[RESTRICTED]

CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT

AGREEMENT NO. CE 47/2020 (CE) –

TERM CONSULTANCY FOR SITE FORMATION AND INFRASTRUCTURE WORKS FOR PROPOSED HOUSING DEVELOPMENTS IN ZONE 2 (2021 – 2024) – FEASIBILITY STUDY

TASK ORDER NO. 4 – ENHANCEMENT OF DEVELOPMENT INTENSITY OF PUBLIC HOUSING DEVELOPMENT AT AREA 48, FANLING

Air Ventilation Assessment in the Form of Expert Evaluation (AVA-EE) Report (Final – Issue 3)

Nov 2023

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PROJECT NO.: 2512219A

DATE: NOVEMBER 2023

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REVISION HISTORY

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Final – Issue 1	15 August 2022	Yufeng Lin	Vincent So	Calvin Li
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Final – Issue 3	1 November 2023	Yufeng Lin	Vincent So	Calvin Li

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ABBREVIATIONS

ASD	Architectural Services Department
B/Ds	Bureaux / Government Departments
CCPHI	Control relating to Potentially Hazardous Installations
CEDD	Civil Engineering and Development Department
DSD	Drainage Services Department
EFS	Engineering Feasibility Studies
EPD	Environmental Protection Department
FLN	Fanling North
GIC	Government, institution or community facilities
HD	Housing Department
HyD	Highways Department
KTN	Kwu Tung North
LandsD	Lands Department
LCSD	Leisure and Cultural Services Department
NDA	New Development Area
OZP	Outline Zoning Plan
PE	Public Engagement
PlanD	Planning Department
PRH	Public Rental Housing
SSF	Subsidised Sale Flats
STNW	Small Traders New Village
SWHSTW	Shek Wu Hui Sewage Treatment Works
TPDM	Transport Planning and Design Manual
TPEDM	Territorial Population and Employment Data Matrix
WSD	Water Supplies Department
WSP	WSP (Asia) Ltd.

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 The Government is committed to facilitating steady and continued land supply, not only for providing people with a place to live and work, but also for the developments of Hong Kong's commerce, industry, innovation and technology and various emerging sectors. In the short to medium term, the Government will continue to optimise the use of built-up land and its surrounding areas to meet the demand of the public for land for housing and other purposes.

1.1.2 Potential Sites are/would be identified for housing developments. The respective locations of the Site(s) would be provided by the Director's Representative (DR) throughout the course of the Assignment. Boundaries of the instructed Site(s) would be subject to review and determination from the findings of study(ies) and assessment(s) under this Assignment.

1.1.3 It is the government's intention to explore the feasibility of converting land use of the potential Site(s) for housing use and relevant supporting uses. Upon confirmation of the technical feasibility, the CEDD will initiate the application for permission under Section 16 of the Town Planning Ordinance (CAP. 131) for the proposed minor relaxation of plot ratio and building height restrictions for permitted public housing development.

1.1.4 WSP (Asia) Ltd. (WSP) was commissioned by the Civil Engineering and Development Department (CEDD) of the Hong Kong Special Administrative Region to undertake this Feasibility Study of Agreement No. CE 47/2020 (CE) Term Consultancy for Site Formation and Infrastructure Works for Proposed Housing Developments in Zone 2 (2021 – 2024) – Feasibility Study. The commencement date of the Study was 12 March 2021.

1.1.5 WSP was further instructed by the CEDD of the Hong Kong Special Administrative Region to undertake this Feasibility Study of Task Order No. 4 – Enhancement of Development Intensity of Public Housing Development at Area 48, Fanling. The commencement date of the Task Order was 30 June 2021.

1.2 SCOPE OF THIS STUDY

1.2.1 The purpose of the Expert Evaluation of Air Ventilation Assessment (AVA) is to evaluate the natural ventilation performance for the proposed public housing for Enhancement of Development Intensity of Public Housing Development at Area 48, Fanling. The methodology and requirements as outlined in the Technical Guide for Air Ventilation Assessment for Development in Hong Kong (Technical Circular No. 1/06 and Annex A) issued by Housing, Planning and Lands Bureau and Environment, Transport and Work Bureau will be followed.

1.2.2 Based on the site wind availability for the development site, identify any problem area as compared to the different proposed building schemes as well as proposing any mitigation measures if necessary. The natural ventilation performance due to these changes is assessed under annual and summer prevailing wind directions. The location for development site is referred to **Figure 1.1**.

1.2.3 The Expert Evaluation is a qualitative assessment to evaluate the wind characteristics of the proposed Development Sites and its vicinity areas. The "Feasibility Study for the Establishment of Air Ventilation Assessment System" by Planning Department and Chinese University of Hong Kong in 2005 which indicated the qualitative guiding principles for the air ventilation assessment will be referred to provide useful design reference for better air ventilation. The "Urban Design Guidelines" of Hong Kong Planning Standards and Guidelines Chapter 11 which provides the

qualitative guidelines on air ventilation on both district and site level for better identifying the wind environment on pedestrian level as well as the “Sustainable Building Design Guidelines PNAP APP-152” by Buildings Department are also referred. Based on the existing wind data availability for the site, the following evaluation will be undertaken.

- Propose the guiding principles from air ventilation perspective under both annual and summer conditions;
- Identify major breezeway/air paths;
- Examine the merits and demerits of the proposed development layout;
- Identify the rough order of the magnitude of possible wind problem areas;
- Recommend in refine the development layout with incorporation of proposed mitigation measures;
- Recommend in consultation if further study should be staged into AVA Initial Study or Detailed Study.

1.2.4 The natural ventilation performance due to these changes is assessed under both of annual and summer prevailing wind directions. The likely prevailing wind patterns and directions at the pedestrian level of the assessment area and its surrounding environment will be assessed qualitatively. All adjacent existing and/or planned developments as well as the surrounding topographic characteristic will also be considered.

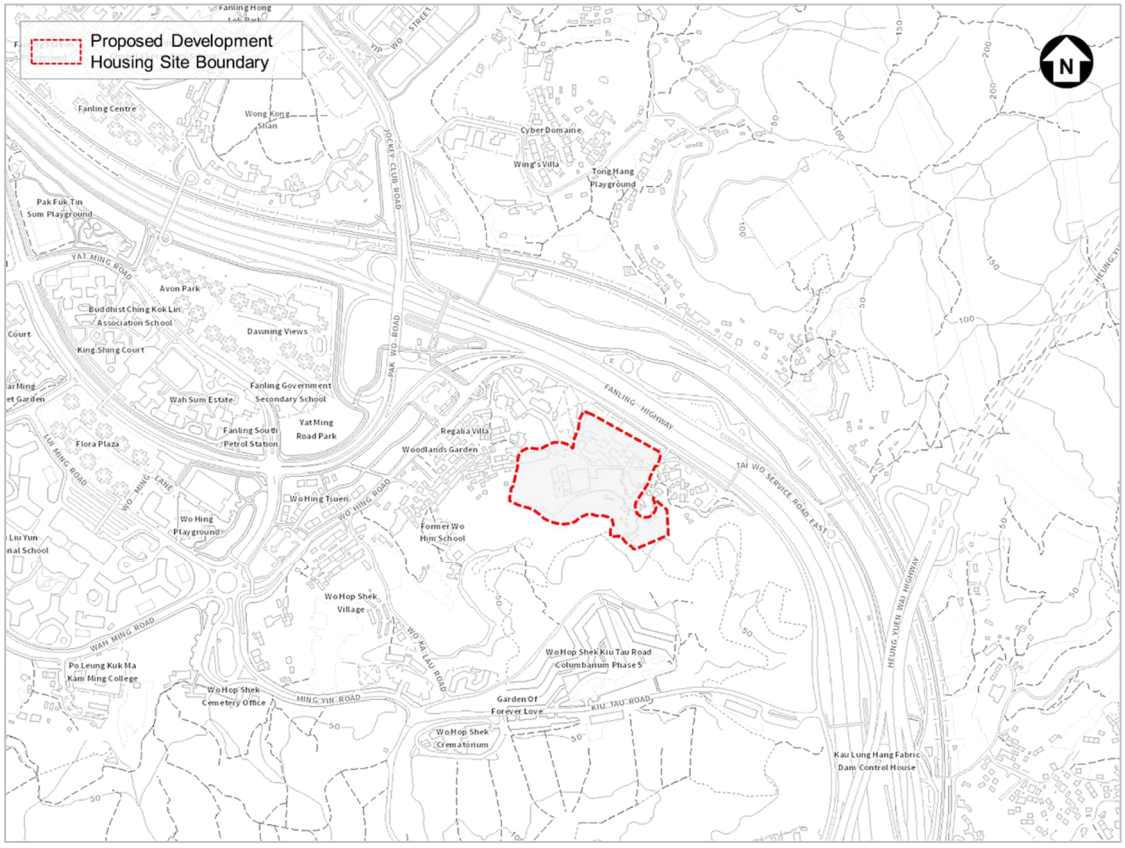

Figure 1.1 – Location of the Development Site

2 THE SURROUNDING ENVIRONMENT

2.1 SURROUNDING TOPOGRAPHY

2.1.1 As shown in **Figure 2.1**, the proposed Development Site is situated at the Wo Hop Shek Tsuen and beside Fanling Highway within the residential area. Based on the site inspection and preliminary desktop analysis, the Site is currently occupied by mixed woodland, grassland, low-rise villages and tin houses.

Figure 2.1 – Surrounding Topography of the Development Site

2.1.2 The digital elevation map (see **Figure 2.2**) around the Site area and its surroundings shows that the topology within the site area is relatively flat, mostly at the level of 0mPD to +40mPD. Meanwhile, in the surround area, the slopes increase gradually in two directions, i.e. the northeast and south directions. The ground level steeply increases at the farther northeast direction from +40mPD to +240mPD. On another hand, the ground level gradually increases from +40mPD to +80mPD at the immediate south side of the site. In addition, the ground at the west to north side is flat reclamation lands at 0 to +40mPD level in general.

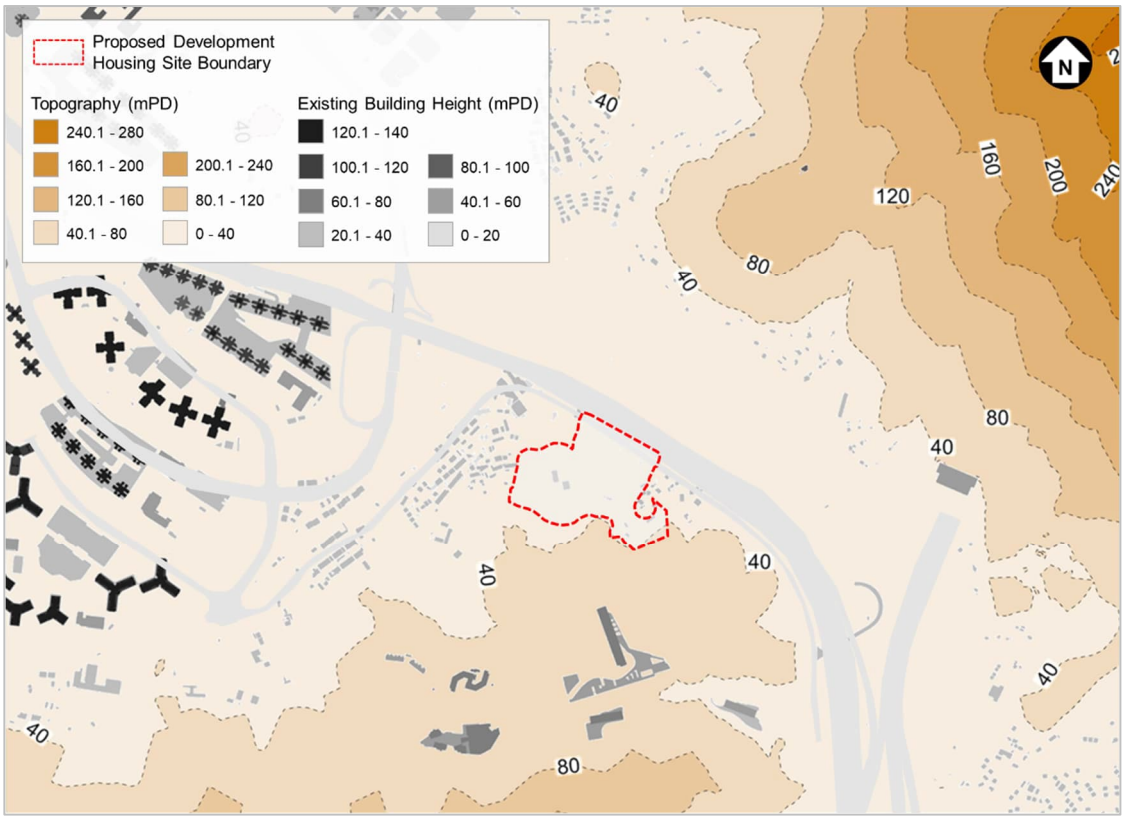

Figure 2.2 – Digital Elevation Map around the Development Site

2.2 ADJACENT FEATURES

2.2.1 In general, the development site is surrounded by open spaces, green belt areas and low-rise buildings and villages in **Figure 2.3**. Some surrounding land uses are classified as Agriculture and Recreation. These green belts and developments are mainly comprising of scattered village houses, residential housing estates, open storage yards, open carpark, mixed woodland and auxiliary of Government, Institution and Community (G/IC) facilities. The metro developments are mainly distributed at the farther northwest direction of the site, i.e. high-rise residential buildings and public facilities buildings. The building height of the major surrounding facilities and developments in mPD level are plotted in **Figure 2.4** for easy reference.

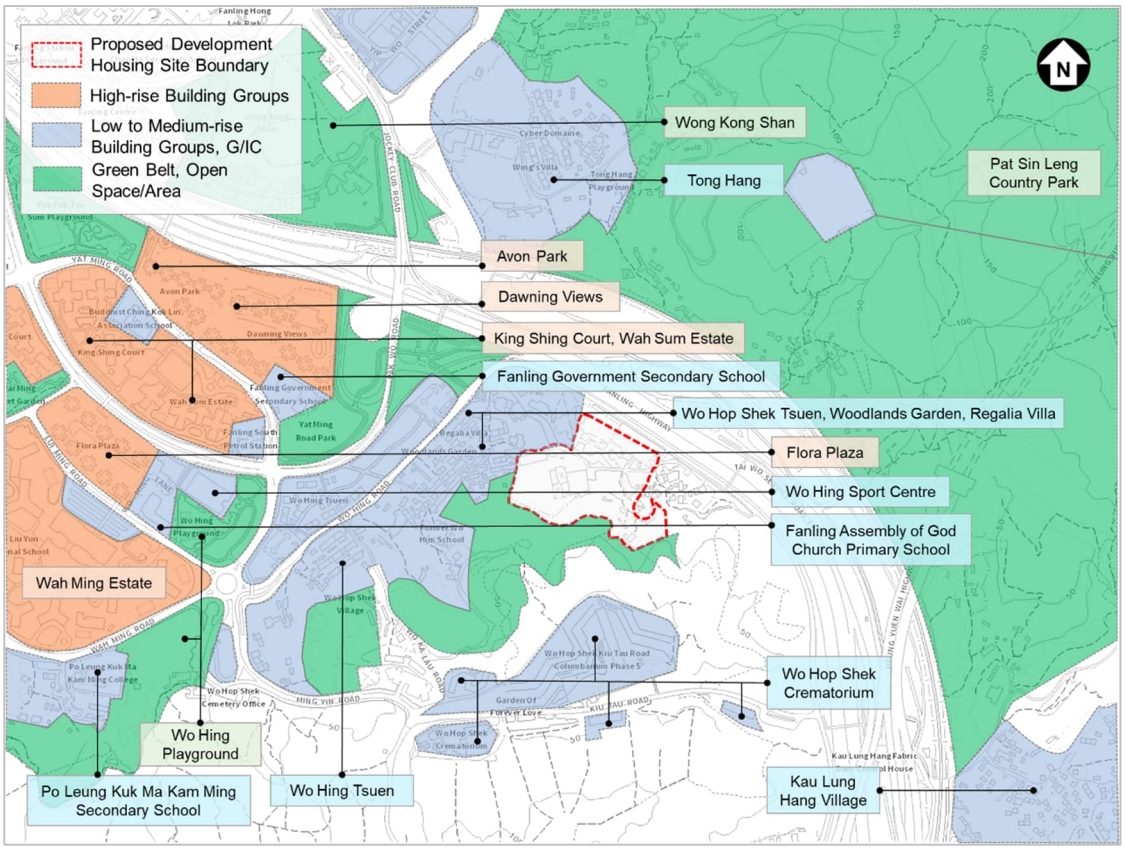

Figure 2.3 – Major Developments and Surroundings of the Development Site

2.3 EXISTING BUILDING HEIGHT IN THE AREA

2.3.1 The Site is bounded by the Fanling Highway at the north and northeast sides. At the immediate northwest side, there are mainly low-rise, low-density village and brownfield developments at Wo Hop Shek Tsuen. At the further northern side, low-rise developments at Tong Hang are located. While green belts of Wong Kong Shan and Pat Sin Leng Country Park are located at farther northwest and northeast side of the Site respectively.

2.3.2 From the south, there are mainly undeveloped rural area. In the further south side, low-rise Wo Hop Shek Crematorium developments are scattered along Kiu Tau Road. low-rise Kau Lung Hang Village locates in the farther southeast side of the Site.

2.3.3 A cluster of low-rise development are located at the immediate west to the Site, namely Wo Hop Shek Tsuen, Woodlands Garden and Regalia Villa. To the further west, several medium-rise developments and open space are located, namely Wo Hing Playground, Fanling Government Secondary School, Wo Hing Sport Centre, Fanling Assembly of God Church Primary School. At the farther west side of the site, there is a series of high-rise residential buildings, namely Avon Park, Dawning Views, King Shing Court, Wah Sum Estate, Flora Plaza and Wah Ming Estate. While, at the farther southwest side of the site, there are mainly scatter low-rise to medium-rise developments and open spaces, namely Wo Hing Tsuen and Po Leung Kuk Ma Kam Ming Secondary School.

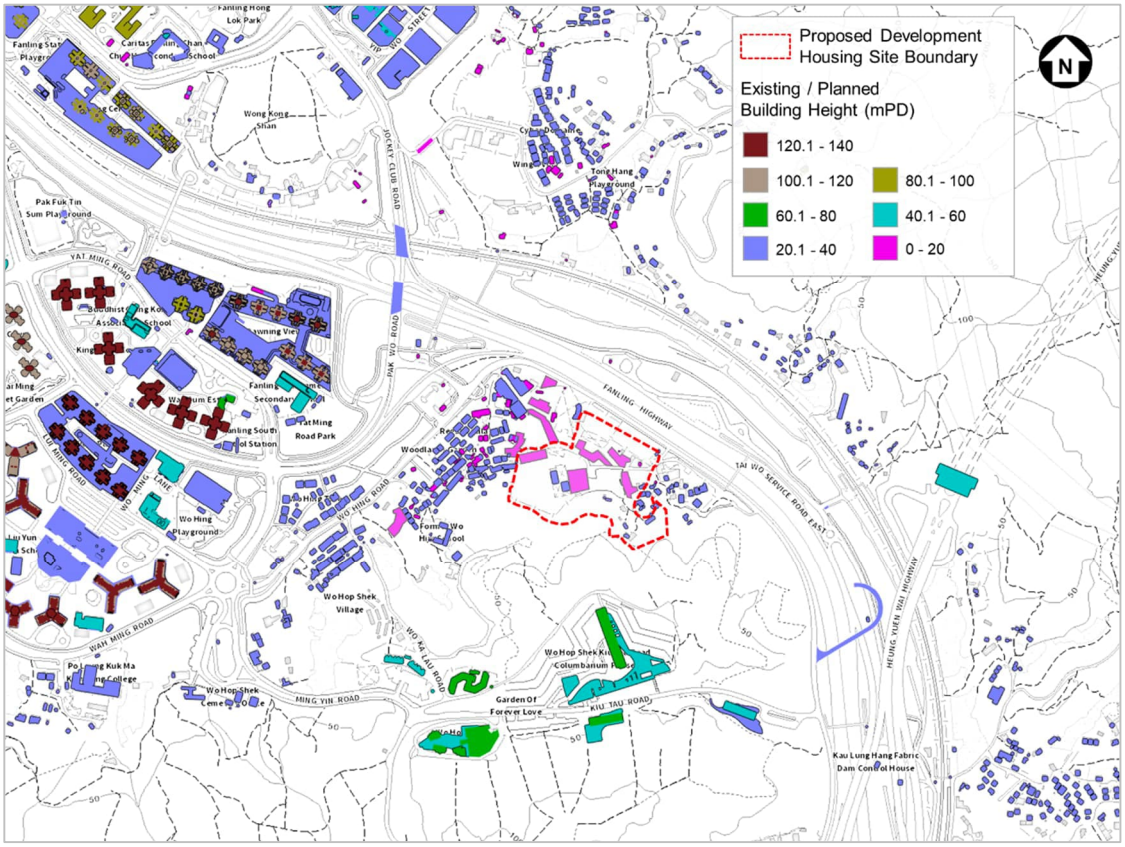

Figure 2.4 – Existing Building Height Plan around the Development Site

2.4 MAJOR ROAD NETWORKS, ELEVATED STRUCTURES, NOISE BARRIERS IN THE AREA

2.4.1 The major roads bounding the site are Fanling Highway, Tai Wo Service Road West and Wo Hing Road. In the vicinity of the site, the substantial road network consists of Jockey Club Road, Pak Wo Road, Yat Ming Road, Ming Yin Road, Heung Yuen Wai Highway, Kiu Tau Road, Lui Ming Road and Ming Yin Road as shown in **Figure 2.5**. Part of the branched Fanling Highway and Heung Yuen Wai Highway are elevated. In addition, discrete sections of noise barriers at the north and northwest directions of the site are installed along Fanling Highway. Meanwhile, the East Rail Line railway is also paved beside Fanling Highway.

2.4.2 Moreover, there are numerous elevated footbridges connecting residential buildings in the farther west of the site above Wo Hing Road, Yat Ming Road, Pak Wo Road and Lui Ming Road. On another hand, there are several footbridges across Fanling Highway and East Rail line railway.

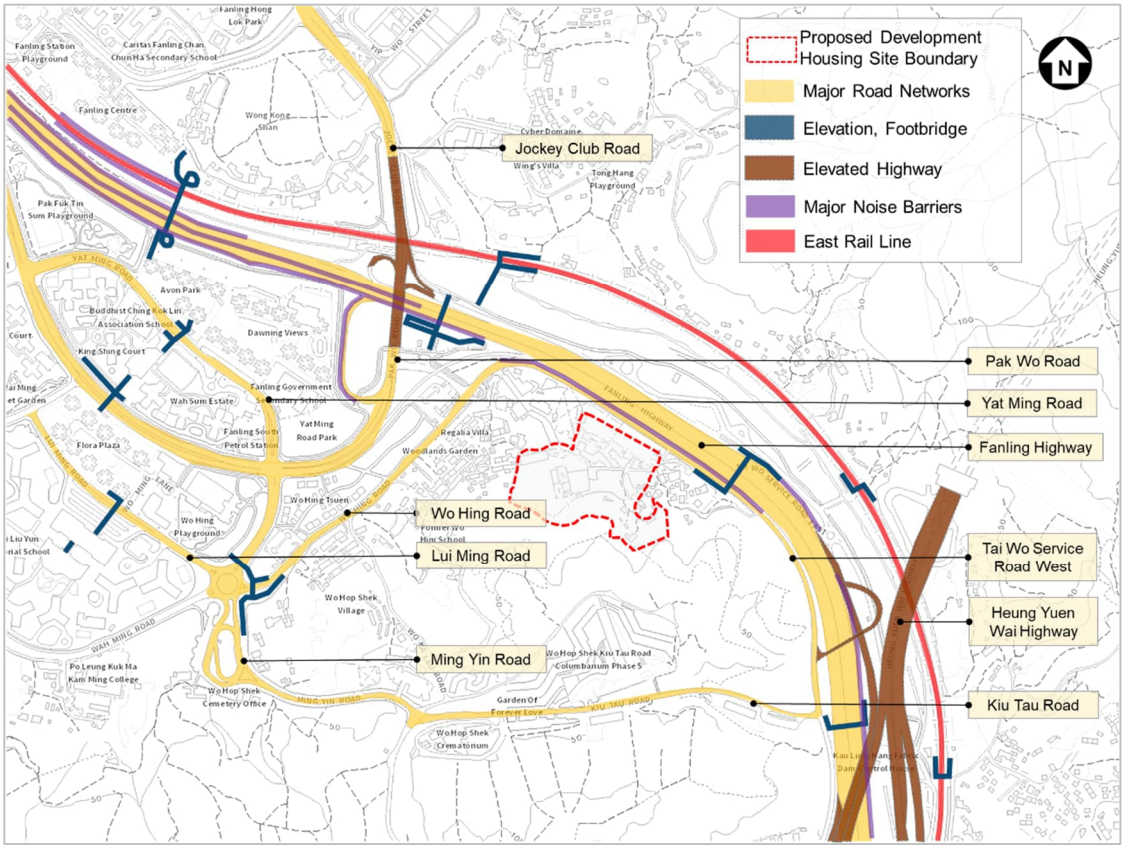

Figure 2.5 – Major Road Networks, Elevated Structures around the Development Site

3 SITE WIND AVAILABILITY

3.1 WIND ENVIRONMENT

3.1.1 In the assessment of air ventilation at the pedestrian level inside an urban area, the long-term characteristics of the approaching wind would need to be known in advance. For instance, the occurrence, i.e. the frequency of a typical wind direction is the key parameter for the subsequent assessment. This information is also essential for the performance comparison for different building forms for a special site. To obtain the site wind availability in Sheung Shui, several widely-accepted methods could be adopted, e.g. Hong Kong Observatory (HKO) direct measurement, reduced scale wind tunnel test and the mathematical models. In accordance with the AVA Technical Guide, all these methods are considered acceptable. The natural ventilation performance is assessed under annual and summer (June to August) prevailing wind directions. The non-typhoon wind roses for both annual and summer prevailing winds of a typical year should be adopted as the site wind availability for this study.

3.2 WIND DATA FROM HONG KONG OBSERVATORY

3.2.1 **Figure 3.1** shows several HKO weather stations which provide both monthly and annual data of wind roses. The location of the Development Site is also added for easy reference. Surrounding the Site, the weather station in Ta Kwu Ling is the nearest (about 5km distance) manned weather station from the Site in Wo Hop Shek Tsuen. Therefore, the wind roses from this weather station are considered as a reference for the subsequent assessment. Based on the average annual wind rose at HKO Ta Kwu Ling weather station from 1986-2020 in **Figure 3.2**, which extracted from HKO's Website as below, it is observed that the winds from east-southeast (ESE) and east (E) direction have over 20% frequency of occurrences, while the wind from north (N) direction has over 10% frequency of occurrences. As a result, the annual prevailing wind is considered as the N, E and ESE winds.

https://www.hko.gov.hk/en/cis/region_climat/windrose.htm?&std=TKL

3.2.2 Wind data from June to August can reflect the wind environment during summers and are used to identify the prevailing summer wind directions. According to the average monthly wind roses from 1986 to 2020 of the summer months at Ta Kwu Ling manned weather station in **Figure 3.3**, the wind from ESE direction has percentage frequency occurrence of about 20% from June to August. The other dominant wind from E direction has close to 20% of occurrence in all three summer months. The south-southeast (SSE), south (S) and south-southwest (SSW) winds have over 10% of frequency occurrence in these three months. Therefore, it can be concluded that the directions of summer prevailing winds are coming from E, ESE, SSE, S and SSW directions.

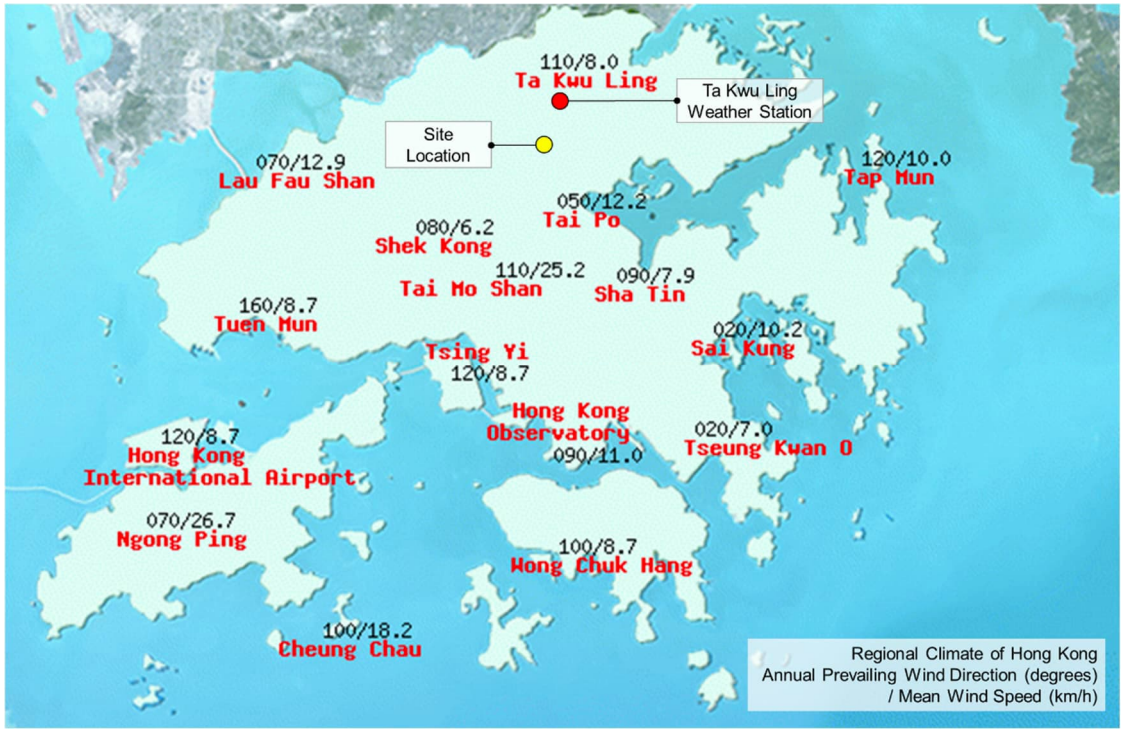

Figure 3.1 – Some of HKO Weather Stations and the Site Location

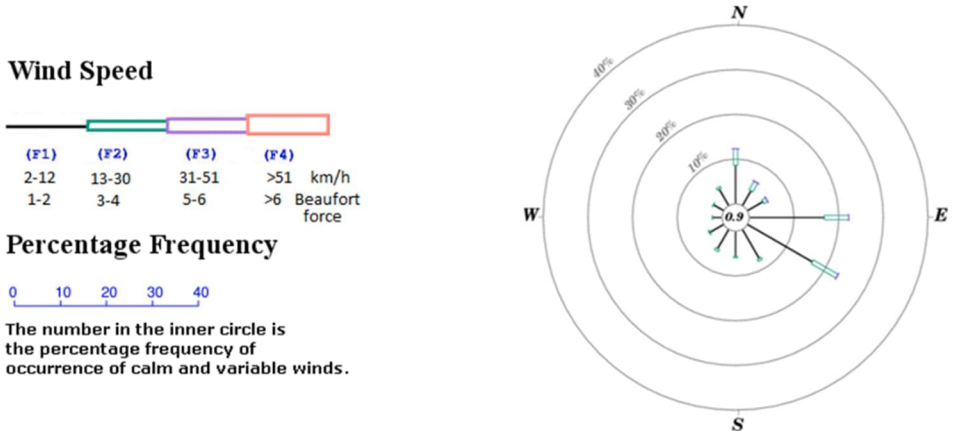

Figure 3.2 – Annual Wind Roses for Ta Kwu Ling, 1986-2020

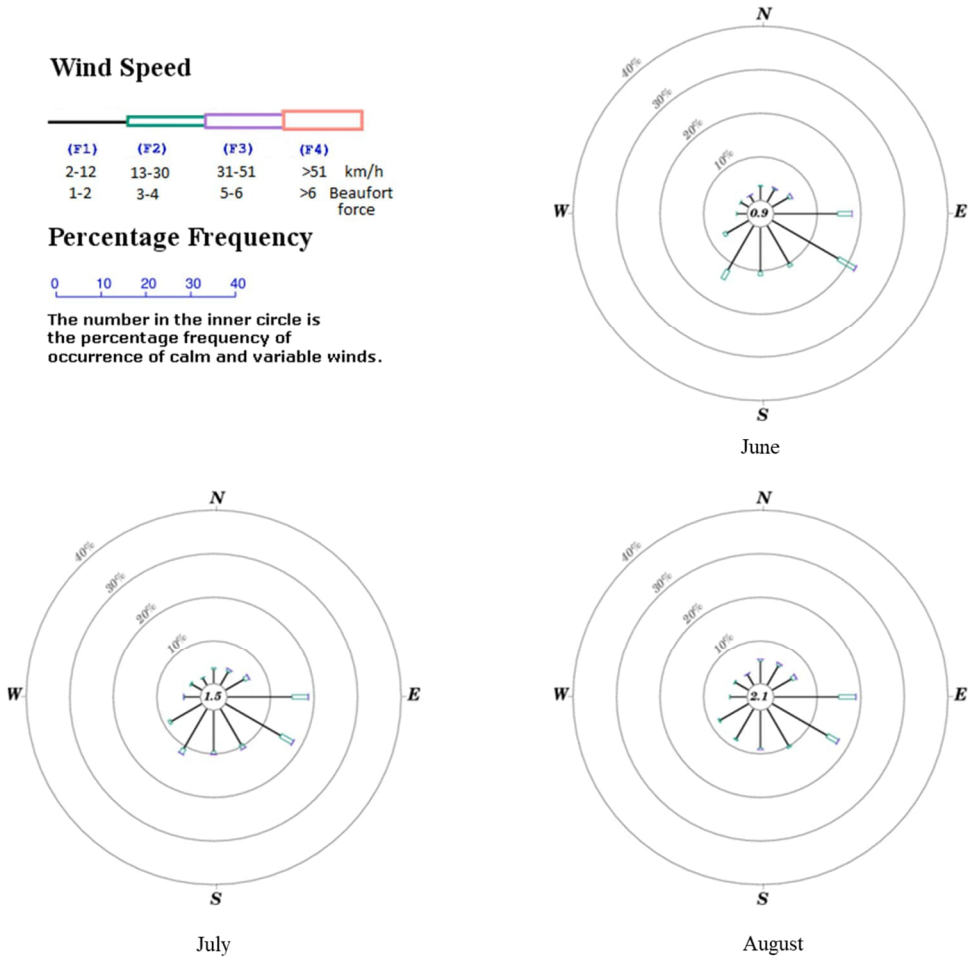

Figure 3.3 – Monthly Wind Roses in Summer for Ta Kwu Ling, 1986-2020

3.3 WIND DATA FROM PREVIOUSLY AVA EXPERT EVALUATION

3.3.1 The previously AVA-EE report of “Cat. A1 – Term Consultancy for Expert Evaluation and Advisory Services on Air Ventilation Assessment (PLNQ 56/2012), Final Report for an Instructed Project at On Lok Tsuen” (OLT AVA report 2016) summarized several wind data of On Lok Tsuen via HKO measurement and RAMS simulations by School of Architecture of CUHK. The subject site of the reference report is about 1km away from the northwest side of the current assessed site.

3.3.2 Referring to this “OLT AVA report 2016”, the wind data at Ta Kwu Ling Weather Station have been extracted for HKO as the nearest stations measuring wind. The measure point in located from the farther NEE direction of the current assessed site. As shown in **Figures 3.4 and 3.5**, the reference report found that the annual prevailing winds from Ta Kwu Ling are East (E) and southeast (SE), while the summer prevailing wind directions are from the east (E), southeast (SE), south (S) and southwest (SW).

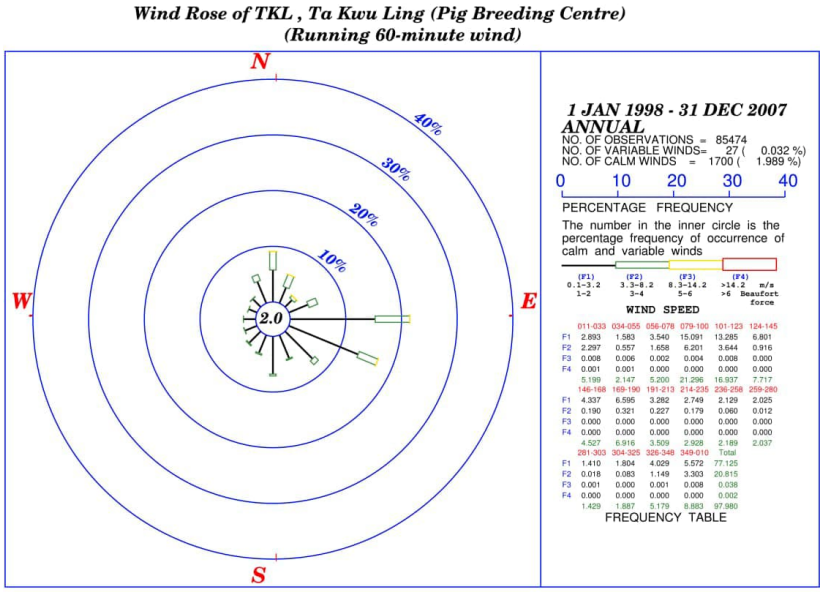

Figure 3.4 Annual Wind Rose Measured at Ta Kwu Ling Weather Station, 1997-2007

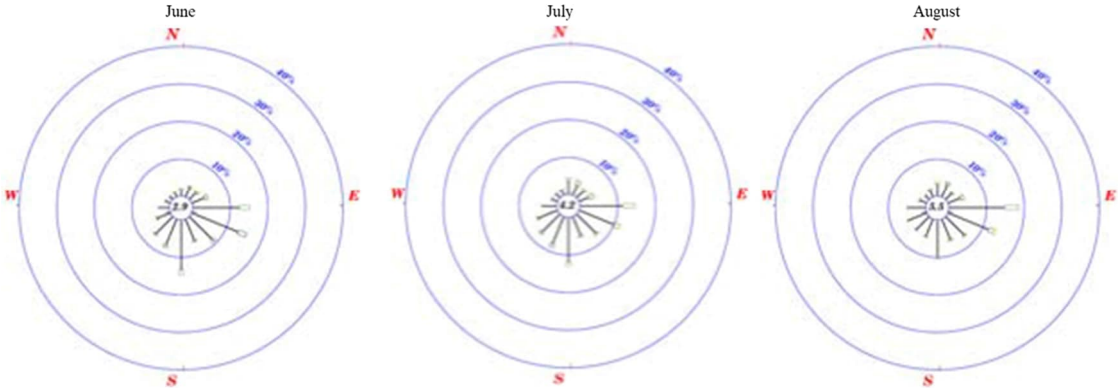

Figure 3.5 Summer Wind Roses Measured at Ta Kwu Ling Weather Station, 1997-2007

3.3.3 "OLT AVA report 2016" also utilised RAMS to simulate the wind roses at the location (x:074; y:082). The wind roses show that the annual prevailing wind directions are Northeast (NE), East (E) and Southeast (SE) while the summer wind comes from the East (E), Southeast (SE) and Southwest (SW) directions. While it is around 1.2km away from the current subject site. Moreover, the data from this reference report is relatively outdated. For example, the wind data retrieved from HKO in the reference report is up to 2007, while the HKO measurement data utilised in this report is updated in 2020. The wind data from the reference AVA EE report can't completely reflect the prevailing wind direction of the current development site. Thus, the findings from "OLT AVA report 2016" are only used for reference in the current assessment.

3.3.4 Another previously AVA-EE report of "Proposed Public Rental Housing Development at Fanling Area 48 New Territories, Hong Kong" (FA48 AVA EE report 2015) summarized several wind data of the current development site location via HKO measurement and the 5th-generation NCAR/Penn State Mesoscale Model (MM5) data. The subject site of the reference report is located on the current assessed site.

3.3.5 Referring to this "FA 48 AVA EE report 2015", it has mainly taken the wind data from MM5 as the prevailing wind reference and found that the annual prevailing winds at the assessed site are from E, ENE and ESE directions, while the summer prevailing wind directions are from the E, ESE and SE.

3.3.6 However, the methodology and data sources of assessing prevailing winds in “FA48 AVA EE report 2015” are outdated. For example, the part of the wind data retrieved from MM5 in the reference report is updated in 2014, while the HKO measurement data utilised in this report is updated in 2020. In addition, MM5 model is also an outdated wind model comparted with RAMS which is discussed in following Section 3.4. The wind data from the reference AVA EE report can’t completely reflect the prevailing wind direction of the current development site. Thus, the findings from “FA48 AVA EE report 2015” are used for reference only.

3.4 WIND DATA FROM HONG KONG PLANNING DEPARTMENT

3.4.1 In recent years, a study on simulated site wind availability data for AVA in Hong Kong was conducted by the City University of Hong Kong and published online on Hong Kong Planning Department’s website for public use since the middle of 2015. In the present study, a mesoscale model Regional Atmospheric Modelling System (RAMS) is used to simulate the site wind data including wind rose and wind profile. As a result, the latest wind data and simulation method can be obtained. Based on the Site Wind Availability Data available on PlanD’s website, the Development Site is located within the grid (X:075, Y:079). The detailed site wind availability data of the Site could be found from the website below.

https://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/072084.html

3.4.2 **Figure 3.6** shows the wind roses (corrected to 200m high above ground level) for annual and summer non-typhoon winds on the Development Site. These wind roses are adopted in determining the prevailing annual/summer winds. According to the wind rose plots below and the summary in **Table 3.1**, the east-southeast (ESE) wind has around 18% frequency of occurrence in annual wind data. The E wind has about 13% frequency of occurrence, and the southeast SE wind has 14% frequency of occurrence in annual wind data. In conclusion, the annual prevailing wind directions are E, ESE and SE in the Development Site.

3.4.3 In summer, the southeast (SE) and SSE winds have over 13% and 16% frequencies of occurrence, respectively. While the ESE, S and SSW winds have about 10% frequency of occurrence during summer (see **Table 3.2**). As a result, the ESE, SE, SSE, S and SSW could be considered as the summer prevailing wind directions in the Site area.

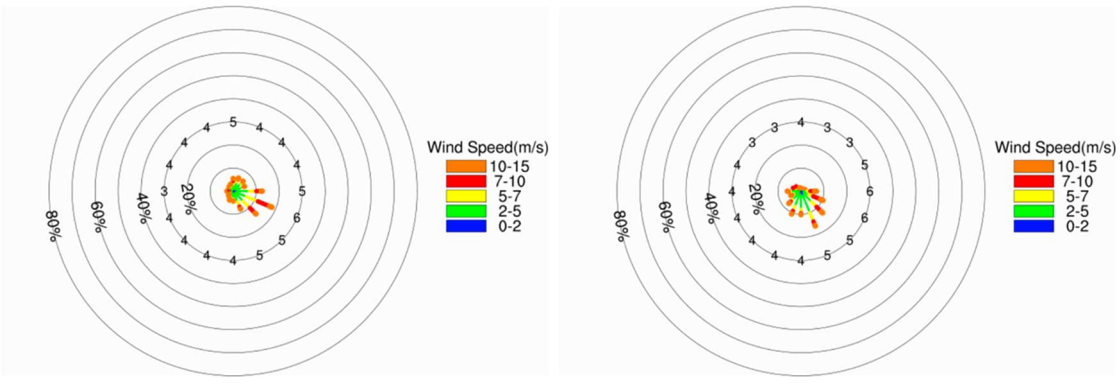

Figure 3.6 – Annual (left) and Summer (right) Wind Roses for Grid (X:075, Y:079) corrected to 200m

Table 3.1 – Annual Percentage Occurrence of Directional Winds, (X:075, Y:079)

Height	N	NNE	NE	ENE	**E**	**ESE**	**SE**	SSE

200m	0.055	0.061	0.061	0.054	**0.127**	**0.183**	**0.140**	0.084
Height	S	SSW	SW	WSW	W	WNW	NW	NNW
200m	0.043	0.042	0.028	0.019	0.027	0.019	0.025	0.032

Table 3.2 – Summer Percentage Occurrence of Directional Winds, (X:075, Y:079)

Height	N	NNE	NE	ENE	E	**ESE**	**SE**	**SSE**
200m	0.013	0.011	0.011	0.019	0.068	**0.105**	**0.134**	**0.163**
Height	**S**	**SSW**	SW	WSW	W	WNW	NW	NNW
200m	**0.102**	**0.107**	0.075	0.048	0.059	0.038	0.030	0.016

3.5 PREVAILING WIND CONDITIONS

3.5.1 **Table 3.3** shows the summary of annual and summer prevailing wind directions from different sets of site wind availability data (HKO measurement in Ta Kwu Ling, OLT AVA report 2016, FA48 AVA EE report 2015 and RAMS model).

3.5.2 For the HKO measurement in Ta Kwu Ling, the weather station is located ~5km away from the Site. The prevailing winds direction may be affected by various factors, e.g. terranes and surrounding buildings/developments, etc. Hong Kong is a hilly city which prompts complicated and changing of wind directions within a district. There is a large possibility that the wind directions are altered by topographical factors. It is considered that the wind data at Ta Kwu Ling cannot well reflect and estimate the prevailing winds at the Site. Hence, the wind data from the RAMS model as discussed above will be considered for further evaluation on the wind environment on and around the Site.

3.5.3 As a result, the annual prevailing winds are considered under E, ESE and SE directions; while the summer prevailing wind directions are ESE, SE, SSE, S and SSW. These prevailing wind directions as shown in **Figure 3.7** are typical in Hong Kong and the building form of proposed public housing developments should make full use of these wind conditions.

Table 3.3 – Summary of Prevailing Wind Directions

Site Wind Data	Relative Position	Prevailing Winds	
		Annual	Summer
HKO measurement (Ta Kwu Ling)	in farther NE side (~5km)	N, E, ESE	E, ESE, SSE, S, SSW
HKO data from “OLT AVA report 2016” (Ta Kwu Ling)	in farther NE side (~5km)	E, SE	E, SE, S, SW
RAMS data from “OLT AVA report 2016” (On Lok Tsuen)	nearby site (~1.2km)	NE, E, SE	E, SE, SW
Finding from “FA48 AVA EE report 2015” (on the Site area)	on Site area	E, ENE, ESE	E, ESE, SE
RAMS numerical model (on the Site area)	on Site area	**E, ESE, SE**	**ESE, SE, SSE, S, SSW**

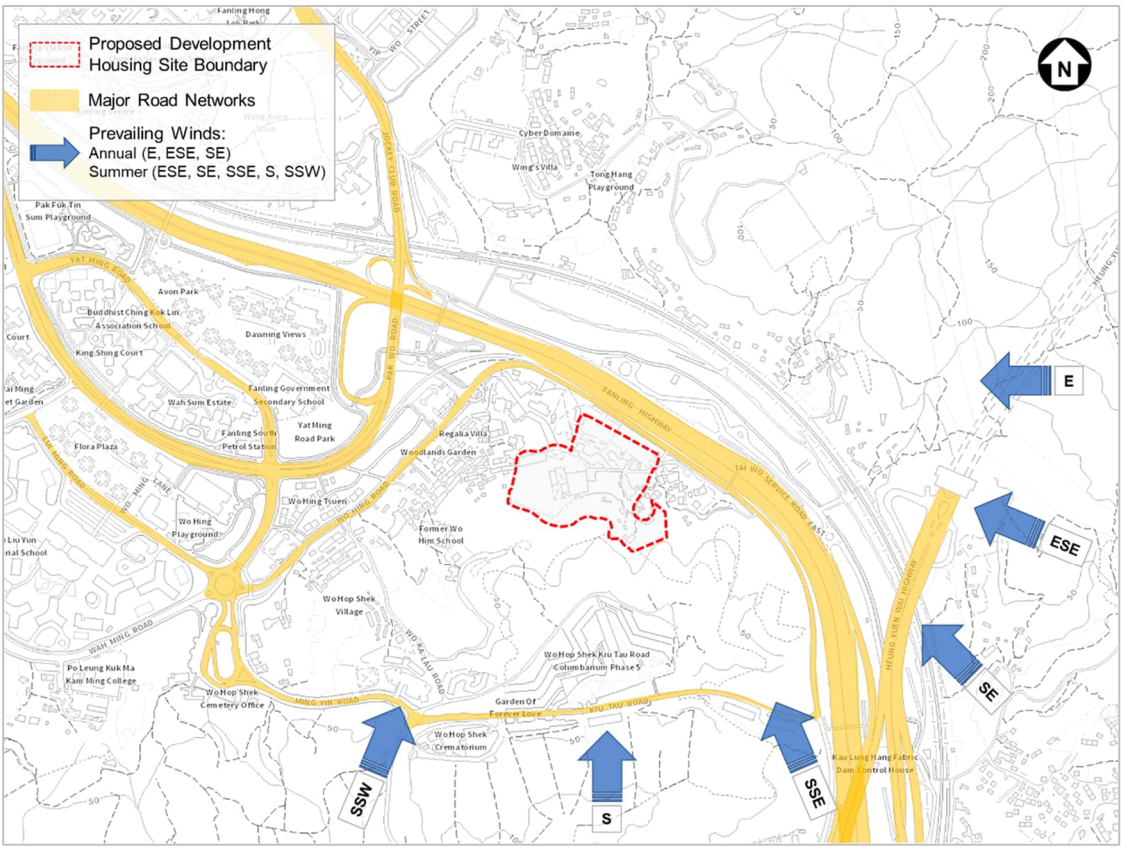

Figure 3.7 – Summary of Annual/Summer Prevailing Winds of the Development Site

4 DESIGN OPTION FOR PROPOSED BUILDING PLAN

4.1 INITIAL DEVELOPMENT LAYOUT

4.1.1 **Figure 4.1** shows the indicative Site layout option plan. Referring to **Table 4.1**, one large irregular housing block (BLK 1) and six "Y-shaped" housing blocks (BLK2, BLK3, BLK4, BLK5, BLK6 and BLK7) are both arranged on podiums. Block 1 of +118mPD high has 26S+6 storeys on a podium of +43.4mPD high. Block 2 of +121mPD high has 27S+6 storeys and a podium of +43.4mPD high. Block 3 of +175mPD high has 47S+R+4 storeys and a podium of +38.1mPD high. While Blocks 4 to 7 share the same podium of +34.7mPD high. Blocks 4 to 6 have the same 46S+R+4 storeys with building height of +173mPD, +175mPD and +173mPD, respectively. On another hand, Block 7 of +145mPD high have 37S+4 storeys. The proposed housing scheme is indicative only and is subject to detailed design. There is also a proposed primary school of around +40mPD high adjacent the eastern side of the housing site.

4.1.2 As descripted in Section 2, the major surrounding building features including low to high-rise developments as well as open areas, green belts located in vicinity of the Site. The proposed Development includes a group of high-rise public housing blocks. It is envisaged that the increasing in development intensity would inevitably lead to some effects on the surrounding pedestrian wind environment as compared to the existing condition. In order to minimize the air ventilation impact on the surrounding areas, especially western regions (e.g. Wo Hop Shek Tsuen, Woodlands Gard Den, Regalia Villa, etc.). The qualitative mitigation measures for the proposed building plan have been considered. It is expected that the potential adverse impact of the proposed Developments could be alleviated.

4.1.3 Referring to the guideline and suggestion from "Feasibility Study for the Establishment of Air Ventilation Assessment System", "Urban Design Guidelines" of Hong Kong Planning Standards and Guidelines Chapter 11" and "Sustainable Building Design Guidelines from Buildings Department PNAP APP-152", the key factors, e.g. building permeability, disposition & orientation of building blocks are considered for this proposed large scale Development Site. The building separations are designed generally aligned to provide ventilation corridors for the prevailing winds to pass through. The buildings separation with at least 15m wide is suggested to allow prevailing wind passing through and minimizing the impedance of wind.

4.1.4 As shown in **Figure 4.1**, the building separation between Blocks 1 and 2, as well as between Blocks 3 and 4 are separated to provide at least 15m wind channel. A wide wind channel is also provided by the separation between the proposed primary school and Block 2. These two wind channels allow prevailing wind to access the vicinity of the site across the north and south of the site. While due to the alignment of Block 1, Block 2, Block 3, Block 4 and Block 7, the building separation clearance penetrating the site would allow the prevailing wind to pass through from the southeast to the northwest direction of the site. Another effective wind channel of at least 15m width is on top of the low-rise podium of Block 4, Block 5, Block 6 and Block 7. This feature allows the access of the wind skimming over the podium and penetrating the cluster of these proposed building blocks.

Table 4.1 – Summary of Prevailing Wind Directions

Blocks	Storeys	Refuge Floor	Podium Height	Building Height
BLK 1	26S+6	-	+43.4mPD	+118mPD
BLK 2	27S+6	-	+43.4mPD	+121mPD
BLK 3	47S+4	1	+38.1mPD	+175mPD
BLK 4	46S+4	1	+34.7mPD	+173mPD
BLK 5	46S+4	1	+34.7mPD	+175mPD
BLK 6	46S+4	1	+34.7mPD	+173mPD
BLK 7	37S+4	-	+34.7/+39.3mPD	+145mPD

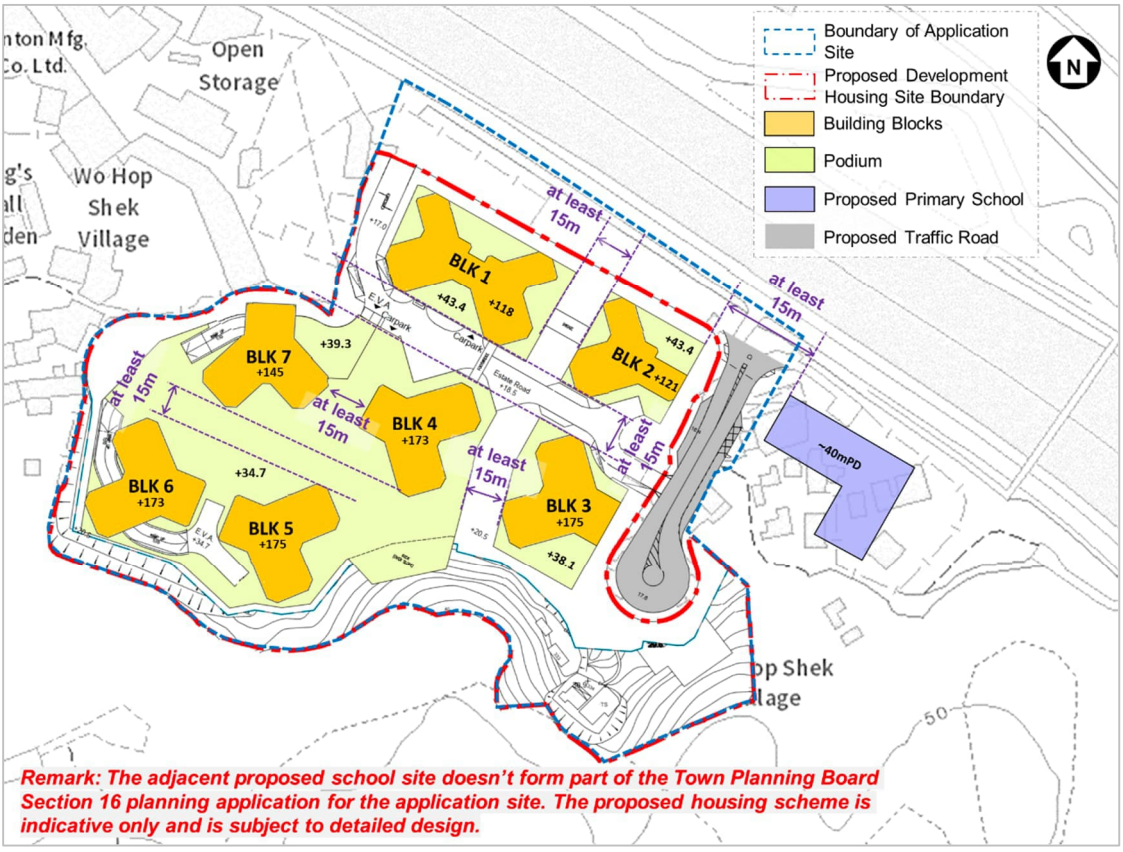

Figure 4.1 – Layout Plan of the Development Site

5 EXISTING WIND ENVIRONMENT

5.1 OVERVIEW

5.1.1 A thorough understanding of the environment of the proposed Development Site and its surrounding is essential, which includes the understanding of existing development around the Site. To identify the existing wind environment over the Site and its surroundings, the prevailing wind discussed above and the adjacent air paths passing through the major road networks and developments are analysed. The annual prevailing winds are from E, ESE and SE directions, while the summer prevailing winds are from ESE, SE, SSE, S and SSW directions.

5.1.2 The major roads provide passages for prevailing winds over the Site includes Fanling Highway, Tai Wo Service Road West, Wo Hing Road etc. The open areas, green belts and low-rise building groups are surrounding the site allow direct and smooth breezes over the Site, especially broad green belt areas from northeast and southern directions.

5.2 UNDER PREVAILING E AND ESE WINDS

5.2.1 As shown in **Figure 5.1**, in the east and southeast sides of the Site, there are mainly undeveloped hilly rural areas and open spaces (i.e. agriculture, green belt). Most of the upstream prevailing winds from E and ESE directions could reach the Site without any critical blockage. Along ESE direction, Fanling highway serves as a major wind corridor to ventilate the northern areas of the site. At the western downstream of the site, a section of Pak Wo Road also takes a role of wind channel to ventilate residential areas at the farther western side of the site. In the immediate downstream area, there are mainly spaces of woodlands with scattered low-rise brownfield and village developments. The open spaces from east and southeast sides are linked by Fanling Highway, downstream low-rise developments and Pak Wo Road. These inter-linked open spaces, road network and low-rise buildings are aligned in a way to form a ventilation corridor under the prevailing E and ESE wind. Hence, the prevailing wind could pass the Site smoothly and ventilate the Site and its surrounding environment at pedestrian level. No significant possible existing problematic area at pedestrian level could be observed within the Site area and its immediate vicinity.

5.2.2 However, at further western side, a possible existing problematic area may be observed at the wake zone generated by a cluster of high-rise residential building and medium-rise G/IC developments, namely Avon Park, Dawning Views, Fanling Government Secondary School King Shing Court, Wah Sum Estate, Wo Hing Sport Centre, Flora Plaza due to the wind blockage effect.

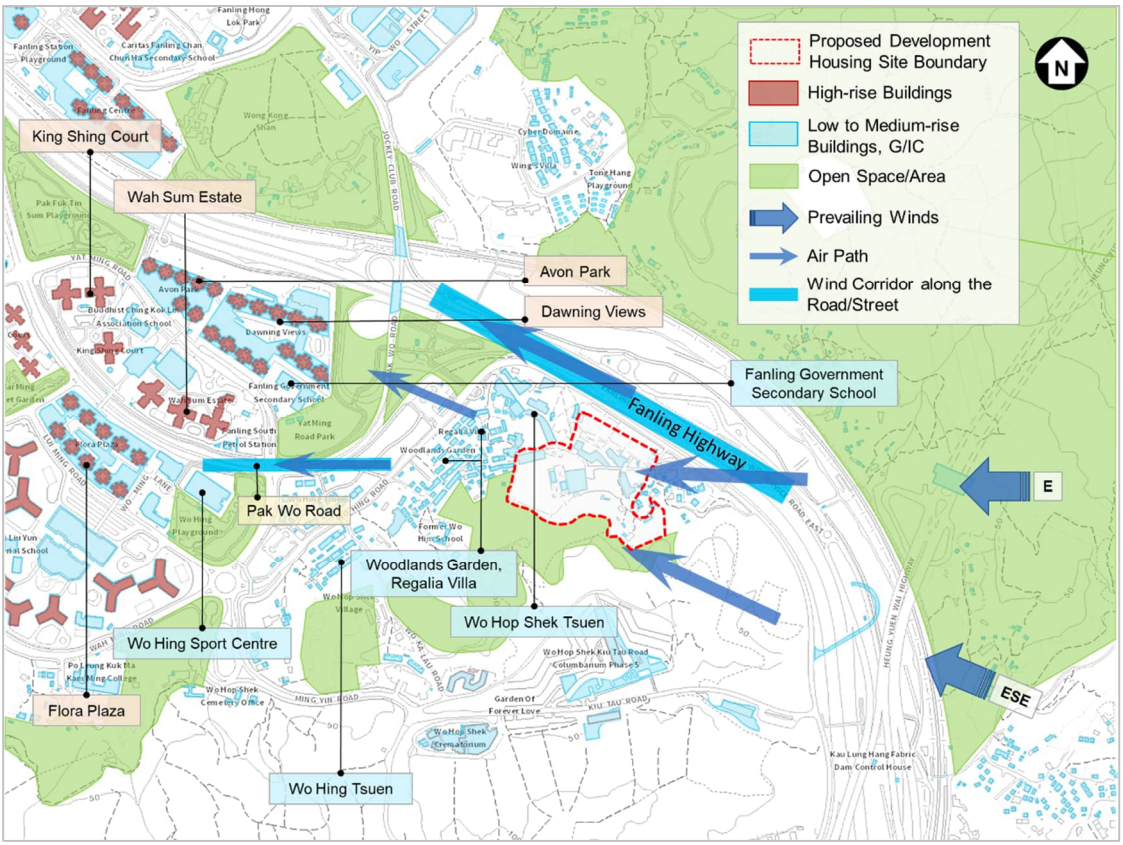

Figure 5.1 – Existing Wind Environment under Prevailing E and ESE Winds

5.3 UNDER PREVAILING SE AND SSE WINDS

5.3.1 As shown in **Figure 5.2**, the upstream areas from the SSE direction are mostly the broad hilly open spaces, G/IC low-rise developments namely Wo Hop Shek Crematorium. Another upstream SE wind from the farther scattered village areas would flow over the open space of road network and rural area to the site, namely Heung Yuen Wai Highway and Fanling Highway. A section of Fanling Highway serves as a wind corridor for the prevailing wind when it is parallel to the SE wind direction at the north side of the Site. At the immediate downstream areas, low rise brownfield developments and open spaces of Fanling Highway and East Rail Line railway are located. At the further downstream areas, open spaces and low-rise village developments can be found, namely Wong Kong Shan and Tong Hang. These open spaces and scattered low-rise developments from the upstream and downstream areas are linked together across the development site. These inter-linked open spaces and low-rise buildings are aligned in a way to form a ventilation corridor under the prevailing SE and SSE winds. Hence, the prevailing wind could pass the Site without any critical blockage and ventilate the Site and its surrounding environment at pedestrian level. No significant possible existing problematic area at pedestrian level could be observed within the Site area and its immediate vicinity.

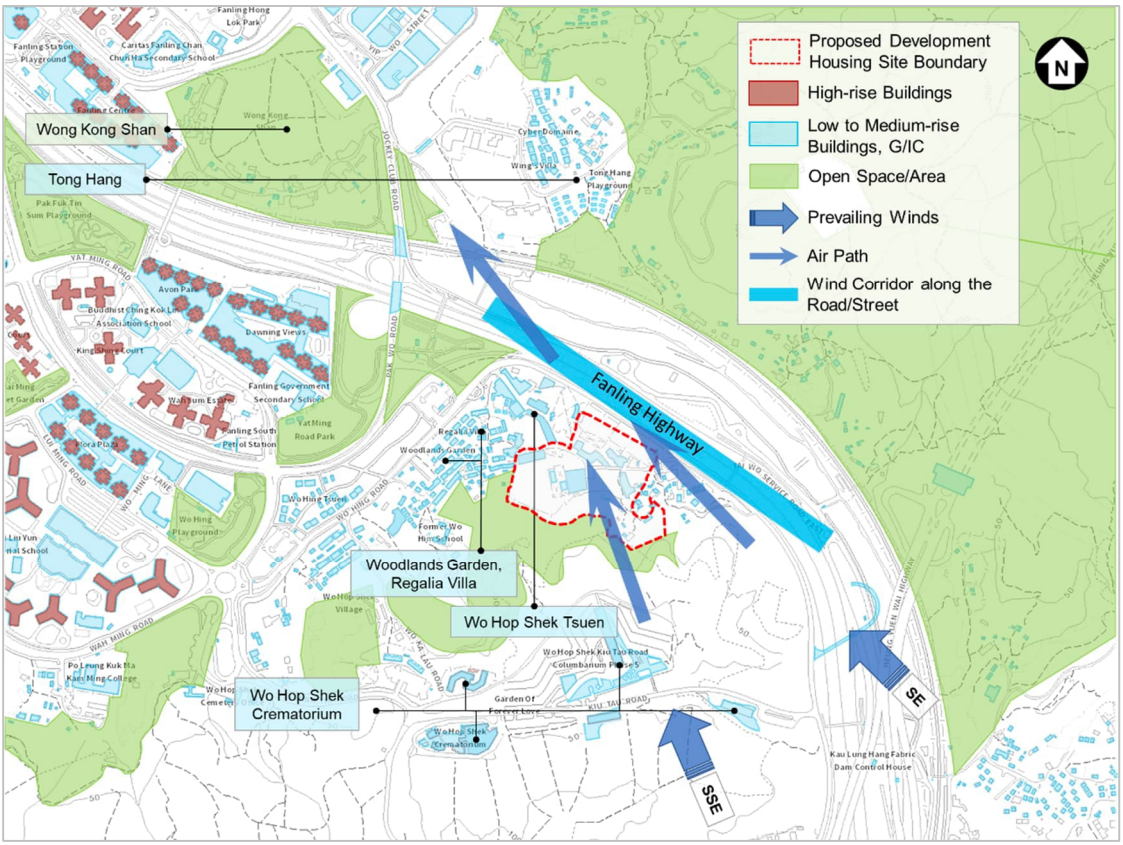

Figure 5.2 – Existing Wind Environment under Prevailing SE and SSE Winds

5.4 UNDER PREVAILING S AND SSW WINDS

5.4.1 As shown in **Figure 5.3**, the existing ventilation characteristics in the vicinity of the site under S and SSW winds are similar to Section 5.3.1. The upstream areas are mostly the broad hilly open spaces, G/IC low-rise developments, namely Wo Hop Shek Crematorium. At the immediate downstream areas, open spaces of Fanling Highway and East Rail Line railway are located. At the further downstream areas, open spaces and low-rise village developments can be found, namely Tong Hang. These open spaces and scattered low-rise developments from the upstream and downstream areas are linked together across the development site. These inter-linked open spaces and low-rise buildings are aligned in a way to form a ventilation corridor under the prevailing S and SSW winds. Hence, the prevailing wind could pass the Site without any critical blockage and ventilate the Site and its surrounding environment at pedestrian level. No significant possible existing problematic area at pedestrian level could be observed within the Site area and its immediate vicinity.

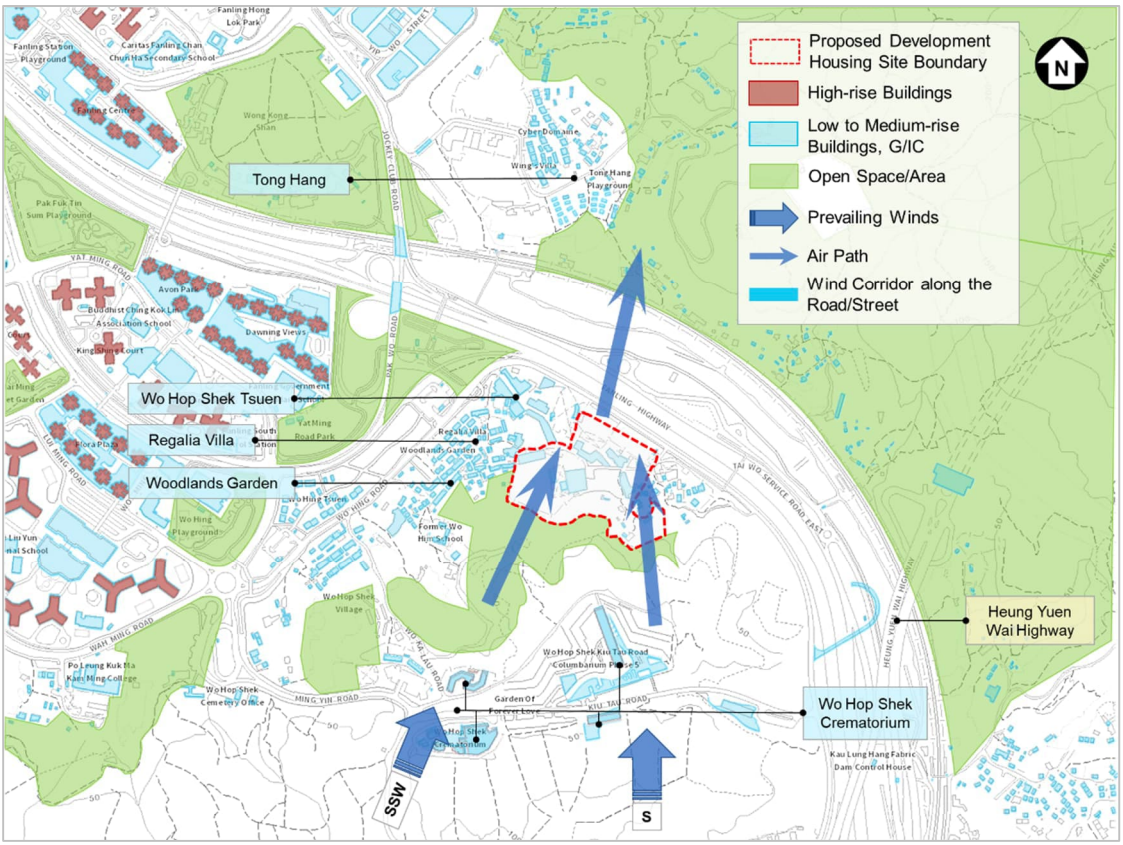

Figure 5.3 – Existing Wind Environment under Prevailing S and SSW Winds

5.4.2 In general, the wind availability of the study area is good. The result of the prevailing winds and the surrounding topography revealed that both annual and summer prevailing winds would flow through the development site as there are no exist large structures to block the wind flow over the site.

6 VENTILATION PERFORMANCE OF PROPOSED DEVELOPMENT

6.1 OVERVIEW

6.1.1 To assess the wind effects by the proposed Developments within the Site area and its vicinity, this section outlines the discussion of the natural ventilation at the pedestrian level under the prevailing wind directions by comparing the proposed and existing wind environments.

6.1.2 Referring to **Table 4.1**, the proposed development includes seven housing blocks erecting on the podiums. A proposed primary school is located adjacent the eastern side of the housing site. The annual prevailing wind comes from E, ESE and SE directions, while the summer prevailing winds are mainly comprised of ESE, SE, SSE, S and SSW winds.

6.2 UNDER PREVAILING E AND ESE WIND

6.2.1 **Figure 6.1** shows the prevailing winds from ESE direction smoothly pass through the site and along Fanling highway. However, for the prevailing E wind, no potential wind corridors penetrating the development site can be captured in general.

6.2.2 There are two ESE wind corridors penetrating the site areas from the upstream open spaces since the proposed housing blocks and proposed primary school are generally aligned to ESE directions. One upstream ESE wind would first flow from the south of Block 3 and skim over the low-rise podium. The stream would then cross the building blocks via the adequate wide of building separations of Blocks 4 & 5 and Block 6 & 7 together with the building disposition (generally aligned in lines parallel to the ESE direction). Due to the wind blockage of the low-rise podium, the ventilation environment at the pedestrian level of its immediate downstream areas is expected to be weakened. While, this wind corridor could alleviate the adverse impact on the continuity of ESE wind to the surrounding at the west of the Site as well as the further downstream areas. Another potential wind corridor of ESE wind is formed between Blocks 2 & 3 and Blocks 1 & 4. The upstream ESE from the south of the proposed primary school would follow this wind corridor to the downstream pedestrian area directly. The ESE winds through these two wind corridors would further flow towards the downstream areas, i.e. Regalia Villa, Wo Hop Shek Tsuen. At the northern boundary of the site, Fanling Highway also serves as a wind channel to facilitate the continuity of ventilation of prevailing ESE wind to the downstream area.

6.2.3 From the eastern direction, most of the upstream E wind would be blocked by proposed housing blocks and proposed primary school. Only small amount of the E wind could bypass the cluster of the proposed buildings from the northern and southern site boundaries.

6.2.4 A major problematic area may be observed within the site and its downstream areas under prevailing E wind, i.e. Regalia Villa. Due to the wind blockage of the proposed primary school and housing blocks, it is expected that ventilation performance at the pedestrian level under E winds would be insufficient. However, most of ESE winds could be directed to ventilate the site and its downstream areas at pedestrian level smoothly. No significant adverse impacts on the wind availability of the site and its downstream areas under ESE winds.

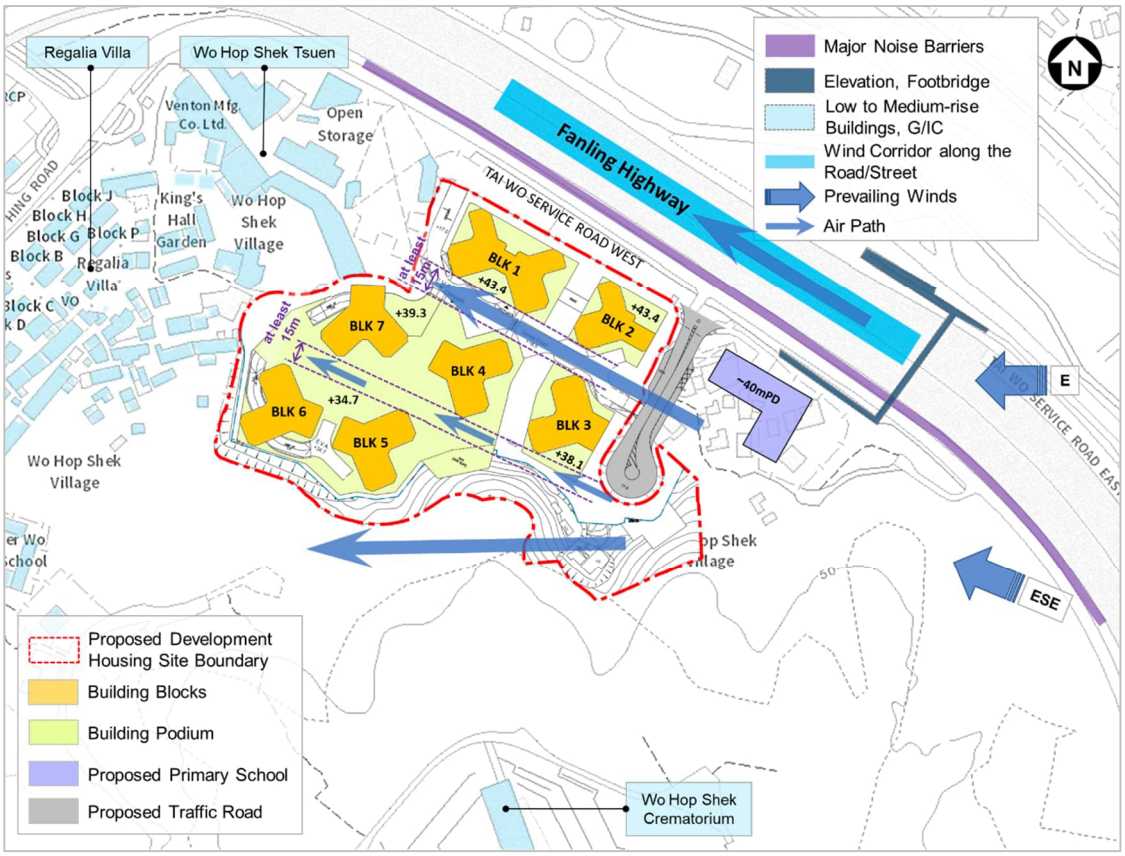

Figure 6.1 – Proposed Wind Environment under Prevailing E and ESE Wind

6.3 UNDER PREVAILING SE AND SSE WIND

6.3.1 **Figure 6.2** shows the prevailing winds from SE and SSE directions pass through the site to ventilate the downstream areas along multiple wind corridors. No significant wind blockage can be captured along SE and SSE wind directions.

6.3.2 SE winds from the upstream open space would flow along the development site to ventilate the downstream areas through two wind corridors. One upstream SE wind would entry the site from the south of the proposed primary school and turn 15° to the west towards the main wind route in the site at pedestrian level. The wind would blow along the building separation between Blocks 2&3, and Blocks 1&4. Another SE stream would entry the site from the south of Block 3 and turn 15° to the west towards another SE wind route in the site. The SE stream would skim over the low-rise podium of +34.7m through the 15m building separation of Block 4 and Block 5 into the atrium above the proposed podium and ventilate the medium to lower space of the downstream area. Also, the adequate wide building separation of Block 6 and Block 7 under SE wind may alleviate the wind block effect by the low-rise podium and the wind would further ventilate the downstream area at pedestrian level, i.e. Regalia Villa and Wo Hop Shek Tsuen.

6.3.3 Regarding to SSE wind, one mainstream penetrates the development smoothly through the wide separation of Block 2 and the proposed primary school. This effective wind corridor would facilitate the ventilation performance at pedestrian level of the downstream Fanling Highway. On another hand, a stream of SSE wind would enter the site from the south of the site and skim over the low-rise podium. This stream would first bypass the proposed housing blocks through 15m building separation of Block 4 and Block 5 and turn 15° to the north. The wind would eventually exit the development site through the second at least 15m wide building separation between Block 4 and Block 7.

6.3.4 Under SE and SSE wind directions, there are total 4 effective wind corridors to facilitate the ventilation performance in the vicinity of the development site from medium level to pedestrian level. Thus, it is expected that there is no significant adverse impact caused by the proposed building block on the surrounding developments in general.

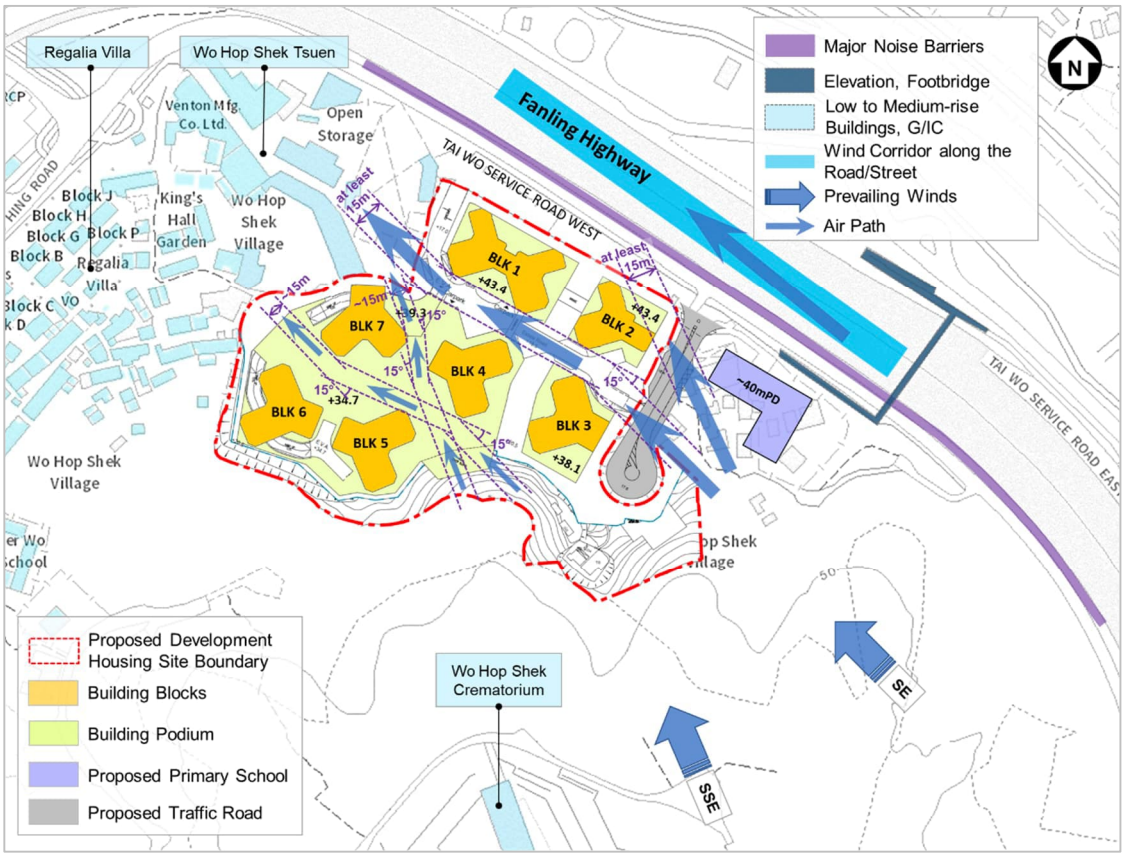

Figure 6.2 – Proposed Wind Environment under Prevailing SE and SSE Wind

6.4 UNDER PREVAILING S AND SSW WIND

6.4.1 **Figure 6.3** shows the part of the prevailing winds from S and SSW directions pass through the site to ventilate the downstream areas. A local wind blockage may be captured at the north and northwest portions of the site along S and SSW wind directions.

6.4.2 S winds from the upstream open space and Wo Hop Shek Crematorium developments would enter the site and follow two wind corridors. One dominant stream would penetrate the site smoothly through a sufficient wide building separation of Block 2 and the proposed primary school. Another S stream bypassing Block 5 would skim over the low-rise podium and turn 5° to the west through the 15m building separation of Block 5 and Block 4. The stream would then turn by 5° to its original direction toward the at least 15m wide building separation of Block 4 and Block 7 to ventilate to medium to lower space of the downstream area, and the wind block effect by the low-rise podium is expected to be relieved. These two effective wind corridors can facilitate the continuity of the prevailing S wind to the pedestrian level of northern downstream area, i.e. Fanling Highway.

6.4.3 Meanwhile SSW winds from the south of the site would be generally divided into two streams. One stream would pass through the site along the channels formed by the alignment of the podiums. The wind would first flow through the building separation of Block 3 and Block 4, and then through the building separation of Block 1 and Block 2. Another stream would ventilate the

eastern portion of the site and first flow pass the east of the Block 3. This stream would pierce the site through a broad building separation between Block 2 and the proposed primary school. These two effective wind corridors can facilitate the wind availability of the prevailing SSW wind at pedestrian level of the northeast downstream area, i.e. Fanling Highway.

6.4.4 Several possible problematic areas may occur in some local regions immediately downstream of proposed housing blocks under S and SSW winds. But the general, no significant adverse impacts on the wind availability of the site and its downstream areas in these two wind directions.

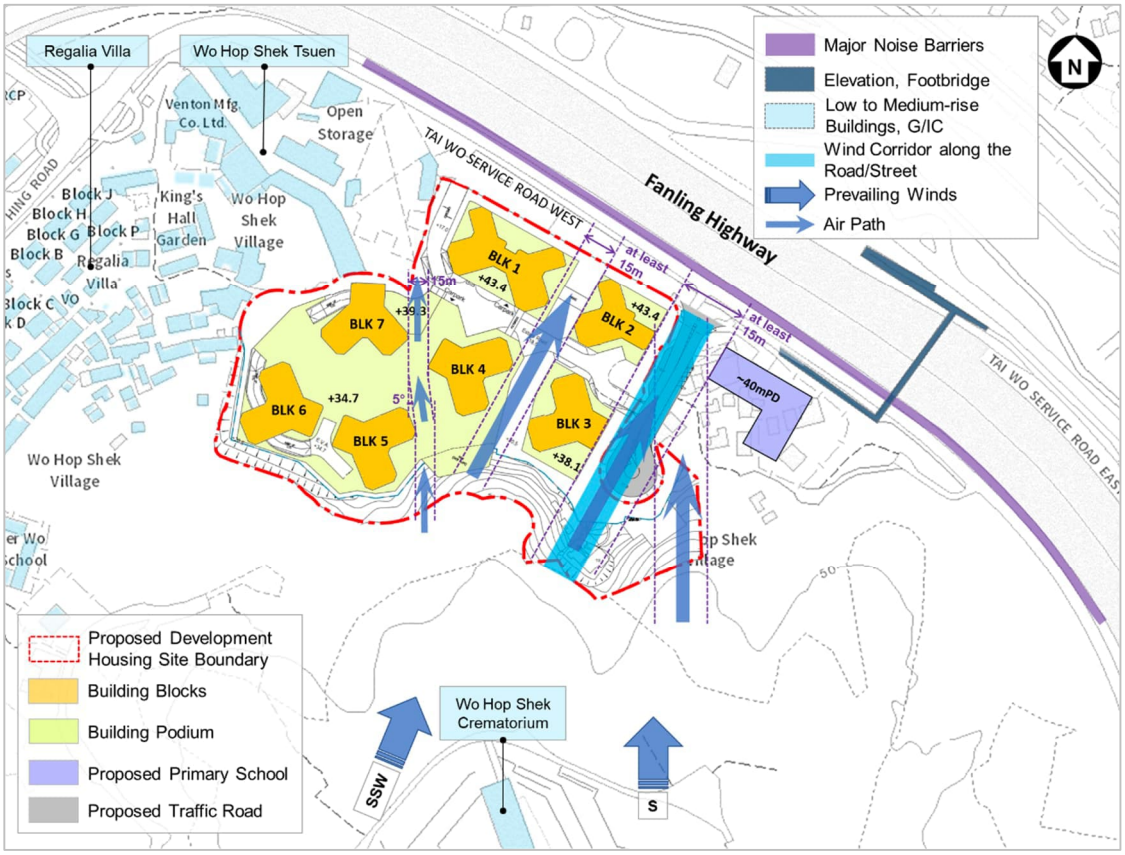

Figure 6.3 – Proposed Wind Environment under Prevailing S and SSW

7 CONCLUSION AND RECOMMENDATION

7.1 CONCLUSION

7.1.1 The Expert Evaluation based on the site wind characteristics and wind environment under the proposed public housing development situation regarding qualitative air ventilation assessment (AVA) was conducted. The result of the evaluation provides an overview of likely impacts associated with the proposed public housing development under both the annual prevailing E, ESE, SE winds and summer prevailing ESE, SE, SSE, S and SSW winds as well as the surrounding topography.

7.1.2 As discussed above, the concerns mainly entail the prevailing winds and the slight impacts that the proposed public housing development might bring up upon to neighbouring built-up areas. The mitigation measures of natural ventilation have to be considered in the development design, including building separations should be incorporated in the proposed scheme.

(a) Under prevailing ESE winds, two major wind corridors across the site are considered to ventilate the Site and its downstream residential areas, namely Wo Hop Shek Tsuen and Regalia Villa in the west;

(b) While the ventilation performance of downstream area of E wind are relatively insufficient in the west of the Site and its downstream area in comparison with other prevailing wind directions;

(c) For the SE and SSE prevailing wind, four major wind corridors in total across the site are considered to ventilate the Site and its northwest downstream areas which are partly residential use and road network;

(d) Moreover, four wind corridors are also provided in the proposed site under S and SSW directions. The adverse impacts on the northern downstream areas (i.e. road networks) would be minimal.

7.1.3 In the directional analysis, it is found that the proposed mitigation measures could help alleviate the potential air ventilation impact induced by the proposed development under various prevailing winds. The major ventilation corridors in the vicinity of the development site can relieve the adverse impact brought by the proposed development. It is expected that the proposed public housing development would not induce a significant adverse effect on the general air ventilation performance in the area (e.g. Wo Hop Shek San Village, Regalia Villa, Dawning Views, Pak Wo Road, Jockey Club Road, etc).

7.1.4 With reference to the previous “FA48 AVA EE” report in 2015, there are two local paths created in the proposed development (the scheme for OZP amendment) channel most of the prevailing winds. The air ventilation performance under the present proposed scheme generally maintains similar performance as compared to the OZP amendment scheme (in FA48 AVA EE report 2015) under prevailing E, ESE and SE wind directions. The present proposed scheme also provides two local paths (wind corridors) to serve the prevailing SSW and S winds to ventilate the site and its downstream area.

7.2 RECOMMENDATION

7.2.1 To further reduce the impacts and improve the wind environment, good design features could be considered in detailed design of the development. Further enhancement may be considered to facilitate wind penetration, such as enhancing building permeability, etc., as far as practicable (see **Figure 7.1**).

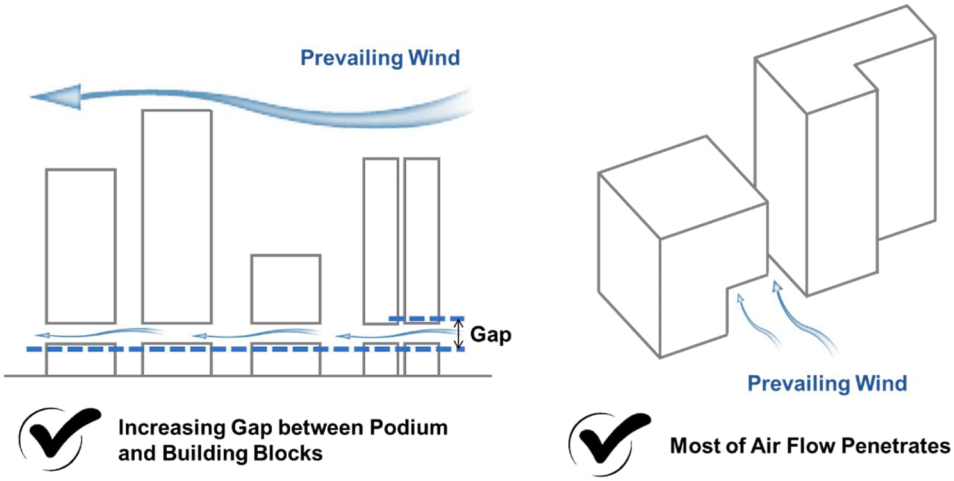

Figure 7.1 – Further Recommendation of Mitigation Measures

7.2.2 Following the Technical Guide for Air Ventilation Assessment (AVA) for Development in Hong Kong (Technical Circular No.1/06 and Annex A), the AVA Expert Evaluation provides a qualitative assessment of the design and/or design options and facilitates the identification of problems and issues. It is particularly useful for large sites and/or sites with specific and unique wind features, issues, concerns, and problems. While, an AVA Initial Study will refine and substantiate the Expert Evaluation. It is to allow for scheme design optimization during the detailed design stage and/or to prove that the future scheme would perform no worse than the current scheme in ventilation performance. To minimize any negative impacts and improve the existing wind environment, the designers shall consider the recommended good design features in the detailed design of the development. The present AVA Expert Evaluation is sufficient for the feasibility study stage, and an AVA Initial Study is recommended to be conducted at the detailed design stage.