Issue No : 3(Rev.3)
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AIR VENTILATION ASSESSMENT FOR THE PROPOSED PUBLIC RENTAL HOUSING DEVELOPMENT AT FO TAN (AREA 16 & 58D), SHA TIN

EXPERT EVALUATION

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EXECUTIVE SUMMARY

An AVA report is prepared on behalf of The Hong Kong Housing Authority (HKHA) to facilitate the amendment to the Outline Zoning Plan for residential use by The Planning Department. This Expert Evaluation on Air Ventilation Assessment (AVA-EE) was conducted for the Project according to the *Technical Circular No. 1/06* and its *Annex A - Technical Guide for Air Ventilation Assessment for Development in Hong Kong* issued jointly by Housing, Planning and Lands Bureau (HPLB) and Environment, Transport and Work Bureau (ETWB) in July 2008 (referred to as the Technical Guide hereafter).

The Project is located adjacent to Fo Tan Industrial Area, Sha Tin. The subject site is currently used as open carpark and bus depots (under short term tenancy) where is surrounded by low-rise residential buildings and high-rise industrial buildings. The subject site is positioned at an elevation of different level. The immediate topographies to the north, north-east, east, south, south-west, west and north-west of the subject site are relatively sloped, except the south-east, where is relatively flat.

Due to the location and elevation of the project site, a good air movement could be facilitated at this large plain on the elevation. The existing high-rise industrial buildings might cause impediment to the oncoming land breezes and annual prevailing wind especially the E and NE winds to penetrate into the street level. Also, since the existing low-rise residential buildings are located on the hillside and the north of the subject site, no prevailing wind is obstructed by the adjacent buildings because of the highest level of the site. Roads such as Wong Chuk Yeung Road, Shan Mei Street and Fo Tan Road are considered as wind corridors within the study area for both summer and annual prevailing winds.

The Public Rental Housing project with about 41000 square meters gross site area will divide into two phases, Phase 1 and Phase 2. Phase 1 will consist of 4 domestic buildings, while Phase 2 will consist of 2 domestic buildings. An initial scheme of the Project which is composed of six public housing blocks ranged from 26 to 36 domestic storeys, providing a total of 4200 residential units approximately, was evaluated in this AVA-EE.

Good design features were incorporated into the initial scheme, which includes the proper building's orientation to capture the prevailing winds, the sufficient building gap to allow wind penetration through the subject site and maintenance of ventilation path at the landscape deck above the 3-storey podium to enhance the wind environment at pedestrian level.

However, some drawbacks for the initial scheme of the Project are also identified including the potential impact on the ventilation effect and the wind permeability into the site, the potential wind shielding effect on the existing low-rise residential area as well as the potential wind screening effect, particular the open areas.

To ameliorate the potential effects, additional design measures are recommended to be adopted in the detailed design of the Project in order to minimize any potential adverse ventilation impact on the surrounding environment. They include:

- **Building Separation**: modifying the shape and the orientation of building blocks to optimize the separation of the buildings in order to reduce the blockage to the prevailing winds and improves wind permeability into the site;
- **Free Flow Area**: relocating Block 6 to allow a free flow area to the existing village and avoid the wind screening effects during the summer;
- **Building Disposition**: modifying the building's shape as "cross-shaped" and providing more building separation to allow the better penetration of both annual and summer prevailing winds.

The abovementioned recommended design measures shall be incorporated into the refined design scheme for the Project. An AVA Initial Study using Computational Fluid Dynamic (CFD) Simulation is recommended to quantitatively assess the potential ventilation impacts on the surrounding environments due to the Project based on the latest design scheme.

1. INTRODUCTION

Hong Kong Housing Authority (HKHA) proposes to develop the Public Rental Housing at Fo Tan (Area 16 & 58D) (the Project). The development will be divided into two phases. Phase 1 comprises a 3-storeys podium structure and 4 numbers of domestic blocks. The remaining 2 numbers of domestic blocks will be included into Phase 2. The construction of the Project for Phase 1 and Phase 2 are tentatively to commence in 2014 and 2017 for Phase 1 and Phase 2 respectively, and for completion in around 2018 and 2021 for Phase 1 and Phase 2 respectively.

Allied Environmental Consultants Limited (AEC) was commissioned by HKHA to carry out an Expert Evaluation on Air Ventilation Assessment (AVA-EE) to qualitatively evaluate the potential air ventilation impacts due to the Project. The AVA-EE was carried out according to the air ventilation assessment framework as set out in *Technical Circular No. 1/06* and its *Annex A - Technical Guide for Air Ventilation Assessment for Development in Hong Kong* issued jointly by Housing, Planning and Lands Bureau and Environment, Transport and Work Bureau (Technical Guide).

2. OBJECTIVE

The objective of the AVA-EE is to qualitatively review and evaluate the potential air ventilation impact on the pedestrian wind environment within and in the vicinity of the subject site due to the Project by comparing that to the existing conditions, i.e. without the Project.

3. SCOPE OF STUDY

The scope of study includes as follows:

- To identify any potentially affected areas due to the proposed building design including building heights, layout and deposition;
- To provide recommendations for alleviating the potential air ventilation impact identified;
- To identify any major wind corridors which should be preserved or reserved; and
- To advise whether any further detailed study is required for concerned areas and the scope of the detailed study required.

4. SITE CHARACTERISTICS

4.0. SITE LOCATION AND SURROUNDING ENVIRONMENT

The Project is adjacent to Fo Tan Industrial Area, Sha Tin Area (16 & 58D) as shown in ***Figure 1***. The subject site is currently used as open carpark and bus depots (under short term tenancy). The subject site is positioned at an elevation of different levels, approximately 31.8mPD, 46.5mPD, 53.3mPD, 67mPD, and 72mPD. The immediate topographies to the north, north-east, east, south, south-west, west and north-west of the subject site are relatively sloped, except the southern-east, where is relatively flat. The immediate surrounding environments as shown on ***Figure 1*** are analysed as follows:

- To the immediate north, the subject site is bounded by low-rise residential buildings, called Kwei Tei New Village, where are located on the slope next to Kwei Tei San Chuen Road. The building heights ranged from 80mPD to 100mPD.

- At approximately 200m to east of the subject site, there are high-rise residential buildings, such as The Grandville, Shatin Lodge, Eden Garden, of which the building heights range from 80 to 160 mPD.

- To the immediate south-east, the subject site is bounded by mid-rise industrial buildings on Kwei Tei Street, such as Wah Lai Industrial Centre, Yale Industrial Centre, Wah Sang Industrial Building, World-wide Industrial Centre and Kerry Warehouse, of which the building heights range from 60 to 120 mPD.

- At approximately 420m to south-east of the subject site, there are high-rise residential buildings, such as Sha Tin 33, Scenery Garden and Sui Wo Court, of which the building heights range from 110 to 190 mPD.

- At approximately 450m to south of the subject site, there are low-rise residential buildings, such as Garden Villa and Ville De Cascade of which the building heights range from 175 to 185 mPD.

- At approximately 130m south of the subject site there is a proposed HOS development situating on the site area of about 8700m^2 and comprising 2 residential block of about 32 -33 domestic storey with proposed maximum building height of 150mPD.

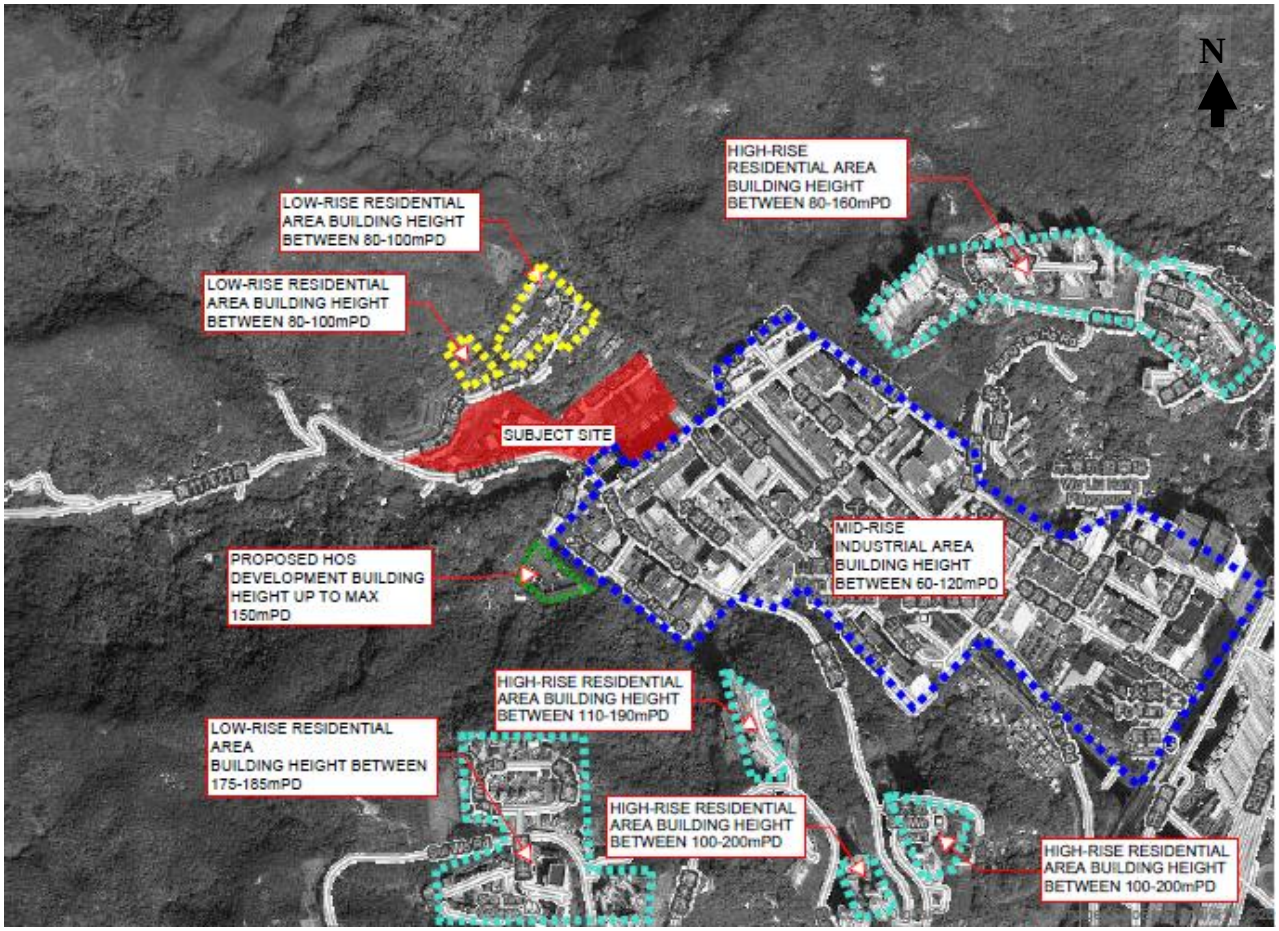

Figure 1 Existing Landuse of the Project

5. WIND AVAILABILITY

The wind data from Hong Kong Observatory (HKO) and Mesoscale Model (MM5) published by PlanD were adopted in this AVA-EE. The HKO wind data represents the lower level wind availability where the wind direction is influenced by local topography in the surrounding environment while the MM5 wind data represents the wind availability at boundary layer (i.e. 596mPD).

The occurrences of winds from different direction are referred to MM5 wind data while local wind conditions for different seasons (annual and summer periods) are referred to HKO wind data.

5.1. WIND DATA FROM HONG KONG OBSERVATORY

There is a HKO automatic weather station located in the vicinity of the subject site, Sha Tin (ST) which is approximately 1.2km on the east away from the subject site as shown in ***Figure 2***. The wind data obtained from these automatic weather stations is to identify wind availabilities during annual and summer periods as this seasonal information are not available in MM5 data.

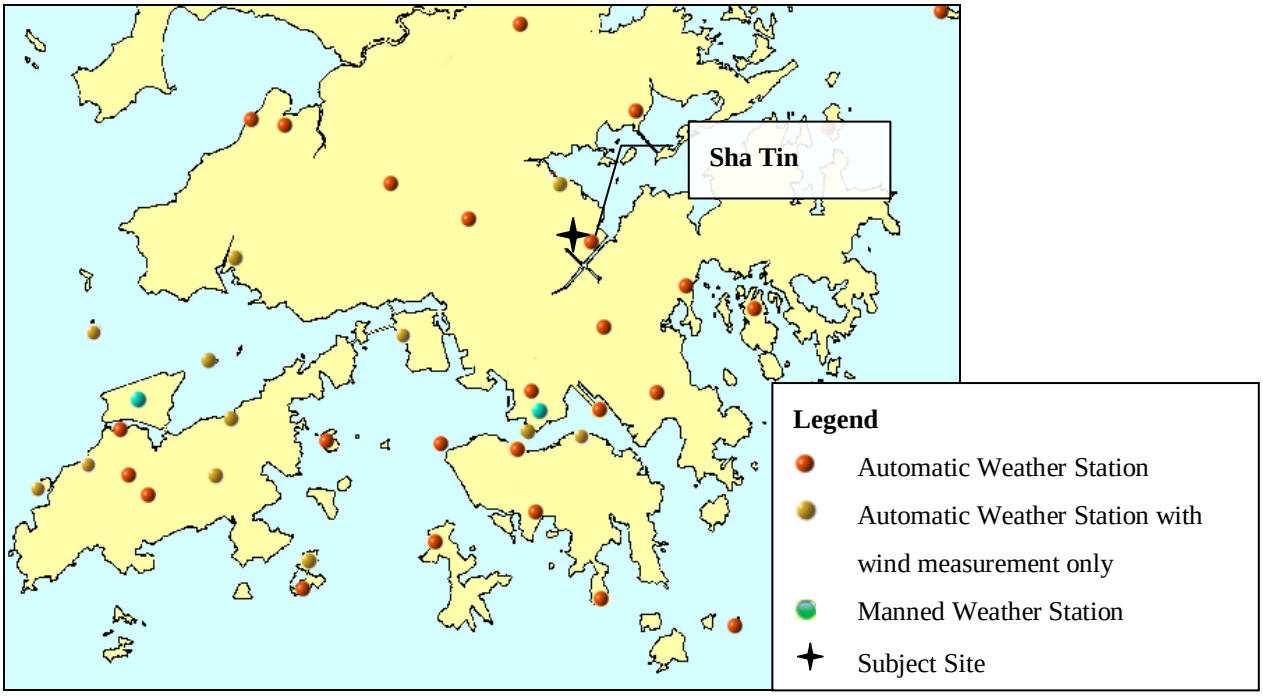

Figure 2 Locations of the Nearest HKO Weather Stations

5.1.1. Sha Tin Weather Station

The recorded annual mean wind speed measured at anemometer of ST automatic weather station was 2.22 m/s (8km/hr) in 2010. Based on the Sha Tin wind rose as shown in ***Figure 3***, it is found that east wind direction dominates the annual wind frequency. The monthly prevailing wind direction and wind speed of year 2010 are listed in ***Table 1***. It is found that wind mainly comes from southwest (SW) direction in summer period, while wind from east (E) dominates annually.

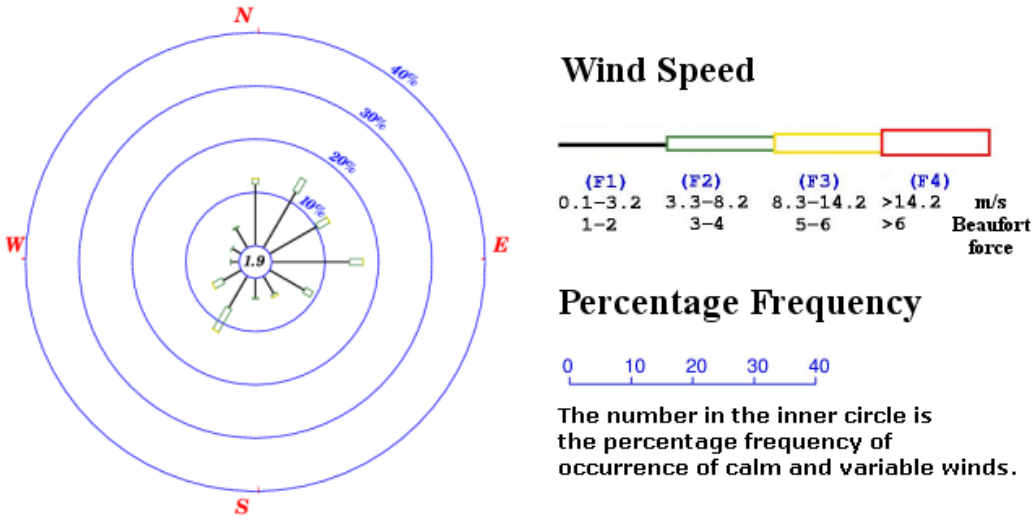

Figure 3 Sha Tin Wind Rose (2010)

Month	Monthly Prevailing Direction (Degrees)	Wind Speed (m/s)
January	30	2.11
February	90	2.22
March	80	2.28
April	90	2.25
May	90	2.17
June	220	2.50
July	220	2.53
August	220	2.14
September	90	2.06
October	90	2.22
November	30	2.17
December	30	2.08

Table 1 Wind Availability Data of Sha Tin, HKO 2010

5.1.2. Wind Data from MM5

The wind availability to the subject site is evaluated with reference to the "Site Wind Availability Data" simulated by the Fifth-Generation NCAR/Penn State MM5 at the height of 596m above ground. The subject site is located within grid (28, 32) and its wind rose is shown in ***Figure 4***. The wind velocity ranges from 0 to 14.2m/s from 16 wind directions and the mean wind velocity is 5.81m/s. It is found that northeast (NE) and east (E) winds dominate the annual wind frequency.

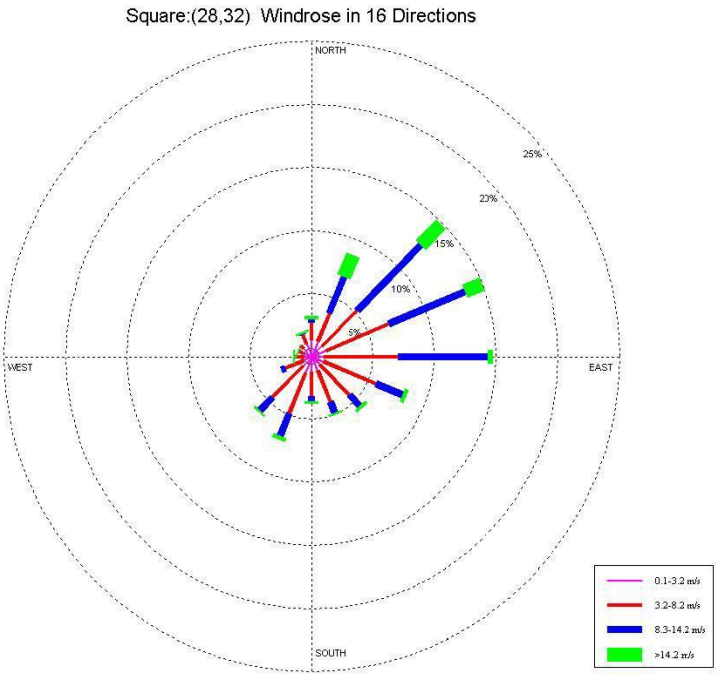

Figure 4 Wind Rose of Grid (28,32), MM5

Power law is used to convert the MM5 data at 596m above ground level to pedestrian level at 2m above ground level by taking consideration of the effect of topography/built-up area in the vicinity of the subject site on site wind availability.

5.1.3. Findings of Wind Availability

Based on the wind data from HKO and MM5, it is concluded that winds come from E and NE are dominant annual wind directions. While in summer period, wind mainly comes from SW directions.

6. EXPERT EVALUATION

This AVA-EE qualitatively evaluates the ventilation performance in the site environs with and without the Project. The study area of air ventilation assessment is approximately 200m from the boundary of the subject site. The coverage is approximately 900m diameter from the centre of the subject site. The conditions of prevailing wind under annual and summer time are considered. Building heights, street/road orientation and patterns, and open spaces have also been taken into account for evaluating the characteristics of wind environment.

6.1. EXISTING CONDITION

The subject site is currently used as an open carpark and bus depots (under short term tenancy) as shown in ***Figure 5***. The existing conditions of subject site (i.e. without the Project) are summarized as the follows.

- Building Heights

The subject site is located in the north-western end of Fo Tan Industrial Area, a large plain on the elevation. The existing land uses in the vicinity of the subject site is mainly residential and industrial uses. The building heights of the existing buildings in the vicinity of the subject site are shown in ***Figure 5.***

The heights of majority of the existing industrial buildings located to the east, southeast and south of the subject site are ranged from 90mPD to 120mPD. These mid-rise industrial buildings might cause impediment to the oncoming land breezes and annual prevailing wind especially the E and NE winds to penetrate into the street level.

Low-rise residential buildings are located on the hillside and the north of the subject site. The average building heights of these residential buildings range from 80 to 100mPD. Due to the highest level of the site, no prevailing wind is obstructed by the adjacent buildings.

A proposed high-rise residential HOS development is planned to be located south of the project site. The proposed maximum building height is 150mPD.

- Road/Street Pattern

Roads such as Wong Chuk Yeung Road, Shan Mei Street and Fo Tan Road are considered as wind corridors within the study area for both summer and annual prevailing winds.

- Open Spaces

Open spaces and areas located within 500m from the subject site as shown in ***Figure 5***, including a bus depot, an open car park and public garden. These open spaces promote air circulation at pedestrian level and increase pedestrian comfort.

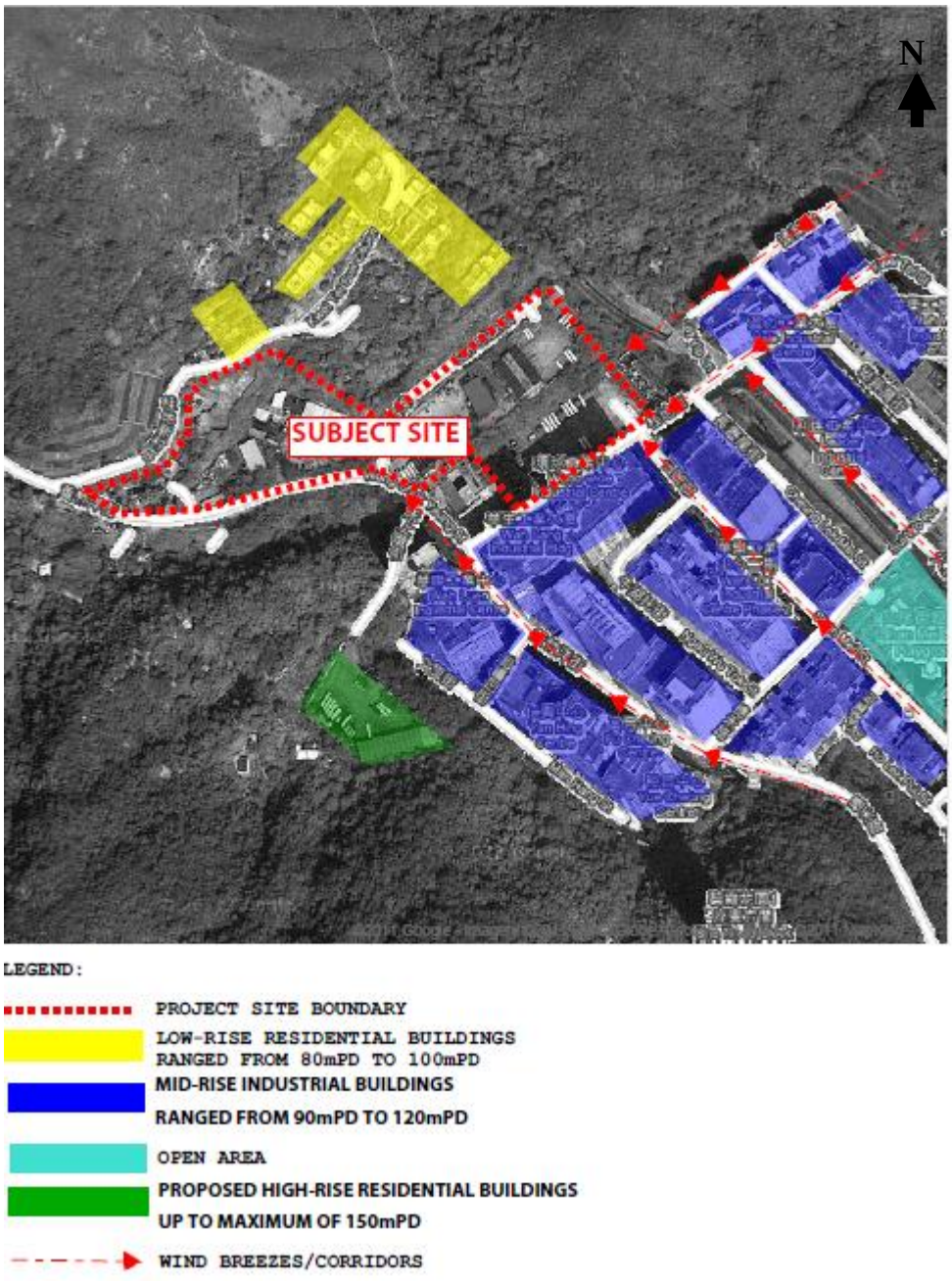

Figure 5 Site Environment and Wind Corridor

6.1.1. Annual Prevailing Condition

Under annual typical condition, it is expected that the prevailing winds from E and NE directions flow pass the subject site.

Although some high-rise industrial buildings are located to the east of the subject site as

shown in ***Figure 6*** and ***Figure 7,*** the road in between these buildings acts as a ventilation corridor to allow the prevailing winds reaching to the subject site and the ventilation at pedestrian level is generally maintained.

As there are no development located at the downstream area. Therefore it is anticipated that no significant impact would cause to the surrounding area with the presence of proposed development.

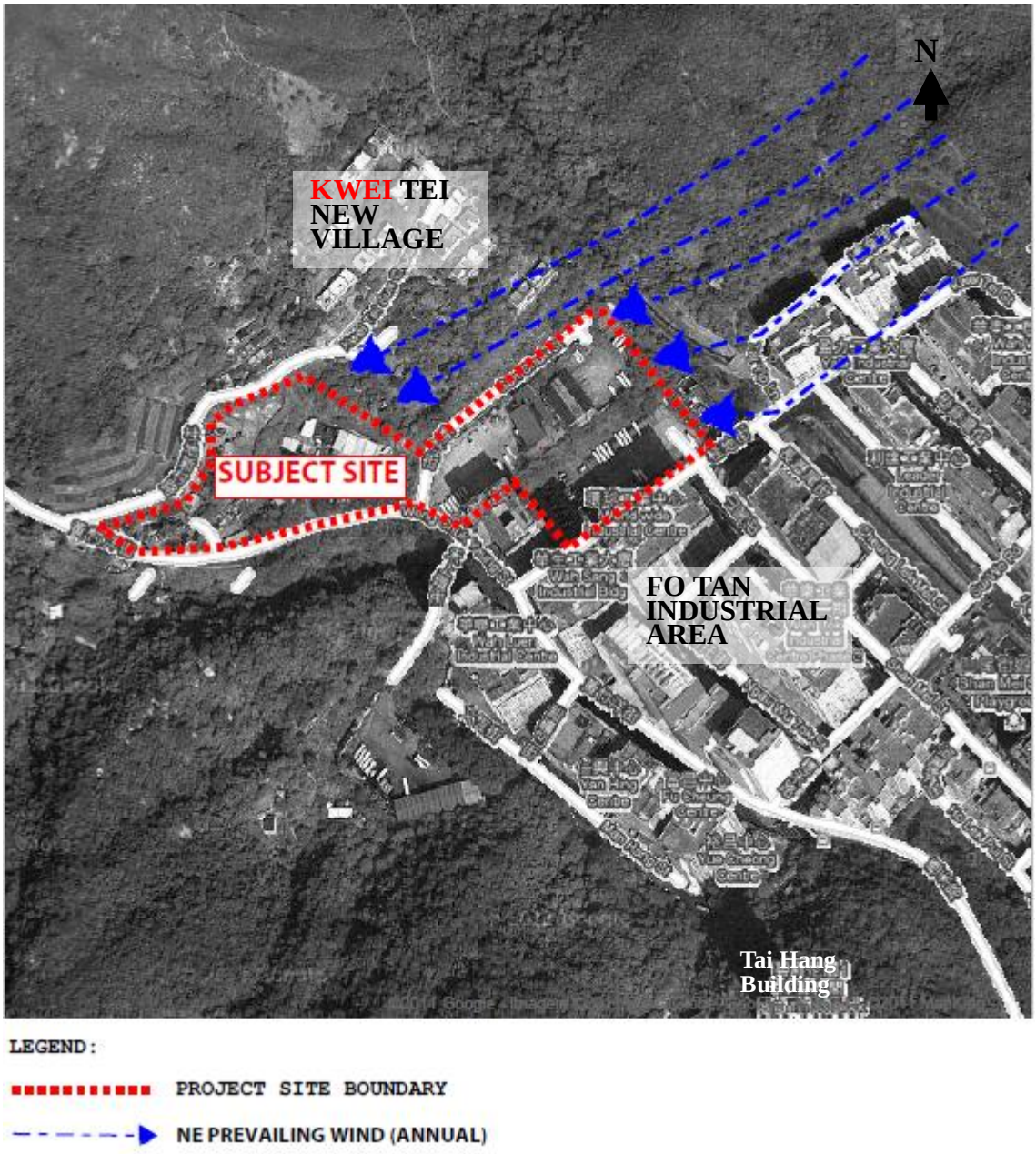

Figure 6 Existing Annual Wind Environment at Subject Site (NE Wind)

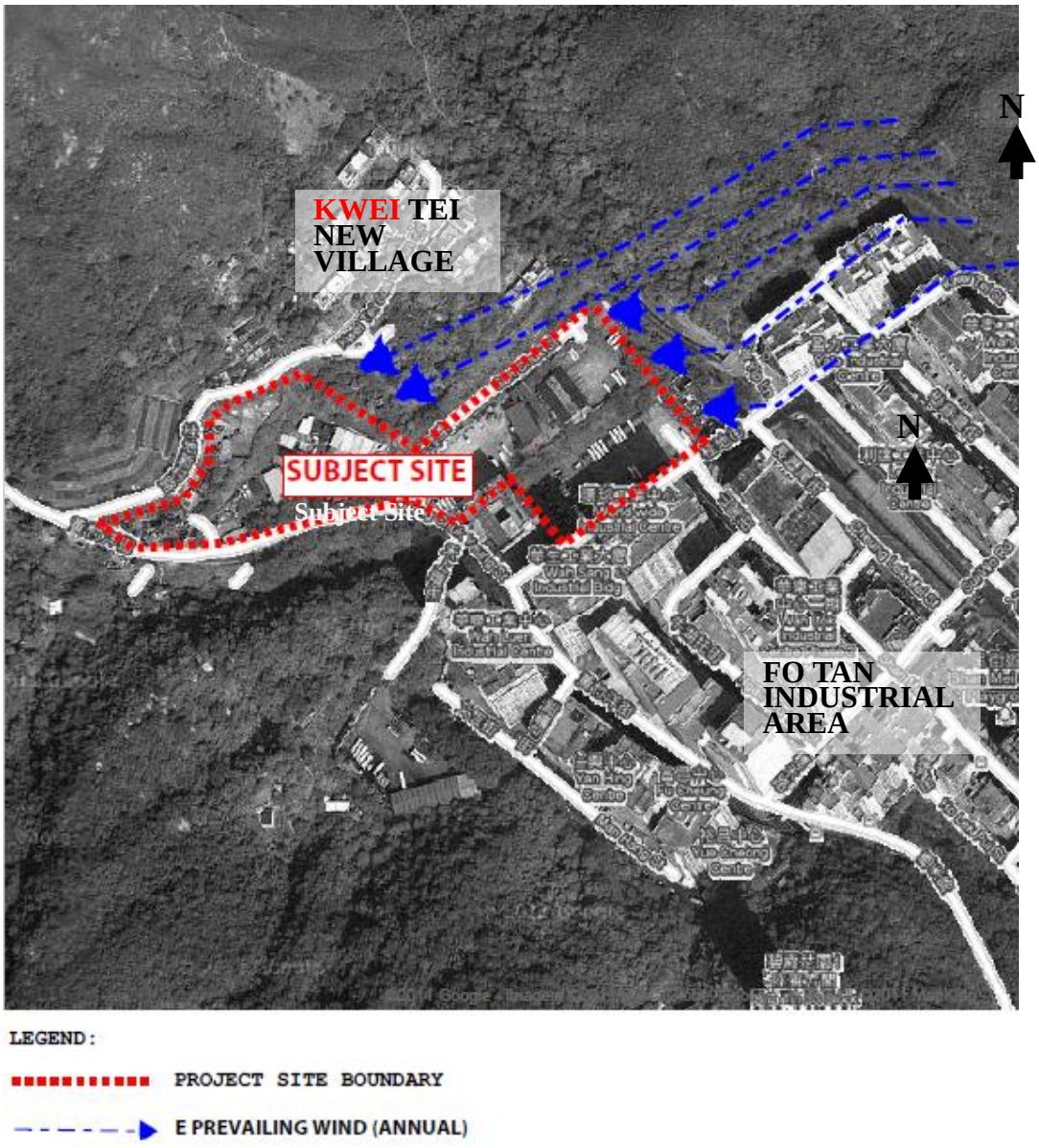

Figure 7 Existing annual Wind Environment at Subject Site (E Wind)

6.1.2. Summer Condition

During the summer period, it is expected that the prevailing winds from SW directions flow pass the subject site.

As shown on ***Figure 8***, since there is no obstruction at the south-west of the subject site, no prevailing wind is blocked. The prevailing wind from SW direction can reach to the subject site directly. However, Kwei Tei New Village may be affected by the presence of building

blocks but the industrial area should be unaffected as the Kwei Tei Street is acting as a wind corridor to facilitate air movements.

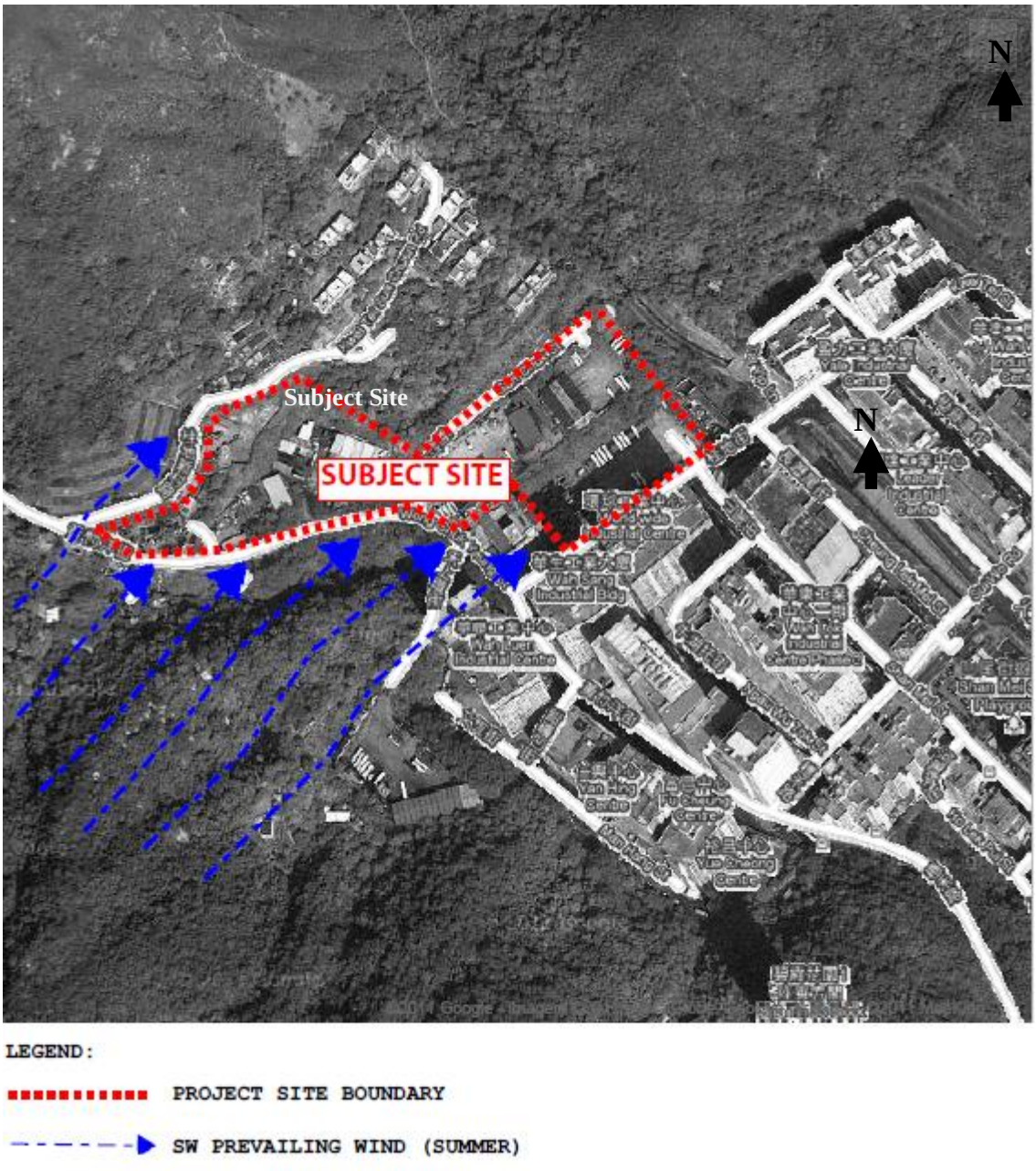

Figure 8 Existing Summer Wind Environment at Subject Site (SW Wind)

6.2. PROPOSED DEVELOPMENT

The Public Rental Housing project will divide into two phases, Phase 1 and Phase 2. As shown on ***Figure 9***, Phase 1 will consist of 4 domestic buildings, 3 numbers at Site 1 and 1 number at Site 2A, while, Phase 2 will consist of 2 domestic buildings at Site 2B. The gross

site area is approximately 41000 square meters. The composition of the initial scheme of the Project is summarized in the following table.

Since the project site is located near the existing industrial area, as recommended by EPD, all the domestic blocks should be placed as far as possible from that area. Therefore, this limitation directly affects the spaces for allocating each block although the project area is very large.

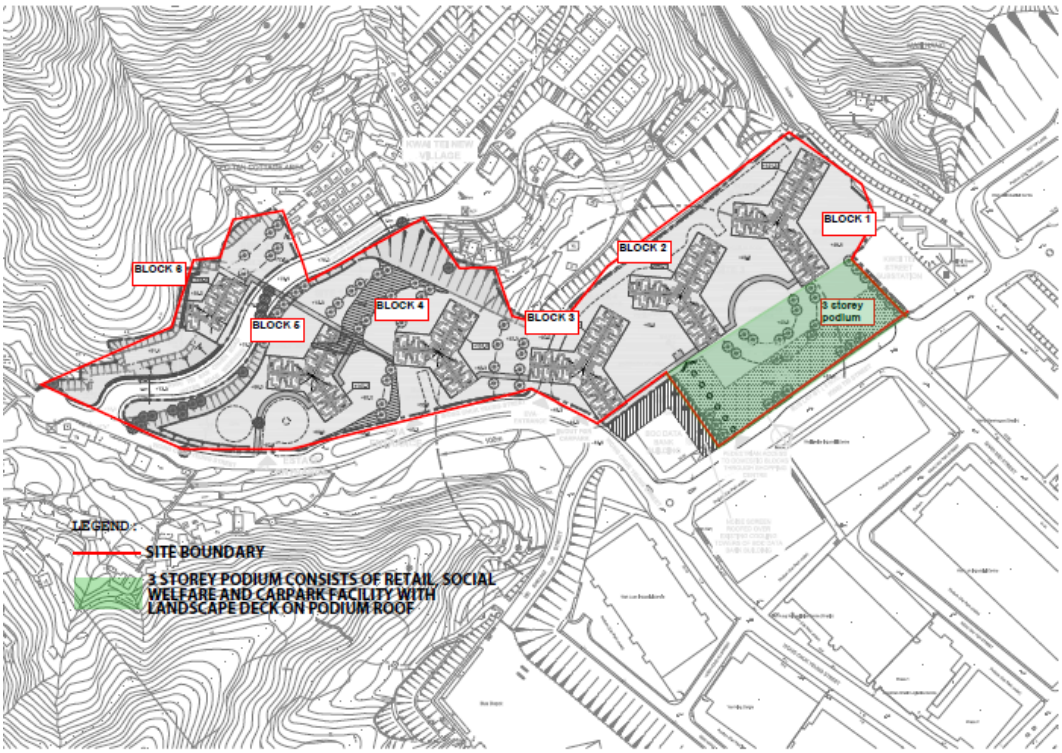

Figure 9 Initial Scheme Layout Plan

	Initial Scheme
Site Area	Around 41000 square meters
No of Residential Blocks	6
No of Domestic Storeys	Ranged from 26-36
No of flats	Around 4200 units
Podium	A 3-storey podium consist of retail, social welfare and carpark facility and podium roof as landsacpe deck area as shown in ***Figure 9***
Building Height	Maximum 160mPD

6.2.1. Good Design Features

Design features of the initial scheme for improving air ventilation performance of the Project include:

- The domestic blocks as shown in ***Figure 10*** and ***Figure 11*** are oriented to capture the prevailing east and south-westerly winds without substantial impediment from and to the surrounding developments and the terrain. This arrangement would reduce the potential wind screen effects due to the building blocks and allows wind penetration through the subject site.
- As described the site constraint in Section 6.2, the space for allocating the 3 domestic blocks at Site 1 is limited, building gaps between each building block are optimized to allow wind penetration for E wind and SW wind through the subject site to the leeward areas. The detail of building separation is shown on ***Figure 12***.
- The podium deck area located at the south-east of Site 1 provided an open area for air ventilation which would maintain ventilation path to enhance the wind environment at pedestrian level during annual and summer periods

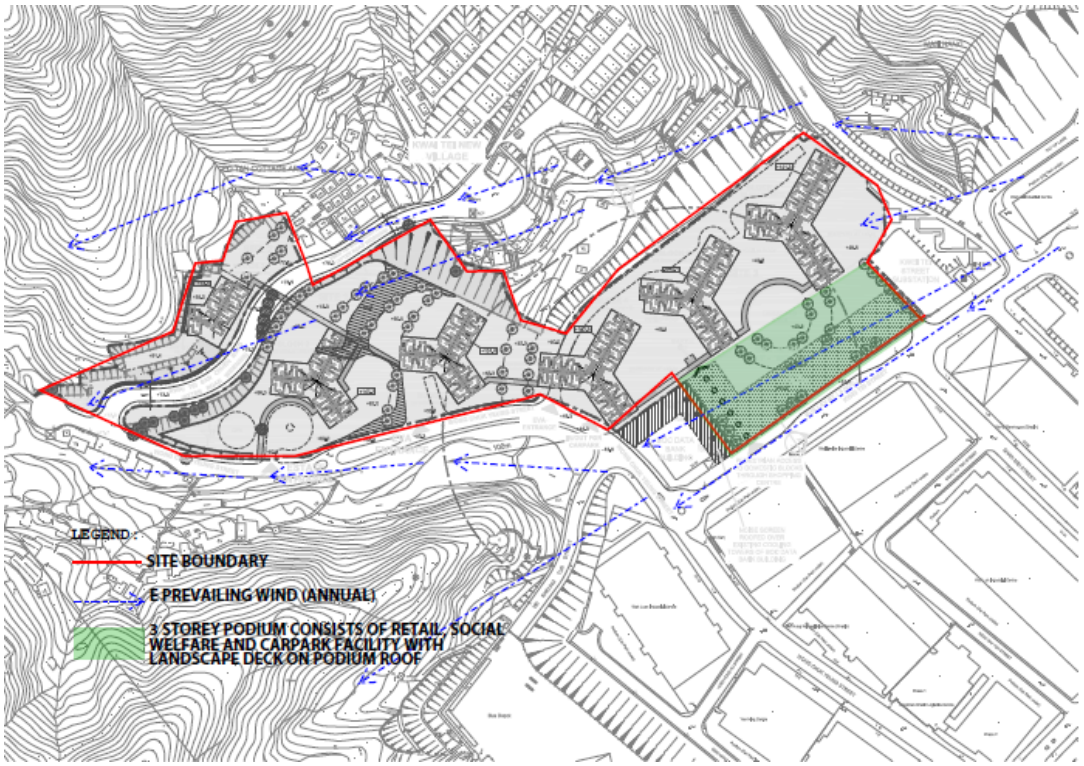

Figure 10 Prevailing Annual E wind passing through the subject site in the Initial Scheme

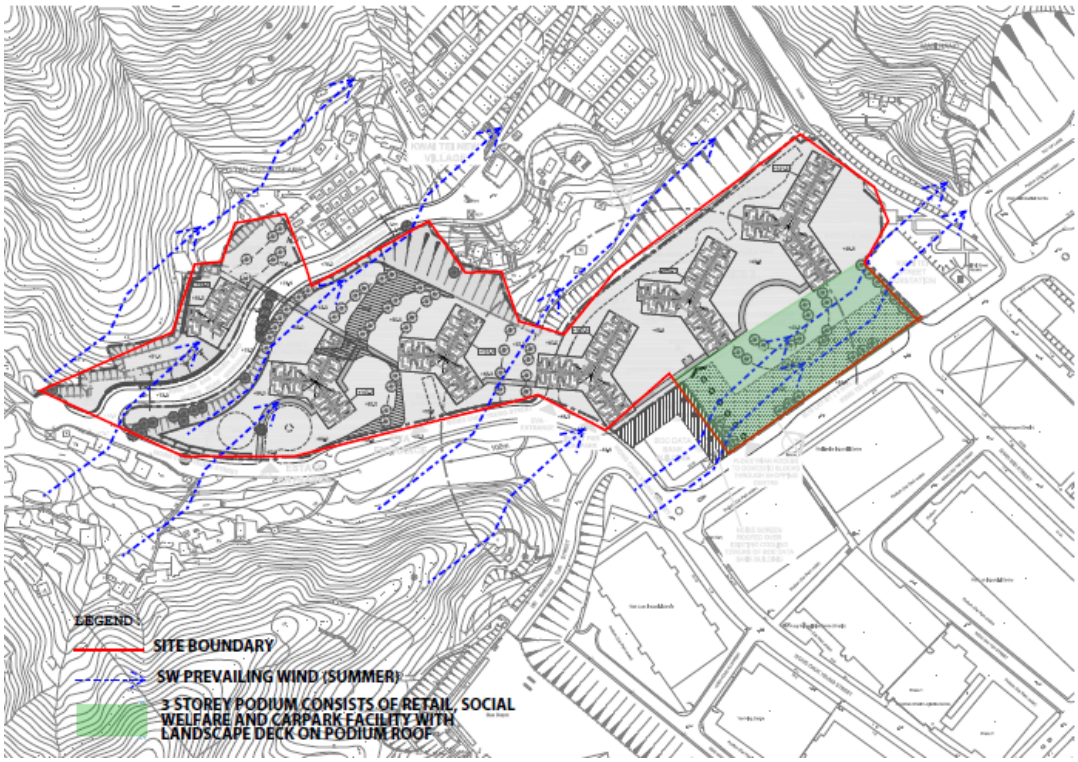

Figure 11 Prevailing summer SW wind passing through the subject site in the Initial Scheme

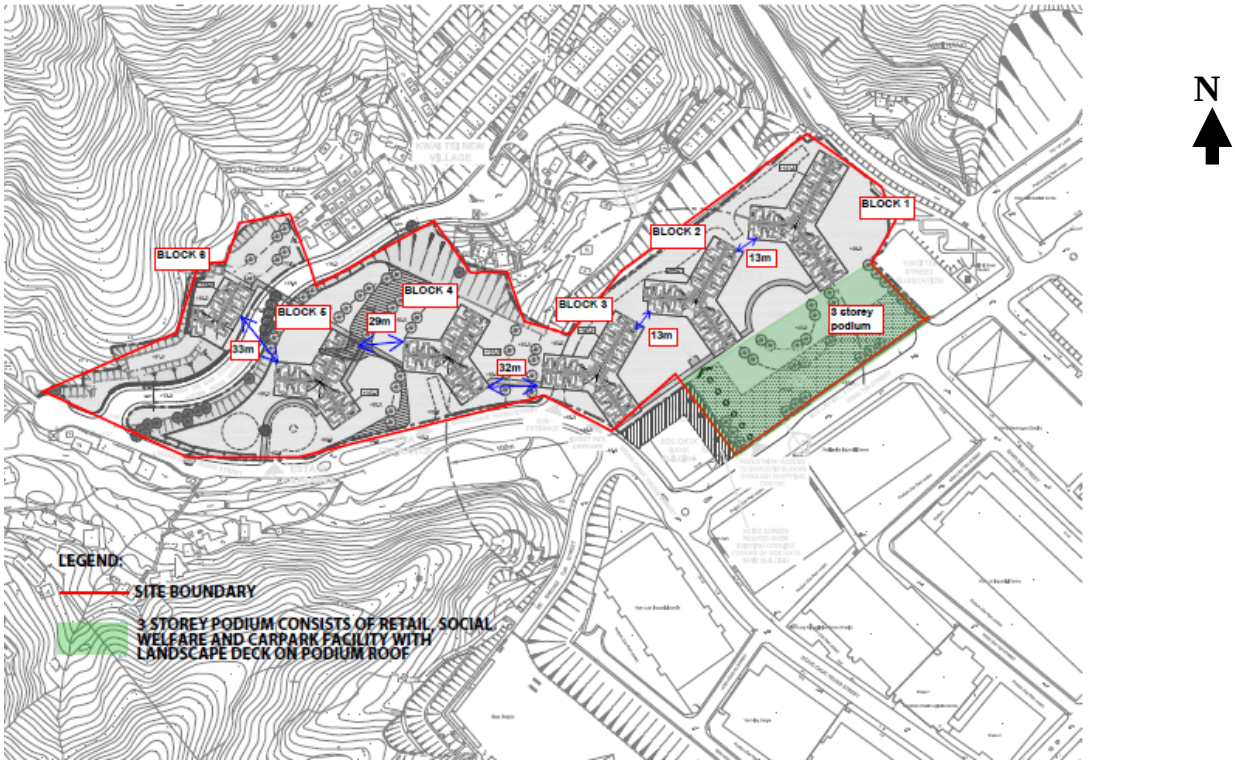

Figure 12 Building Separation in the Initial Scheme

6.2.2. Problem and Focus Areas

Nevertheless, some drawbacks are identified in the initial scheme during the AVA EE study.

- Based on the proposed orientation and the shape of the buildings, the designated corridor in between building blocks at Site 1 is around 13 metres. The narrow corridor would possibly impact on the ventilation effect and the wind permeability into the site.
- Based on the proposed orientation and the shape of the buildings, the part of the building blocks would block the prevailing wind and impact on the ventilation effect at the subject site and the adjacent area.
- As shown in ***Figure 13*** and ***Figure 14***, the building blocks would possibly contribute wind screening effect, particular the open areas and also the existing low-rise residential area.

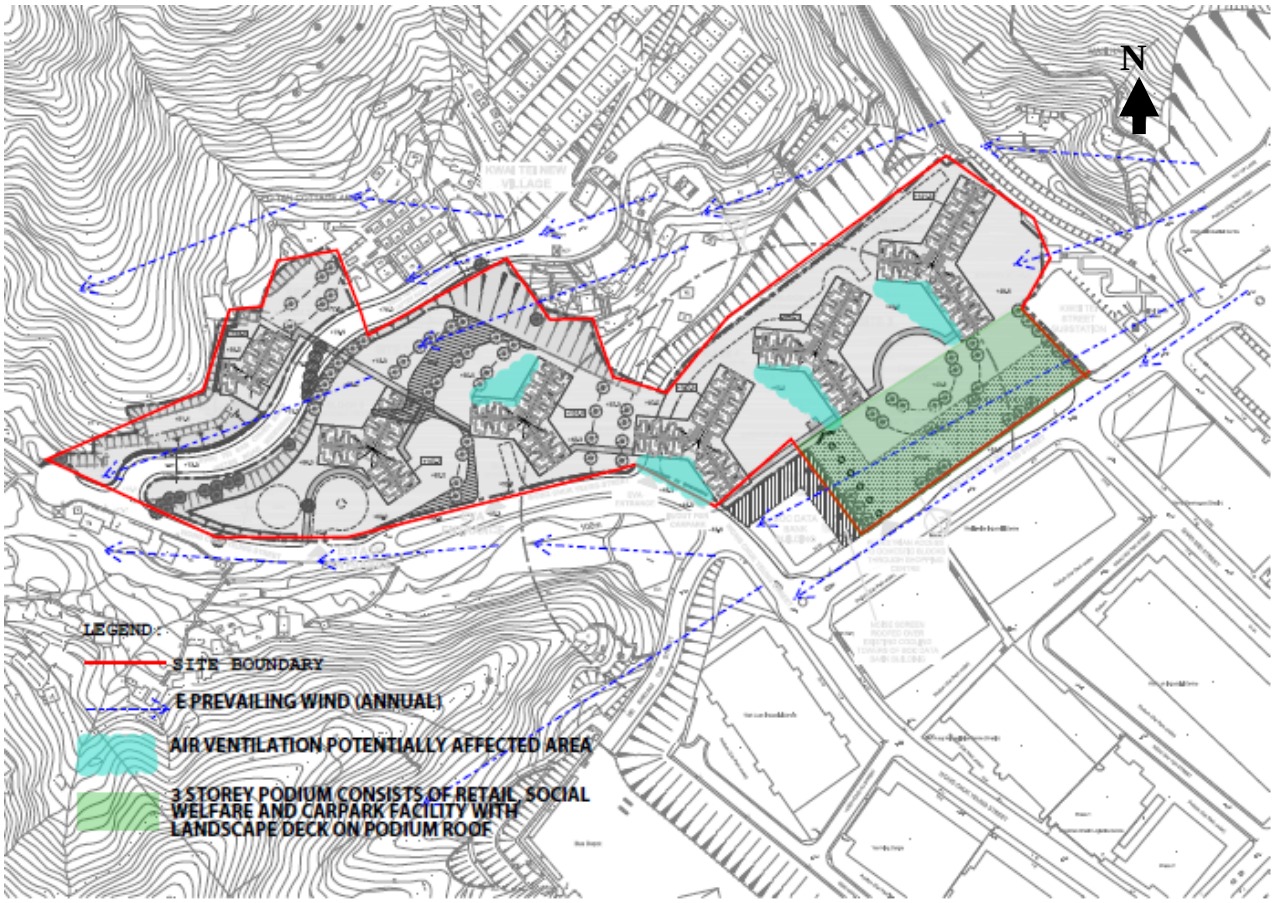

Figure 13 Potential Wind Sheltering by Project of Annual E Wind Penetration

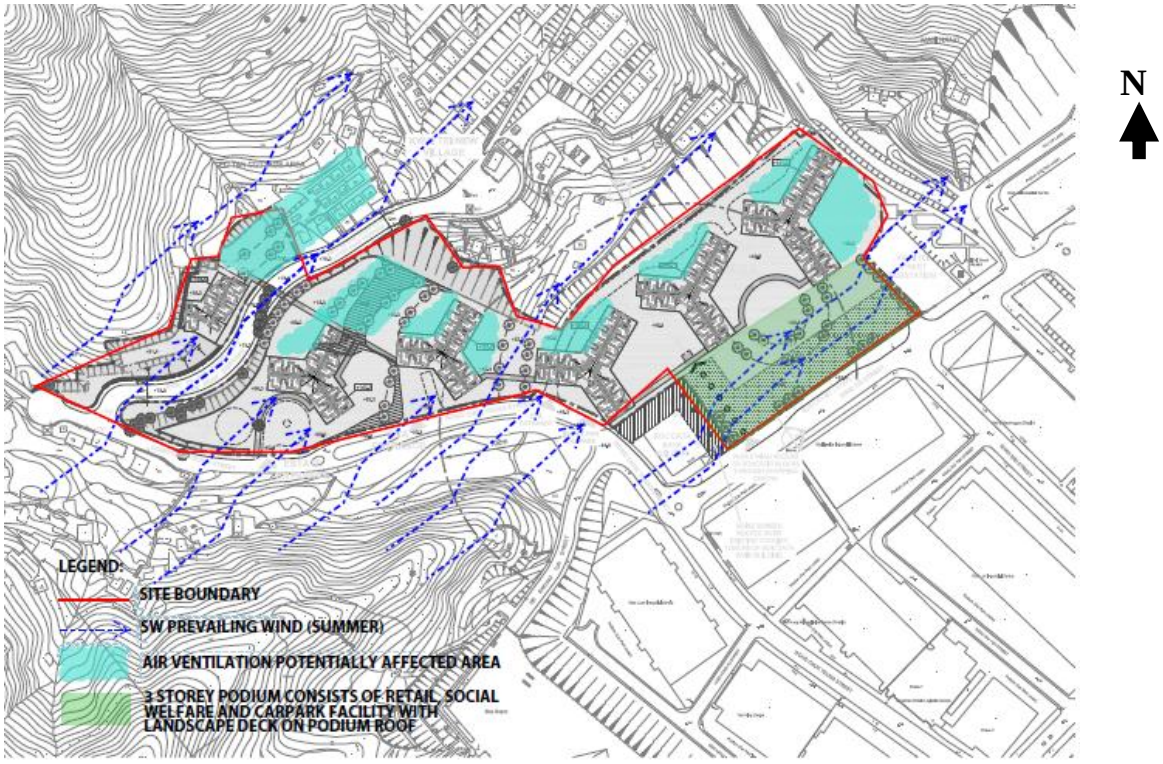

Figure 14 Potential Wind Sheltering by Project of Summer SW Wind Penetration

6.3. RECOMMENDATION

To enhance the air ventilation performance of the Project, the following improvement measures are recommended to be incorporated into the Refined Design Scheme as shown in ***Figure 15***.

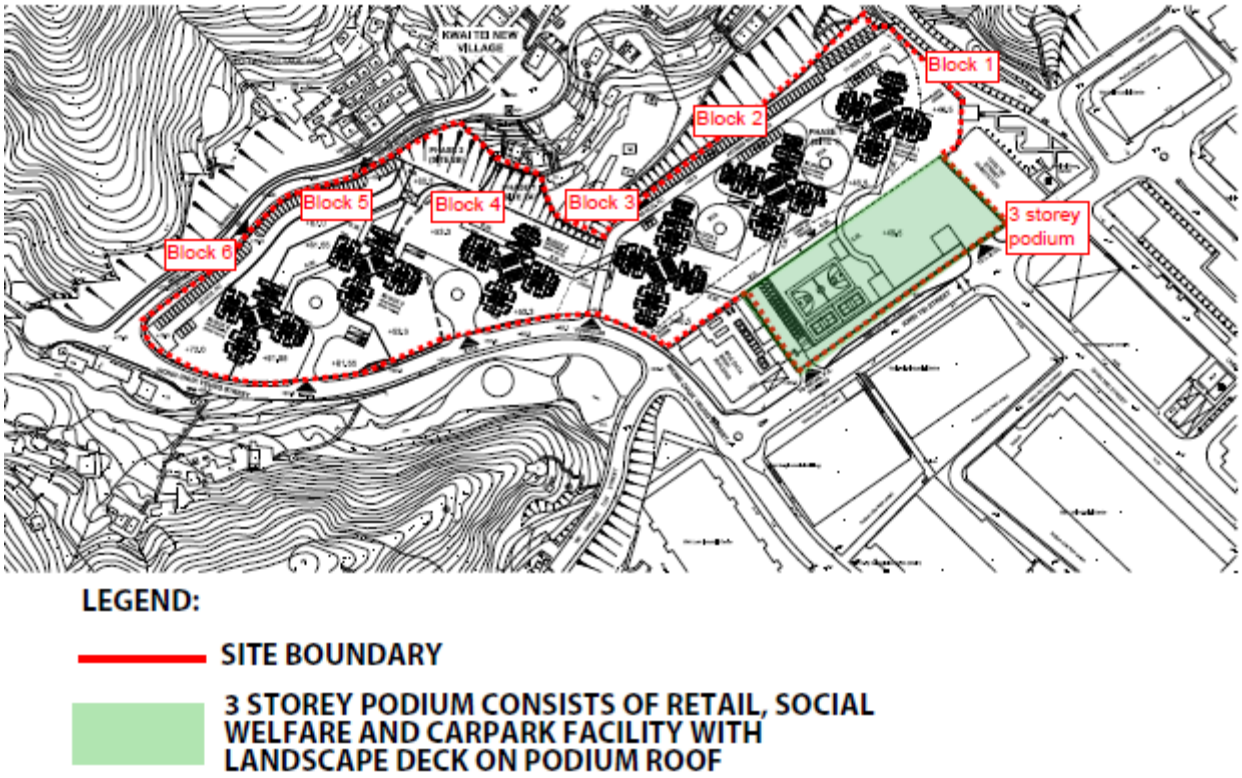

Figure 15 Refined Design Scheme

- Free Flow Area

To reduce the impact of summer prevailing wind on Kwei Tei New Village, it is recommended that Block 6 should be relocated from Site 3 (to the west of Kwei Tei New Village) to Site 2B (at the western end of the subject site). The relocation of the building block would allow a free flow area to the existing village and avoid the wind screening effects during the summer SW prevailing wind (***Figure 16 & Figure 17***).

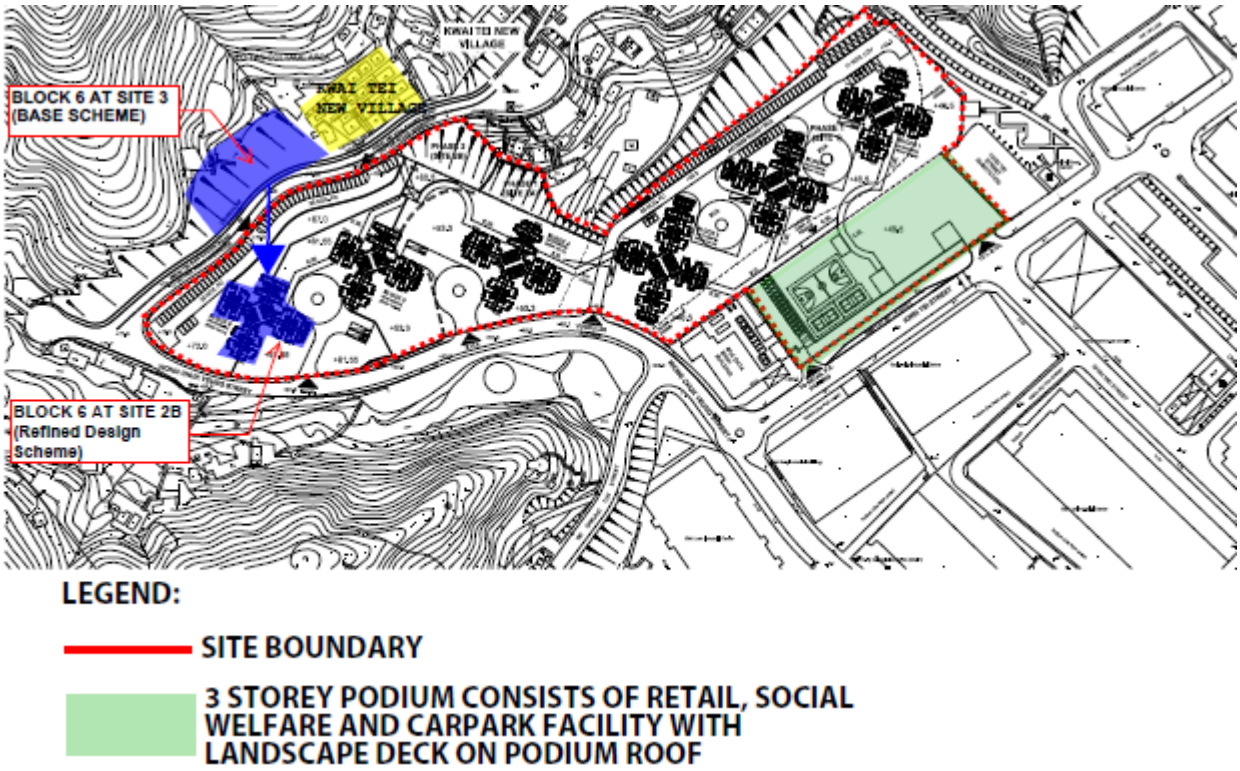

Figure 16 Relocation of Block 6 in the Refined Design Scheme

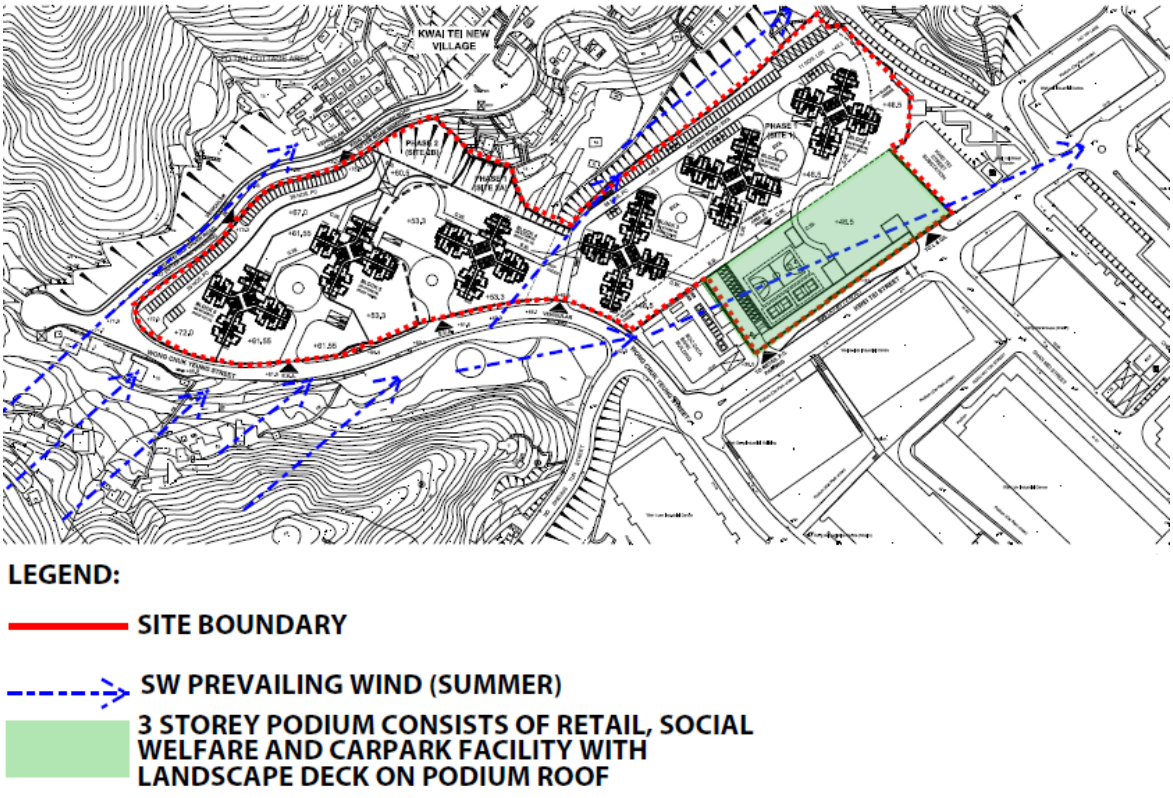

Figure 17 Summer prevailing wind condition in the Refined Design Scheme

- Building Separation

Upon the relocation of Block 6, there are 6 numbers domestic blocked located in the Site 1 and 2 in the Refined Design Scheme. In the improved layout as shown in ***Figure 18***, the shape and the orientation of building blocks has been changed in order to optimize the separation of each building block. However due to the site constraint not all blocks could be aligned with the prevailing wind directions. Moreover an approximately 30-metre separation and a path angle within 30 degrees from the prevailing SW and NE wind between block 3 and block 4 is designed for wind corridor to enhance wind penetration from NE to SW under NE wind and vice versa.

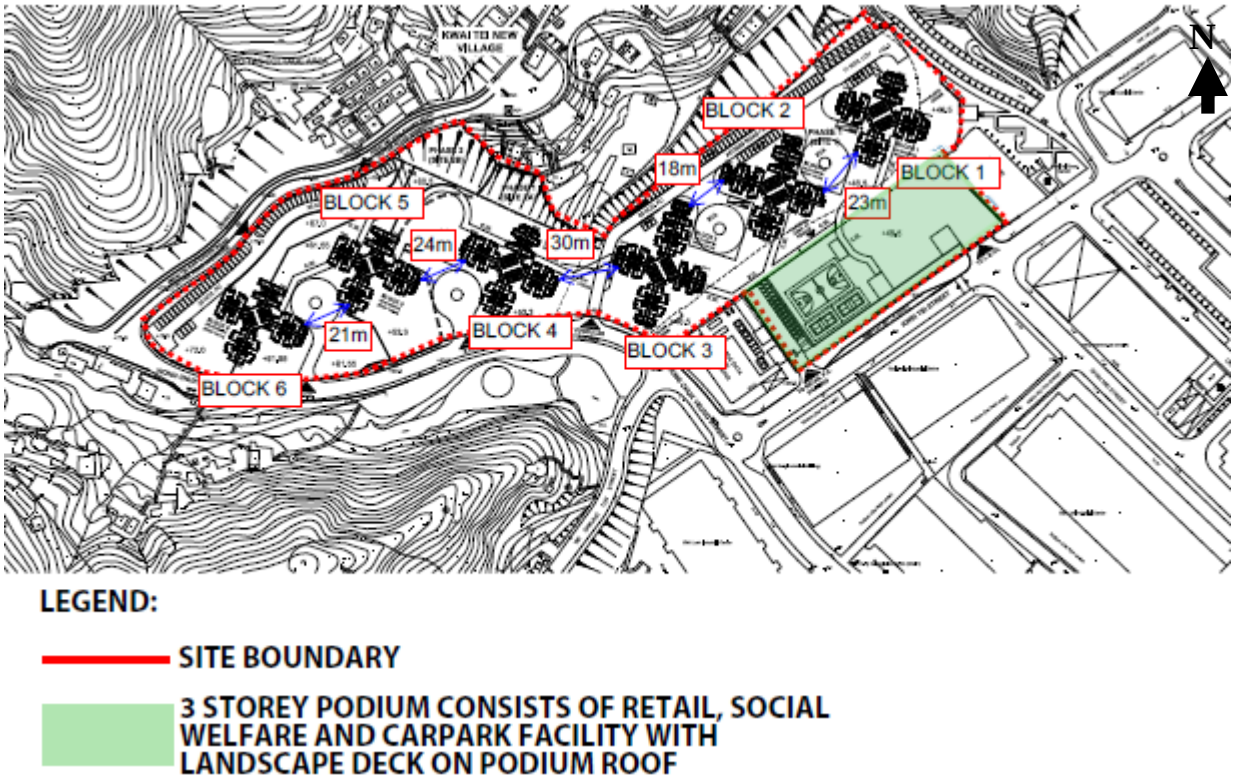

Figure 18 Building Separation in the Refined Design Scheme

- Building Disposition

The shape and orientation of residential blocks are revised to "cross-shaped", instead of "Y-shaped". This disposition allows better penetration of both annual and summer prevailing winds from E and SW directions as shown in ***Figure 19*** and ***Figure 20***.

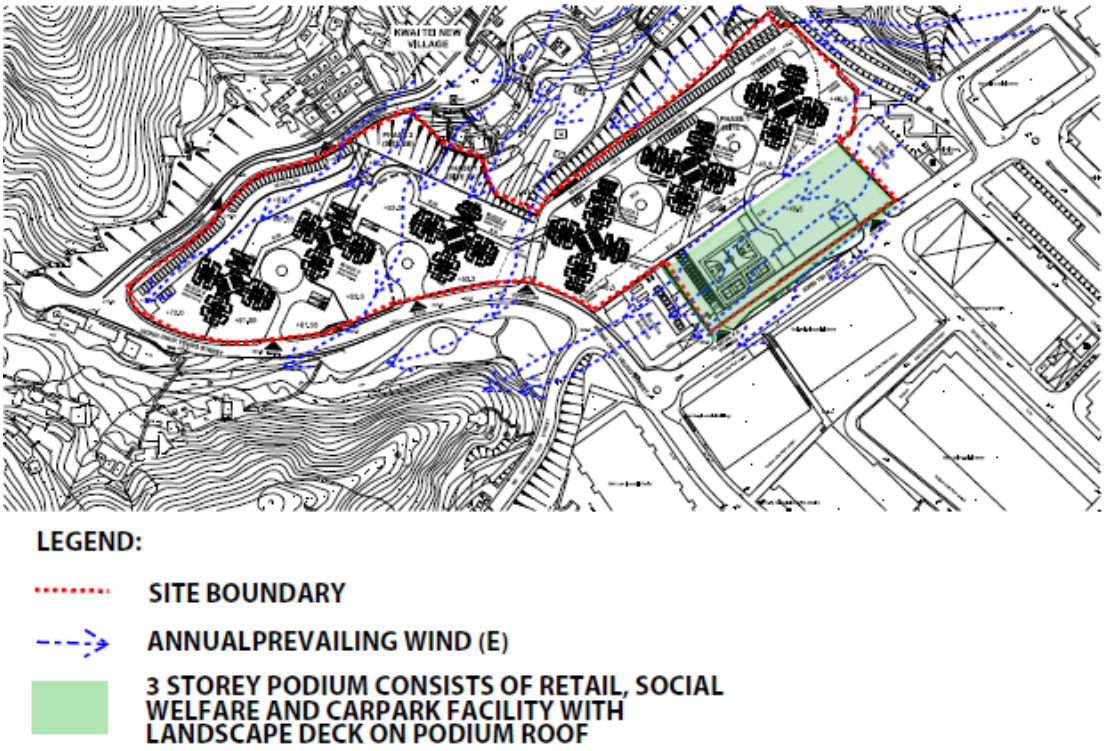

Figure 19 Prevailing annual wind in the Refined Design Scheme

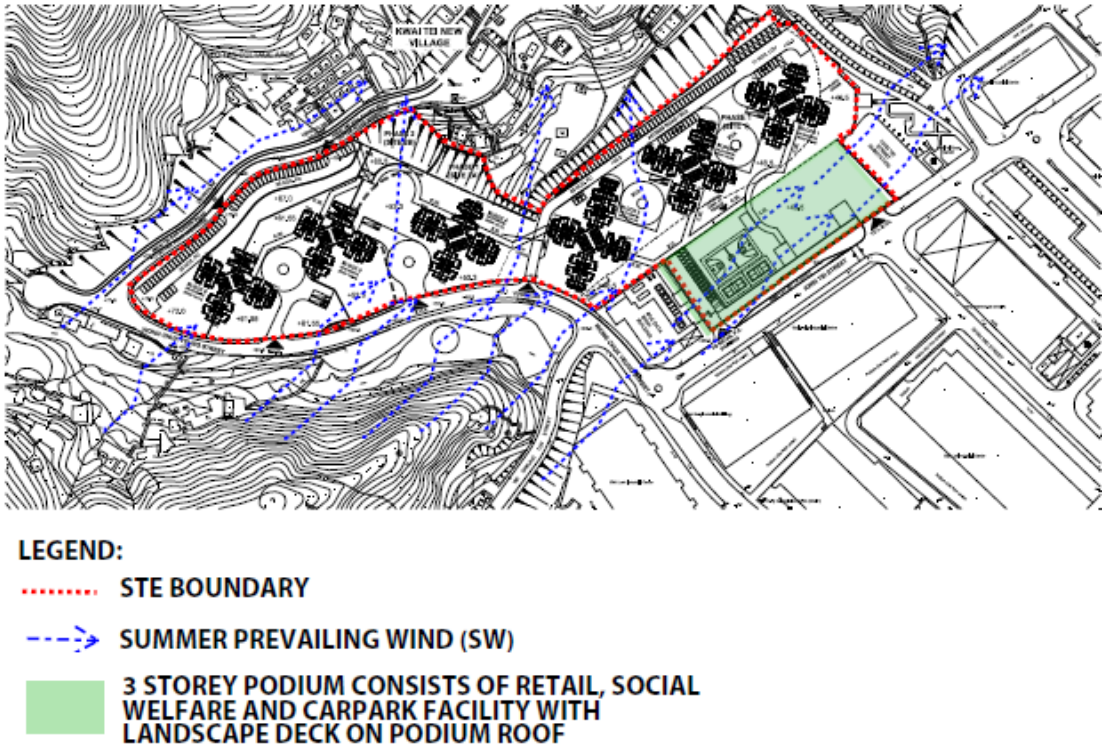

Figure 20 Prevailing summer wind in the Refined Design Scheme

HKHA has incorporated the above mentioned recommendations into the latest design scheme to improve the air ventilation performance of the Project. It is recommended an AVA Initial Study to be conducted for the design scheme to quantitatively evaluate the air ventilation performance at the pedestrian level to evaluate the effectiveness of the recommended design measures.

7. FUTURE STUDY

As the Project would likely impose changes on the existing wind environment in the surrounding area, an AVA Initial Study will be conducted to quantitatively assess the potential air ventilation impacts due to the Project, identify any potential problematic areas and the assess the effectiveness of the proposed mitigation measures to minimize the adverse impact caused to the surrounding environment

7.1. METHODOLOGY FOR INITIAL STUDY

According to the Technical Guide, both Computational Fluid Dynamics (CFD) and wind tunnel could be considered as the appropriate tools for AVA Initial Study. CFD is recommended as a cost-effective means for AVA Initial Study to evaluate the changes of the wind environment due to the Project.

The AVA Initial Study is to quantitatively evaluate potential air ventilation impacts of the proposed development based on wind data obtained from MM5 by determining the Velocity Ratios (VR) at various concerned locations. The airflow distribution within the flow domain, being affected by the subject site-specific design and the nearby topography will be visualized under the prevailing wind conditions round the year.

8. CONCLUSION

This AVA-EE Study aims at providing qualitative evaluation of wind performance of the subject site under existing condition and proposed design option. The subject site is currently used as an open carpark and bus depots where is surrounded by low-rise residential buildings and high-rise industrial buildings. Building heights of these surrounding buildings have different degree of implications on air ventilation at pedestrian level within neighbourhood during summer and annual conditions.

The air ventilation performance of the initial scheme of the Project, which consists of six proposed public housing blocks, has been evaluated by comparing to the latest design scheme.

Besides, the following good design features in the Initial Scheme has been considered:

- Capturing the prevailing east and south-westerly winds without substantial impediment from and to the surrounding developments and the terrain;
- Reducing the potential wind screen effects due to the building blocks and allowing wind penetration through the subject site;
- Allow some wind penetration for E wind through the subject site to the leeward areas via building gaps between each building block;
- Maintaining ventilation paths to enhance the wind environment at pedestrian level during annual and summer periods in the landscape deck area located at the south-east of Site.

The following enhancement measures are recommended in the Expert Evaluation in order to improve the air ventilation performance of the Refined Design Scheme:

- **Building Separation**: modifying the orientation of building blocks to increase the separation of the buildings in order to reduce the blockage to the prevailing winds and improve wind permeability into the site;
- **Free Flow Area**: relocating Block 6 to allow a free flow area to the existing village and avoid the wind screening effects during the summer;
- **Building Disposition**: modifying the building's shape as "cross-shaped" and providing more building separation to allow the better penetration of both annual and summer prevailing winds.

Lastly, an AVA Initial Study is recommended to quantitatively assess the potential air ventilation impacts on existing environment due to the Project based on the latest design scheme using Computational Fluid Dynamic (CFD) Simulation.