PLANNING DEPARTMENT
Term Consultancy for Air Ventilation Assessment Services

Cat A – Term Consultancy for Expert Evaluation and Advisory Services on Air Ventilation Assessment (PLNQ 37-A14/2007)
Tuen Mun New Town Area

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Contents

1 Introduction

In the Team Clean report published in August 2003, the Government undertook to examine the practicality of stipulating Air Ventilation Assessment (AVA) as one of the considerations for all major development or redevelopment proposals and in future plan making. Subsequently, a strategic objective to promote sustainable urban planning and design practices has been set out. One of the objectives is to look at issues such as buildings restricting air flow.

2 Objective of the Study

To facilitate better planning control, it is helpful to have a better understanding on the air ventilation characteristics of the Study Area (the Area), namely the area of the Tuen Mun New Town "Outline Zoning Plan No. S/TM/25". The objective of this assignment is to carry out an expert evaluation (EE) to assess the likely impact of the proposed building intensity and building height restrictions of the development/redevelopment sites within the study area on the pedestrian wind environment. The TMNT is a very large area. This study will take a abroad-brush look at the ventilation condition of zones and sub-zones of TMNT. Detailed ventilation condition of individual building estates will not be addressed.

This expert evaluation is carried out based on the Air Ventilation Assessment framework as set out in the Housing, Planning and Lands Bureau, and Transport and Works Bureau Technical Circular No. 1/06 and its Annex A – Technical Guide for Air Ventilation Assessment for Development in Hong Kong.

2.1 Materials for study

This expert evaluation report is based on the materials supplied by the Planning Department to the Consultant on 27th February 2009 and 6 March 2009, listed as follows:

The Current OZP No. S/TM/25 and Notes/Explanatory Statement
Wind data
- HKUST MM5 data
- Site wind data for Tuen Mun East area

Existing Development Building Profile
- As-built situation of Existing Building Profile in mPD
- Spot Height Level in mPD

Layouts and Building Heights for Developments Approved and Committed by the TPB or the Administration
Proposed Layouts and Building Heights for Sites with Redevelopment Potential
Proposed Building Height Restrictions
Existing Height Restrictions Stipulated in the Notes of the Current OZP
- Proposed Rezoning Sites
- Proposed Building Height Restrictions
- Planned building height profile

Location & view points of site photo
Site photos

MM5 wind data over site
Aerial photo

2.2 Site visit

The consultant visited the Area and carried out site inspections between 27st February 2009 and 25th March 2009. Special features of the site are referred to and photographs are given in Annex 1 of the report.

3 Study Scope

The scope of work includes the tasks as follows.

- To identify good development features;
- To identify any key ventilation corridors;
- To identify any potential problem areas;
- To provide recommendation for mitigation measures; and
- To advise if any further detailed study is required and the scope of the detailed study required.

4 Study Area

4.1 Site boundary and coverage

The Study Area covers the Tuen Mun New Town (TMNT) area with a total area of about 2,253 hectares. It is located at the Castle Peak Bay in the North West New Territories. It is bounded by the Castle Peak Ridge to the west, Lam Tei Interchange of Castle Peak Road to the north and the Tai Lam foothills to the east. To its south is the Castle Peak Bay. The Tuen Mun River Channel (photo P1) running in the north-south direction flows out to the Castle Peak Bay. The Tuen Mun developments are on both sides of the Channel which sort of bisecting the area. Along the coast, towards the southeast, the TMNT area extends to Siu Lam Interchange of Tuen Mun Road, and towards the southwest, the area extends to the Power Station at Tap Shek Kok. A map of the Area is given in Figure 4.1.

The TMNT area is a substantially large area covering both sides of the Tuen Mun River Channel which runs in the Tuen Mun valley. Land along the valley is relative flat. Urban developments in the area are mixed with relatively high-density residential, commercial and industrial developments. Such developments are also seen on reclaimed land on the southern side of the Area around the Castle Peak Bay. On the two sides of the valley are mountain slopes; the east side is flanked by the slope of the mountains of the Tai Lam Country Park whereas the west side is flanked by the slopes of the Castle Peak. Along the lower slopes there are relatively lower density developments.

In general, spread out all over TMNT area are the older developments with building heights in the range of 40m to 80m. Scattered in between are more recent developments of public and private housing estates. These are typically of 80m to 100m tall. There are several very tall developments in the Area, the Sun Tuen Mun Centre (P2) (around 140m) and the Tai Hing Industrial Building (about 120m). There are also pockets two to four-storey constructions such as the village houses and low rise industrial buildings.

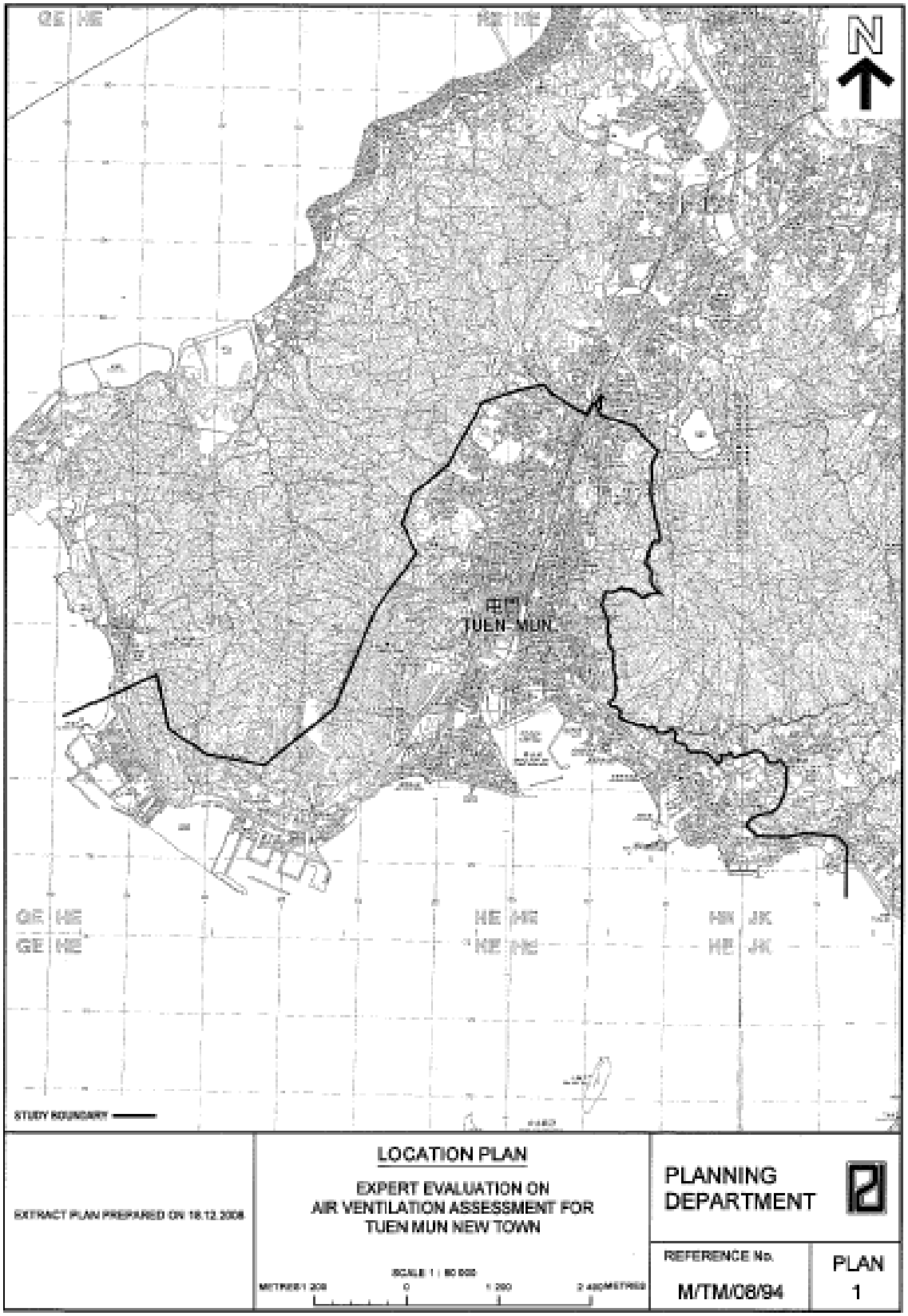


Figure 4.1 Map of Study Area

4.2 Site characteristics

4.2.1 Topography:

As mentioned, the TMNT area is situated on a low lying valley running more or less in the north-south direction. At the northern end it runs slightly towards the NNE direction. The valley connects to the Yuen Long plain on the north and opens to the Castle Peak Bay to its south as shown in Figure 4.2. The valley is relatively flat with a width of about two kilometers. On its east is the mountain of the Tai Lam Country Park with the highest peak at about 500m and other peaks at about 300m. On the west of the valley is the Castle Peak mountain range. The range runs roughly in the north – south direction with general heights of more than 300m. There are several peaks over 500m high with the tallest Castle Peak at 583m. Besides thes main topographic features, there are other minor features. To the west of the TMNT valley, cutting across the Castle Peak Range are minor valleys running in a lateral direction to the range. To the east of TMNT, there are also minor side valleys opening up from the Tai Lam Country Park into TMNT area. The Southern portion of the Tai Lam Country Park mountain range runs in the east – west direction. To the south of this range is the southeast coastal low land of the TMNT area. This coastal low land opens up to the Tai Lam Chung Reservoir further to the east.

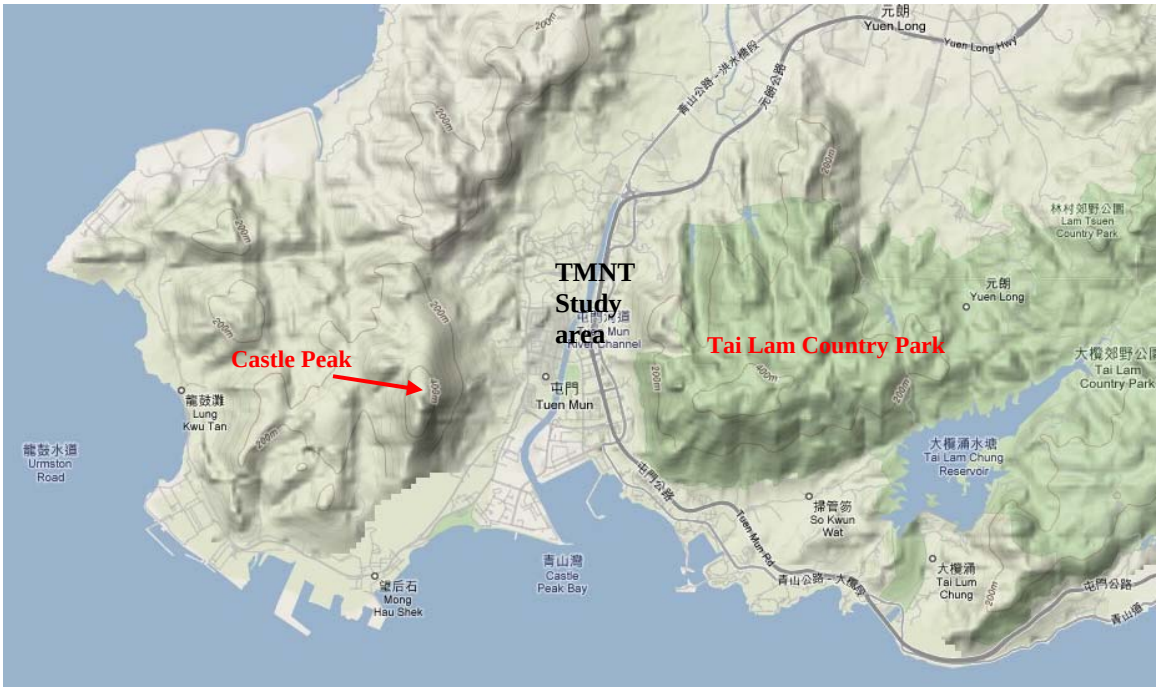


Figure 4.2 Contour map of the area (source from Google Map)

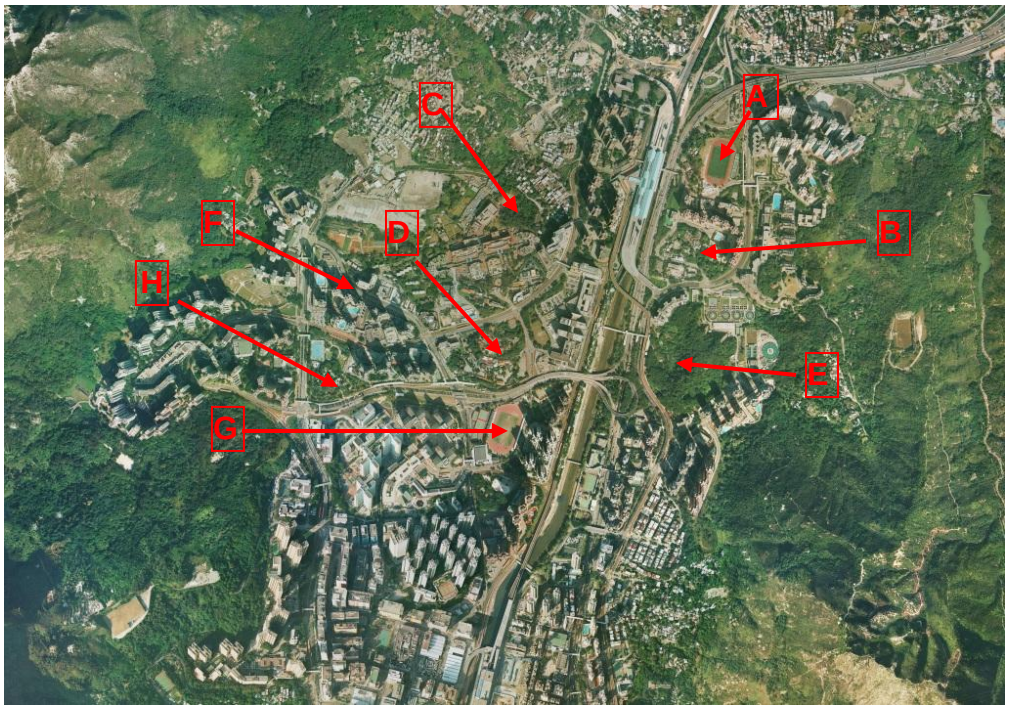


Figure 4.3a TMNT area (northern part)

Figure 4.3b TMNT area (southern part)

4.2.2 Greenery and open space:

As the TMNT area is situated in a valley bordering the Tai Lam Country Park on its east side and the Castle Peak Range on its west, there are ample greenery spaces over the slopes on the two sides of the valley. On the southern side of the TMNT area, that is, around the coast of Castle Peak Bay, there are greeneries on the lower hill slopes. Greenery and open space are also found inter-mingled or forming part of the building development. The major ones are listed as follows: (These are marked in Figures 4.3a and 4.3b)

- The Lingnan Multi-purpose Sport Ground (A)
- The Ching Leung Nunnery (B)
- Area around Tuen Mun Nursing School (C)
- Developments of the Ching Chung Koon (D)
- Area next to Tuen Mun Treatment Works (E)
- Developments of the Castle Peak Government Quarters (F)
- Tuen Mun Tang Shiu Kin Sports Ground (P3) and adjacent swimming pools(G)
- Tsing Tin Play Ground (H)
- The Tuen Mun Town Park (P4) (I)
- Land adjacent to Tin Hau Temple (J)
- The Siu Lun Sports Ground (K)
- The Wu Shan Recreation Playground (L)

The Tuen Mun River Channel and the strip along its banks is also a long stretch of open space which is very important in serving the ventilation purpose.

Open spaces in an area, especially area within building developments, serve as breathing pockets and under suitable setting, will help to re-vitalize air ventilation

Note: Photographs of the areas described are given in the Photograph Section at Annex I.

4.2.3 Layout of building development and street pattern:

In general, like any other towns developed from a small old town, the development of TMNT area is also sprawl from the Tuen Mun old town and the older industrial developments on the two sides of the Tuen Mun River. In more recent years, there are patches of housing estates being constructed further away from the town centre, along the hill slopes and along the shore front of the Castle Peak Bay. Generally, the building layout and street pattern of the old town and industrial area are more or less in rectangular grid pattern. Whereas, the recent developments do not follow the rectangular pattern. The developments in the TMNT area are discussed according to the following zones in more detail as follows:

1) The Central Area: This zone covers lands in the Tuen Mun valley on the two sides of the Tuen Mun River Channel (TMRC) spreading from the foot of slopes on the east side to the west side. In the north-south direction it covers from the northern border of the TMNT OZP to the coast of the Castle Peak Bay. Running through the whole area is the TMRC in the north-south direction. Also running through the area, there are the arterial roads, the Tuen Mun Road and the Ming Kum Road/Tsing Wun Road in the north-south direction. Crossing the area in the east-west direction are theTsing Tin Road, Pui To Road and the Wong Chu Road. The zone is further divided into four areas for discussion.
    a) The northern core:- This covers lands stretching from the northern border of TMNT OZP to Shek Pai Tau Road on the south. There are many Government & Institutional developments in the area, e.g. the Tuen Mun Hospital, the Castle Peak Hospital, Lingnam University, Nursing Quarters and Government Quarters. There are also many sports, recreation and open space in the area as discussed in the previous section, e.g. the Lingnam Sports Ground, the Tuen Mun Tang Shiu Kin Sport Ground and the Tsing Tin Playground. There are also developments with lots of greenery, e.g. Ching Leung Nunnery and Ching Chung Koon. On the north-western part of the area is the low-rise houses of the Siu Hang Tsuen. In general, the taller buildings in the area are about 70m to 100m tall. On the outskirt of the sub-area there are some dense high-rise residential developments in the area. These are, for example, the Fu Tai Estate (buildings about 110m high) and Siu Hong Court (about 95m) on the northeast, and the Po Tin Estate (about 85m high) and the Tin King, Leung King group of Estates (about 100m high) on the west. The street pattern in this sub-area does not conform to the rectangular grid pattern.
    b) The central core:- Covering from Shek Pai Tau Road on the north to the Wong Chu Road on the south. This is the older part of Tuen Mun where the initial town sprawl out. On the east side of TMRC is the town centre area of TMNT of commercial and residential developments. The heights of the buildings are quite mixed; there are the low and medium heights of about 20m to 60m (P5). The heights of the taller buildings are about 70m to 100m. On the west side of TMRC are mainly industrial developments; there inter-mingle some residential buildings. The Bus Depot buildings are less than 30m tall. Other industrial buildings are having heights of 40m to 95m. There is a very tall building, the Tai Hing Industrial Building (P6) (about 120m). For residential developments, buildings of the Chelsea Heights are about 115m

tall, and those of the Tai Hing Garden residential estates have general heights of about 100m. Further towards the west on the foot of the hill slope is the Shan King Estate residential developments. They are buildings of general height about 95m and built more or less along a line parallel the hill slope. Over the eastern side of the sub-area, on the hill slope are low-rise village houses around Sun Hui village and Leung Tin Village. There are two large greenery open spaces in the area, the Tuen Mun Park east of the TMRC and the land adjacent Tin Hau Temple west of the TMRC. The street pattern in this sub-area especially the older industrial area, is more rectangular, parallel and perpendicular to the TMRC. However, such older developments are more haphazard with many streets blocked at their ends and do not go through (P7, P8). In the sub-area, the Tai Hing Garden development is not of the rectangular street pattern.

c) The southern core:- The sub-area covers from Wong Chu Road on the north to the line marked by the Wu Shan Road and the shore front of Castle Peak Bay on the south. This sub-area consists mainly of residential developments. On the east side of TMRC residential buildings, for example, the Siu Lun Estate, Tsui Ning Garden, have a general height of about 100m and the Oceania Heights is about 120m The Tuen Mun Central Square is just less than 110m. On the west side of TMRC are the Lung Mun Oasis (P9), Glorious Garden and the Sun Tuen Mun Center residential developments. The buildings of Sun Tuen Mun Center perhaps are the tallest buildings in TMNT with building heights of about 140m. Along the coast of Castle Peak Bay on the east side of TMRC are some commercial/industrial Buildings of about 20m to 30m tall. There are several quite large open, recreational green spaces in the sub-area. They are the Wu Shan Recreational Playground, the Tuen Mun Training Ground and the strip on land for container storage. In general the building and street layout in the sub-area is not of the rectangular pattern.

d) The coastal core:- This covers the triangular patch of coastal land south of Wu Shan Road. Most of the buildings in the sub-area are residential developments. On the south side of the sub-area fronting the sea, buildings stretching from the east, the Marina Garden, the Miami Beach Towers, to the Pierhead Garden(P10), the Richland Garden and to the Melody Garden on the west, form a continuous line of buildings of around 85m to 100m high. In the interior of the sub-area are residential developments such as the Butterfly estate, the Yuet Wu Villa and the Siu Shan Court with building heights around 55m to 80m. In general the building and street layout in the sub-area is not of the rectangular pattern.

2) The Tuen Mun East Area:- This area covers the strip of land and lower hill slopes along the sea coast extending from Sam Shing Hui on the west to around Siu Lam on the east. The area consists of residential developments, holiday and vacation villas and hotel complex. The area is a mix of low-rise, medium-rise to high-rise buildings. On the western side of the zone, building heights of residential developments, e.g. Bayview Terrace, Seaview Garden and Tsing Yung Terrace are in the range of 40m to 85m. Around the central portion of the zone, there is the Gold Coast Complex with the Hong Kong Gold Coast Holiday Flats and houses and the Gold Coast Hotel. These are buildings about 70m tall for high-rise and 20m for medium-rise. Other high-rise developments in the locality are the Monte Carlo Villas, the Spring Seaview Terrace and the Aegean Coast(P11). Especially the Aegean

Coast is a long line of building over 80m high. There are also many low-rise houses of about 10m high spreading all around, for example the Beailieu Pennisula development and houses around Ka Fook Lane area. In fact this mixed developments of 10m high low-rise to 20m-50m medium and high-rise is common to the whole zone. Further to the east in the Lok On Pai Siu Lam Flea Market area, there is a long low-rise building slightly over 10m high (seem not to be in use) near the shore (P12). In general running along the coast through the zone is the Tuen Mun Road and the Castle Peak Road. Running perpendicular the coast leading from the shore to the lower hill slope are several side roads. However they are mostly curve and winding and not running in the rectangular grid pattern.

3) The Tuen Mun West Area:- This zone is the strip of coastal land south of Castle Peak. It extends from Butterfly Beach Park on the east to the Tap Shek Kok Power Station on the west. The majority of the area is for industrial usage. From the east there is the River Trade Terminal and container storage and handling area. Next ti it is the Resource Recovery Park, Special Industrial Area and the Cement Plant (P13). Buildings in these developments are mostly 10m to 25m industrial buildings. The west end of the zone is the Power Station. There are several large buildings about 60m to 75m tall. In this zone there is the Lung Fu Road running parallel to the coast. There are side streets connecting the Lung Fu Road down to the water front. One special feature of the zone is that buildings in the area are very big in foot print. Although many of these are low rise of 10-15 metre high, they are bulky and cover large ground space.

The street pattern and the building lay-out of the different zones are very different. In general except major arterial routes as mentioned above, i.e. the TMRC, the Tuen Mun Road, the Lung Mun Road/Tsing Wun Road, and in the lateral direction, the Tsing Tin Road, the Pui To Road and the Wong Chu Road, many other streets do not cut through the area (i.e. blocked one end or both) and some are more curved.

5 The Wind Environment

5.1 Wind data from Hong Kong Observatory

Hong Kong is situated on the southern coast of Asia. The wind climate in Hong Kong can broadly be described as follows. There are the two monsoon seasons, the north-east monsoon in the winter months and the south-west monsoon in the summer months. Besides monsoon wind, Hong Kong is also subject to typhoons and thunderstorms.

Wind data are measured by the Hong Kong Observatory (HKO) at more than 40 stations spreading out all over Hong Kong. These stations measure the low level wind. One of the station where the wind is least affected by surrounding terrain and topography is Waglan station (WGL). The station is situated on top of a small island far off the south-eastern side of Hong Kong. Wind data from WGL are usually referred to by wind engineers as the more representative of Hong Kong wind condition. Figure 5.1a shows the probability distribution of wind in direction and speed for the year 2004. It can be seen that the wind from the east and north-east sectors has the higher probability of occurrence, with east being the highest. It can also be observed that the south-west sector has a small peak reflecting the occurrence of the south-west wind. Despite Figure 5.1a shows that the easterly wind as being the most frequent, wind-rose for the summer season is very different. For summer months with the south-west monsoon, a typical distribution looks like Figure 5.1b which gives the distribution for the month July 2004. It can be seen that wind from the south-west sectors has the highest probability of occurrence. From these figures, it can be concluded that wind conditions in Hong Kong is such that, for the whole year majority of the wind comes from the east and north-east. However during the summer months, majority of the wind comes from the south-west.

While the wind condition as described is the wind condition for Hong Kong not, or minimally, affected by obstructions, terrain and topography, for a specific site, however, the site wind is always affected by terrain and topography. It is therefore necessary to have the site wind data. The nearest HKO wind station to the Area is the Tuen Mun (TM) station which is on top of a building right at the centre of the Area. Figure 5.2 shows the annual wind directional distribution for (TM) Station in 2004. It can be seen the pattern is very different from that of Figure 5.1a for WGL. There are two directions where the wind are more frequent in TM. These are the NNE and SSE components; they are substantially bigger than other directions. The next larger component is the S component. This shows that the topography of Tuen Mun area has strong effect on the wind. The much larger NNE and SSE components reflects the funneling effect of the wind blowing into the Tuen Mun valley from the north and south ends of the valley.

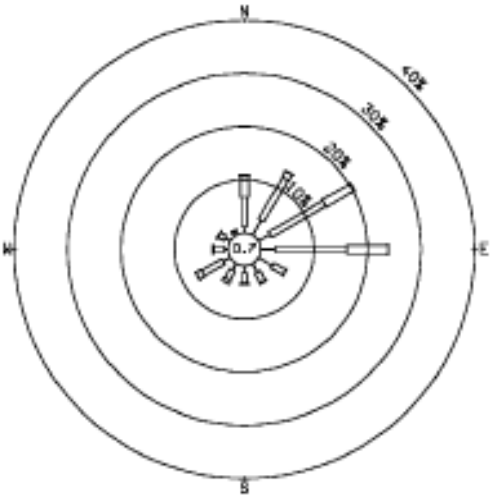


Figure 5.1a Wind rose for WGL Annual for year 2004 (HKO)

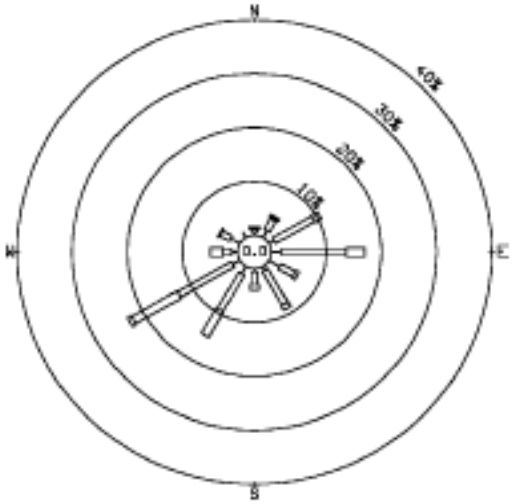


Figure 5.1b Wind rose for WGL monthly for July 2004 (HKO)

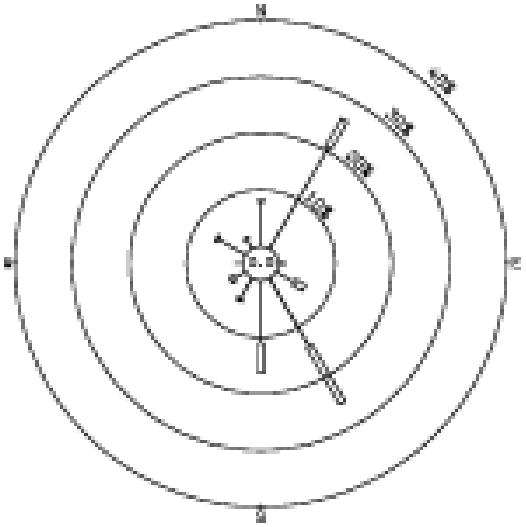


Figure 5.2 Wind rose for Tuen Mun Annual for year 2004 (HKO)

The above result is for the single year 2004. Statistically, to have a better estimation of the wind, a much longer period than one single year is required. Using a longer data period, the annual directional probability distribution for TM is obtained an presented in Figure 5.3a. The pattern of Figure 5.3a is very similar to that of Figure 5.2. There are minor differences, e.g. the SSE component for year 2004 is slightly bigger than the long term average. The long term summer condition (the three months June, July and August) for Tuen Mun is also obtained and given in Figure 5.3b. It can be observed that the wind rose is very different from the annual condition. Winds are mainly from the SE sector with the largest component from the SSE at close to 30% probability. The NNE component for summer is much smaller than that of the annual. Comparing Figure 5.3b with Figure 5.1b, they are observed to be very different. This again shows the strong effect on the wind due to the topography of Tuen Mun.

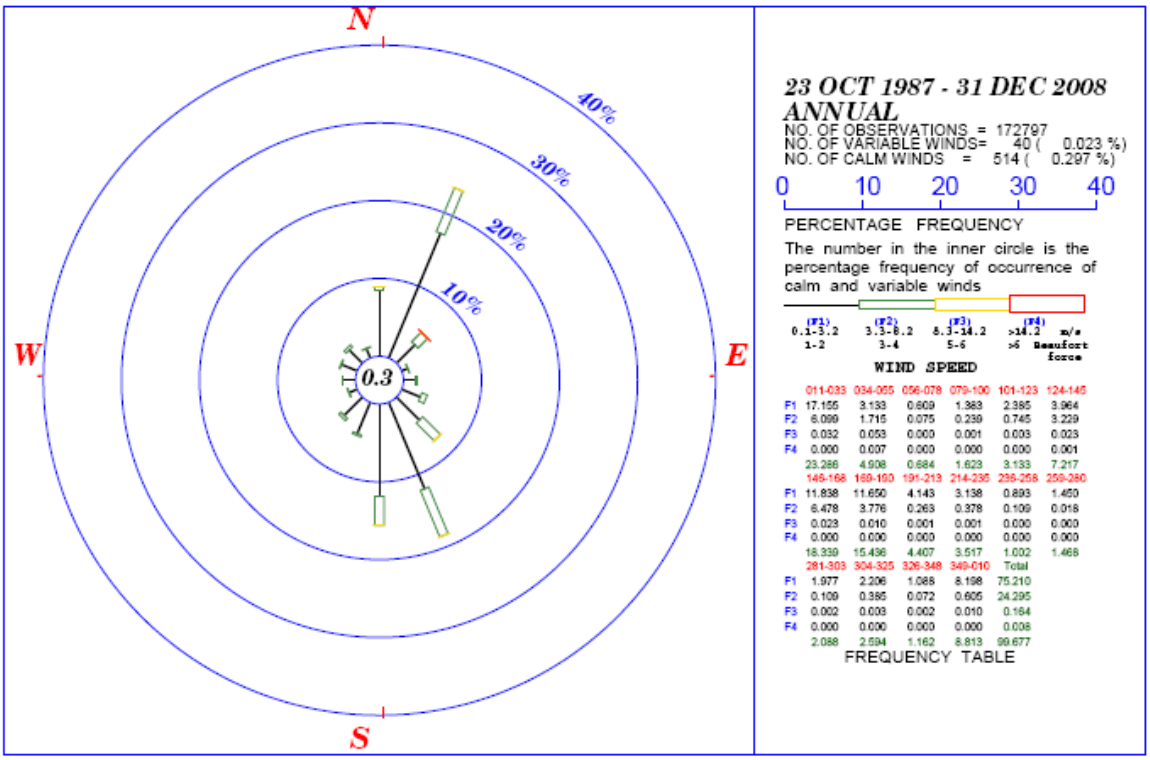


Figure 5.3a Wind rose of Tuen Mun 1987-2008 annual (HKO)

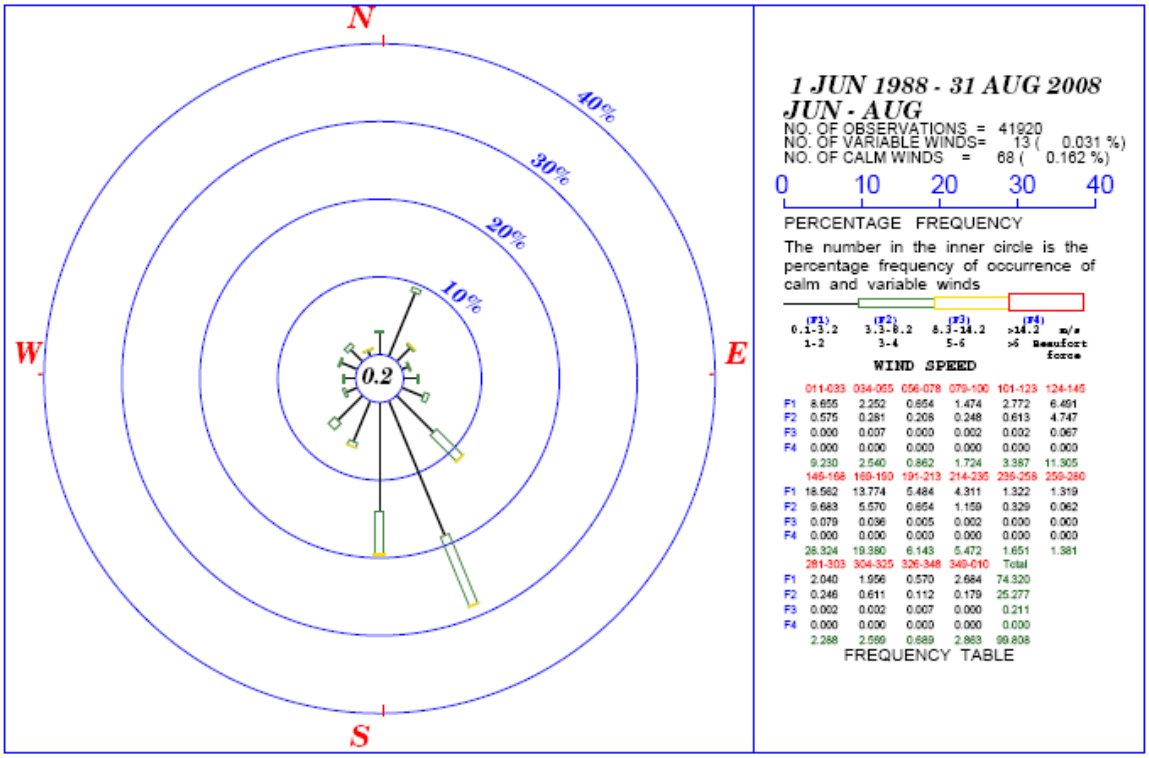


Figure 5.3b Wind rose of Tuen Mun 1987-2008 summer (HKO)

5.2 Wind data from MM5 simulation result and site wind availability

In the previous section, it is mentioned that the wind station from HKO is in the town centre on top of a building, thus liable to be affected by the building itself and surrounding buildings. It is therefore useful to employ other means to estimate the site available wind. One method is by using mathematical modeling. The Institute of Environment, Hong Kong University of Science and Technology has produced a set of Hong Kong wind field simulated data using the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5). The simulation period is for one whole year 2004. As this set of data covers the whole of Hong Kong, it is used for the present study.

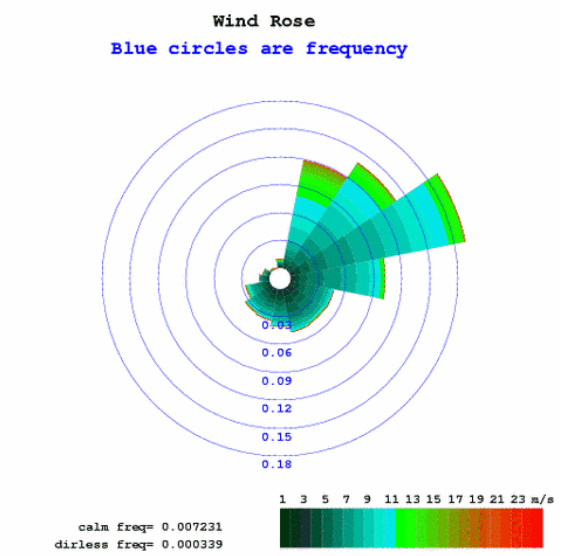


Figure 5.4a WGL (230m) annual

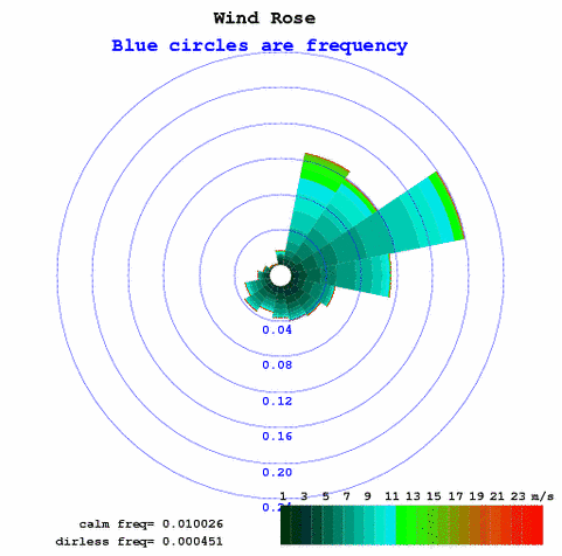


Figure 5.4b WGL (60m) annual

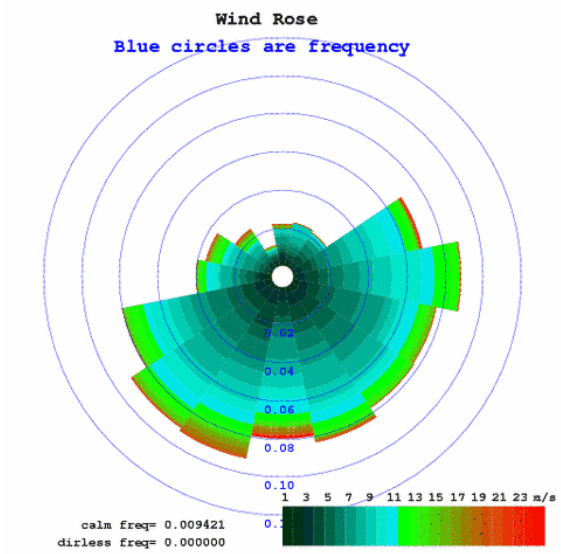


Figure 5.5a WGL (230m) summer

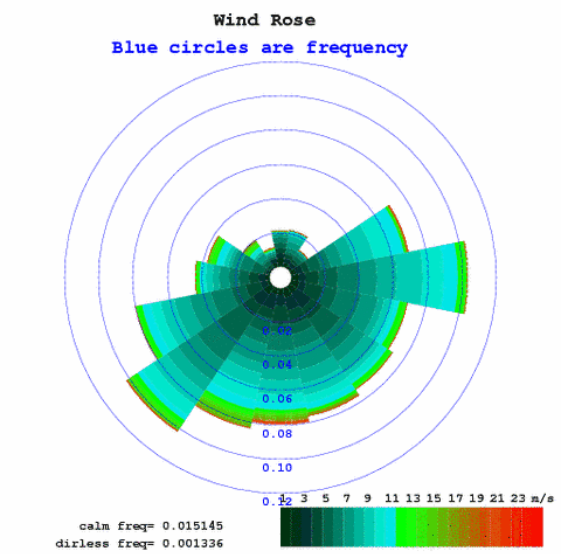


Figure 5.5b WGL (60m) summer

Figure 5.4a shows the annual (2004) wind rose of the simulation result of the higher level wind (230m) for WGL. Figure 5.4b show a similar result but for low level wind (60m). Comparing the simulated data, Figure 5.4a and even the low level result of Figure 5.4b, with the measured data, Figure 5.1a, there are some discrepancies. Although both results have the majority of the wind coming from the N-NE-E sectors, the highest probability of the simulated data is from ENE; while that of the measured data is from E. Figures 5.5a and 5.5b are the result of the simulated data for the summer months (June, July and August). Some discrepancies can also be observed when compared with Figure 5.1b. Although discrepancies are observed, the main pattern of variation is produced by the MM5 simulation. Without having a better data source, the MM5 simulated data for the Area can be considered.

MM5 result for Tuen Mun annual condition wind rose for heights 230m and 60m are shown respectively in Figures 5.6a and 5.6b. Comparing Figures 5.6 with Figures 5.4, the effect of topography as discussed above is again observed. Comparing Figure 5.6b, i.e. the lower level wind with that of the higher level (Figure 5.6a), it can be seen that more wind are shifted to the NNE and SSE sectors at lower level. Comparing the MM5 result Figure 5.6b with the HKO data Figure 5.3a, it can be seen there are differences. In the NE quadrant, HKO has much stronger NNE component and much smaller NE component than the MM5. In the SE quadrant, HKO has much stronger S and SSE components and much smaller SE component than MM5. IT seem HKO data reflects much stronger topographic effect than the MM5 simulation.

MM5 summer condition result for high and low level wind are given in Figures 5.7a and 5.7b. They are again observed to be different from the WGL result (Figures 5.5) due to topographic effect of Tuen Mun. Looking at the low level result, the wind blows mainly from the SE quadrant. Comparing the HKO data (Figure 5.3b), HKO has much larger S and SSE components.

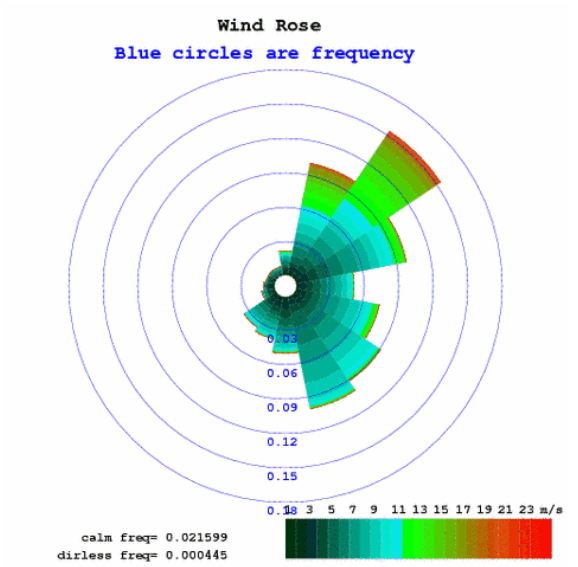


Figure 5.6a TM (230m) annual

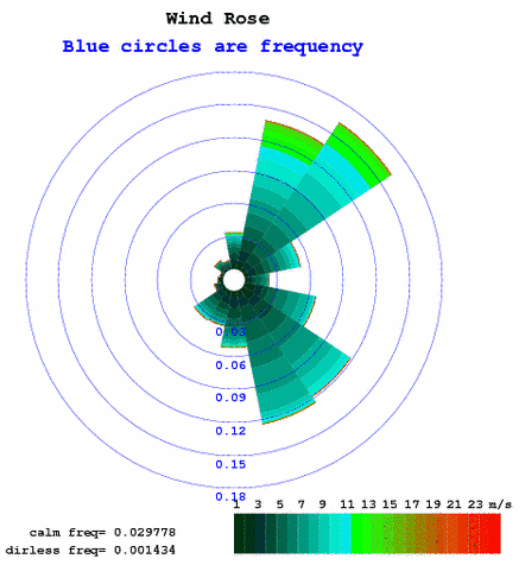


Figure 5.6b TM (60m) annual

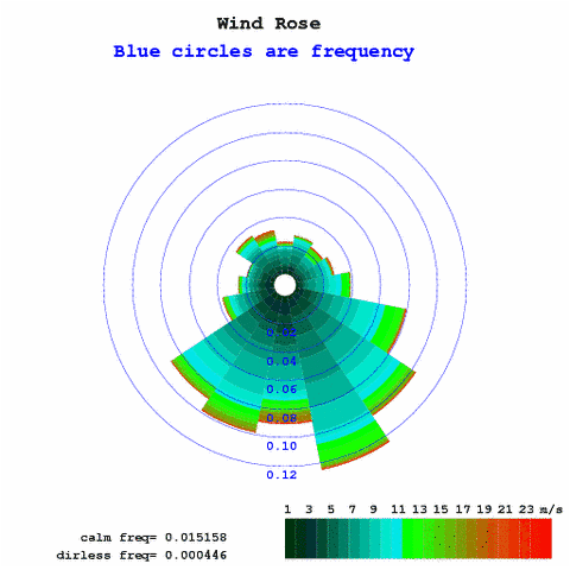


Figure 5.7a TM (230m) summer

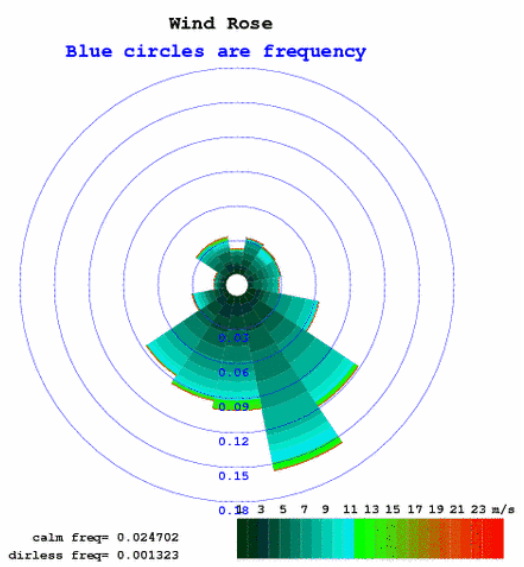


Figure 5.7b TM (60m) summer

As TMNT OZP covers a very large area, it is useful to know whether there are variations in the available wind from location to location within the area. To this effect, results of MM5 low level (60m) wind simulation at two locations, (1) at the northern portion of TMNT, and (2) at the southern portion of TMNT are studied as shown in Figure 5.8a. To see how the wind pattern changes from north to south, for the annual condition, Figure 5.8b, 5.8c is read in conjunction with Figure 5.6b which lies somewhere in between point 1 and point 2. Considering wind from the Yuen Long plane, the prevailing direction of the oncoming wind should be from the NE – ENE direction. It can be seen that as the wind flows into Tuen Mun valley from the north, it becomes more aligned with the direction of the valley as it blows southward; that is, more frequent NE wind over the northern part of the valley progressively change to more frequent NNE wind over the southern part of the valley. The same phenomenon can be observed with winds blowing from Castle Peak Bay into the south end of the TM valley. At point (2) there are more frequent ESE and SE wind. As it blows northward, it gradually changes to much smaller components for these two directions, but a larger component at the SSE direction. This reflects the effect of the valley topography funneling the wind into the valley. Reading Figure 5.8d and 5.8e with Figure 5.7b, it can be seen that for the summer condition, winds over Castle Peak Bay has high probability components all over the SE and SW quadrants (point 2). As the wind blows northwards into the TM valley, the wind becomes more aligned with the direction of the valley, i.e. high probability components concentrated at the SSE and S sectors.

Figure 5.8a Location Map

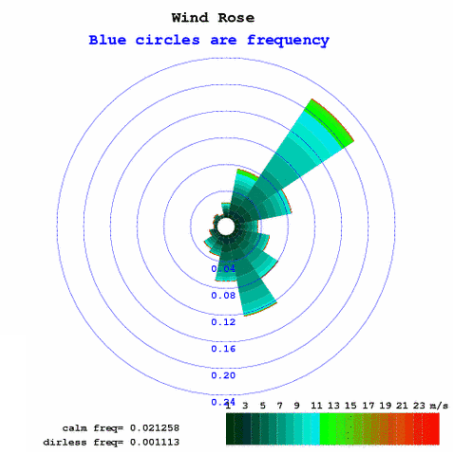


Figure 5.8b TM north (1) annual

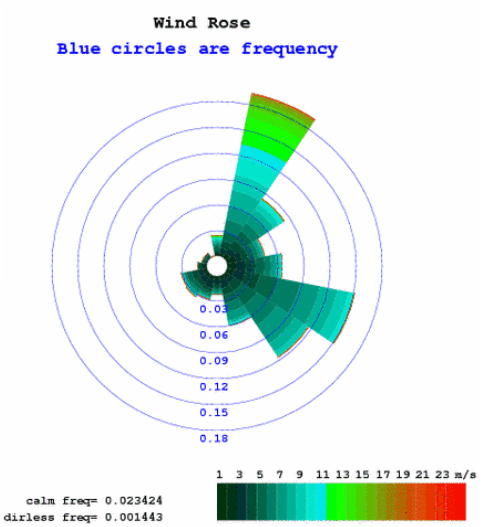


Figure 5.8c TM south (2) annual

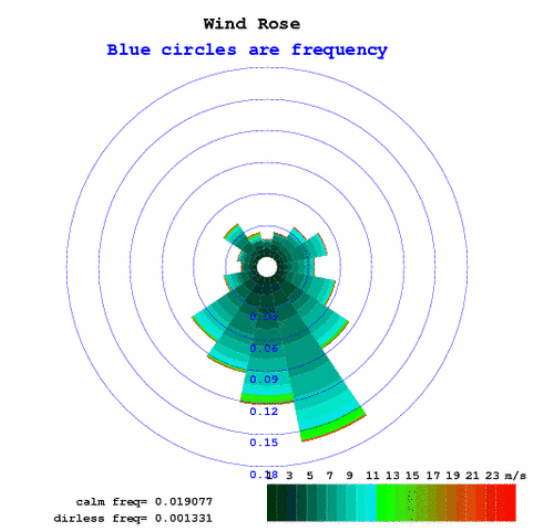


Figure 5.8d TM north (1) summer

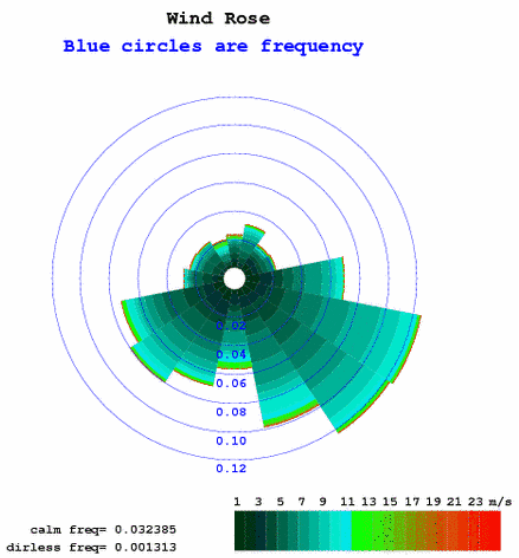


Figure 5.8e TM south (2) summer

5.3 Wind information from the study of "EXPERIMENTAL SITE WIND AVAILABILITY STUDY FOR TUEN MUN EAST AREA, HONG KONG"

A study of the wind availability of the Tuen Mun east (TME), i.e. the Tuen Mun East Area described above, was conducted by CLP WWTF of HKUST titled "EXPERIMENTAL SITE WIND AVAILABILITY STUDY FOR TUEN MUN EAST AREA, HONG KONG". The study investigated the available wind at two site locations at the Tuen Mun East Area area using wind tunnel testing technique. The available wind was calculated based on the Waglan wind data. Report of the study was made available to the consultant.

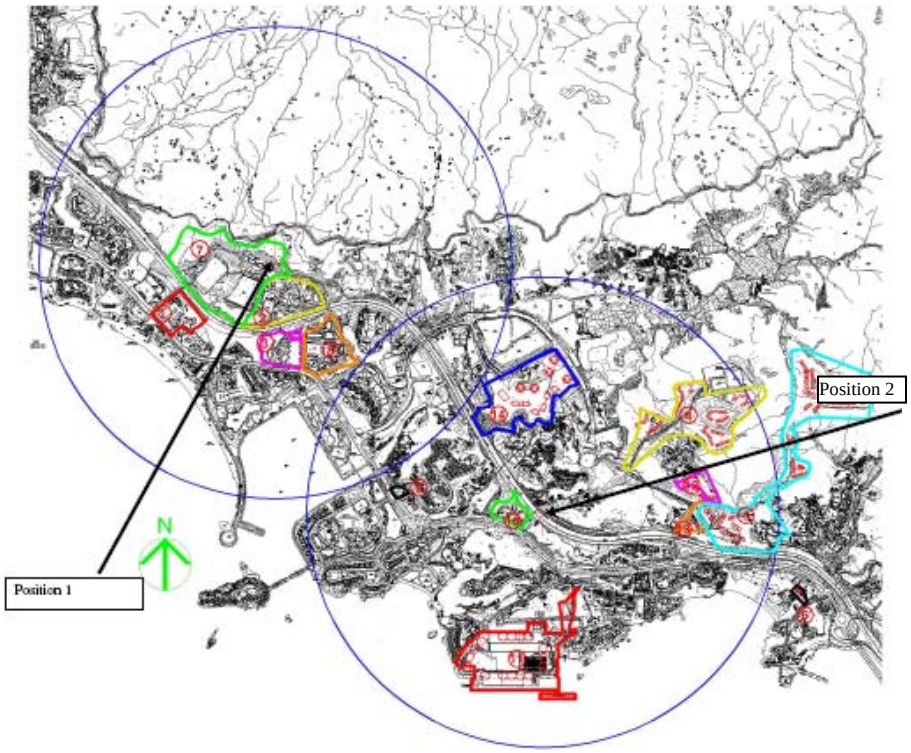


Figure 5.9a Location of TME (TME study report)

Result of the study was summarized in wind roses of the two locations (Figure 5.9a). The wind roses for annual wind condition for position 1 and position2 at the 50m-height are extracted and presented in Figures 5.9b and 5.9c. It can be seen that the wind pattern at the two locations are quite similar, with the larger wind components from the E and ENE. This is probably as a result of the south mountain range of the Tai Lam Country Park which runs in the east-west direction. Furthermore, the eastern side of TME opens up to the Tai Lam Chung reservoir which forms a gap to channel the wind to blow towards TME in an easterly direction (refer to Figure 4.2). There are differences between the two wind roses. There is a high component of the N sector for position 2; whereas for position1, the high value is shifted to the NNW direction. This probably results from the blockage effect of the Tai Lam Country Park mountain blocking the northerly wind at position 1; as position 1 is closer to the mountain. Comparing the two figures with Figure 5.8c, it can be seen that the strongest wind component, the NNE component, available to the south central of TM is significantly reduced.

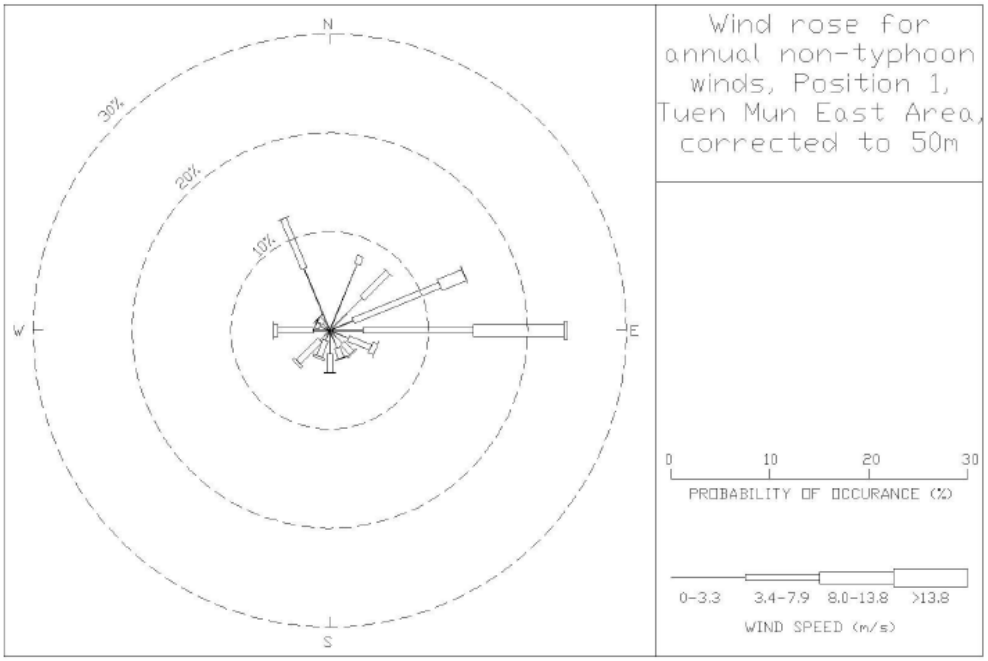


Figure 5.9b Annual wind rose at Position 1 at 50m high (TME study report)

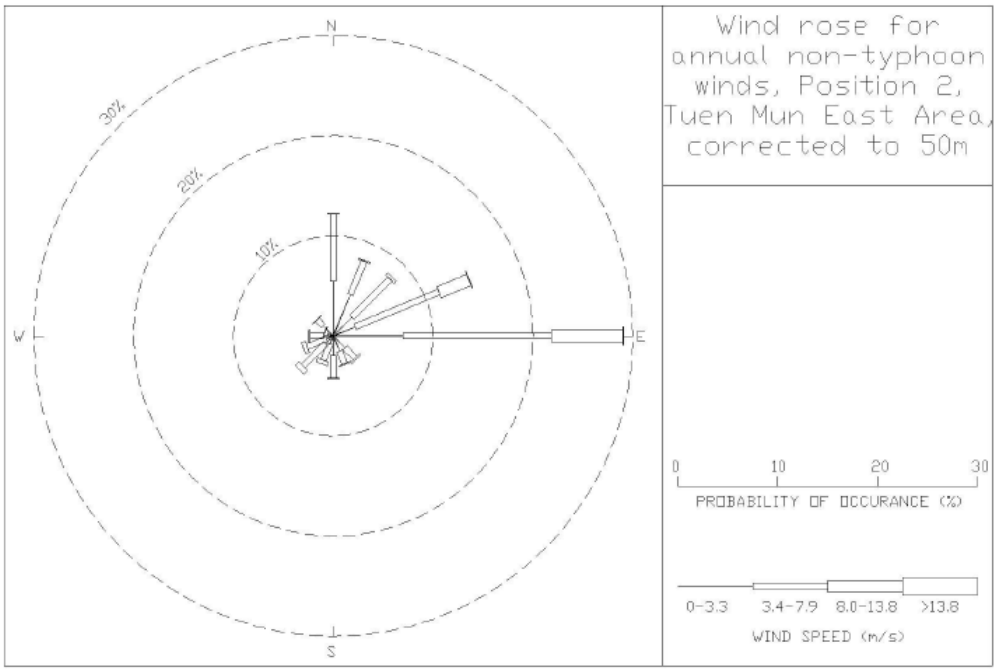


Figure 5.9c Annual wind rose at Position 2 at 50m high (TME study report)

5.4 Other relevant information and summary of available wind

To have a better understanding of the wind flow over TMNT area, wind pattern over a broader region, specifically over the stretch of sea south of Castle Peak Bay and north of Lantau Island. Some information is available from the Urban Climatic Map (UCmap) study of the Planning Department. Figures 5.10a and 5.10b are extracts from the UCmap study giving the annual and summer (July) wind patter over this area. It can be seen that for annual condition, winds over the stretch of sea are mainly in the ESE and E direction. Whereas, for summer condition, winds are mainly from the SSW and generally the SE quadrant.

Figure 5.10a Annual condition Wind direction Tuen Mun – Lantau region
(UCmap, Planning Department)

Figure 5.10b Summer condition Wind direction Tuen Mun – Lantau region
(UCmap, Planning Department)

Other than the wind direction, an estimate of the magnitude of the available wind speed would be useful. To calculate the magnitude of the wind speed, the detail values of the probability distribution is required. Such table can be obtained from the Planning Department web site where some MM5 data are available. Unfortunately, the data is for only the period 1st October 2000 to 30th September 2001 and at elevation of 596m. Without a better data source, wind speed for the present study is estimated from this set

of data. The average annual wind speed at 596m over Tuen Mun is calculated as 7.3m/s. With this wind blowing over open areas (i.e. area with little roughness), the unobstructed pedestrian level wind would be about 2.5m/s to 3.0m/s. With this wind (7.3m/s at 596m high) blowing over city centre area (i.e. very rough terrain), the unobstructed pedestrian level wind would be about 0.5m/s to 1.0m/s using Power Law estimation. A rough estimation can also be obtained from the HKO data (Table in Figure 5.3a). Wind speed at the anemometer height (located at city centre) of 69m MSL is estimated to be 2.6m/s. The unobstructed pedestrian level wind would be about 0.5m/s to 0.8m/s. For summer condition the average wind speed estimated from the HKO data (Table in Figure 5.3b) is about the same at 2.65m/s. Thus the unobstructed pedestrian level wind would be also about 0.5m/s to 0.8m/s for summer condition over the city centre area.

From the discussion above, the following points are summarized:

- The valley shape topography of Tuen Mun area has a strong effect on the available wind. Winds blowing into the valley are funnel to be more aligned with the direction of the valley.
- For annual condition, the major wind component is from the NNE-NE direction. There is a smaller peak in the ESE-SSE sector reflecting the summer wind.
- For the summer condition, the majority of the wind comes from the SE and SW quadrants, with higher values from the SE quadrant.
- It is also observed that as wind blows from north to south down the valley, there is slight shift in wind direction from principally in the NE direction to principally in the NNE direction.
- As wind blows from south to north up the valley, change in wind direction characteristics can also be observed. At the southern part of the valley, wind direction is distributed over the SE to SW sectors. Whereas at the northern part of the valley, wind direction concentrates more around the SSE sectors.
- There are some discrepancies between the HKO data and the MM5 simulation. HKO data shows stronger topographic effect, with sharper peaks at the NNE and SSE sectors than the MM5 simulation.
- For the southern portions of TMNT OZP, that is the Tuen Mun East Area and the Tuen Mun West Area, the wind in predominantly in the E - ESE directions for annual condition. The northern parts of both zones, i.e. portions at the entrance of the valley, there will be certain northerly component wind. For summer condition, prevailing wind direction over the Tuen Mun East Area would be in the E and SE directions. And, over the Tuen Mun West Area, the prevailing wind would be in the WSW – SSW directions. To a smaller extend, there would be certain southerly wind components for both zones in the summer.
- For wind speed estimation, the available wind speed at pedestrian level is estimated to be about 2.0m/s to 3.0ms for wind blowing onto the outskirt of TMNT (e.g. coastal). This would be slightly smaller for wind coming over the Yuen Long Plain. For city centre area, the available pedestrian level wind is estimated to be about 0.5m/s to 0.8m/s. Values for summer condition are similar.

Based on the above, the estimated available prevailing wind pattern over the TMNT OZP area is presented as in Figures 5.11a and 5.11b.

Figure 5.11a Prevailing wind pattern for annual condition

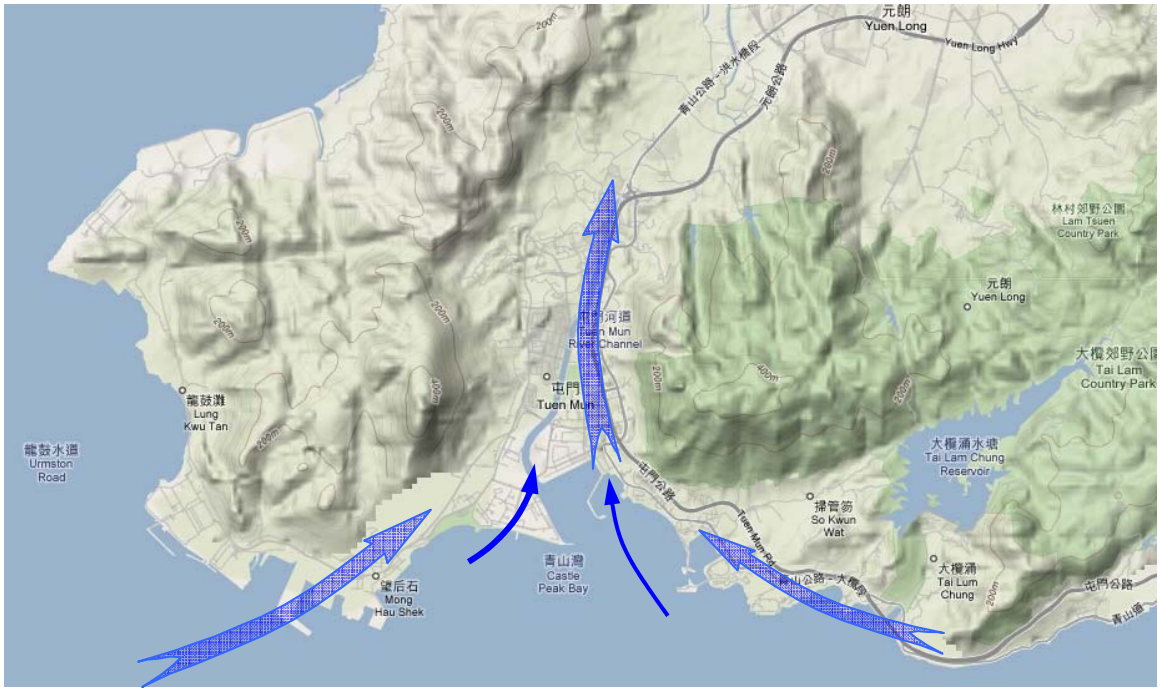


Figure 5.11b Prevailing wind pattern for summer condition

6 Flow Evaluation

6.1 Topographic effect

As discussed in the previous section, topography has a very strong effect on the wind flow over the TMNT area. It has been summarized in Figures 5.11a and 5.11b that the wind blowing over the majority of the Tuen Mun area (other than the Southeast and Tuen Mun West Areas), is mainly in the NNE and SSE directions. From the HKO data, annually, there is 32% of wind coming from N+NNE sector and 34% from S+SSE sector. During summer about 48% of wind is in the S+SSE direction and 12% from N+NNE direction. That is to say, in a year winds from these two directions account for 66% chance of occurrence.

When the upstream unobstructed wind is blowing at a more obtuse angle to the direction of the valley, there may induce air currents in a direction lateral to that of the valley. Wind speed of such currents blowing laterally across the valley is usually small. Figure 6.1 shows a schematic view of such flow.

Although the main Tuen Mun valley runs in the N-S direction, there are smaller side valleys running off the mountain range of Tai Lam Country Park on the east as well as the Castle Peak range on the west into Tuen Mun valley. These side valleys also induce wind flow in a lateral direction.

For the Tuen Mun East Area and the Tuen Mun West Area, it is discussed in the previous section that the winds in general are parallel to the mountain range. That is prevailing in the easterly direction for the annual condition. In the summer months, winds over the Tuen Mun East Area are more probable from the ESE-SSE directions. For the Tuen Mun West Area winds are more probable from the WSW-SSW directions.

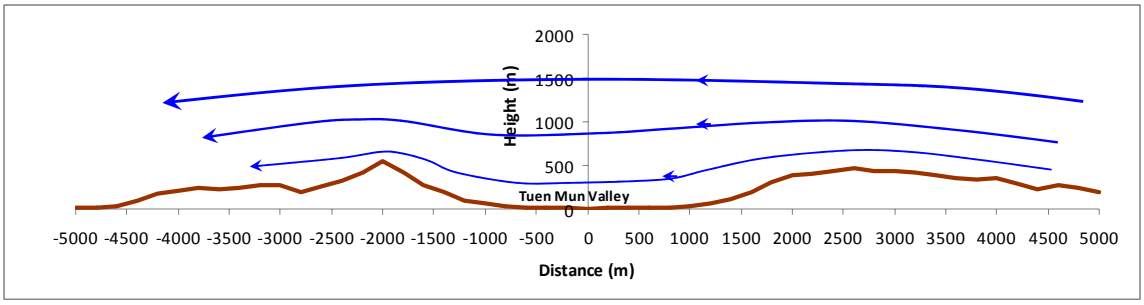


Figure 6.1 Lateral flow

6.2 Effect of greenery and open space

TMNT area is situated in the Tuen Mun valley with the Tai Lam Country Park to its east and the Castle Peak mountain range to its west. So there is a lot of greenery on the hill slopes surrounding the area. The differences between the urban developments and the vegetated slopes will create temperature difference and this will induce the Katabatic air movement. The cooler air flowing down the slope will help to alleviate the summer heat.

It has been discussed in the previous section that there are ample greeneries dotted around the TMNT area. The various patches of greenery and open space, especially those larger ones and those adjacent or connected to arterial flow paths (e.g. the Tuen Mun Tang Siu Kin Sports ground) will help to re-vitalize air ventilation. There are also smaller open spaces such as tennis court in housing estates, though not very effective, they play a part in helping the general ventilation situation, as they help to reduce the general density of development.

6.3 Effect of building layout and street pattern

6.3.1 General features and flow pattern relevant to TMNT area

(a) Downwash

In general from the wind environment study, it is observed that the available wind coming onto the outskirt of TMNT area is quite adequate (2m/s – 3m/s), at times it can be too strong. As shown in Figures 5.11a and 5.11b this wind will blow principally across the Tuen Mun valley in the N-S direction. At lower altitudes, say 50m to 100m above ground, this wind will channel through the valley along the main N-S arterial flow paths, e.g. the TMRC. It is also observed that at the interior of town centre area, the available wind is small, around 0.5m/s to 1.0m/s. Thus there are two concerns pertinent to air ventilation for the area. They are, (1) The issue of having too strong wind at locations and (2) The issue of bring the wind into pockets of interior areas of town centre.

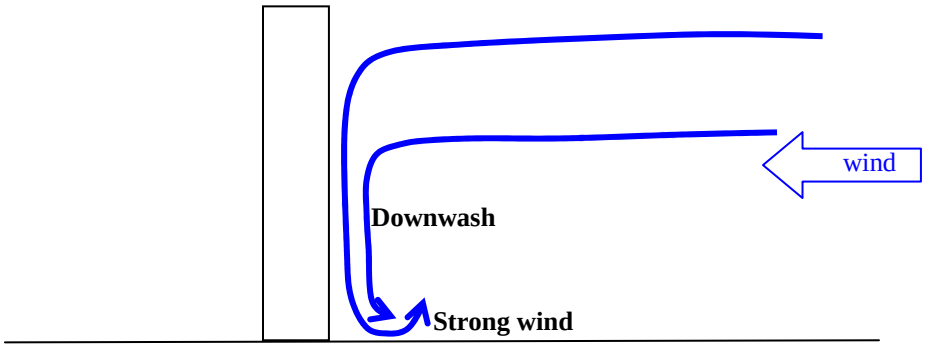


Figure 6.2a Downwash wind

As wind blows on to a building and impinges onto the front face of the building, as the wind is being blocked by the building, there creates a downward air stream (Figure 6.2a). This is known as the downwash. The taller the building and the wider the building, the stronger is the down wash. This down wash when reaching the ground will blow along the ground as the pedestrian level wind. Its magnitude can be as high as the roof level wind which the downwash is originated. This can be too strong at time.

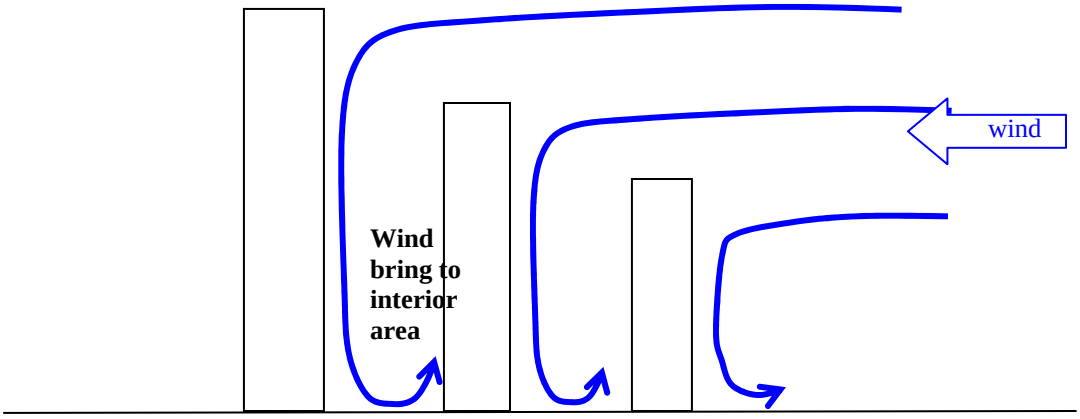


Figure 6.2b Downwash wind for buildings with progressively increasing heights

To reduce the strength of the downwash, A staggered building height development strategy can be used. Buildings are constructed with progressively increasing heights in the direction of the wind as shown in Figure 6.2b. It can be seen from the figure that as the first row of building is not as tall the downwash is reduced. The wind above the roof of first row building is being caught by the building in the second row and brings down to ground level as downwash. And, the wind at still higher elevation will be caught by the building of the third row and also generating downwash. This will reduce the strength of downwash in front of the building of the first row. Furthermore it has the advantage of bringing the wind deeper into urban development as discussed later.

(b) Building & gap width

As wind blows onto a building and being blocked by the building, it tries to flow around it. Figure 6.3 shows the plan view flow pattern. The wind will sweep around building corner and around the side of the building. The strength of this flow on the side of the building will depend on the width and height of the building. The wider the building the stronger is the flow. Moreover, if there are adjacent buildings, the space or gap between the buildings forms a corridor for the wind to blow through. Wind speed in the gap will depend on the ratio of gap width to building width. In general the smaller the ratio, the higher is the wind speed. Furthermore a small gap/building ratio has the disadvantage of letting less amount of wind to blow into the interior.

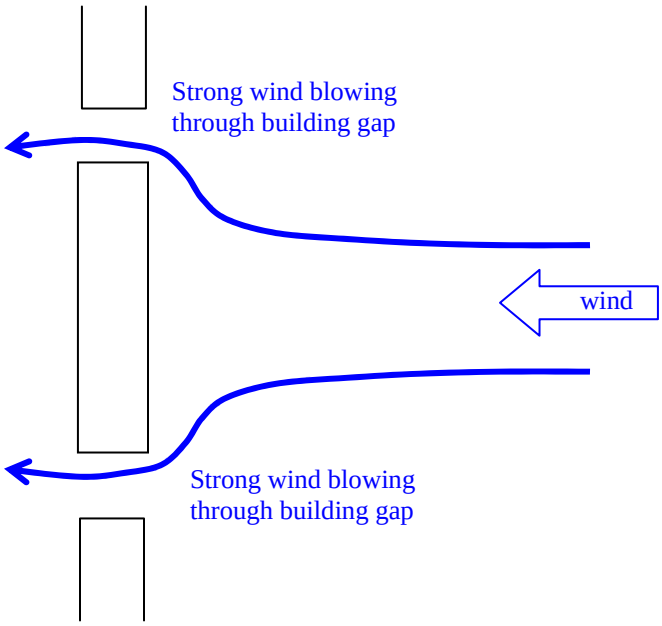


Figure 6.3 Flow between building gaps

(c) Cross flow

Wind blows along a path of least resistance. Thus it will blow along continuous paths created by major roads and water channels. As such wind, especially pedestrian level wind, over areas outside the flow path will be much less. It is thus important to create cross flows between major flow paths. Figure 6.4a and Figure 6.4b show two configurations of developments around major flow paths.

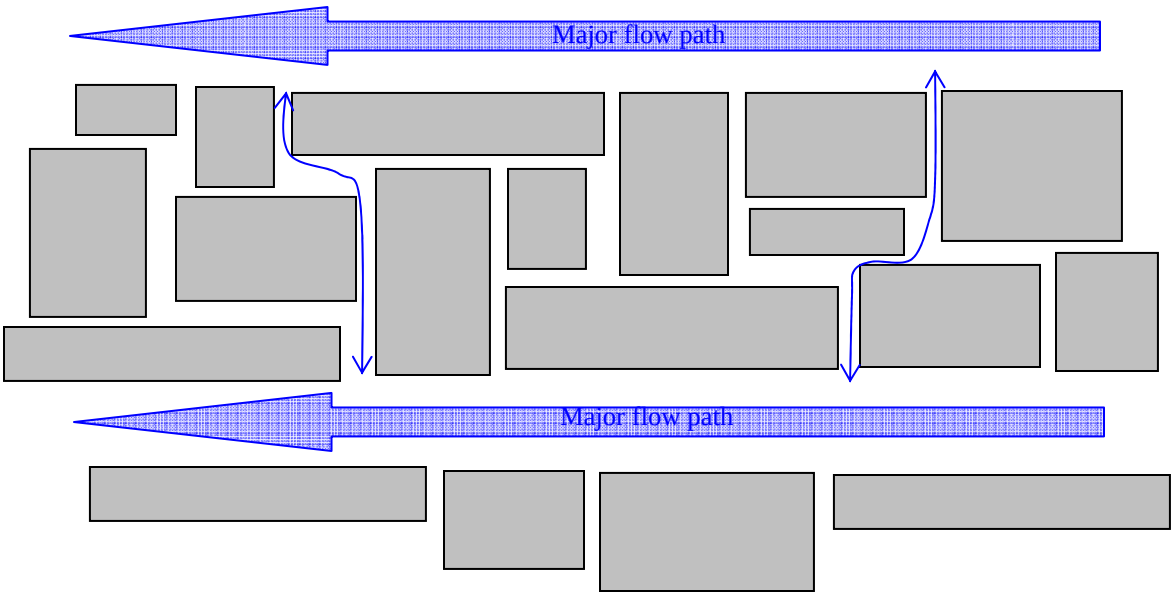


Figure 6.4a Little cross flow between major flow paths

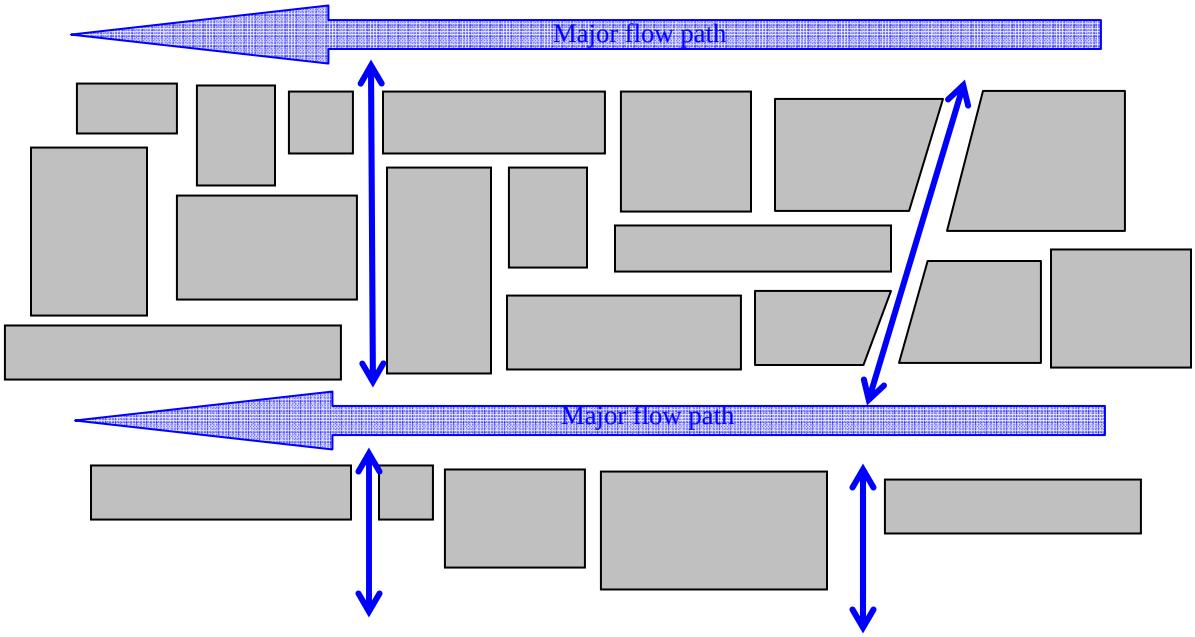


Figure 6.4b Better cross flow between major flow paths

The wind flow in the major flow path will induce flows in side streets connecting to it. However if there are no direct route linking the major flow paths, (for example only zig-zag side streets as in Figure 6.4a) the cross flow will be weak. For better cross flows, directly connected paths as in Figure 6.4b are desirable. That is, without adequate connecting paths, the wind blow along the major flow paths will not benefit too much the area on the two sides adjacent to the major flow path.

(d) Building geometry

For a given Gross Floor Area (GFA), within limits of the height restriction, a building can be tall and narrow or it can be not so tall but bulkier in plan. The effects on wind of these two building configurations are not quite the same. In general, a tall and narrow building contributes towards higher ground roughness and hence slows down the wind downstream. In the immediate neighborhood of the build, because the building is narrow, the blockage and shielding effect is not so strong. For a bulky but shorter building, the blockage and shielding effect to the immediate neighborhood is large. It contribution towards ground roughness is probably less than the tall building. Overall in terms of air ventilation, a tall and narrow building is generally preferred than a bulky building.

(e) Podium

Nowadays, many buildings are constructed with a podium. The podium can be several storeys high and more often than not, the foot-print of the podium covers the entire building lot. On top of the podium, one or more high-rise buildings are constructed. Tall and narrow buildings are desirable as mentioned above. However, a podium occupying the entire building lot will be bad for the air ventilation at pedestrian level of the surrounding neighborhood. Podiums have the effect of lifting the wind off the ground. In fact podiums are used in countries of strong wind to overcome strong pedestrian wind problems. The mitigation of this is to make the podium permeable.

In the following sections, air ventilation condition for the various TMNT zones will be discussed in the light of the flow scenarios presented in this section.

6.4 Evaluation of air ventilation conditions for Existing, Approved and Committed building profile

6.4.1 Central Area

As presented in section 4.2.3, the Central Area is the main part of TMNT area located in the Tuen Mun Valley. The wind flow over this area as given in Figure 5.11a is predominantly in the NNE direction for the annual condition. Cutting through the area in the general north-south direction are several major continuous routes. These forms the major flow path of the wind; they are the TMRC, the Tuen Mun Road and the Tsing Wun/Ming Kum Road as shown in Figure 6.5a. These will bring the wind into and through the area. As discussed in Section 6.3.1c, although the wind blows through the area and there is adequate wind in the flow paths themselves, areas interior to the flow path will have to rely on cross flow or other means to ventilate the area.

For summer condition, the wind is reversed blowing predominantly from the SSE-SSW sectors. The major flow paths are the TMRC, the Tuen Mun Road and the Tsing Wun/Ming Kum Road as shown in Figure 6.5b with wind generally blowing northwards. For interior areas off the major flow paths, there is the similar problem as for annual conditions.

Ventilation for each sub-zone of the Inner core is discussed as follows:

The Northern Core:-
As shown in Figure 6.6a, other than the major flow path along TMRC/Tuen Mun Road and Ming Kum Road, there are other flow paths. On the eastern slope, the Lingnan section and the San Hui section of Castle Peak Road also serves as a N-S flow path. Flowing down from the north along Tsing Lun Road, Tsing Chung Koon Road to the open space of the Tuen Mun Tang Siu Kin Sports Ground, this is an important path bring wind to the open space and thus ventilating the neighborhood areas. The areas north of Tsing Tin Road, the Tsing Chung Koon, Castle Peak Hospital and to the Siu Hang Tsuen areas are mostly low to medium-rise buildings. Also buildings in this area are not so densely constructed. Thus, in general wind from the north should be able to penetrate into this area. These N-S flow paths not only bring wind into the area. They serve as the supply paths for wind to reach the “Central Core sub-zone” south of this area. Thus it is important to preserve these flow paths.

Other than the N-S flow paths, there are also flow paths in the general E-W directions. The main ones cutting through the area linking the N-S major flow paths are along the Tsing Tin Road and along the Shek Pai Tau Road. Also there is a strip of land between the Leung King Estate and the Po Tin Estate which serves as a breeze way bring down the wind from the slope eastwards into the streets in area adjacent to Hoi Lai Garden.

Bordering both sides of the Tuen Mun valley are the hill slopes. On the slopes are patches of high-rise building constructions. These developments are of high-rise and higher density. They do increase the roughness of the terrain, having the effect of slowing down the wind and blocking the wind in their immediate neighborhoods. Presently, these patches of high-rise developments are isolated, for example Fu Tai Estate and Prime View Garden on the east side, and Leung King/Tin King and Po

Tin on the west. Thus their effects are mainly local around the Estate. However as the developments are on higher ground on the slope, the wind condition is usually relatively stronger. Nevertheless, it is important that future developments will not inter-connect with each other or with existing developments such as to form long continuous lines of building blocking the wind (either N-S or E-W directions).

For summer condition, the dominant wind direction is from the general south sectors. The major flow paths are TMRC/Tuen Mun Road, Ming Kum Road and Castle Peak Road similar to the annual condition but with direction reversed as shown in Figure 6.6b. Tsun Wen Road will form another flow path with wind diverted from TMRC. However since the summer wind is from the south, which means that the Northern Central Area is down wind of the Tuen Mun Town Centre. Thus in general the wind over this area during summer will be weaker. Flows benefited by the lower building heights as shown in Figure 6.6a will not be available for the summer wind. Paths for cross wind flow are the same as for the annual condition. However, since the N-S wind is weaker, the area will rely more on the cross wind flow during summer.

Wind condition over the east and west slopes will be similar as for the annual condition but with wind direction reversed.

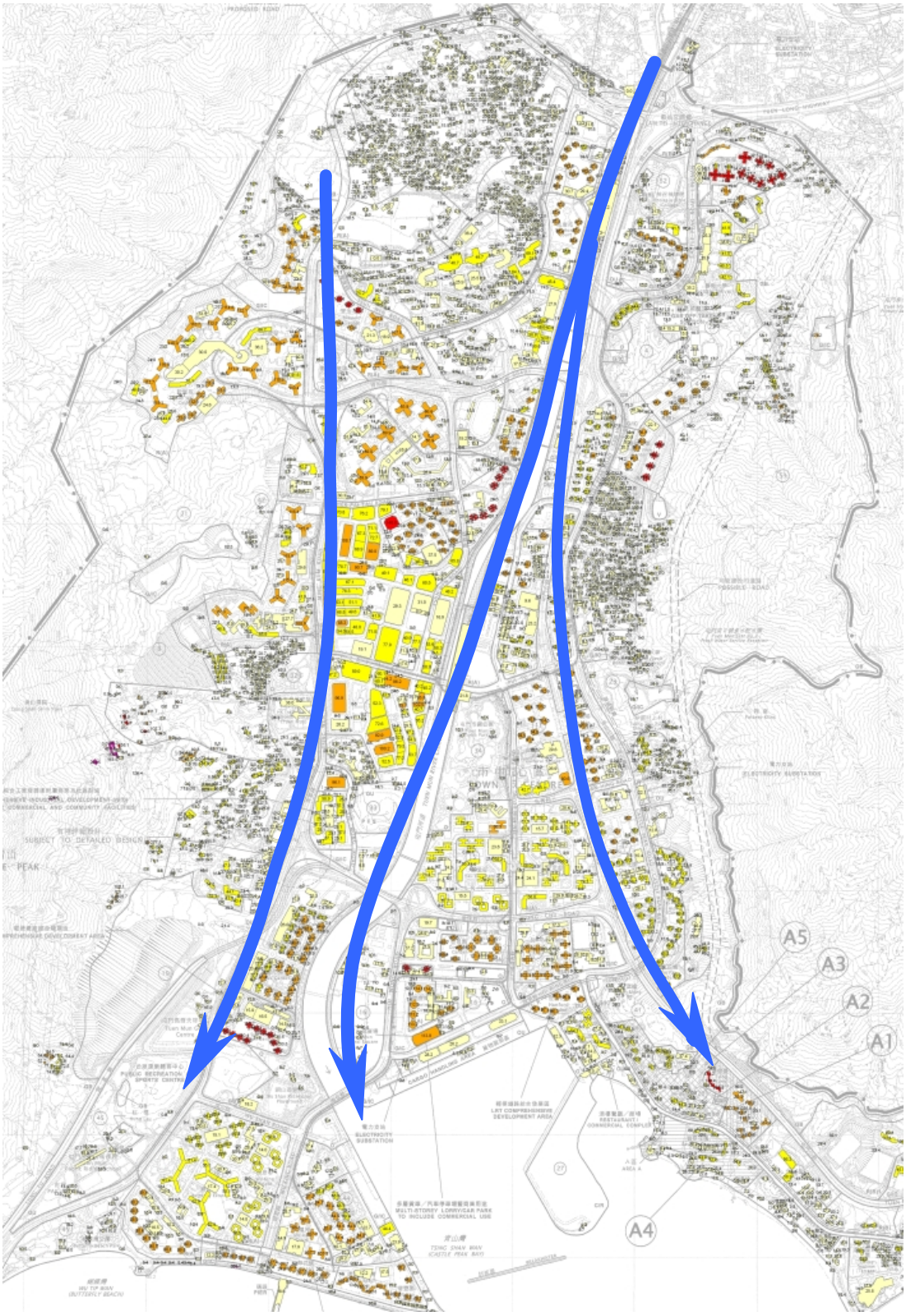


Figure 6.5a Major flow paths in Inner core Zone Annual condition

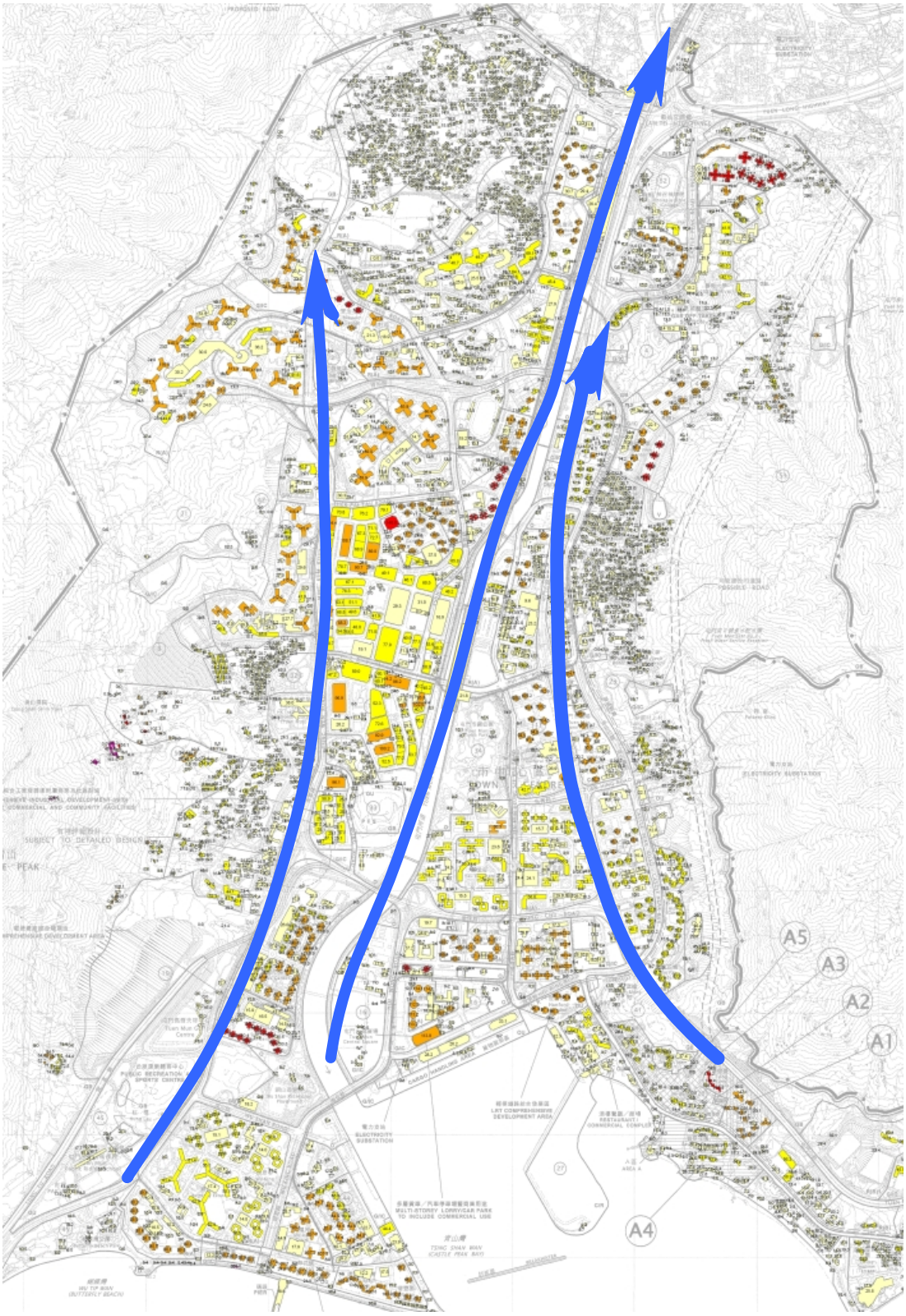


Figure 6.5b Major flow paths in Inner core Zone summer condition

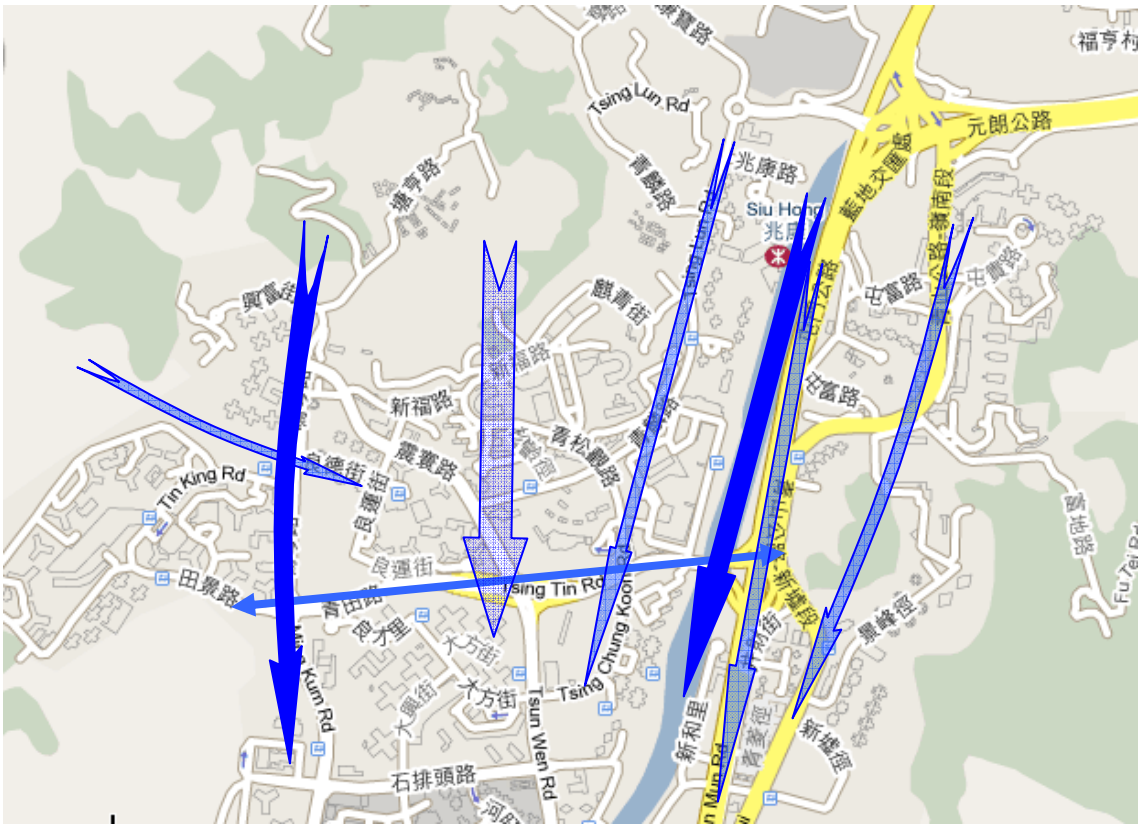


Figure 6.6a Flow paths in Northern Inner core Zone annual condition

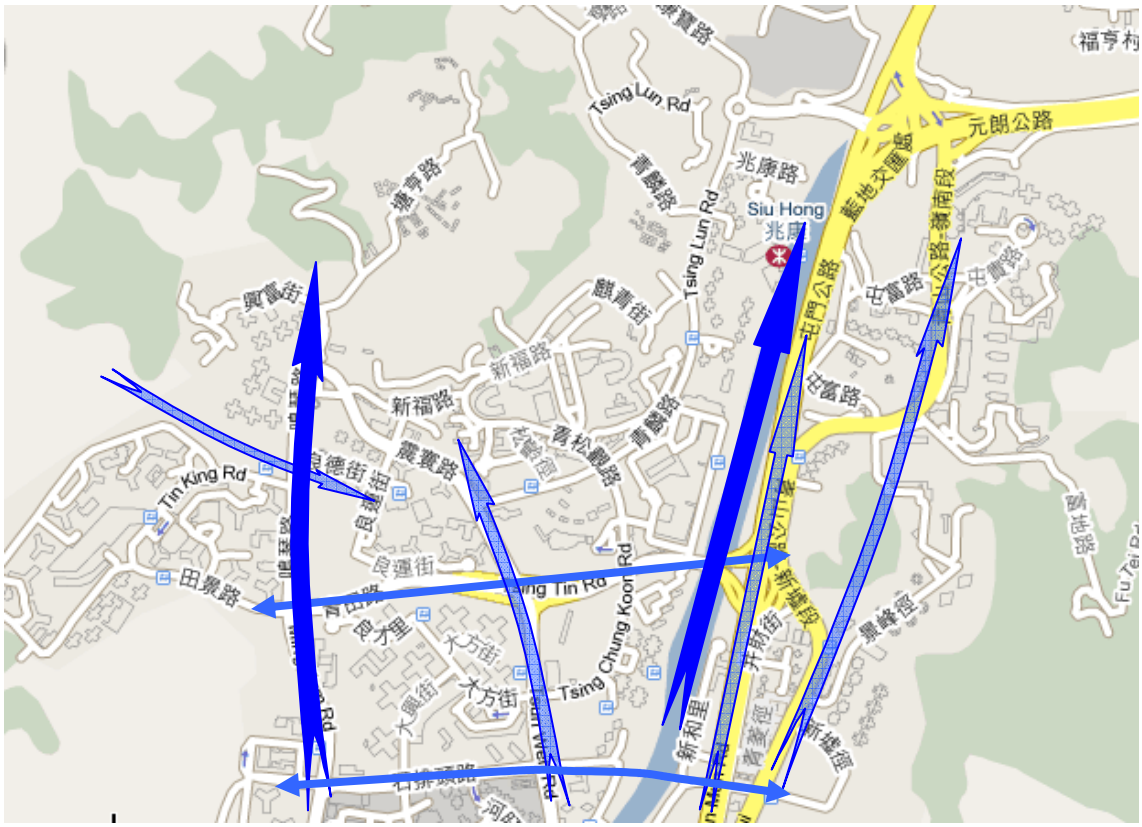


Figure 6.6b Flow paths in Northern Inner core Zone summer condition

There are several groups of buildings that are proposed/approved for developments (except circled A) as shown in Figure 6.6c. Comparing with Figure 6.6a, it can be seen that these buildings (120mPD) will present certain amount of blockage to the NNE wind which blows, for existing built condition, over low-rise buildings. Thus less wind will feed into the North Inner Core and beyond. Fortunately, the flow path down from the north along Tsing Lun Road, Tsing Chung Koon Road to the open space of the Tuen Mun Tang Siu Kin Sports Ground, seems to be preserved. There are also gaps in between these building groups which, though break up the flow, still allow certain paths of wind to blow through. However, in the future, in order to preserve flow paths for wind to blow down from the north, zones designated as open space or low density, low-rise zone should be implemented. Otherwise, mitigation measures should be provided to preserve flow paths.

The development circled A, is in the only strip of open/greenery space between Leung King Estate and Po Tin Estate (P14) serving as lateral flow path from the slope down to the North Central Area. Preferably, this strip of land should be left as a separation to the two Estates such that they would not become a large continuous patch of high density, high-rise development. If buildings are built in this strip, Katabatic wind blowing down the slope and as well as cross wind flow will be hampered.

Figure 6.6c Approved and Committed developments – North Inner Core

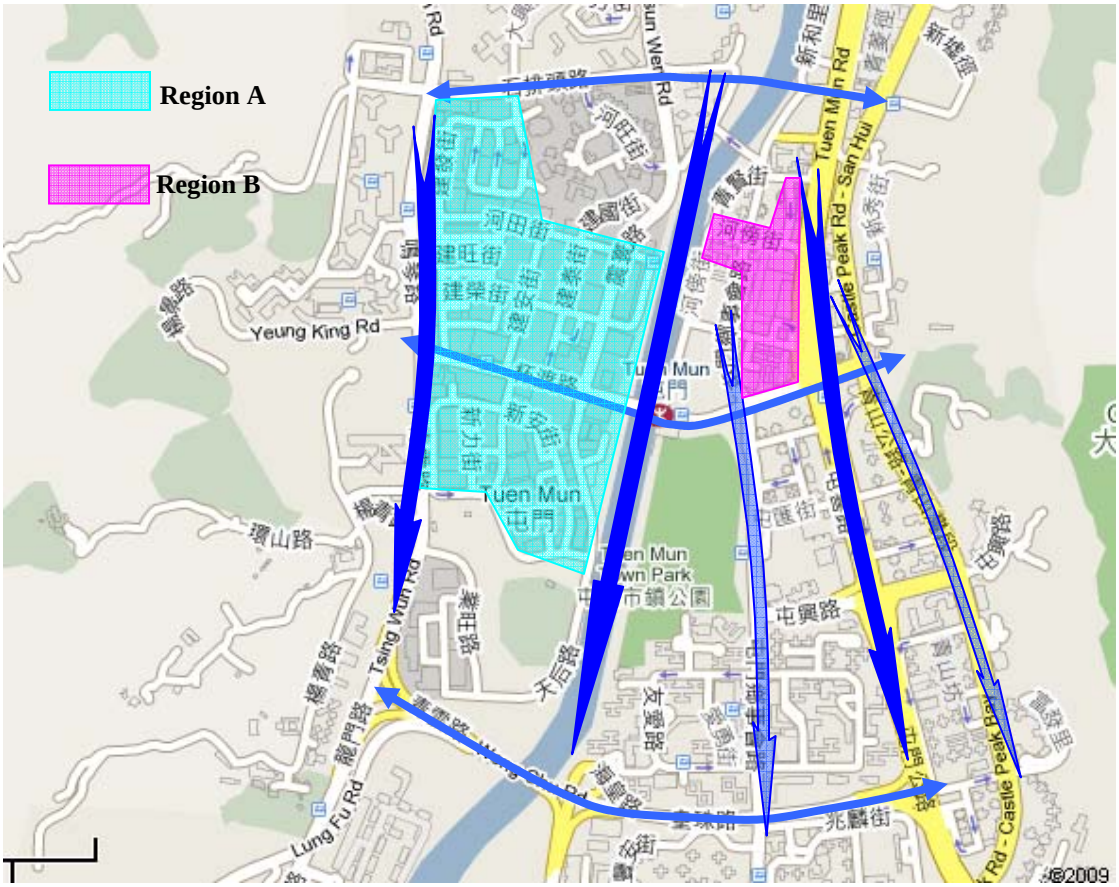


Figure 6.7a Flow paths in Central Inner core Zone annual condition

The Central Core:-
As shown in Figure 6.7a, the major flow paths are along TMRC, Tuen Mun Road and Tsing Wun Road. Other flow paths also in the N-S direction is along the Tuen Mun Heung Sze Wui Road and along the Castle Peak Road. Winds are fed into the area through these major flow paths. As explained earlier, to bring winds into areas interior to the major paths, cross direction flow paths are required. The minor flow paths cutting across the area are along Pui To Road and along Wong Chu Road. However, this sub-zone is the town centre area with denser building constructions and furthermore it is down wind of the Northern sub-zone, the Central Core will have generally weaker winds.

There are two regions in the area warrens further discussion. Region A (as shown in Figure 6.7a) is the area west of the TMRC for industrial usage. North of this region is the Tai Hing Garden and the Tai Hing Estate. The Tai Hing Garden and the adjacent developments consist of more than 20 high-rise buildings in the range of 100m tall. Also, next to it is a building about 120m tall, the Tai Hing Industrial Building. All these developments will shelter the wind from Region A. In Region A there is a mix of building of different heights; from low-rise of less than 30m to high-rise of more than 80m. However one special feature is that, foot prints of all these buildings are large. Most of the buildings cover the whole building lot and many of the lots are relatively big (P15). Another feature of the region is that, though the streets are in

rectangular grid pattern, many streets are blocked at their ends, e.g. west end of Ho Tin Street (P8), south end of Kin Tai Street and etc. As a result, the pedestrian level wind in this region is expected to be weaker. Region B is the region east of TMRC and it consists of residential/commercial buildings of the old town development. Buildings in this Region have heights ranging from 10-15m to over 60m. One feature of the region is that buildings are closely built together (P16) and with narrow streets. Moreover, to the north and south side of this Region there are tall residential buildings. Thus wind inside this Region is also expected to be weaker.

Other locations in this sub-zone are mostly medium to high-rise residential building estates, for example, Tai Hing Garden on the north and Yau Oi Estate & On Ting Estate on the south. Lay-out around these building estates is not so much of the rectangular grid patter. So it is not so effective for the wind to blow through. For Tai Hing Garden area, it is likely to be partly benefited from the NNE wind blowing down from Tuen Mun Tang Siu Kin Sports Ground. On the south, the relatively open space of the Tuen Mun Park will benefit directly the Yau Oi Estate to its south and less directly the On Ting Estate on its south-east. It is expected that there are pockets of areas interior to these building estates having weaker pedestrian wind.

Wind condition over the east and west slopes bordering the Central Core Sub-zone will be similar as for the annual condition of the Northern Core Sub-zone.

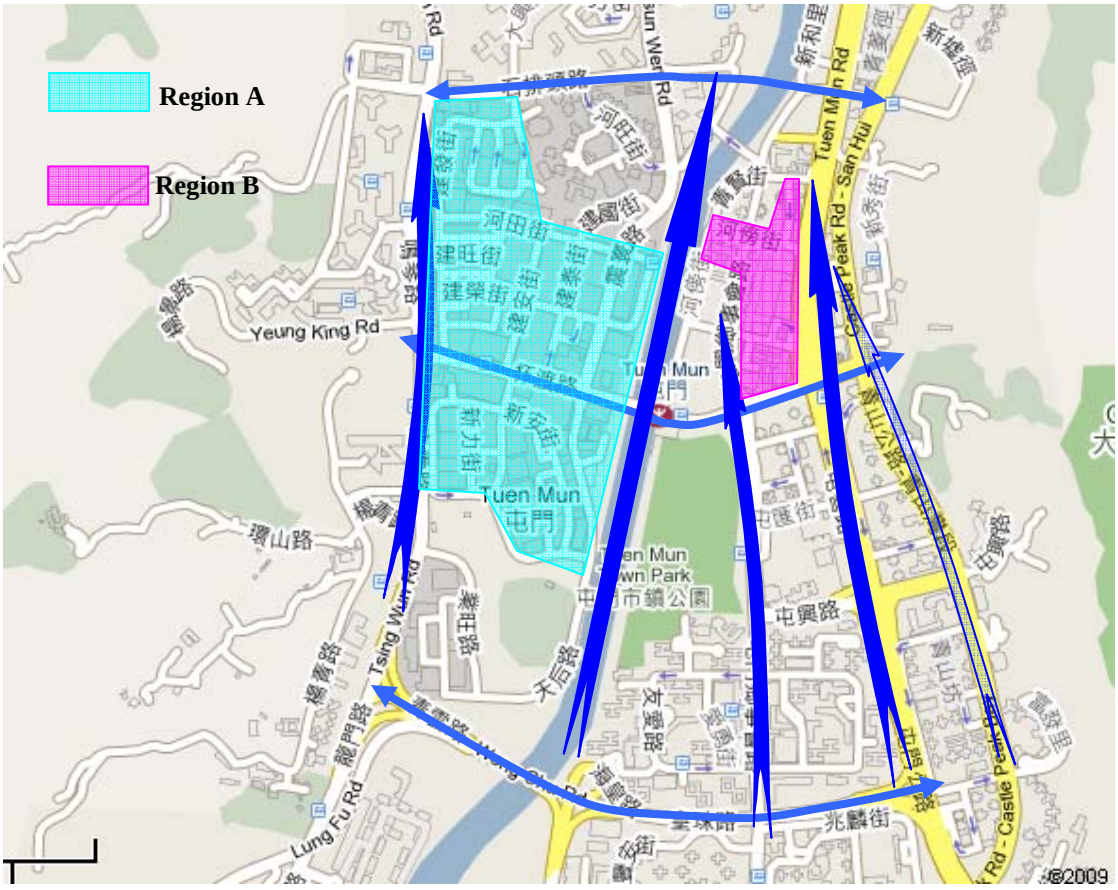


Figure 6.7b Flow paths in Central Inner core Zone summer condition

For summer condition, major flow paths with wing blowing northwards are the same as that of the annual condition but with direction reverted, i.e. TMRC, Tsing Wun Road and Tuen Mun Road. The Tuen Mun Heung Sze Wui Road catching the wind from the south will be a major flow path for the summer wind. Flow along the Castle Peak Road will be slightly blocked by the buildings directly on its south end. Cross wind flow paths in the E-W directions are the same as the annual condition. Except as discussed later, the Central Core Sub-zone is sheltered by buildings of the Southern Core Sub-zone. Thus, wind condition over the Central Core Sub-zone is weaker for the same reason as discussed for the annual condition.

Wind condition for the southern portion of Region A is expected to be improved by the Tin Hau Temple open space which catches the south wind all the way from the Castle Peak Bay. Pedestrian level wind condition at the northern portion of Region A is expected to remain weak as it is blocked by all the buildings to its south. Pedestrian wind conditions for Region B will remain weaker similar to the annual condition.

Areas around Yau Oi Estate and On Ting Estate are expected to have slightly better wind condition for the summer condition than the annual condition, as they are closer to Castle Peak Bay where the south summer wind comes from.

It is understood that two strips of 15m wide non-building areas are introduced on each side of the Tuen Mun Heung Sze Wui Road. This will improve the amount of air feeding into and penetrate through the Central Core Sub-zone especially for the summer wind.

Wind condition over the east and west slopes bordering the Central Core Sub-zone for summer condition will be similar as for the annual condition but with wind from the southerly direction.

There are several building developments proposed/approved in this sub-zone. The one worth special mentioning is the development next to the Tuen Mun Station on its east side. As shown in Figure 6.7c, this building complex comprises seven high-rise buildings of about 130m to 150m tall. This group of tall buildings will certainly present blockage to the wind. Especially the three blocks of buildings on the south side are built close together in a line; they will block the wind on its leeward side. Also, the effect of their increased drag, slowing down the wind will affect areas one to two kilometers downstream. Fortunately on the two sides of this development are two main flow paths, along the TMRC and the Tuen Mun Heung Sze Wui Road which will help to replenish the ventilation. Another problem created by this development is the massive podium of this complex. It is 24.5mPD high and it is long in the N-S direction. Unless it is permeable, it will block all lateral flow in the E-W direction, e.g. flow along Yan Ching Street in the old Town area.

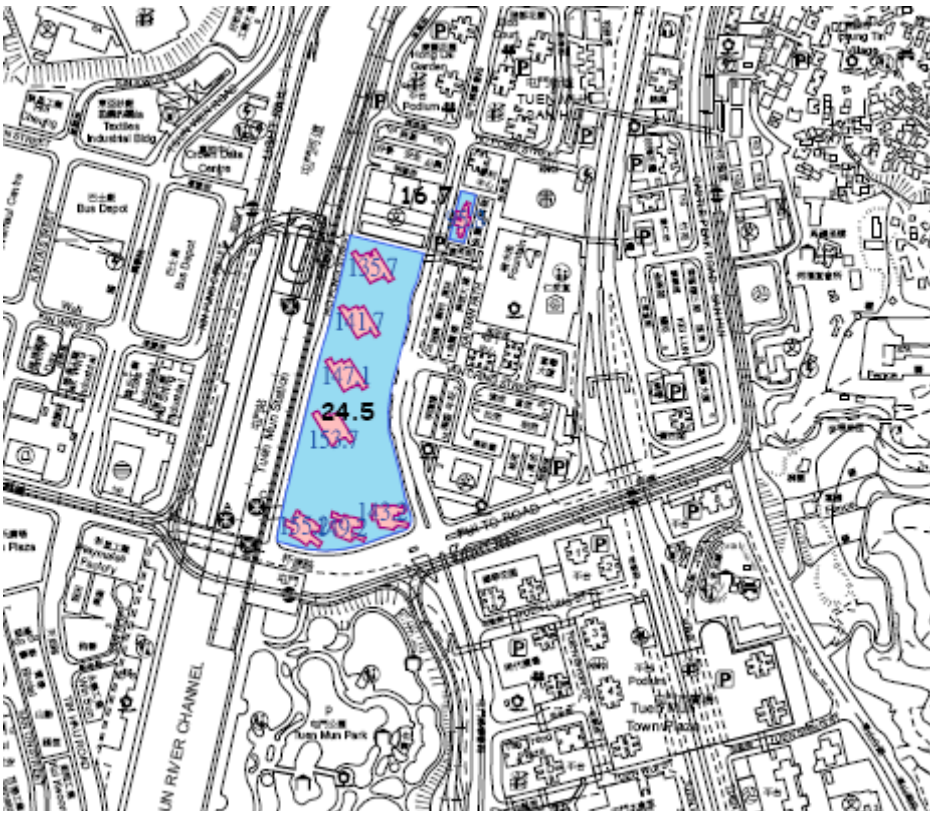


Figure 6.7c Approved and Committed developments – Central Inner Core

The Southern Core:-
The major flow paths in the Southern Core Sub-zone continue from the Central Core Sub-zone from the north; which are along the Lung Mun Road, Tuen Mun Road and Tuen Mun Heung Sze Wui Road. Besides these, TMRC and the large patch of open land at the mouth of the Channel is a thoroughfare for wind to blow through. Since the Sub-zone is on the coast front, paths for cross flow is not quite as important, except at the east and west ends. On the east side continuing on from Castle Peak Road wind blows down the path along Hoi Wing Road. On the west side, wind blows along the strip of land connecting the hill slope to the TMRC, between Wu Shan Road and the Sun Tuen Mun Centre.

With wind from the north, area east of the TMRC of the Sub-zone will be downwind of the Yau Oi Estate and On Tin Estate developments and generally downwind of the town centre area. This will mean that generally the wind is weak from the north. However, as the Sub-zone is near the sea, certain amount of land and sea breeze may help with the ventilation condition. On the west side of TMRC there are the Lung Mun Oasis, Glorious Garden and the Sun Tuen Mun Centre developments. These are high density, high-rise residential building groups, especially buildings of Sun Tuen Mun Centre are about 140m tall. With more than 30 buildings over 80m tall, they will certainly increase terrain roughness and introduce blockage to the wind. There would be locations within and immediately adjacent to the buildings where the wind might be blocked. However, these three building Estates are surrounded by open space on most sides, their blockage effect on other building areas is expected to be less severe.

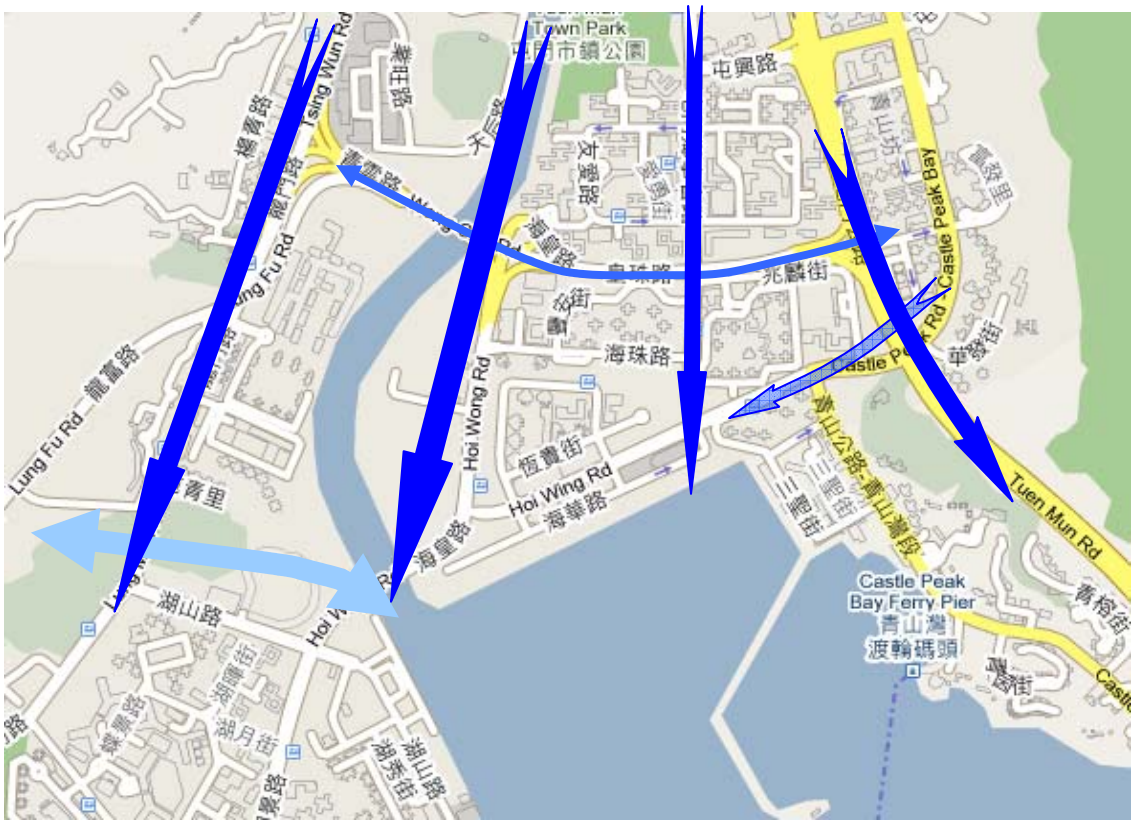


Figure 6.8a Flow paths in Southern Inner core Zone annual condition

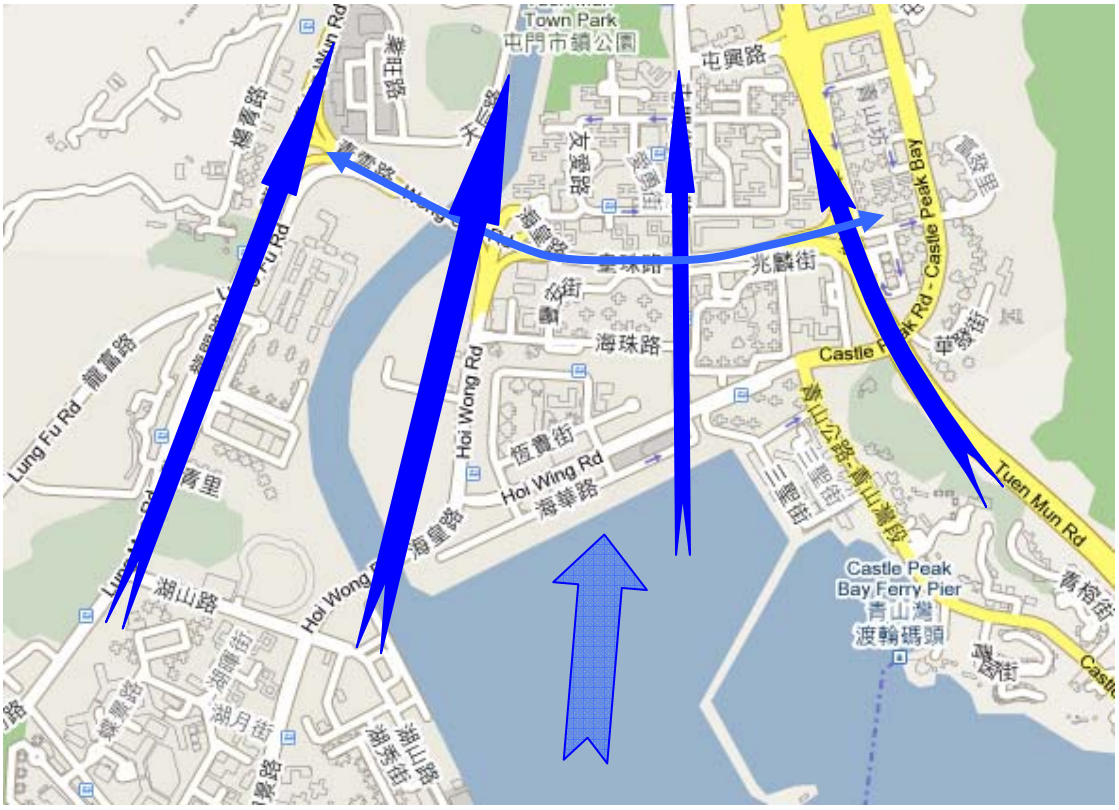


Figure 6.8b Flow paths in Southern Inner core Zone summer condition

For summer condition wind directly blows from the Castle Peak Bay on to Southern Core Sub-zone (Figure 6.8b), except the western end where the wind has to blow over the triangular coastal development. Even this western end is benefited by the open greenery space down the slope to the Wu Shan Recreation Playground. In general the summer ventilation will be quite adequate. As wind comes from the open sea, it is expected to be quite strong at times. Thus locations along the coastal strip may be too windy at times. However, it is important to remember that on the other hand we need as much wind as possible to penetrate the area and blow northwards into the town centre and subsequent areas up north. It is necessary to preserve as much flow as possible but at the same time trying to reduce the wind speed at spots of high-wind. In this respect, the technique of using "progressive height increase" as discussed earlier is important and is a good planning strategy. Presently, the row of low-rise building at the shoreline is partly moving in this direction. Managing the building/gap width ratio could also be used to reduce strong wind between building gaps.

The proposed/approved development in this sub-zone is the building group north of the Lung Mun Oasis. The two 100mPD buildings will block the northerly wind blowing to Lung Mun Oasis; and also block the summer wind blowing to the industrial area to their north. However, as the two buildings are extension to several denser and taller building developments (e.g. the Sun Tuen Mun Centre), the overall effect is not expected to differ significantly from the existing condition.

The Coastal Core Sub-zone:-
This is the triangular patch of land at the mouth of the TMRC. As shown in Figure 6.9a this area catches the north wind coming down from the TMRC. Wu King Road continues on from TMRC cutting across the Sub-zone will be a flow path. Otherwise wind coming out of the TMRC will generally blow onto this area. Wind also blows down along the Lung Mun Road adjacent the hill slope. In general it is expected that the available wind blowing to this area should be adequate. However, as a result of the building lay-out and geometry of the developments, for example the densely built Yuet Wu Villa and the long double Y-shape of the Butterfly Estate, there would be locations in the shadow of the buildings where the wind is blocked by the building.

For summer condition winds directly blow onto this area from the general SW-S direction (Figure 6.9b). In general the summer ventilation will be quite adequate. As wind comes from the open sea, it is expected to be quite strong at times. Thus locations near the southern coast may be too windy at times. There is a feature of the building lay-out of developments along the coast-line (perhaps a common problem of building developments fronting the coast), that is, they are constructed as a long line fronting the shore. Some developments, e.g. the Melody Garden have buildings spaced wider apart. While other developments, e.g. the Miami Beach Towers are constructed with buildings closely spaced forming a long continuous line. This result what is commonly termed the “Curtain” effect. This will introduce two ill effects; 1) it will largely block the wind blowing into the interior, and 2) it will create un-acceptable high wind speed sweeping round building corners and between building gaps. Another point is that, the general height of this line of buildings is around the 100mPD, which is taller than the buildings to their interior, e.g. the Butterfly Estate (around 60mPD) and Yuet Wu Villa (about 85mPD). Therefore the interior buildings are completely sheltered. Little or no wind could be created by the downwash effect on the interior buildings. As discussed earlier, it is necessary to use techniques such as “progressive height increase” and “managing building/gap width ratio to allow as much wind to flow through as possible and yet keeping the high wind speed to an acceptable level.

Figure 6.9a Flow paths in Coastal Inner core Zone annual condition

Figure 6.9b Flow paths in Coastal Inner core Zone summer condition

6.4.2 The Tuen Mun East Area:-

This area covers the strip of coastal land and lower hill slopes along the sea coast extending from Sam Shing Hui on the west to around Siu Lam on the east. The expected prevailing wind directions for the annual and summer conditions are given respectively in Figures 5.11a and 5.11b (enlarged in Figures 6.10a & 6.10b). In general wind for the annual condition is in the easterly direction and wind for the summer season is in the general E-SE direction. The wind is more or less parallel to the coastline. Besides wind blowing over the sea in the prevailing direction, it will also blow along paths of the Castle Peak Road and the Tuen Mun Road. Without actual numeric wind data for this zone, it is difficult to obtain a quantitative estimate of the pedestrian level wind speed. However it is expected that there should be adequate available wind over this zone and it might be quite strong at times.

As discussed earlier, this zone consists of residential developments, holiday and vacation villas and hotel complex. The area is a mix of low-rise, medium-rise to high-rise buildings. Generally, building developments are built in clusters with one group of building slightly separated from the next group. There are several high-rise building developments with the layout of a long continuous line, for example the Aegean Coast, the Gold Coast Seaview Apartment and the Bayview Terrace. Such developments will create the adverse “Curtain” effect blocking substantially the wind at their downwind area. Aegean Coast with building height over 80m is one of the typical examples. Presently, as mention earlier, the building groups are not so close together so as to create a macro “curtain” effect on the surrounding. Their effect is more to their immediate neighborhood. Furthermore, presently there are ample greenery/open spaces in the area and the zone is along the coast, there will be better opportunities for the wind to penetrate the area. However, such “Curtain”constructions should be discouraged in the future.

All over the area, there are many low-rise to medium-rise building groups. For example the low houses of Beaulieu Peninsula, those of Agua Blue and houses from Babecue Gardens to The Castle Bay, these are all close the sea shore. There are also low-rise developments on the hill slopes, e.g. those houses north of Tuen Mun Road. Outside this pattern in the Lok On Pai Siu Lam Flea Market area, there is a low-rise building which is quite a long building with large foot-print. This building is slightly over 10m high (seem not to be in use) and located not far from the shore. For such a long building, it will create blockage effect; however the building is low such that the effect will be more local around the building itself.

In general the available wind in this zone is expected to be adequate. However there are local spots sheltered by building groups as explained earlier or sheltered by topography (mountain range on north side). With the zone being a strip of land along the coast and the prevailing wind directions more or less parallel to the coast and also from the sea, air ventilation would be improved with ample spaces between building groups. Flow paths in the prevailing wind direction should be maintained and created. Furthermore, with the Tai Lam Chung Country Park mountains to the north of this strip of land, flow paths perpendicular to the coast to accommodate the cooler down flow of Katabatic wind from the slope and the land and sea breeze would also help the ventilation situation.

Figure 6.10a Prevailing flow directions in Tuen Mun East Area annual condition

Figure 6.10b Prevailing flow directions in Tuen Mun East Area summer condition

Within the zone, there are several proposed/approved developments. One of such is the buildings enclosed in the blue marked area in Figure 6.10c. It has been mentioned that from the point of view of air ventilation, a long line of building is not desirable. This building complex is still having such a layout forming a semi-circle. This blocks the wind to its downstream. Furthermore, together with the buildings in the orange marked area (*pending approval, new scheme is expected*), they form an oval ring. This building layout arrangement is good for protecting the inner area from strong wind; however it will present weaker air ventilation. And the overall oval development will block winds to their leeward sides, especially to the area enclosed. To know precisely the wind condition in and around the complex, a more detailed study may be necessary.

There are also many areas in this zone that are marked “Developable” which are encircled in green. Certain possible building layouts are also presented for these areas. In general they are medium-rise buildings of about 10-storey high and built not so close together, e.g. the area around the Lok On Pai Siu Lam Flea Market. Provided that buildings in such developments are built with adequate spacing gaps and that building complexes are spaced apart to avoid forming large patch of continuous building groups, the modification to the wind environment in the zone should be tolerable. It is noted that many of these building groups are proposed with the buildings in a group having the same height. This arrangement has the adverse effect of having the wind skimming over the buildings. Building with staggered heights would better bring the wind to lower elevations. Different building layout would have different effects on air ventilation; to have a precise knowledge on a specific case, further study would be required.

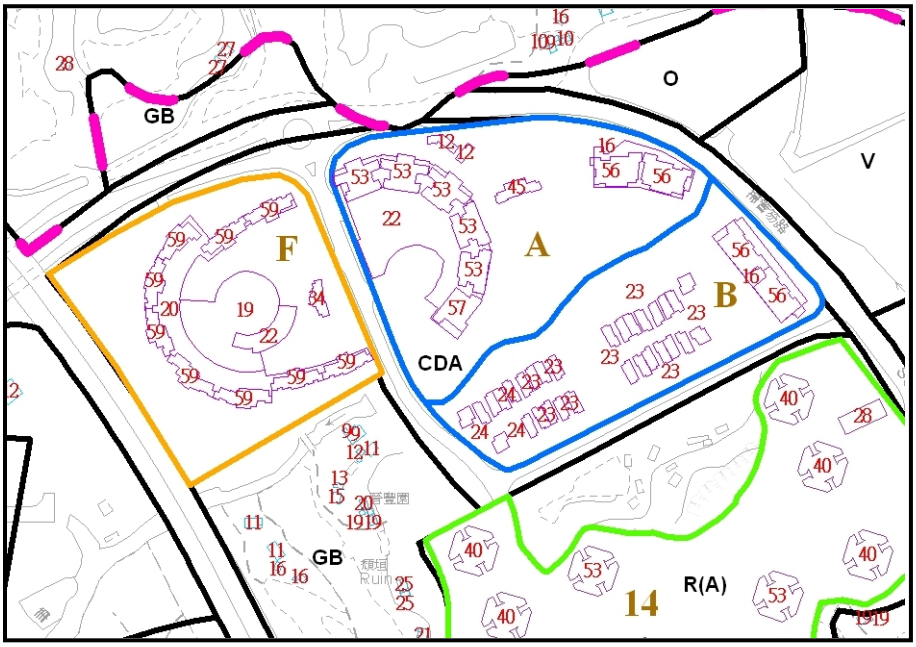


Figure 6.10c Example of proposed/approved developments

6.4.3 The Tuen Mun West Area:-

This zone is the strip of coastal land south of Castle Peak. The expected prevailing wind directions for the annual and summer conditions are given respectively in Figures 5.11a and 5.11b (enlarged in Figures 6.11a and 6.11b). In general wind for the annual condition is in the easterly direction and wind for the summer season is in the general SW-S direction. Other than wind blowing over the sea, it also blows along the Lung Fu Road running at the foot of the slope parallel to the coastline. Buildings in area are mostly 10m to 25m industrial buildings. The west end of the zone is the Power Station with several large buildings about 60m to 75m tall. In general, since the area is a narrow strip of coastal land and with low-rise buildings, it is expected that there is plenty of available wind. Furthermore, buildings in this area are not likely to affect wind conditions in other areas. One concern is that buildings in this area are large in foot print which can create high wind sweeping around building corners.

The six oil storage tank proposed/approved (shown on Figure 6.11c) in the zone will not affect much the ventilation condition as commented above.

Figure 6.11a Prevailing flow directions in Tuen Mun West Area annual condition

Figure 6.11b Prevailing flow directions in Tuen Mun West Area summer condition

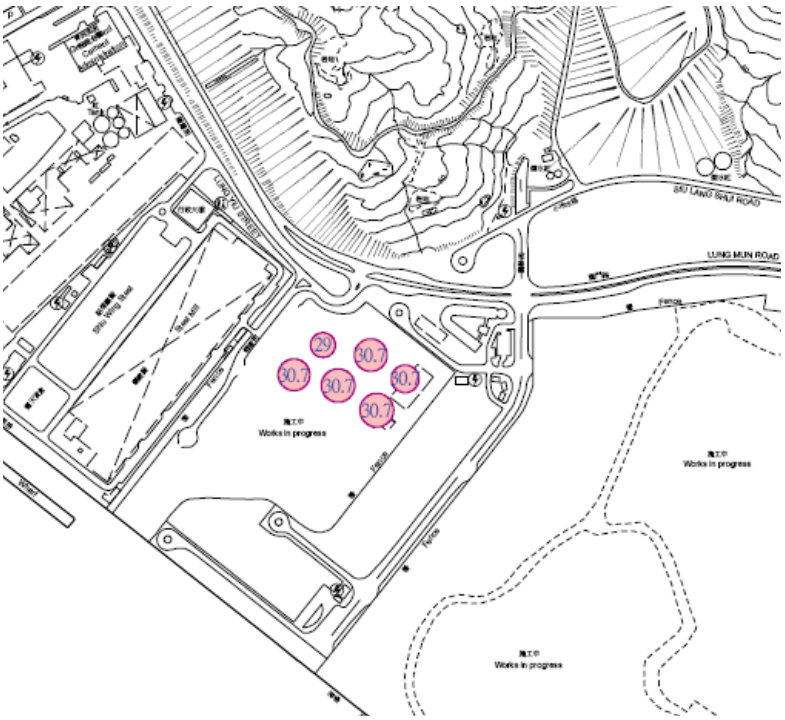


Figure 6.11c Proposed/approved oil storage farm

6.5 Evaluation of air ventilation conditions for Proposed Height Restrictions and Potential Redevelopments

6.5.1 Proposed Height Restriction

The evaluation is carried out based on information supplied by the Planning Department on the Proposed Height Restrictions and the Redevelopment Plan and for the wind environment as discussed above. It is generally understood that taller buildings will increase the drag on the wind and hence resulting in a slower wind speed as discussed earlier. However building height is not the only factor that affects the pedestrian wind over the Area. Other factors as important, if not more important, are size and geometry of the podium, permeability of the podium, lay-out and geometry of the tower blocks, greenery and open spaces. The ventilation condition of a location is a function of a matrix of combination of these factors.

In general, the Proposed Height Restriction Plan (except for several special cases which will be discussed later) reflects the profile of the existing building height. From the Proposed Height Restriction Plan (Figure 6.12a & b), it can be seen that most of the existing greenery, open spaces and low-rise zones are being maintained, e.g. zones 23, 24, 33, 34, 54 and etc. There are also several proposed rezoning sites, for example in and around the Central area, these are mainly low-rise, such as patches around Tuen Mun town centre (2 to 8 storeys). These changes are not expected to alter much the wind flow as discussed for existing condition. Over the Tuen Mun East Area, there is a fair amount of rezoning. Most of them are rezoned to medium-rise of 10-storey restriction, e.g. Area. 59, north of 56 and etc. The effect of such modifications has been discussed earlier. It is also noted that all the major air flow paths as presented in the earlier sections remain intact. On the other hand, neither has these been enlarged and improved. Thus the overall flow pattern would remain similar.

Looking at the Proposed Height Restriction and comparing it with the existing building profile, there are several cases where the existing buildings are taller than the restriction. To name a few, these are Prime View Garden 146mPD v.s 100mPD of Area. 4, Tai Hing Industrial Building 140mPD v.s. 120mPD of Area. 9, Luen Cheong Industrial Centre 96mPD v.s. 85mPD of Area. 17, Sun Tuen Mun Centre 150mPD v.s. 100mPD of Area. 18. There are also many existing buildings with heights slightly exceed the restriction. If and when the existing buildings are replaced, the lowering in height will present certain amount of contribution to air flow.

As mentioned earlier, there are special cases that call for special attention. The first is the industrial area make up of Area. 9 and Area. 12, that is the patch of land shaded aqua blue in Figures 6.7a & b. It has been commended that there can be ventilation problems in this area due to the large building foot print and blocked street ends. The comment was made for the existing condition where some buildings are low and medium-rise. With the proposed height restriction set at 100mPD for Area. 9 and also 85mPD for Area. 12, the problem will be compounded. The problem then is not just for air ventilation local to the area. This large patch of “future” high-rise buildings will block and slow down the wind downstream; that is, for annual prevailing wind in the northerly direction, it will block the wind to its south and for summer wind from the south, it will block the wind to its north. This height of restriction will create adverse air ventilation

effect to a large portion of TMNT area. Unless special mitigation measures are implemented, the restricted height should be set to a much lower value.

The second case that warranted discussion is Area. 10 which is the older Tuen Mun Town Centre area. It was discussed earlier that this area (shaded pink in Figures 6.7a & b) might have weaker air ventilation. The comment was made based on the existing built environment with most of the buildings in the area being low-rise. The proposed height restriction is set to 85mPD (site area>400m^2 at 100mPD) and the strip east of Tuen Mun Road set to 85mPD. This will worsen the situation and further weaken the wind. Air ventilation locally around the area will be weaker; and it will block and slow down the flow to its leeward sides.

The third case that is worthy of discussion is the areas at the very northern portion of TMNT. These are the patches of areas in Area. 54. The proposed height restriction is set at 120mPD. As discussed earlier, for annual condition with the prevailing northerly wind direction, winds for the urban core of TMNT comes through the northern part. Thus these large patches of high-rise building areas would deplete the wind blowing down and weaken further the ventilation of the down town industrial and residential areas.

The proposed height restrictions for different patches of zones are set at different heights. At around the central portion of TMNT there is the highest value of 156mPD for the patch of area next to Tuen Mun Station. Other zones are set at 120mPD, 100mPD, 85mPD and etc. down to the medium and low-rise of a few-storey. The proposed height restriction should be set at more regulated increasing steps to take advantage of the "progressive height increase" concept to bring the wind to the inner areas. This has the benefit of having the upper portions of the buildings catching the wind as the wind blows inwards. The down wash generated over these different layers of buildings helps to increase the air ventilation of the interior areas. Height zones should be arranged more in bands aligned in the E-W direction; so as to catch the N-E prevailing winds.

While the progressive increase height arrangement is beneficial, a cluster of buildings of the same height will not be good. It would be useful for air ventilation to have buildings of different heights mixed together while still keeping the general progressive increasing height concept.

Although the "progressive height increase" concept helps to a certain extend to improve the ventilation situation. However the general built environment of TMNT is that the urban area is lengthy in the N-S direction, And, with the prevailing wind direction for summer months from the southerly direction, the wind direction for non-summer months is from the north. This will present a situation that having the taller buildings at the central part will always have problem for wind being blocked at the leeward area when winds come from the other direction. The wind will encounter the taller buildings first. Thus catching the wind on the upper portion of the building as discussed earlier helps to bring wind into the central part, but not further north or south. The taller buildings actually block the wind to its leeward side. It is therefore important to have gaps between buildings and podiums for the wind to penetrate through the area. Further discussion will be given later.

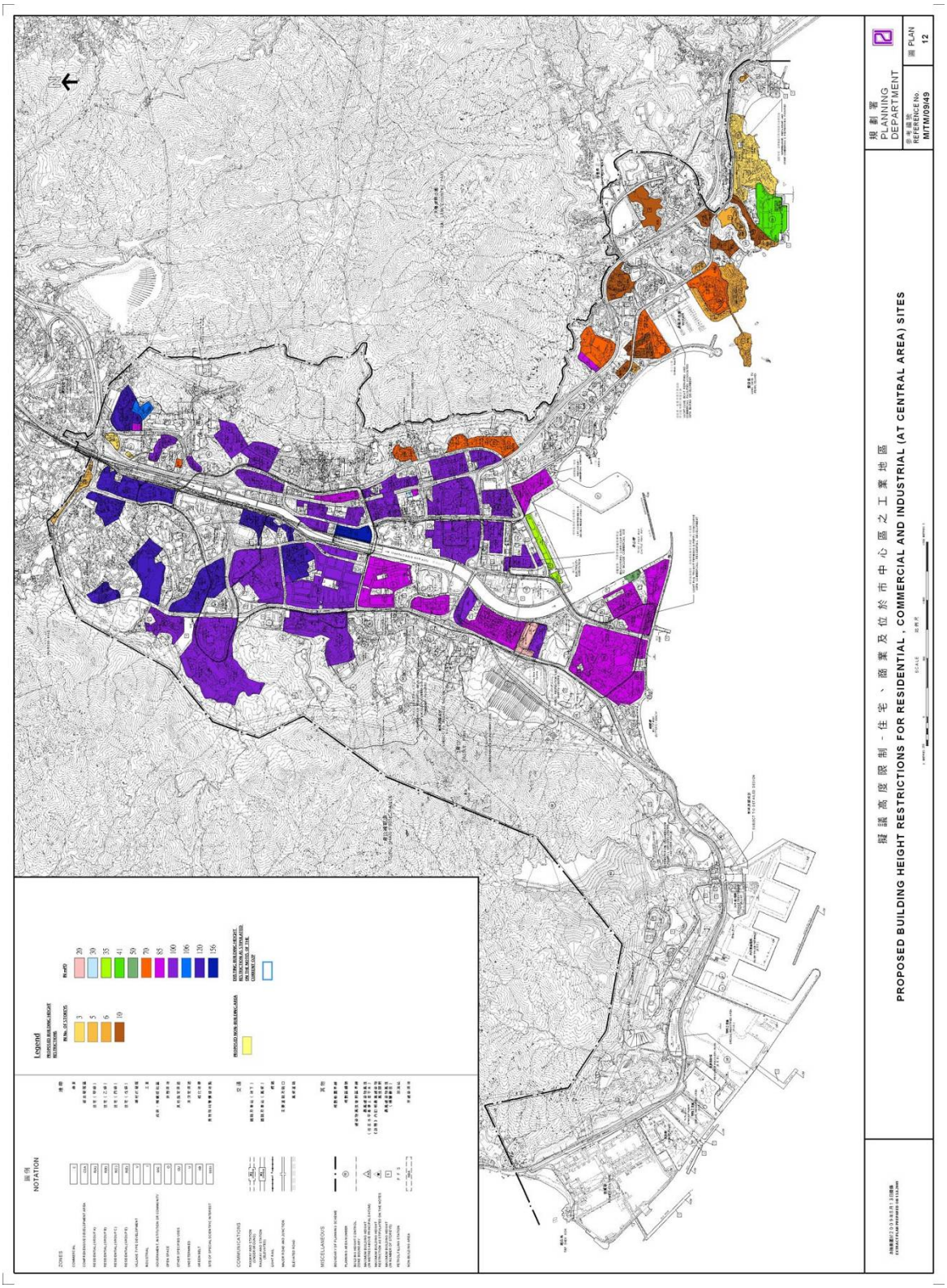


Figure 6.12a Proposed Height Restriction TMNT (residential, commercial & industrial at central area)

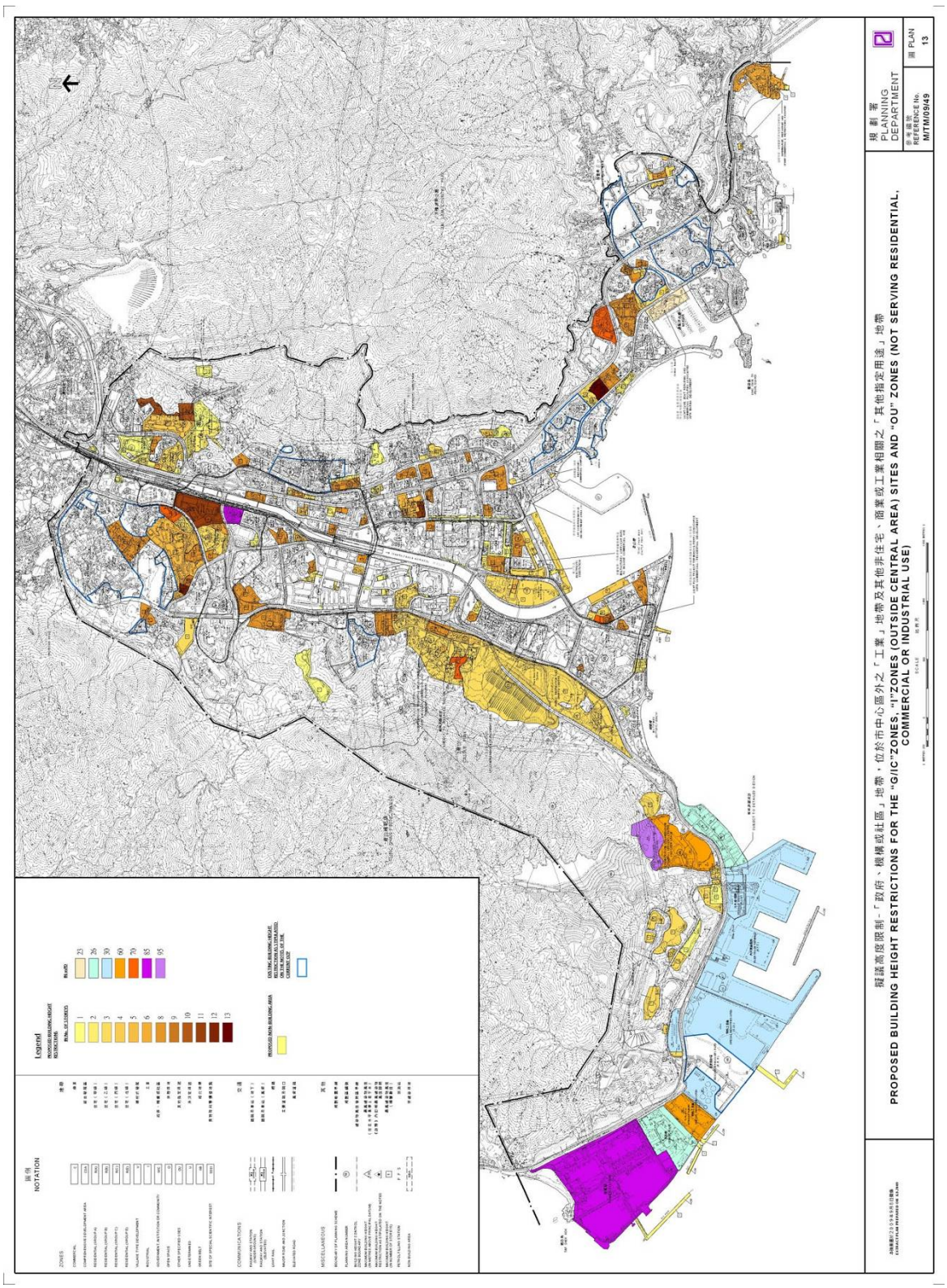


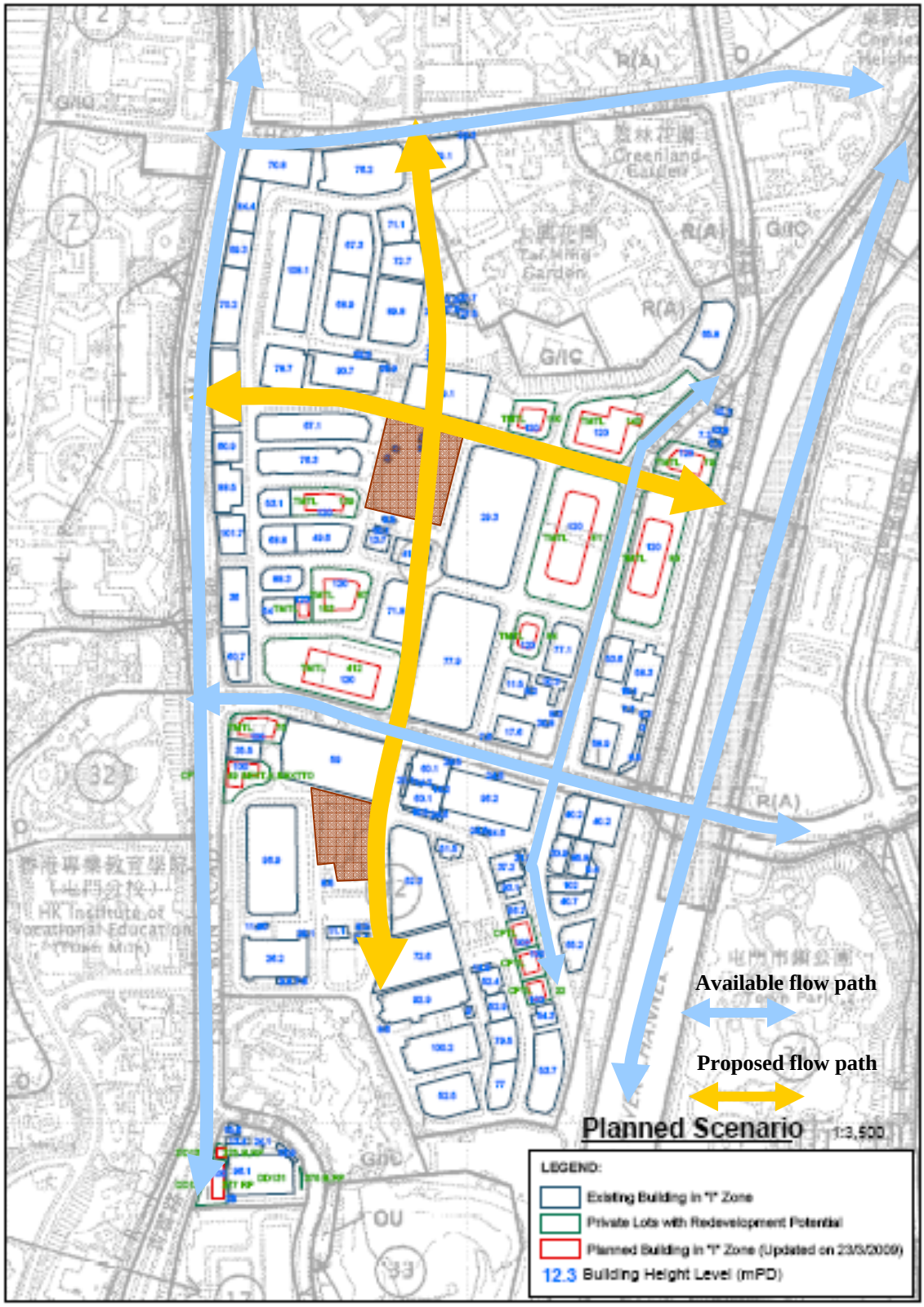
Figure 6.12a Proposed Height Restriction TMNT ("Q/IC", "I" and "OU" sites)

6.5.2 Proposal for Potential Redevelopments

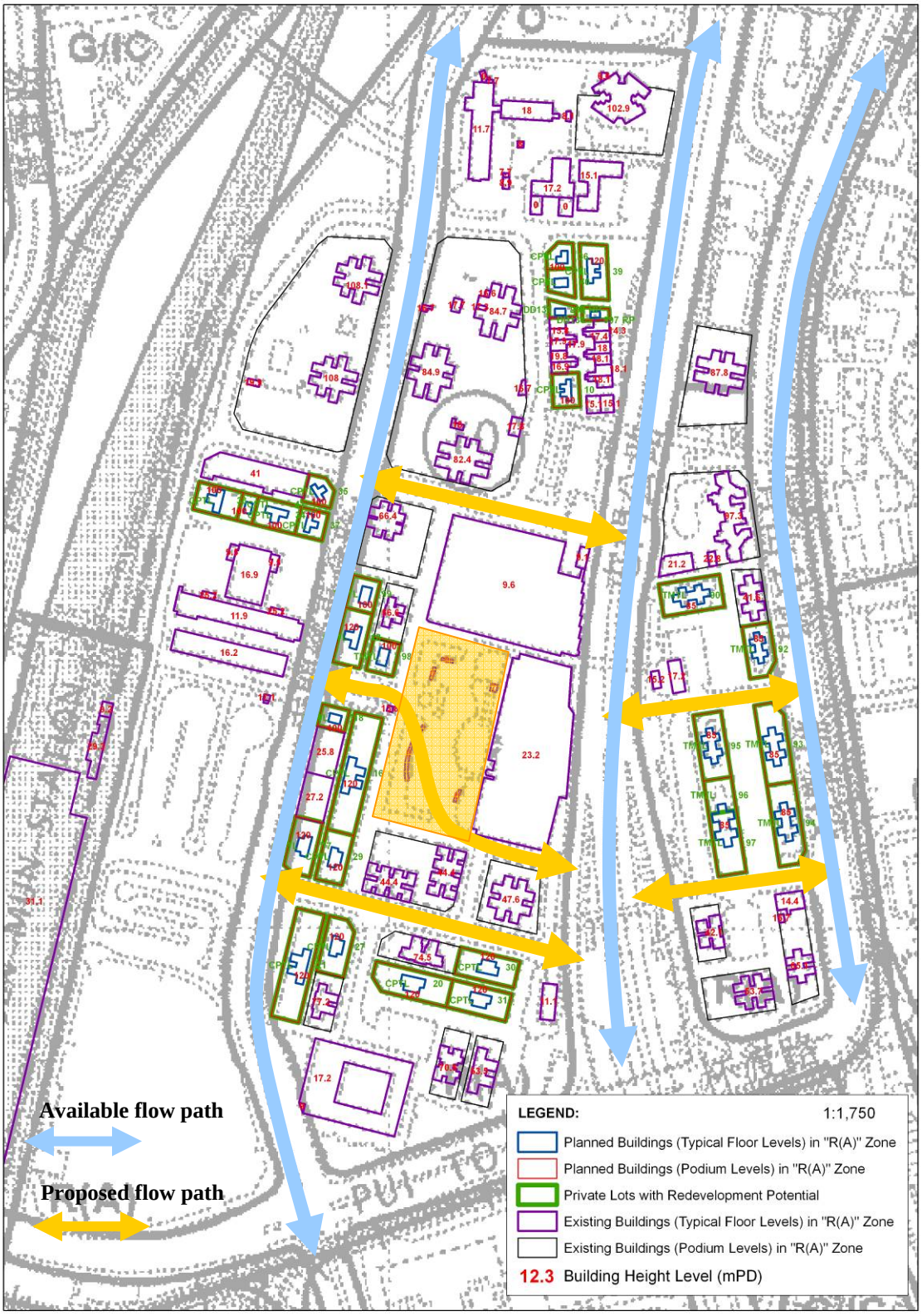
There are two areas for proposed redevelopment; they are 1) the industrial area west of Tuen Mun Station and 2) the Tuen Mun town centre area to the east. They are discussed as follows:

- Redevelopment of the Industrial area is shown in Figure 6.13a. In the proposed plan, it can be seen that there are several tall buildings in the order of 100mPD – 85mPD in the proposal. Furthermore, the foot prints (podium) of all the buildings remain big covering the whole lot. It is shown that the tall blocks have been set back so that they have a smaller foot print. However, for pedestrian level wind at and around the area, it is the effect of the podium that is more important. As discussed earlier, the large site coverage and the increased building height will induce poorer air ventilation to the area. Measures have to be taken in order to improve or even just to maintain the current ventilation condition. A possible means is to have wider flow paths cutting cross the area. This will allow winds to penetrate into the area as well as through to the lee areas. Wider cross flow paths will allow better flow being suck or blown into areas interior of the major flow paths. In this particular instance, it will be useful to make use of the sport ground/open space (shaded brown) in the area. A flow path running N-S across the area and linking the two spaces would be useful as a ventilation path, breathing space and bring air to the interior. In the E-W direction, a flow path through or linking the open space would be useful for the cross flow. The possible flow paths are shown in Figure 6.13a.

- The second proposed potential redevelopment area is the Tuen Mun old town centre area as shown in Figure 6.13b. It was commended that the ventilation in the area is weaker due to the closely built buildings. With the proposed redevelopment, their configurations are podium and tall tower constructions and the height of the tall towers are higher than those of the existing old buildings. While the towers are higher, the podiums are lower than the existing building. The gaps between towers would allow wind to flow through. However the foot prints of the podiums remain covering the whole lot. Thus the pedestrian level wind is not expected to improve due to the slimmer high-rise. For such a situation, permeable podiums would improve the pedestrian level ventilation. It is also good to make use of the fact that the area is two narrow strips in between the Tuen Mun Heung Sze Wui Road and the Castle Peak Road and with the Tuen Mun Road running through the centre. Flow paths with sufficient width cutting laterally across the strips would be useful to improve the ventilation situation. Maintaining the open space in front of Yan Oi Tong is good to link up various side paths.



(Building layouts for redevelopment sites are indicative only and are prepared for AVA EE Assessment purpose)
Figure 6.13a Proposed Potential Redevelopment Industrial area



(Building layouts for redevelopment sites are indicative only and are prepared for AVA EE Assessment purpose)
Figure 6.13b Proposed Potential Redevelopment Tuen Mun old Town area

6.6 Summary of main findings of the AV study

To summarize, the AV condition for the TMNT area which has been discussed in detail in the previous section, some of the main points are re-iterated as follows:

- ✧ The prevailing annual wind direction is NNE which blows down along major flow paths along the TMRC, the Tuen Mun Road and the Ming Kun Road/Tsing Wun Road. The Castle Peak Road and the Tuen Mun Heung Sze Wui Road are also N-S flow paths. These flow paths also serve the summer wind blowing north. Winds penetrate TMNT through these paths from north to south and vice versa.
- ✧ Besides the N-S flow paths, there are several E-W paths along the Tsing Tin Road, Shek Pai Tau Road, Pui To Road and Wong Chu Road. These paths form the linkage between the N-S flow paths and allow cross flow to bring wind to areas interior of the major flow paths.
- ✧ In general buildings in the northern part of TMNT are not so densely developed and there are more low and medium-rise buildings. This allows more wind to blow through and south into the Tuen Mun valley. In summer the northern area is at the leeward side of the Tuen Mun built-up area. Thus ventilation will be weaker. Pockets of locations sheltered in and around building complexes might have poor ventilation. Thus it is important to preserve the existing low-rise GIC facilities as well as the open spaces for better air penetration.
- ✧ The central portion of TMNT area is more densely built. There is the industrial area with buildings having large foot prints west of TMRC and the developments with narrow streets the eastern side of TMRC. Furthermore it is downwind of the northern portion for the NNE wind for the annual condition and also downwind of the southern portion during the summer southerly wind. This region will have weak ventilation. At location sheltered behind buildings for some wind directions, there might be poor and even stagnant air ventilation.
- ✧ The south and coastal core area is on the leeward side of the northern and central areas during the northerly wind. However for summer months, the southerly available wind blowing northwards from the Castle Peak Bay will be adequate and strong at times. Several buildings on the shore line along the southern coast are built forming a continuous line creating the so call “curtain” problem. Besides blocking the wind, winds around building corners and between gaps can be strong at times.
- ✧ The available wind for the Tuen Mun East Area should be adequate. The zone comprises of residential flats, holiday villas and hotel of manly medium to low-rise buildings. There are also several high-rise building developments; some of which are built in a line posing the “curtain” effect. Buildings in this area should maintain at ample space between builds and building groups so as to make use of the available wind. At location sheltered behind buildings/building group for some wind directions, there might be poor air ventilation. In this zone, there are areas marked “Developable” with certain proposed building layouts generally of medium-rise buildings about 10-storey high and built not so close together. Provided that buildings in such developments are built with adequate spacing gaps and that building complexes are spaced apart to avoid forming large patch of continuous building groups, the modification to the wind environment in the zone should be tolerable. As different building layout would have different effects

on air ventilation; to have a precise knowledge on a specific case, further study would be required

- The available wind for the Tuen Mun West Area should be adequate and large at times. The zone comprises of mainly large industrial buildings. With buildings of large foot print, locations around the building can be blocked at certain wind direction.
- In general the proposed building height restriction reflects to a certain extend the existing building profile. From the Proposed Height Restriction Plan, it can be seen that most of the existing greenery, open spaces and low-rise zones are being maintained. Also several proposed rezoning sites are mainly rezoned to low-rise. These changes are not expected to alter much the wind flow as discussed for existing condition. It is also noted that all the major air flow paths as presented in the earlier sections remain intact. On the other hand, neither has these been enlarged and improved. There are three cases given special consideration as follows:
  - The height set for the Industrial area next to Tuen Mun Station is very high. It will worsen the air ventilation to a large portion of TMNT area unless mitigation measures are taken.
  - To a less extend, the old Tuen Town area is also having weaker air flow. The taller and slimmer buildings (large solid podium) proposed might not help with the air ventilation.
  - Patches of area up north of the TMNT area have height restrictions set at 120mPD. This is expected to weaken the wind coming down to the rest of TMNT area from the north. It is also observed that there are gaps in between the proposed/approved building groups which, though break up the flow, still allow certain paths of wind to blow through. However, in the future, in order to preserve flow paths for wind to blow down from the north, zones designated as open space or low density, low-rise zone should be implemented.
- The proposed potential redevelopments of the Industrial area and the Tuen Mun old town area have been discussed. It was pointed out that mitigation measures need to be taken to avoid the deterioration of the air ventilation condition as a result of taller buildings in and around these areas.

7 Problematic areas and mitigation measures

7.1 Problematic areas

There are several problematic areas which have been discussed. These are reiterated as follows:

- Weaker air ventilation in Industrial area due to a taller height restriction and the potential redevelopment.
- TMNT being a very long stretch of area in the N-S direction, bringing wind to the downwind area is problematic.
- Taller buildings for Area. 54 up north of TMNT.
- Podiums covering the whole lot inducing wind to skim over the podium and reducing ventilation in street level.
- Weaker air ventilation in Tuen Mun old town area due to a taller height restriction and the potential redevelopment.
- Buildings forming a long line creating the “curtain” effect
- Wind too strong at times at south water front

7.2 Mitigation measures

1. To improve the air ventilation of the Industrial area, it has been suggested that a flow path cutting through the area and linking the open spaces would help to letting air blowing through (Figure 7.1). Set-backs can be considered to form a continuous path and possibly with widened gaps. This will allow a wider path for wind to blow through. At the same time it will reduce the W:H (gap width to building height) ratio so as to induce more circulation for the cross flow situation as shown in Figure 7.2. A wide N-S flow path by linking through Hung Cheung Road, Kin On Street and to Tai Hing Street on the north, as indicated (encircled A in Figure 7.1) will allow the summer wind to reach up north to the North Core TMNT area. An E-W flow path (encircled B in Figure 7.1) linking TMRC and the Ming Kum Road and connecting the open space will help to distribute the flow to areas interior of the main flow paths as discussed in the “Cross flow” in the previous section. As shown in the figure, Ho Tin Street would be a suitable flow path if its western end can be unblocked and open up to a side street on the west side of Ming Kum Road. No-blockage down to ground level would be ideal. This is to enhance the cross-flow wind condition and make better use of the cooler down flow from the slope.

2. It has been mentioned in previous sections that TMNT is a relatively long stretch of area with the length in the prevailing wind directs (northerly and southerly). Various methods have to be used to bring wind into the interior and downwind areas. The technique of using the “progress height increase” concept should be used to bring wind into the interior. Having heights progressively increased towards the Tuen Mun town centre area will be useful to bring the summer wind progressively into the inland and town centre area (with the help of downwash). To bring wind beyond to the further north, other means have to be used. In this respect, it is important to have wide flow paths cutting through the area to bring wind through. The TMRC, Tuen Mun Road, Ming Kum Road, Castle Peak Road and Tuen Mun Heung Sze Wui Road are important flow paths cutting through the

area and need to be maintained; e.g. Structures like the Stations built over the TMRC should be kept to a minimum. For the large patch of area between TMRC and the Ming Kum Road, it is proposed that a flow path as suggested in Figure 7.1 be created. This will allow better flow from north to south and south to north.

3. It has been discussed that for the areas at the very northern portion of TMNT, i.e. Area. 54, the proposed height restriction is set at 120mPD. It was pointed out that for annual condition with the prevailing northerly wind direction, winds for the urban core of TMNT comes through the northern part. Thus these large patches of high-rise building areas would deplete the wind blowing down and weaken the ventilation of the areas of TMNT to the south. There are groups of proposed/approved buildings to be constructed. There are gaps in between these building groups which, though break up the flow, still allow certain paths of wind to blow through. Further AVA study would be advisable to better understand the flow around these buildings and their effect on the surrounding. As for the future, in order to preserve flow paths for wind to blow down from the north, zones designated as open space or low density, low-rise zone should be implemented. Otherwise, mitigation measures should be provided to preserve flow paths.

4. It has been mentioned that the open/greenery space between Leung King Estate and Po Tin Estate is the only strip of land in the area left serving as lateral flow path from the slope down to the North Central Area. It allows Katabatic wind blowing down the slope feeding air penetrating to the residential area to its east as well as enhancing lateral flow. This strip of land should be left as a separation to the two Estates such that they would not become a large continuous patch of high density, high-rise development.

5. Many of the buildings for the proposed redevelopment (also existing developments) are having a podium covering the whole building lot. In an area where many of the buildings are constructed with podium, this will lead to the situation where the wind is forced to skim above the podiums without reaching the ground (Figure 7.3). This affects largely the air ventilation at pedestrian level. For such cases in general, controlling building height may not be the most effective means to improve pedestrian level air ventilation. Controlling the size and permeability of podiums, providing flow paths and gaps between buildings are measures to be considered.

6. An effective means of improving the ventilation at pedestrian level in areas with podiums is to ensure that the lower floors of the podium be made permeable and that wind can blow directly through. Podiums which allow cross ventilation from street on one side to street on the other side would help significantly the AV condition. Flow through (or partially flow through) podium is shown in P17; it would bring more wind to the pedestrian level if the ground or first floor have a similar configuration.

7. For the Tuen Mun old town area, as mentioned in the previous section, the area is relatively narrow and with N-S flow paths passing through or next to it. Thus to minimize the adverse effect of the proposed taller buildings with podiums, it would be useful to have permeable podiums to improve the pedestrian level

ventilation. It would also be desirable to have wider cross flow paths as given in Figure 6.13b. This would also reduce the W:H ratio and increase circulation.

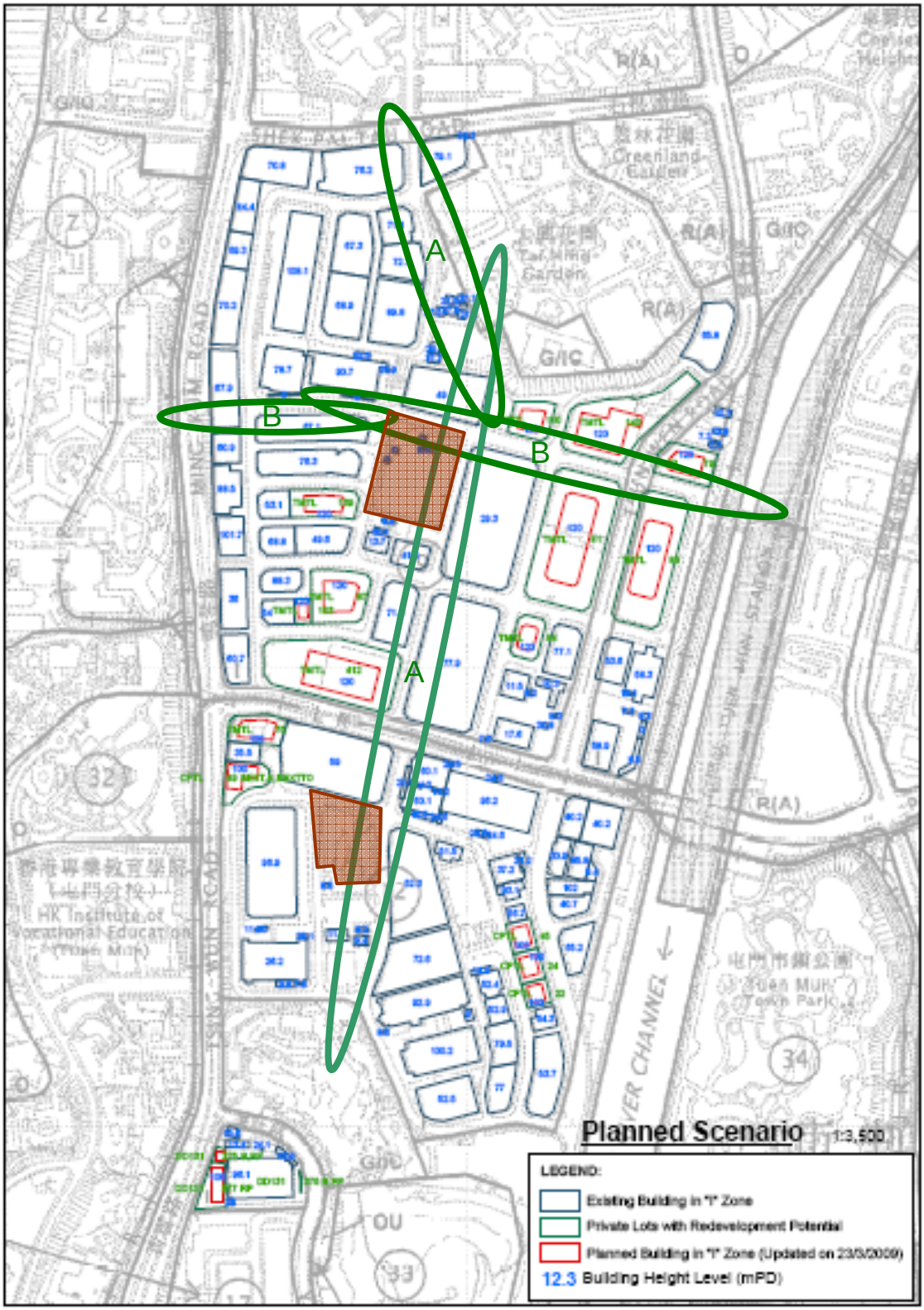
8. Building blocks linking together or built close together to form a long continuous line is no good for air ventilation, for example as shown in Figure 6.10c in the Tuen Mun East Area. It will block the wind over a large part of area on its leeward side. This should be discouraged and for specific cases, further AVA study of the air flow in and around the building development may be required for particular sites.

9. It has also been mentioned that over an area, groups of buildings having the same height will post a similar problem as the podium, that is, the wind will tend to blow over the top of the buildings. Mixed heights (with certain randomness) within the general concept of progressive increasing height should be introduced.

10. For the areas fronting the south coast facing the Castle Peak Bay, there are two conflicting issues of wind flow problem. On the one hand, these are the upwind buildings, thus it is important that wind should be allowed as much as possible to blow through so as to benefit the air ventilation of the downwind area. On the other hand, it is important that during periods of stronger wind, the environmental wind at locations between buildings, off building corners, and around the building in general, should not be too strong for the intended use of the location. Thus, it is important to control the “building/gap width” and the building podium geometry so as to reduce the high wind speed locally and yet allowing as much wind as possible to blow to the interior. This is a complex problem, further environmental wind study of this issue is recommended.

11. Planting ample amount of trees is a good means of providing shade, reducing temperature and yet allowing air to blow through. It is also a means of alleviating the strong wind locations. This should be done as often and as wide spread as possible.

12. Lastly, it should be mentioned that given the situation that there are many tall buildings already spread all over TMNT, varying the building height a bit one way of the other would not affect much the pedestrian level wind. Controlling building height may not be the most effective means to improve pedestrian level air ventilation. Measures such as to increase the permeability of podiums, providing continuous flow paths for the wind to penetrate, providing open space for the wind to re-generate, controlling building geometry and gaps between buildings could be used to improve air ventilation.



(Building layouts for redevelopment sites are indicative only and are prepared for AVA EE Assessment purpose)

Figure 7.1 Flow paths and locations for set-backs & building gaps for Industrial area

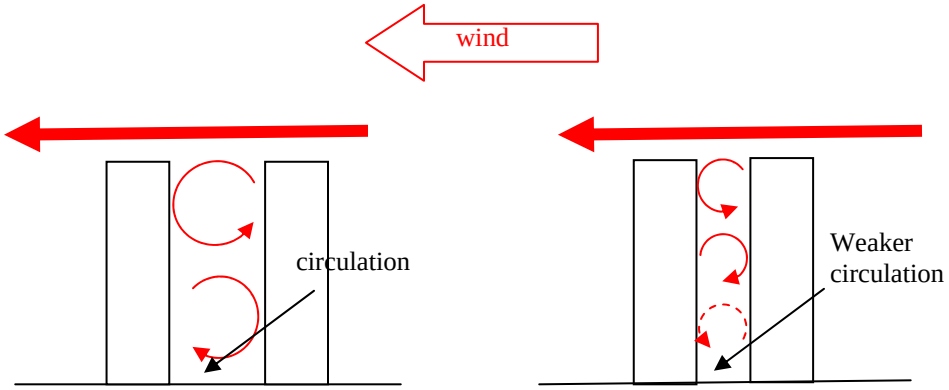


Figure 7.2 Circulation between buildings for wider & narrower gaps

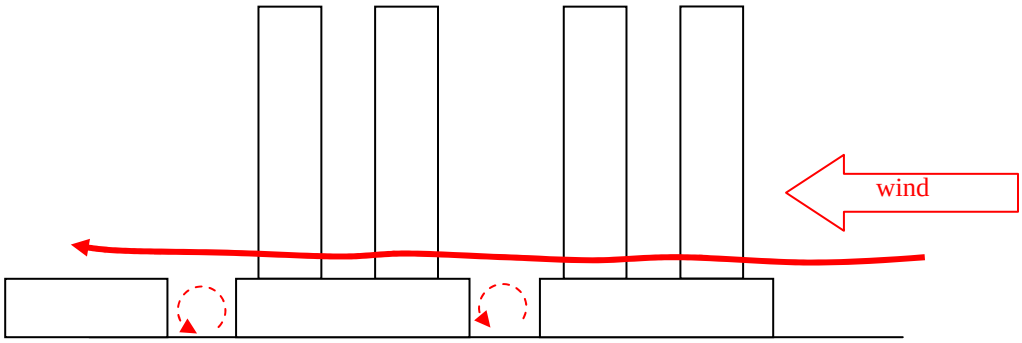


Figure 7.3 Wind forced to blow over podiums

8 Further Studies

As discussed earlier, for the major part of the Area, the proposed building height restriction reflects to a certain extent the existing condition. The consultant expects that the AV condition will not differ much from the existing condition except for those special cases which have been discussed in the previous sections. However as pointed out in the introduction, as the TMNT.OZP area is a very large area consisting of various type, format and configuration of developments, the current study can only be a broad-brush study of the overall pattern. For a detail understanding of specific sites, building complex or building developments further AVA studies might be required. Some of such studies which have been discussed in the previous section are:

- High-rise building groups in Area. 54 at northern part of TMNT on ventilation issue.
- Building developments where building blocks forming a continuous line on ventilation issue.
- Building groups fronting the south coast facing the Castle Peak Bay on strong wind issue.
- The public housing sites (private as well) where the development will be large and with many building blocks to study AVA impact
- With the exact building profile of the future developments in the Industrial area, it might be useful to perform a detailed ventilation study of the area.

However to improve on the understanding of air ventilation issues, the following generic studies are also suggested.

At present, podium with high-rise is the main form of proposed construction in the Area. The effect of the size, shape, height, permeability and layout of the podiums on pedestrian level ventilation is to be studied. A parametric study would give insights to how air flow at pedestrian level will be influenced by these parameters.

Another area that requires further understanding is the effect of building/gap width ratio on air flow. It would be useful to know the critical building spacing which will allow the larger amount of wind blowing through and at the same time keeping the wind speed around corners to a tolerable value.

9 Acknowledgement

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ANNEX I – Site Photographs of TMNT

P1 Tuen Mun River Channel

P2 Sun Tuen Mun Centre

P3 Tuen Mun Tang Siu Kin Sport Ground

P4 Tuen Mun Park

P5 Tuen Mun old town area

P6 Tai Hing Industrial Building
(at background)

P7 Street end blocked (old Town)

P8 Street end blocked (Industrial area)

P9 Lung Mun Oasis

P10 Pierhead Garden

P11 Aegean Coast

P12 Long low-rise building
Lok On Pai Siu Lam

P13 Cement Plant

P14 Gap between Leung King Estate (left) and Po Tin Estate (right)

P15 Building with large foot-print and covering the whole lot

P16 Closely built buildings

P17 Permeable podium