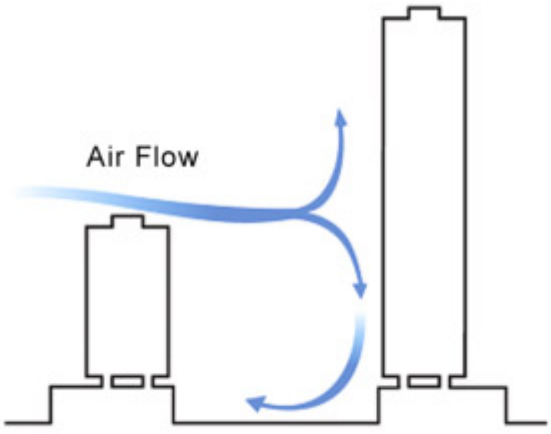


Figure 7.7 Stepping height profile to divert winds to lower levels

8.0 Expert Evaluation of the Revised Planned Scenario

8.1 In response to the expert evaluation of the initial planned scenario in section 7.0, a revised scenario for the non-building areas is proposed by the Planning Department as illustrated in Figures 8.1 to 8.3. Three non-building areas and two building gaps are proposed to respect the air paths as indicated in Figure 5.6.

(1) Non-building Area 1 (Figure 8.1)

A 30m-wide non-building area on the south of Hing Man Estate is introduced to facilitate air ventilation along the southwest-north air corridor as illustrated in Figure 5.6.

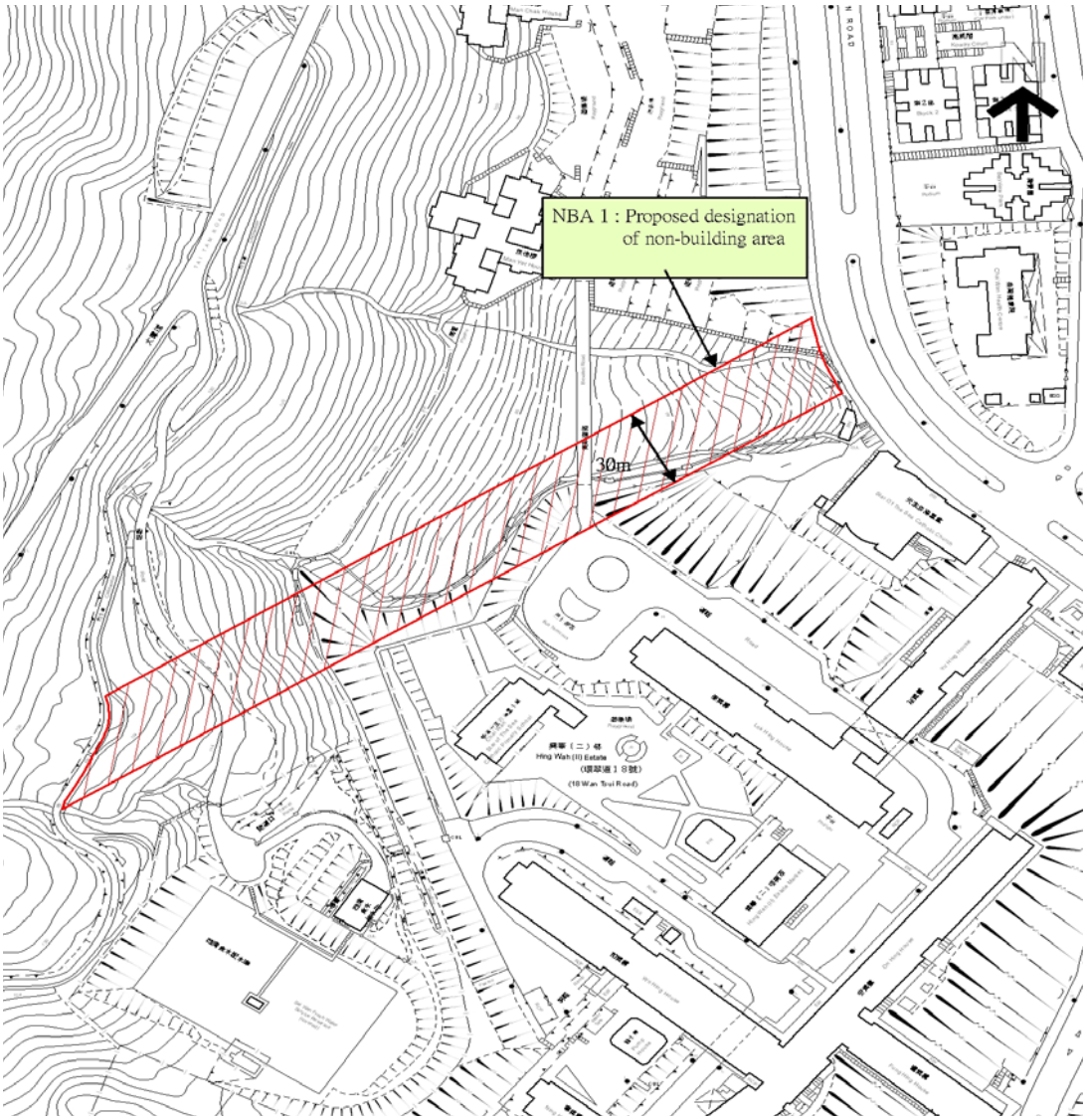


Figure 8.1 Proposed non-building area on the south of Hing Man Estate

(2) Non-building Area 2 and Building Gaps 1 and 2 (Figure 8.2)

Non-building areas are introduced along Hong Man Street and on both sides of the pedestrian stairway through to Tai Man Street. By widening the street to 20m, the proposed non-building areas will facilitate the air ventilation along the southwest-north air corridor as illustrated in Figure 5.6.

A building gap on the northwestern side of the existing Chai Wan Flatted Factory site to create a 20m wide air path along Chui Hang Street and a 15m-wide building gap between two existing industrial buildings namely the Chai Wan Industrial Centre and Minico Building are introduced. With wind channeling through the existing 3-storeyed Telephone Exchange Building (21mPD) at the junction of Cheung Lee Street/Chui Hang Street, the proposed building gaps will facilitate the air ventilation along the major southwest-northeast air path via the proposed building gap fronting Lee Chung Street and the existing open-air bus terminus alongside Ning Foo Street.

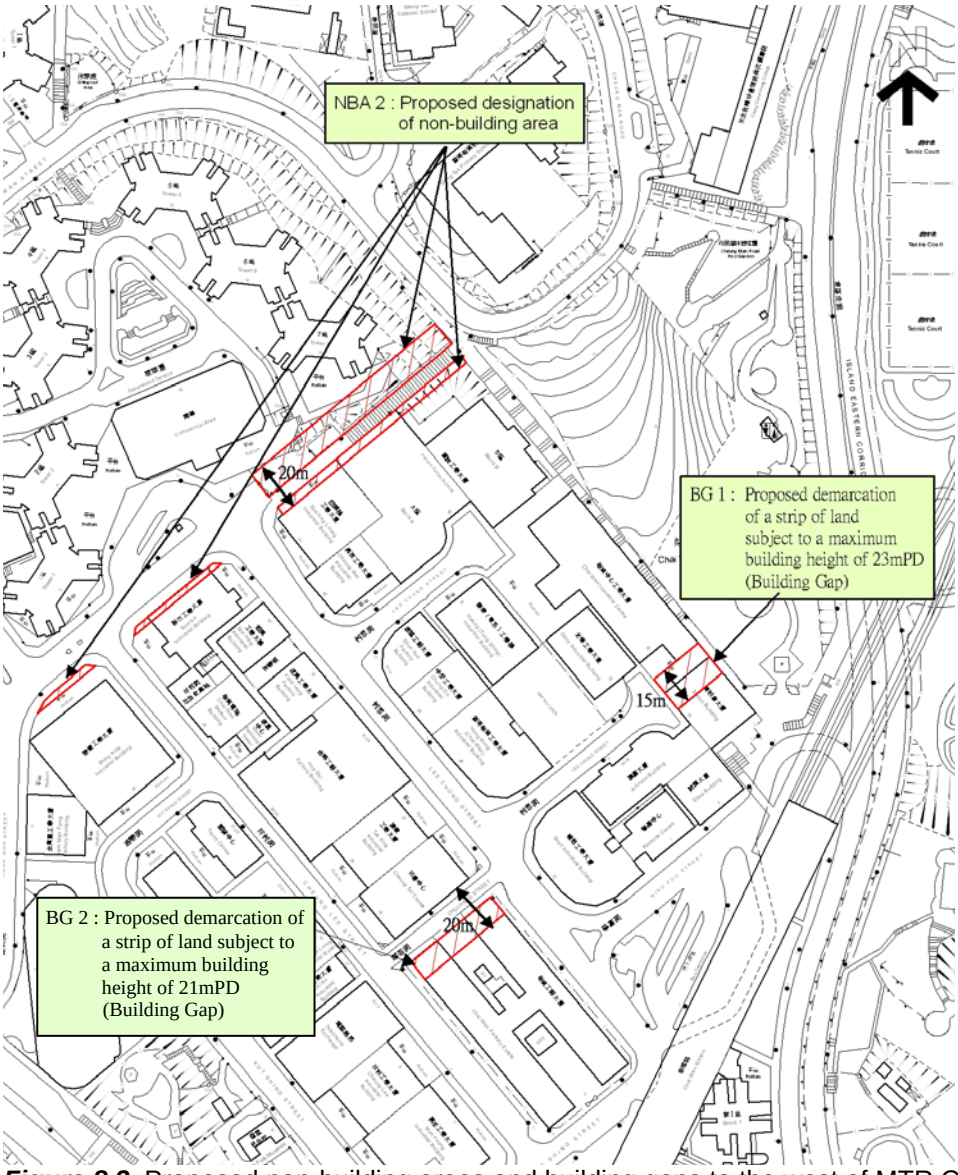


Figure 8.2 Proposed non-building areas and building gaps to the west of MTR Chai Wan Station

(3) Non-building Area 3 at Tsui Wan Estate (Figure 8.3)

A 20m-wide non-building area is introduced at Tsui Wan Estate, which is generally in line with the recommendation as shown in Figure 7.3.

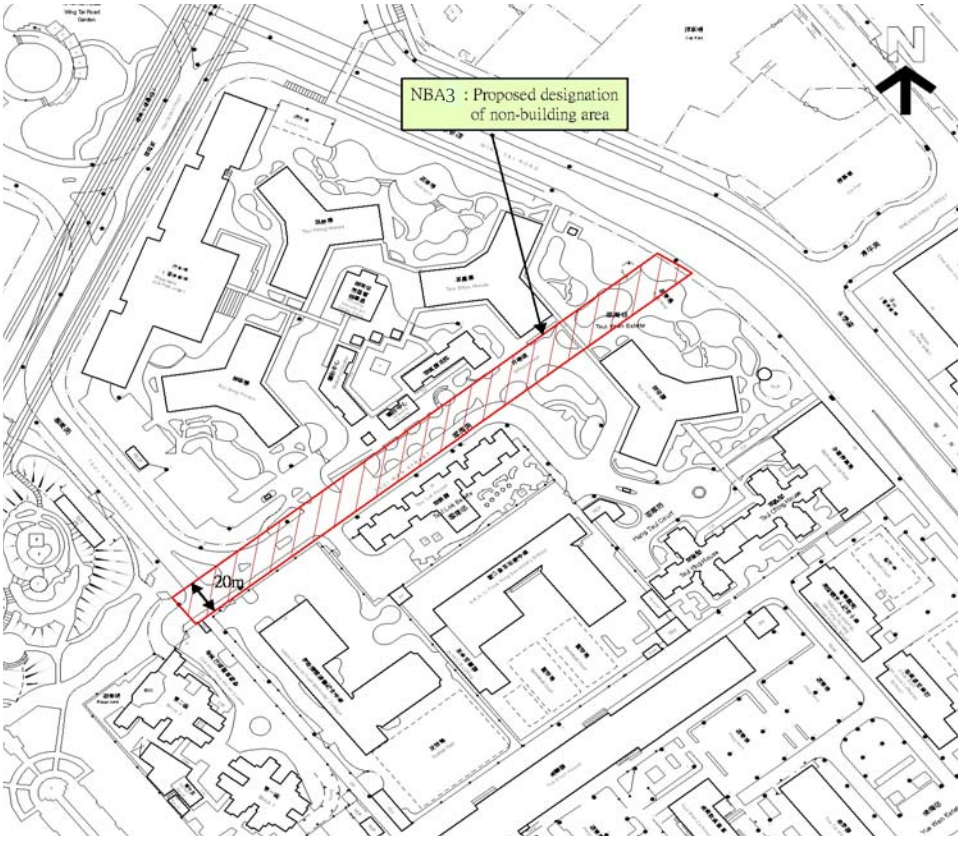


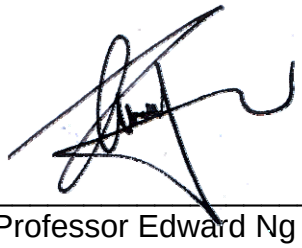
Figure 8.3 Proposed non-building area at Tsui Wan Estate

8.2 The proposed mitigation measures have been formulated having regard to the practical constraints and the need to respect 'development rights' of the land owner. In general, the proposed non-building areas and building gap are in line with the recommendations in section 7 above and thus considered acceptable.

9.0 Further work

9.1 Based on the expert assessment, there should be no major air ventilation issues if the suggestions can be followed. Further study is not necessary.

9.2 There is no focus of concern in the study area due to the generally medium-rise and medium building volume density characteristics of the Area.



Date: 16 December 2011

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On behalf of technical experts in the term consultant term

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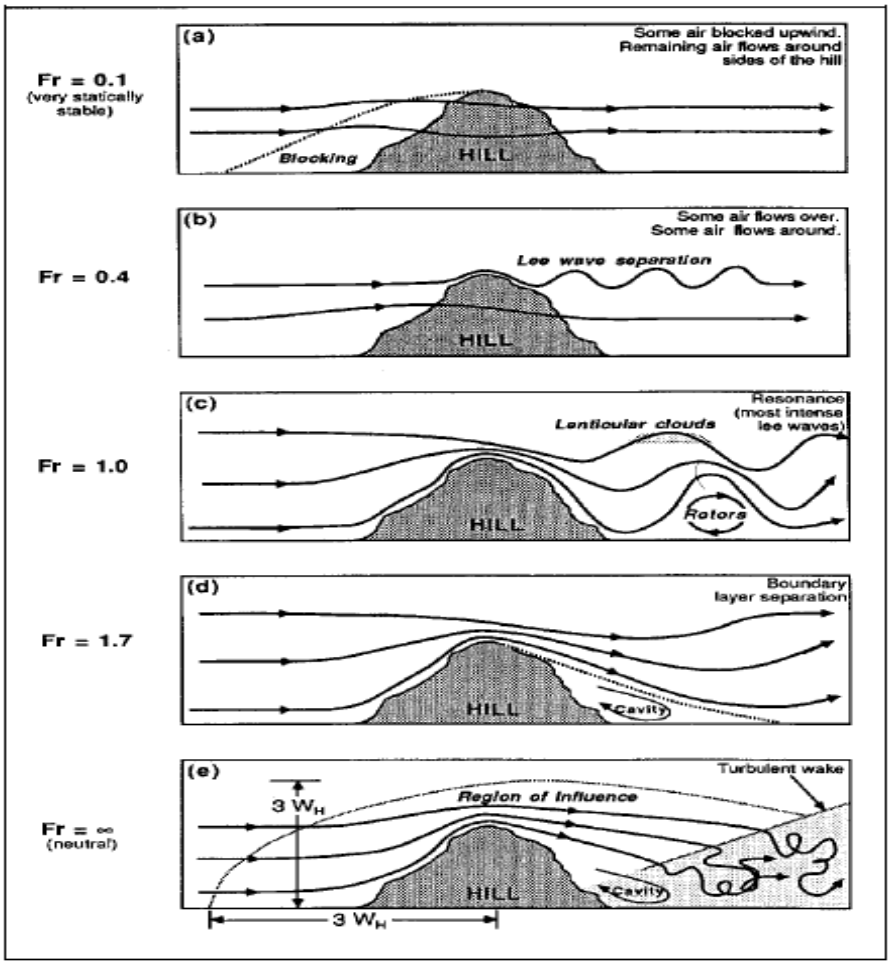
Appendix A: Wind over a small hill.



For a strongly stable environments, i.e. where the buoyancy affects are strong, and Fr ≈ 1, the air flows around the hill ((a)) and a stagnant mass of air builds up before the hill. **At a slightly faster wind** (Fr ≈ 0.4) some of the air flows over the hill ((b)) while the air at lower altitudes separate to flow around the hill. The natural wavelength of the air that flows over the top is much smaller than the hill size and the flow is perturbed by the hill to form lee waves. A lee wave separation occurs from the top and flows above the air that flows around the hill. A column of air with the same height as the hill approaches the hill and a fraction of it flows above the hill. **At higher wind speeds** and Fr ≈ 1.0, the stability is weaker and the wavelength of the gravity waves (lee waves) approaches the size of the hill ((c)). A natural resonance forms the large amplitude lee waves or mountain waves. If there is sufficient moisture, lenticular clouds can form along the crests of the waves downstream of the hill. **For stronger winds** with Fr ≈ 1.7 ((d)) the natural wavelength is longer than the hill dimensions, thus causing a boundary layer separation at the lee of the hill. **Neutral stratification** ((e)) occurs for strong winds with neutral stability (no convection) and Froude number approaching infinity. The streamlines are disturbed upwind and above the hill out to a distance of about 3 times the hill length WH. Near the top of the hill the streamlines are packed closer together, causing a speed-up of the wind. Immediately downwind of the hill is often a cavity associated with boundary layer separation. This is the start of a turbulent wake behind the hill. The height of the turbulent wake is initially the same order as the size of the hill and grows in size and diminishes in turbulent intensity downwind. Eventually the turbulence decays and the wind flow returns to its undisturbed state.

Froude number (Fr)

$$F_r^2 = \frac{\text{Inertial forces}}{\text{Bouyant forces}} \qquad F_r^2 = \frac{\bar{u}_0^2/W_h}{g\Delta\theta/\theta_0}$$

The inertial forces (order $\bar{u}_0^2/W_h$) act in the horizontal direction along the wind flow, and the buoyant forces (order $g\frac{\Delta\theta}{\theta_0}$ where $\Delta\theta$ is a typical temperature disturbance, g is gravitational acceleration, θ_0 is potential temperature) act in the vertical. The Froude number can be more elaborately defined as

[courtesy Sykes, R.I., 1980, "An asymptotic theory of incompressible turbulent boundary-layer flow over a small hump", J. Fluid Mech.101: 647-670.]