ARUP

Hong Kong Housing Authority

Public Housing Development at Po Shek Wu Road, Sheung Shui

Air Ventilation Assessment - Initial Study

Reference:

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Job number

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Contents

1. Introduction

1.1 Background

Ove Arup & Partners Hong Kong Limited (Arup) has conducted an Air Ventilation Assessment (AVA) – Initial Study for the planning application of the proposed public housing developments at Po Shek Wu Road, Sheung Shui (The Development) in the North District.

The application site is currently zoned "Residential (Group A)" ("R(A)5") on the Approved Fanling/Sheung Shui Outline Zoning Plan (OZP) No. S/FSS/28 with maximum building height restriction of 130mPD and plot ratio 7.0. This document is to support the section 16 application for minor relaxation of building height restriction from 130mPD to 149mPD and plot ratio from 7.0 to 7.5.

The Technical Guide for Air Ventilation Assessment for the Developments in Hong Kong *(Annex A of Technical Circular No.1/06 for Air Ventilation Assessments)* [1] *(termed as AVA Technical Circular hereafter)* dated 19 July 2006 lay down the foundation of this methodology statement.

1.2 Objective of AVA Initial Study

Among all available wind data, an Initial Study will be conducted by using Computational Fluid Dynamics (CFD) techniques. It aims to achieve the following tasks:

- Initially assesses the characteristics of the wind availability of the Study Site;
- Gives a general pattern and a rough quantitative estimate of the wind performance at the pedestrian level using Velocity Ratio VR;
- Identify the air paths within the site ascertain their effectiveness; and
- Identify good design features and problematic areas if any and recommend mitigation measures.

2. Location and Site Characteristics

Development is located in Sheung Shui Area in the North District. The Development is sited on a flat topology and situated at the junction of Po Shek Wu Road (**Orange Dotted Line**) and San Wan Road (**Green Dotted Line**).

The Development is surrounded by mid-rise industrial clusters to the north to southwest, high-rise future residential developments, including planned Sheung Shui Areas 4 and 30 Site 1 and 2 (SS Site1 and Site 2) and completed Po Shek Wu Estate (PSWE) from northwest to south. At the north of the Development are the open spaces Shek Wu Hui Jockey Club Playground and at the west is a large cluster of mid-rise developments. The location of the Development and its surroundings are shown in Figure 1.

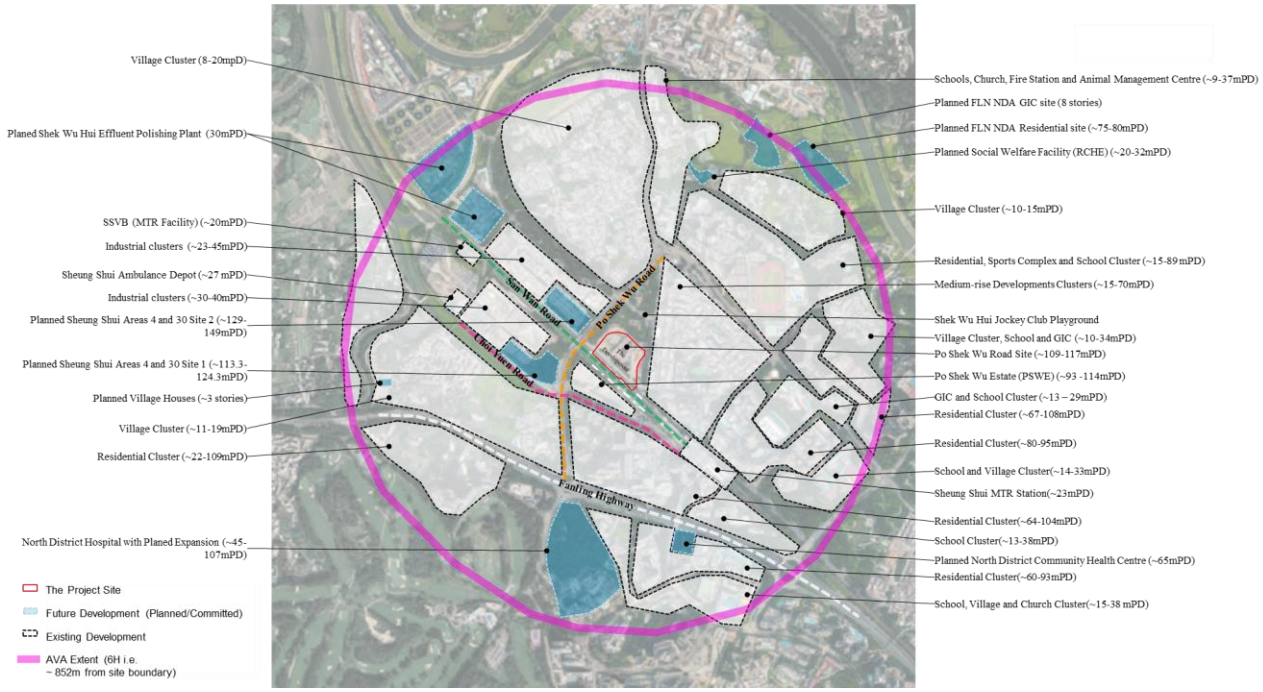


Figure 1 Site Location of the Development and Surroundings (Source: Google Map)

2.1 Proposed Development, Noise Barrier and Elevated Structure

There are several planned developments, noise barriers and elevated structures around the study sites, which will be considered in this AVA – Initial Study. Their locations are shown below.

Future Development

The planned developments, are indicated in Figure 1.

Noise Barrier

Future semi-enclosures, future full-enclosures, existing noise barriers and future noise barriers would be located adjacent to the Development, as well as further south along Po Shek Wu Road, as well as Fanling Highway, in order to mitigate the noise impact, subject to detailed design.

Elevated Structure

There are multiple elevated structures located within the surrounding area, including elevated walkways, covered walkways and elevated roads. There are 4 future elevated walkways, connected to SS Site 1, SS Site2, Po Shek Wu Road and Sheung Shui MTR Station to the Development. There is also a future elevated road above Po Shek Wu Road connecting to Fanling Highway, subject to detailed design.

Figure 2 Elevated Structures and Noise Barriers

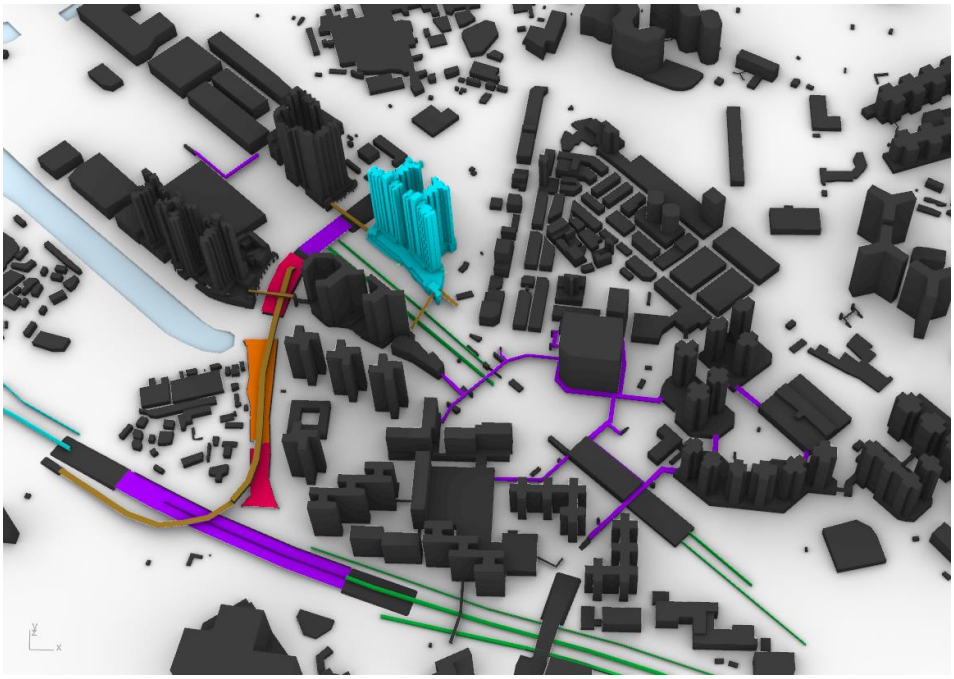
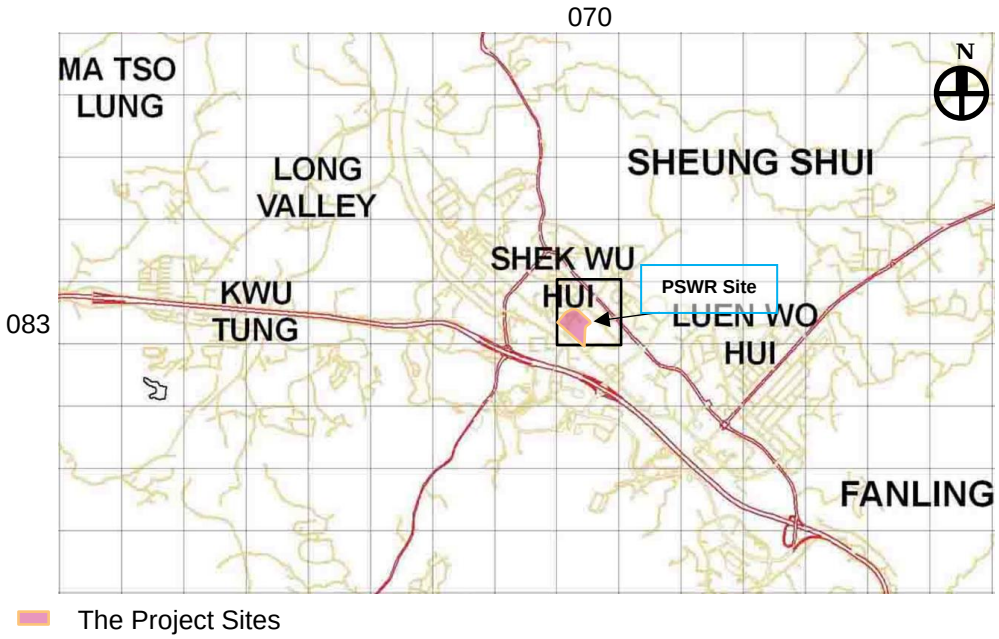


Figure 3 3D model of the Elevated Structures and Noise Barriers

3. Wind Availability Data

As per the *AVA Technical Circular,* at least 75% of the time in a typical reference year (frequency of occurrence) would be studied under both annual and summer wind condition in the Initial Study when using a Computational Fluid Dynamics (CFD) modelling technique. Since the CFD approach is adopted for the present project's AVA, this criterion together with the following selected wind data are to be applied as the methodology.

The site wind availability of the application site and its surrounding is an essential parameter for AVA. As stipulated in the *AVA Technical Circular. The* site wind availability would be presented by using appropriate mathematical models. Planning Department (PlanD) has set up a set of simulated meso-scale data of Regional Atmospheric Modelling System (RAMS) of the territory for AVA study, which could be downloaded at Planning Department Website. Simulated meso-scale data of Regional Atmospheric Modelling System (RAMS) from PlanD [2] will therefore be adopted in this AVA Study. The location of the Development falls within the location grid (x: 070, y:083) in the RAMS database as indicated below.



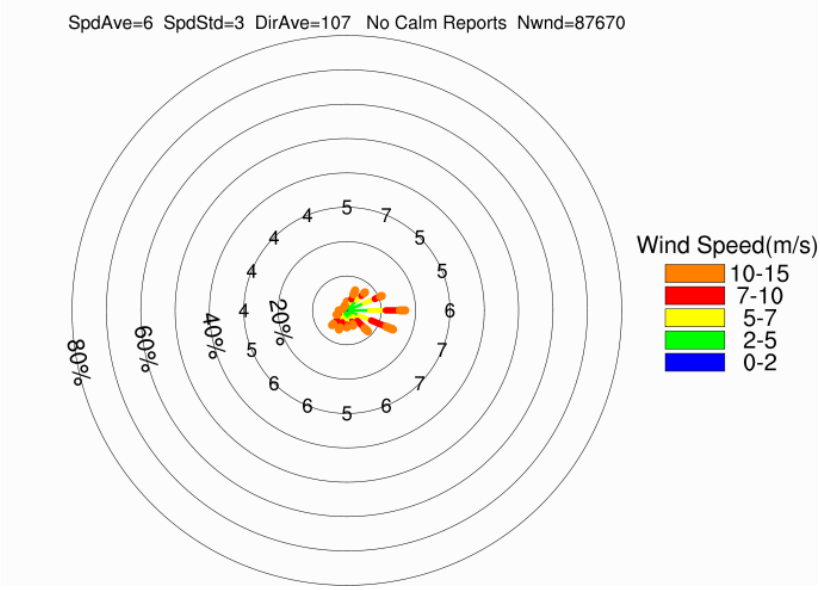


Figure 4 RAMS annual wind rose at 500mPD

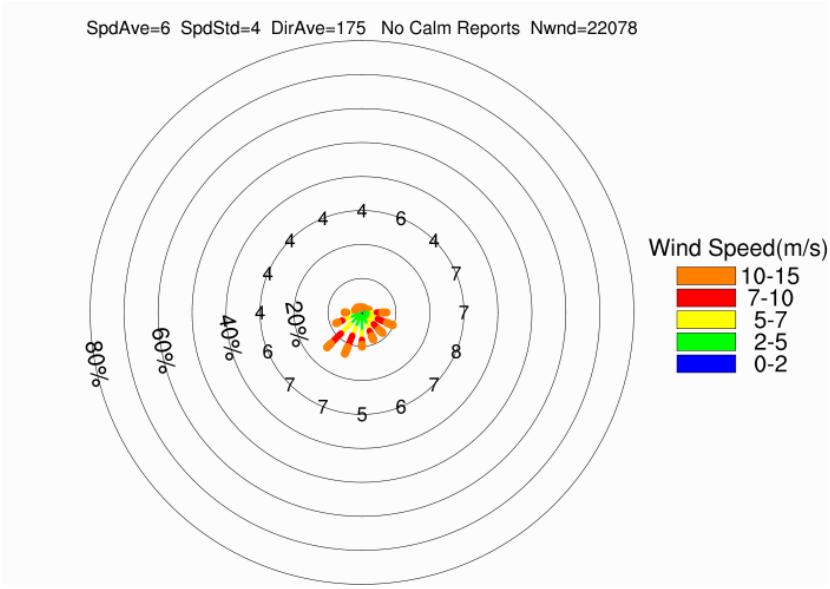


Figure 5 RAMS summer wind rose at 500mPD

3.1 Prevailing Wind Directions

As mentioned above, the RAMS wind data of location grid (x:070, y:083) is adopted for the site wind availability in this study.

3.1.1 Annual Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 1) are considered in this AVA Study which covers 77.8% of the total annual wind frequency. They are north-north-easterly (6.4%), north-easterly (7.5%), east-north-easterly (11.1%), easterly (17.2%), east-south-easterly (14.7%), south-easterly (8.7%), south-south-westerly (6.1%) and south-westerly (6.1%) winds.

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	2.6%	6.4%	7.5%	11.1%	17.2%	14.7%	8.7%	4.8%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	5.0%	6.1%	6.1%	3.3%	2.4%	1.2%	1.2%	1.5%	77.8%

Table 1 Annual Wind Frequency

**** The wind frequency showing in red colour represents the selected winds for the CFD simulation.***

3.1.2 Summer Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 2) are considered in this AVA Study which covers 81.9% of the total summer wind frequency. They are easterly (7.6%), east-south-easterly (10.2%), south-easterly (8.7%), south-south-easterly (8.7%), southerly (10.2%), south-south-westerly (13.4%), south-westerly (14.7%) and west-south-westerly (8.4%) winds.

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	1.5%	1.6%	1.5%	2.3%	7.6%	10.2%	8.7%	8.7%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	10.2%	13.4%	14.7%	8.4%	5.1%	2.1%	2.0%	1.7%	81.9%

Table 2 Summer Wind Frequency

**** The wind frequency showing in red colour represents the recommended wind direction for the CFD simulation.***

3.2 Wind Profiles

The profiles of wind speed from the PlanD RAMS database (x:070, y:083) is studied and the selected extracted. In the RAMS data the vertical profiles of the normalised mean wind speed were provided and the exact profile will be modelled in the CFD model for each corresponding wind directions to be studied. The vertical wind profile for all wind directions to be studied are shown in Figure 6 through Figure 8.

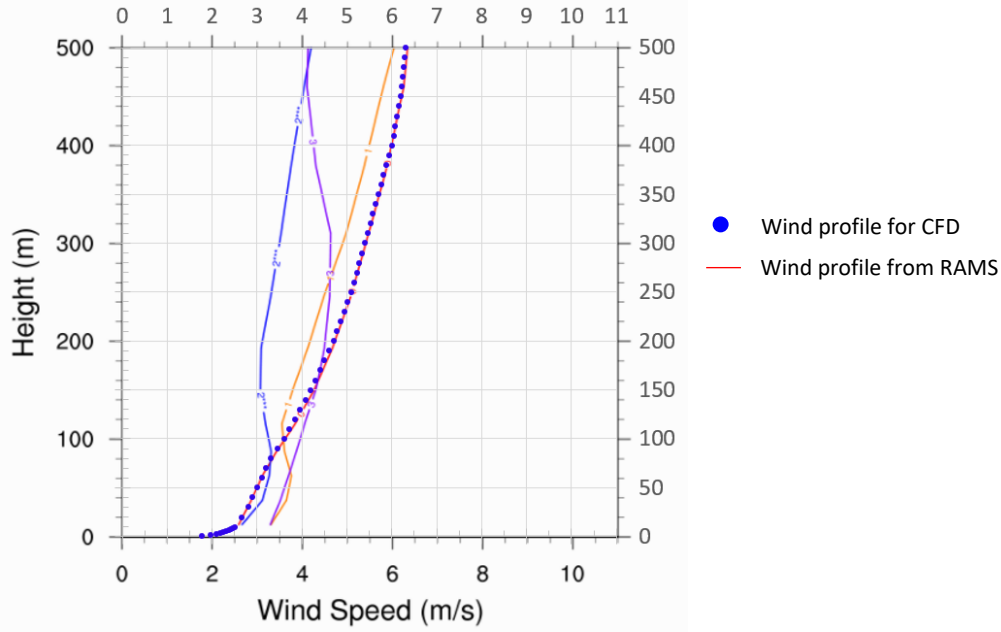


Figure 6 Vertical Wind Speed Profile of 22.5° - 112.4° winds

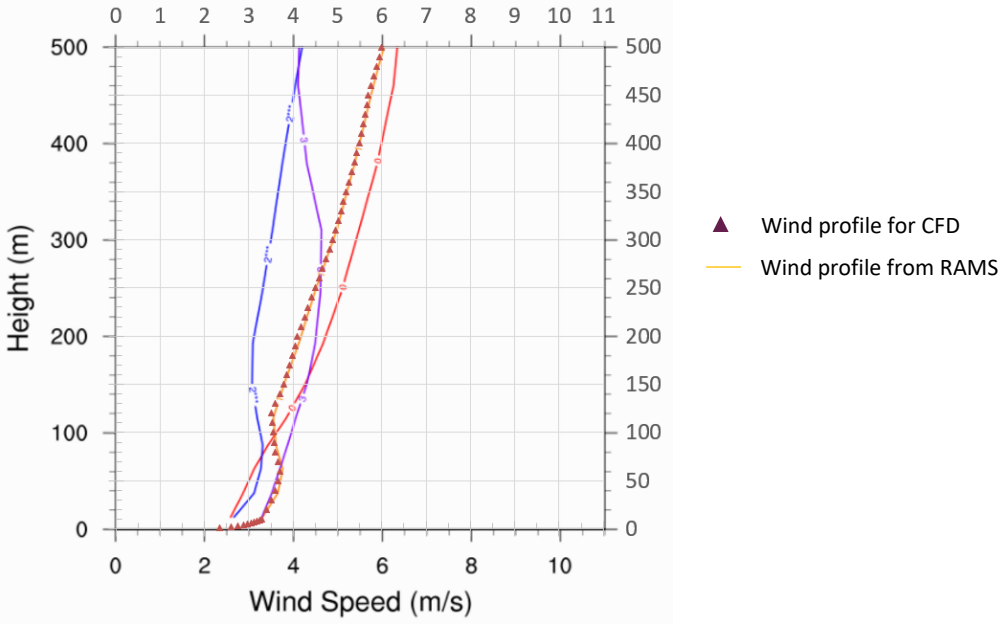


Figure 7 Vertical Wind Speed Profile of 112.5° - 202.4° winds

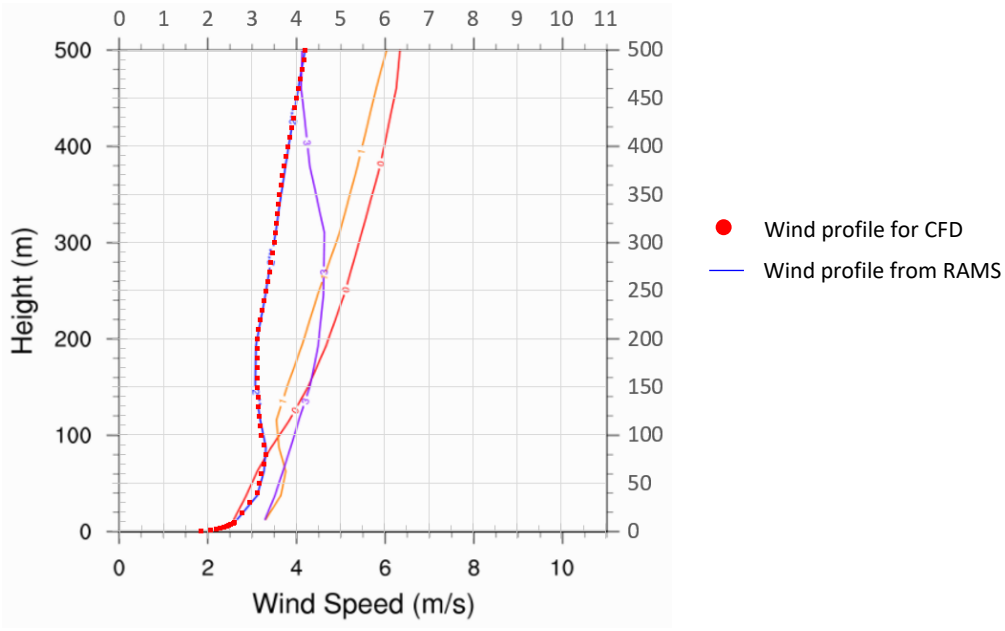


Figure 8 Vertical Wind Speed Profile of 202.5° - 292.4° winds

4. Design Schemes for Initial Study

To investigate the ventilation impacts of the Development and effectiveness of wind enhancement features. Two schemes, the Baseline Scheme and the Proposed Scheme are to be analysed and compared in this AVA Initial Study.

4.1 Baseline Scheme

The Baseline Scheme is an OZP-compliant scheme with a building height at +128mPD and a single aspect wing facing the railway. The Baseline Scheme consists of two 36-storey domestic towers atop a 4-storey podium structure and a basement carpark. It has incorporated two 15m on-site air paths, one through the building separation between the domestic towers and the other between Block B and the lift tower. There is also a G/F empty bay (~14m wide), building setbacks from the northwestern and northeastern site boundary from ~8 to 22m, and a tower setback from the southwestern site boundary of ~16m.

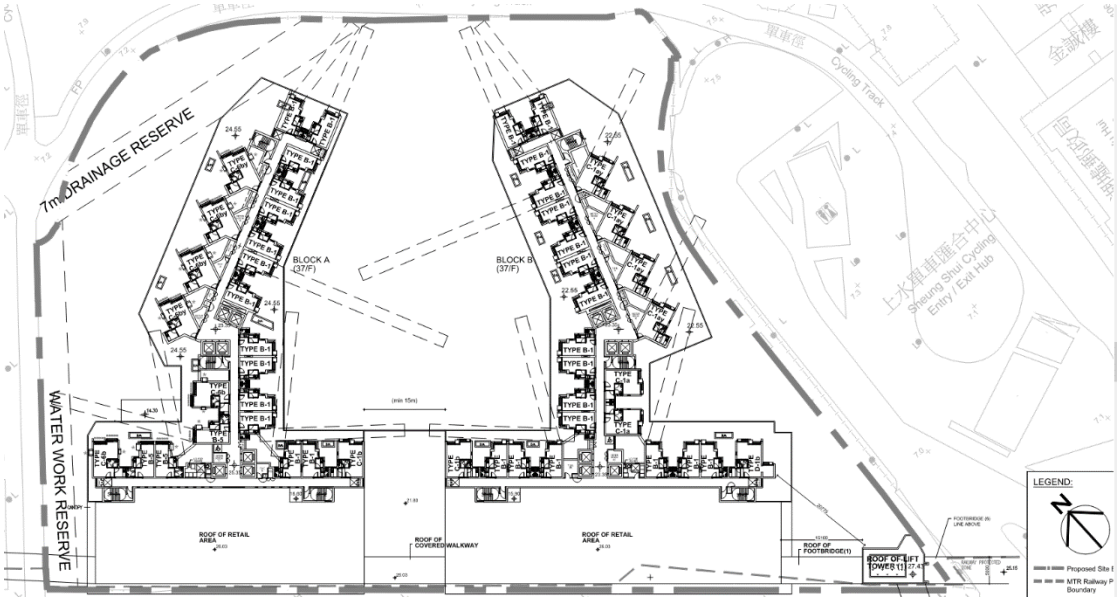


Figure 9 Baseline Scheme MLP

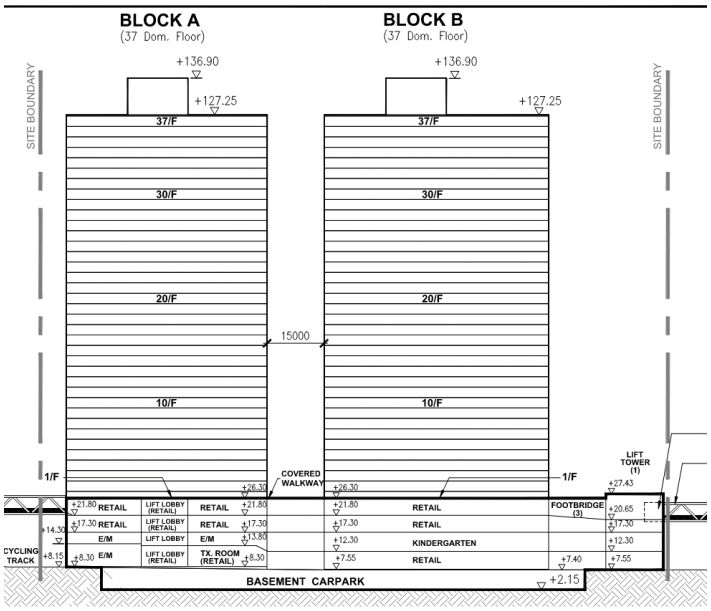


Figure 10 Baseline Scheme Section

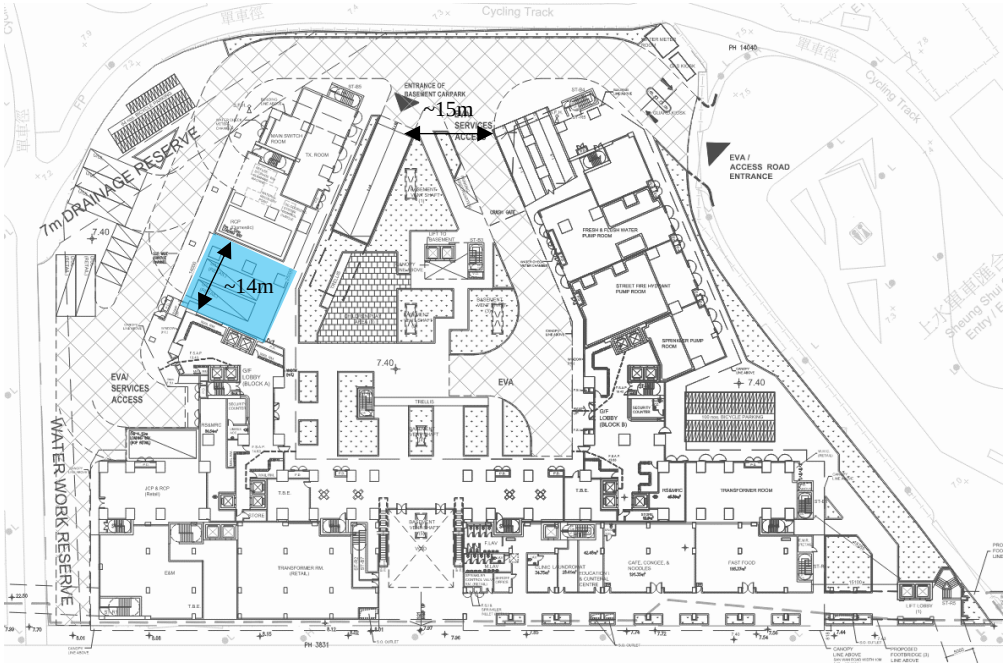


Figure 11 Baseline Scheme Wind Enhancement Features (GF)

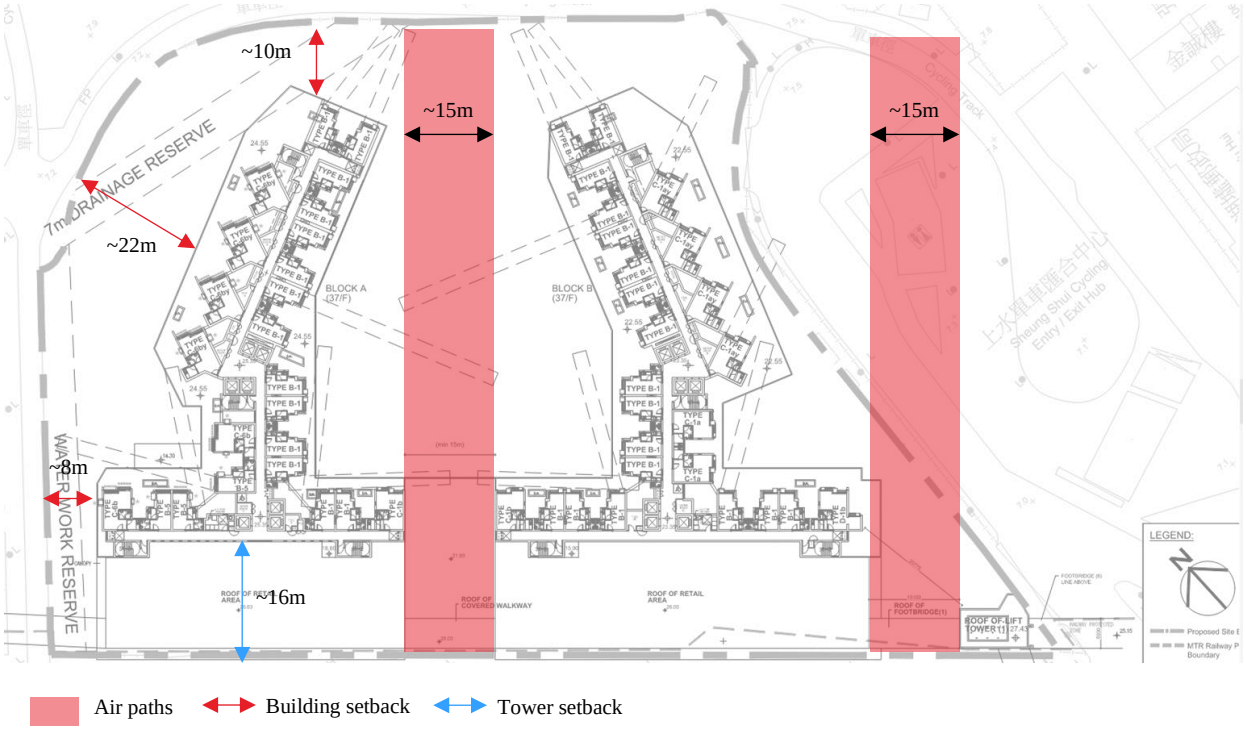


Figure 12 Baseline Scheme Wind Enhancement Features (Typical Floor)

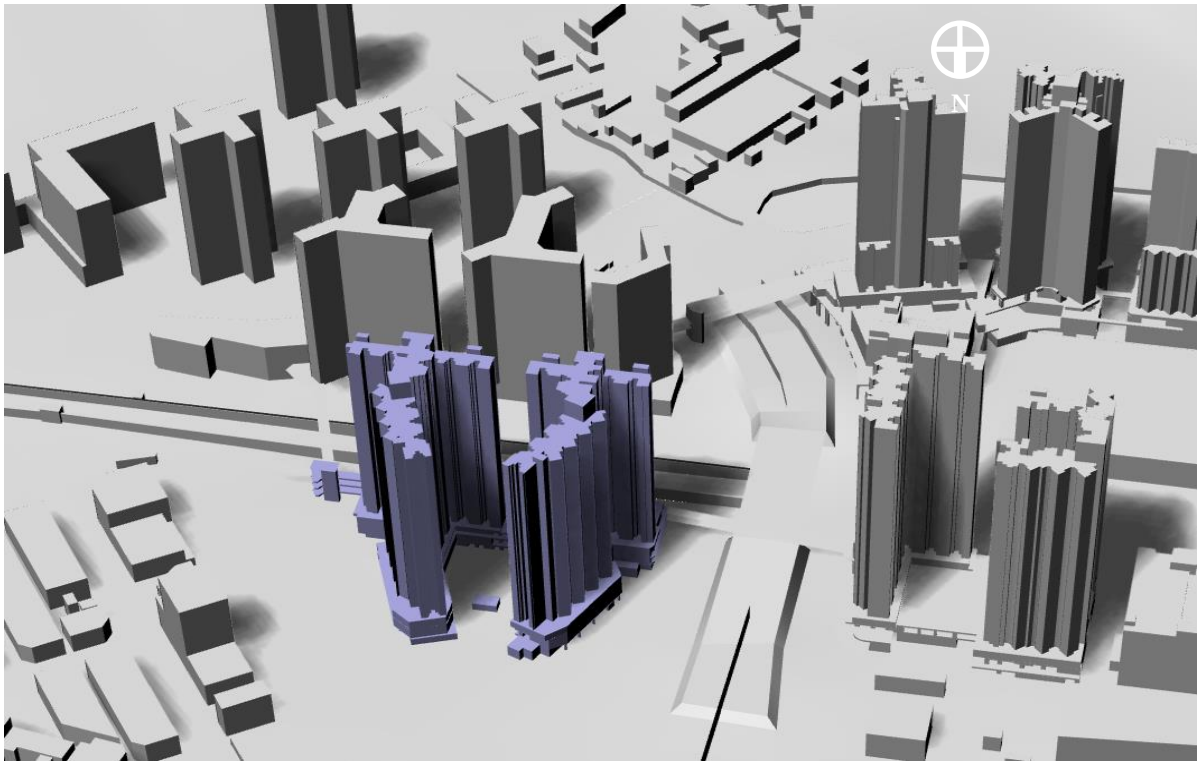


Figure 13 Northerly view of Baseline Scheme

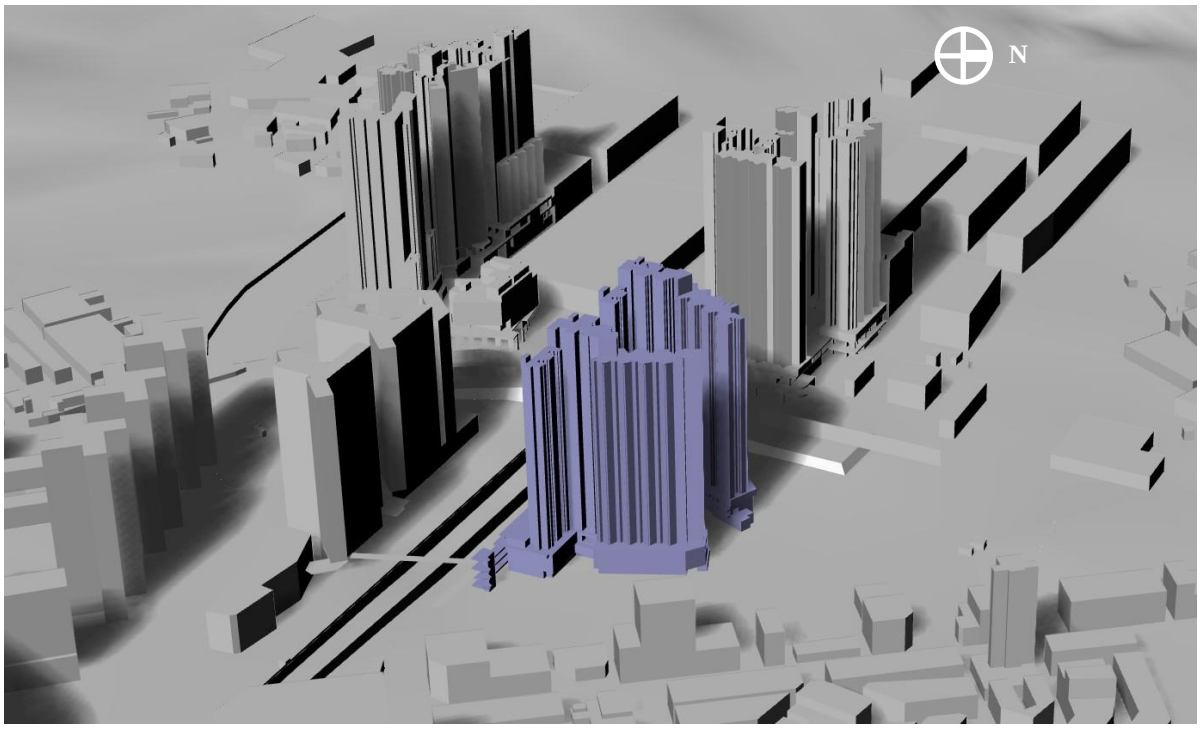


Figure 14 Easterly view of Baseline Scheme

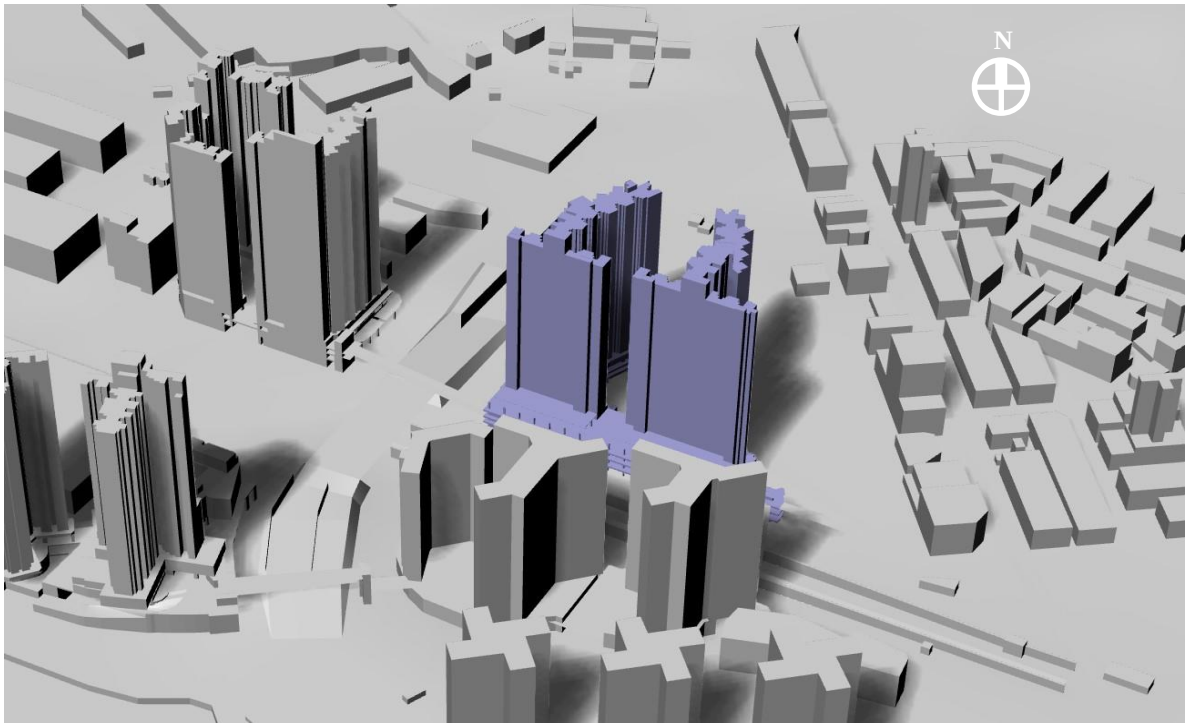


Figure 15 Southerly view of Baseline Scheme

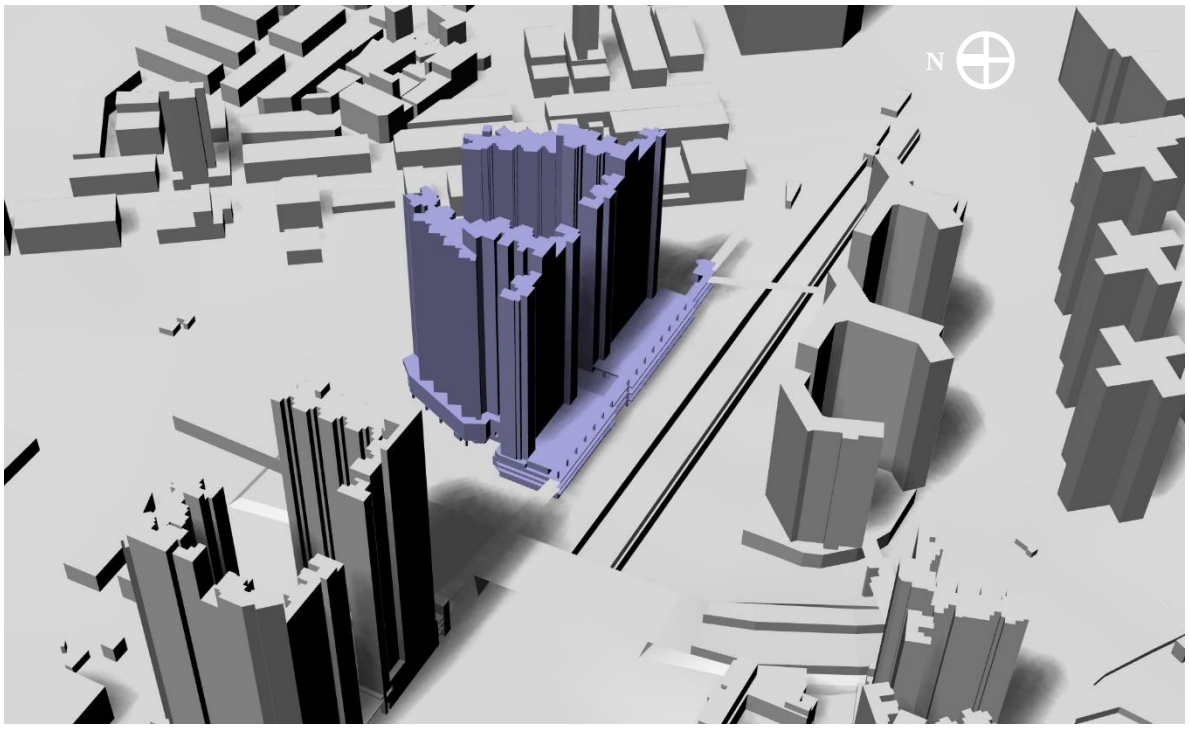


Figure 16 Westerly view of Baseline Scheme

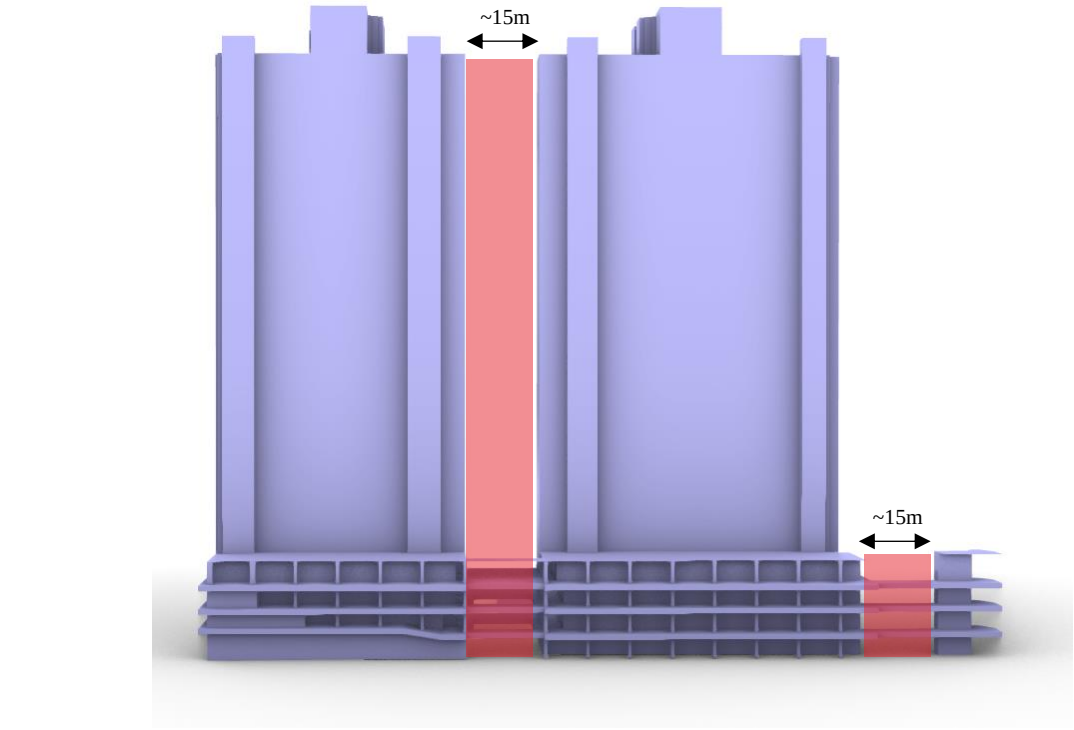


Figure 17 Wind Enhancement Features (Airpaths)

Figure 18 Wind Enhancement Features (Empty Bay)

4.2 Proposed Scheme

The Proposed Scheme consists of two domestic blocks (Block A and Block B) with 40 and 41 domestic storeys respectively atop a 4-storey podium structure which includes a naturally ventilated carpark. The Proposed Scheme consist of a full height building separation of ~15m, a G/F empty bay of ~7m wide It also has a tower setback from the southwestern site boundary of ~25m, as well as building setbacks from ~8m to 25m. The naturally ventilated carpark as well as a permeable podium design would also assist the enhancement of ventilation performance.

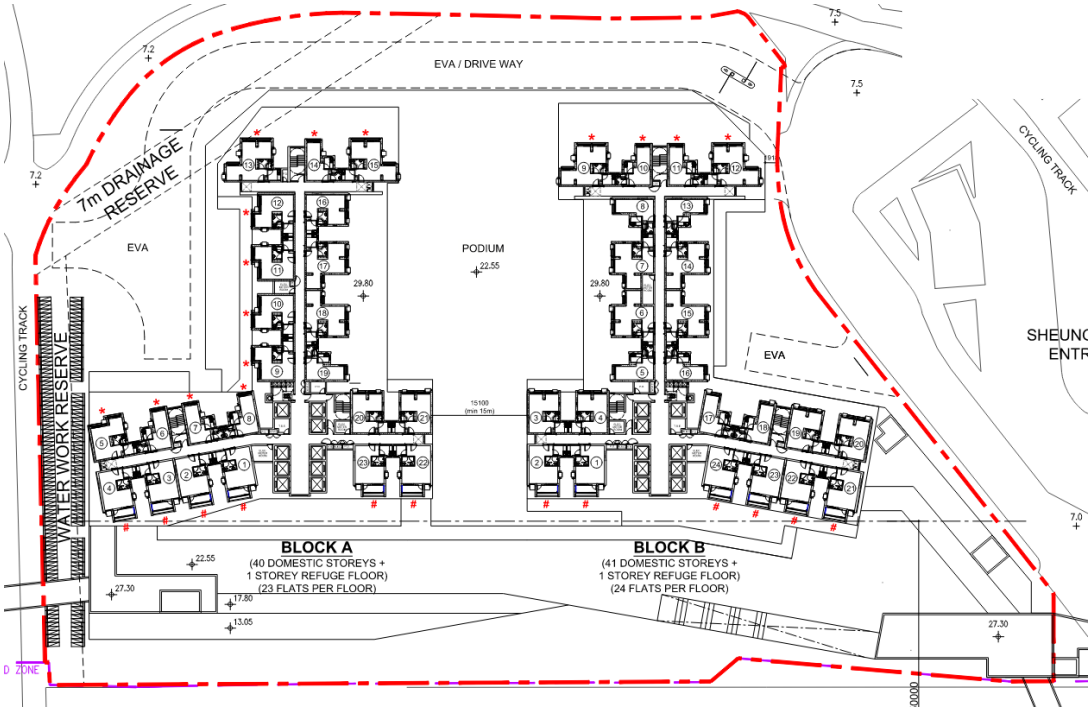


Figure 19 Proposed Scheme MLP

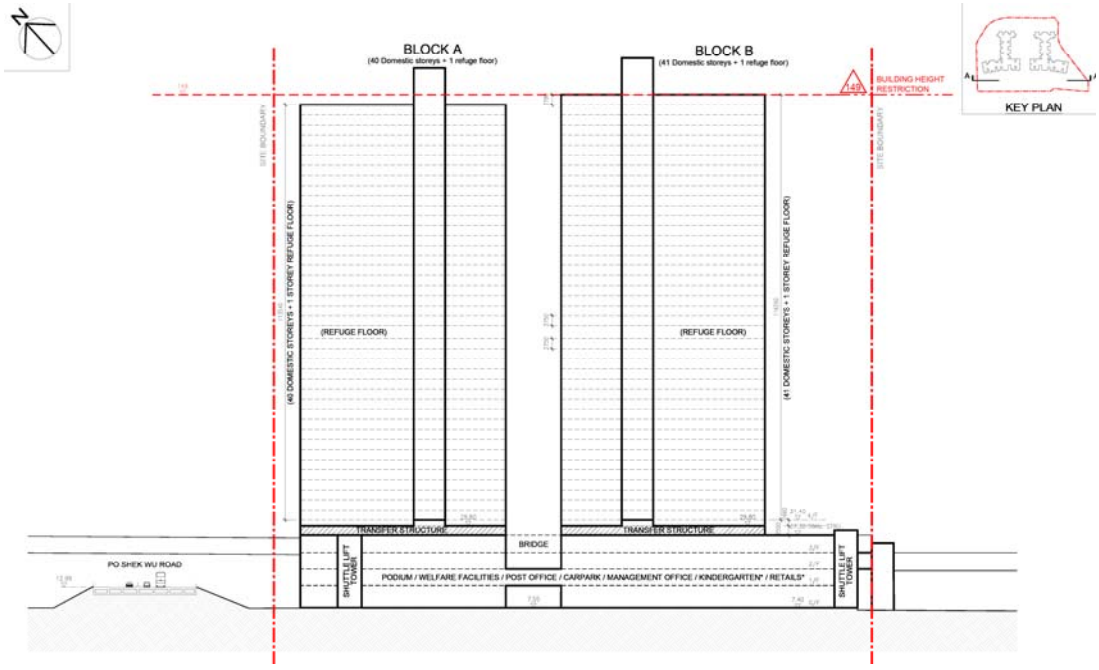


Figure 20 Proposed Scheme Section

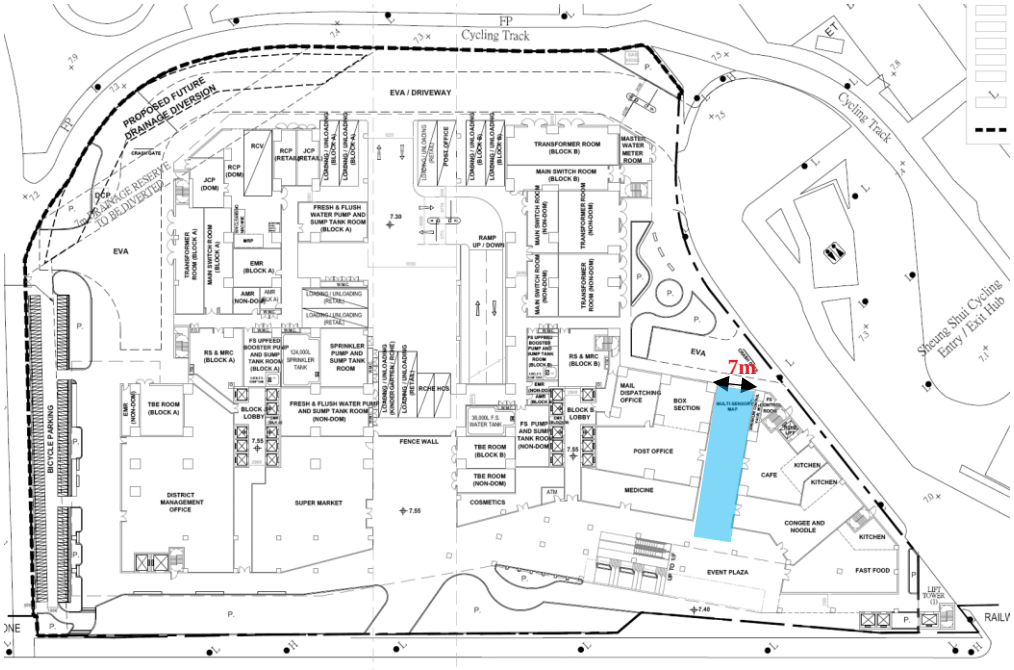


Figure 21 Proposed Scheme Wind Enhancement Features (GF)

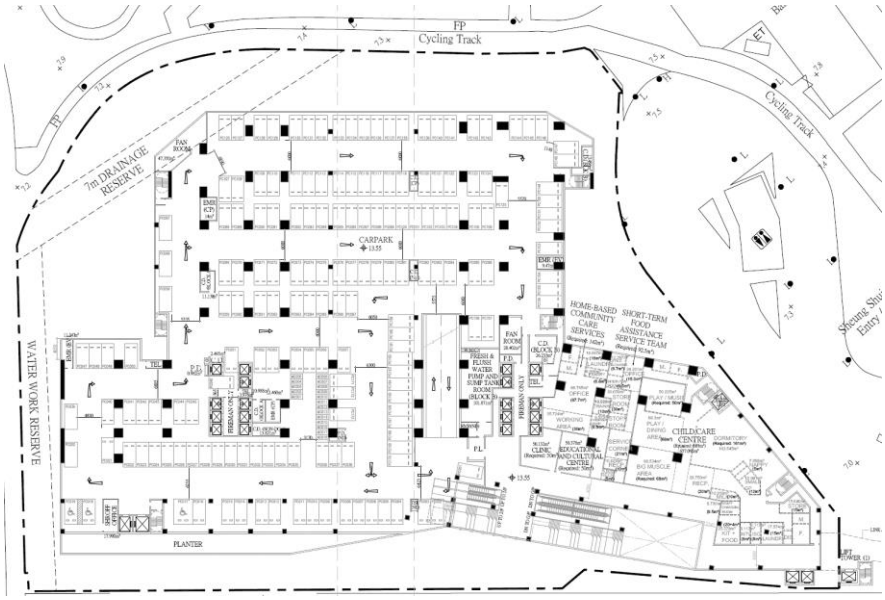


Figure 22 Proposed Scheme Wind Enhancement Features (Naturally ventilated carpark on 1/F)

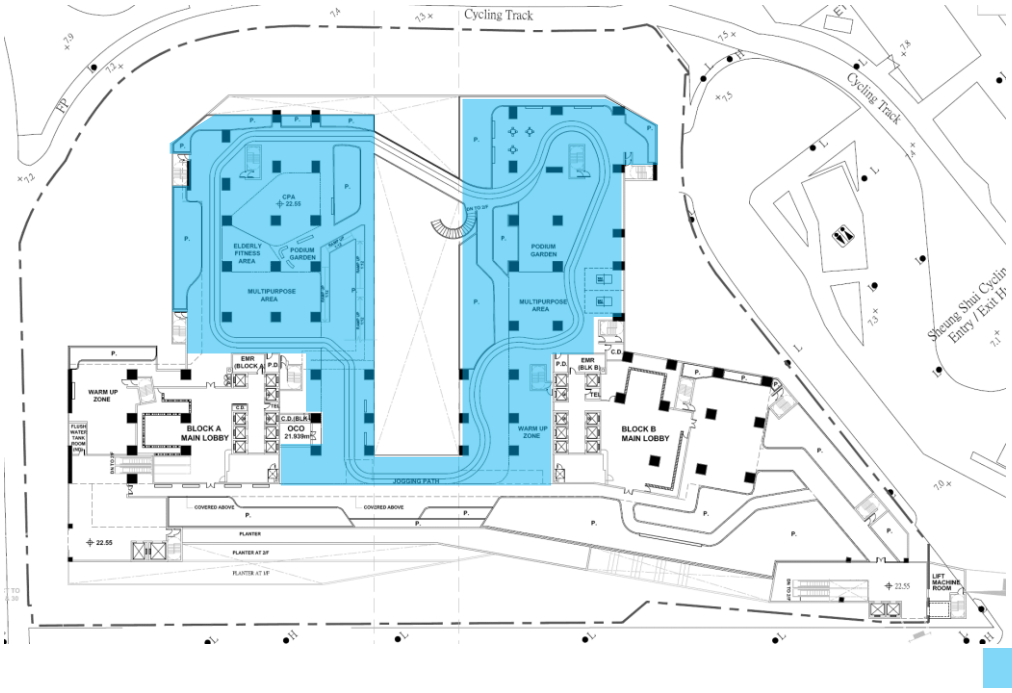


Figure 23 Proposed Scheme Wind Enhancement Features (3/F)

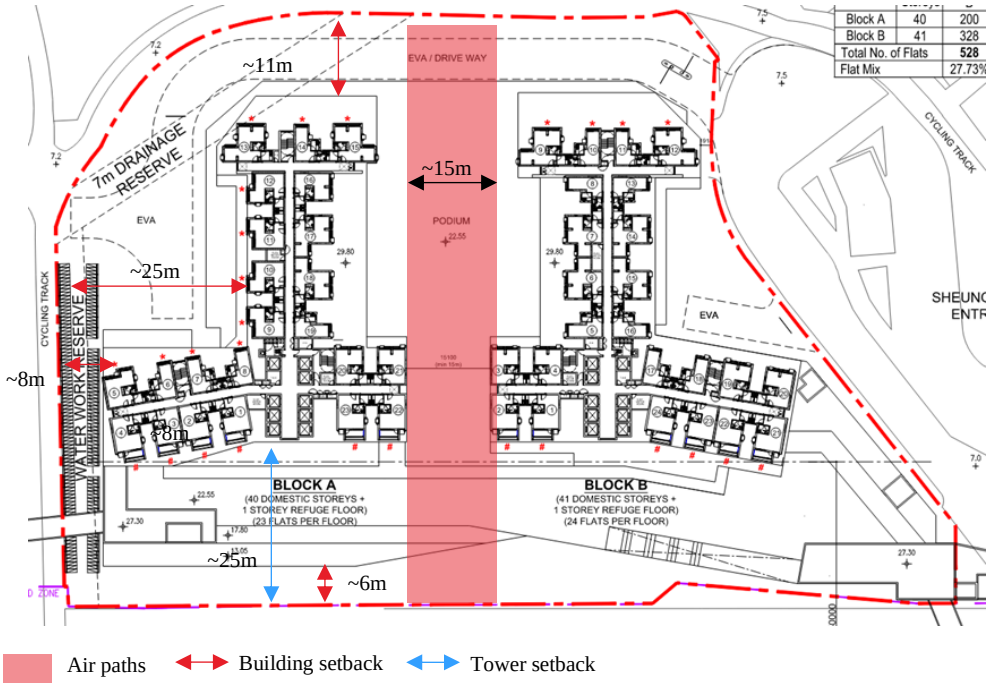


Figure 24 Proposed Scheme Wind Enhancement Features (Typical Floor)

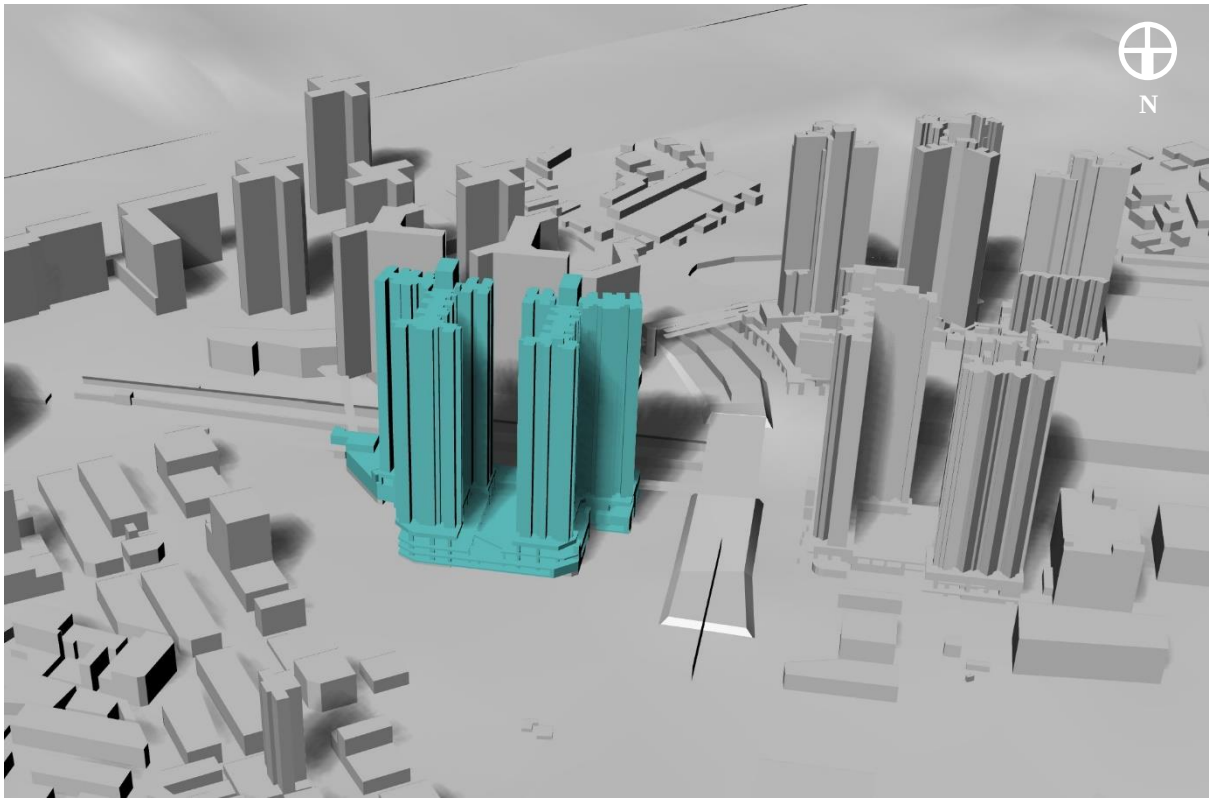


Figure 25 Northerly view of Proposed Scheme

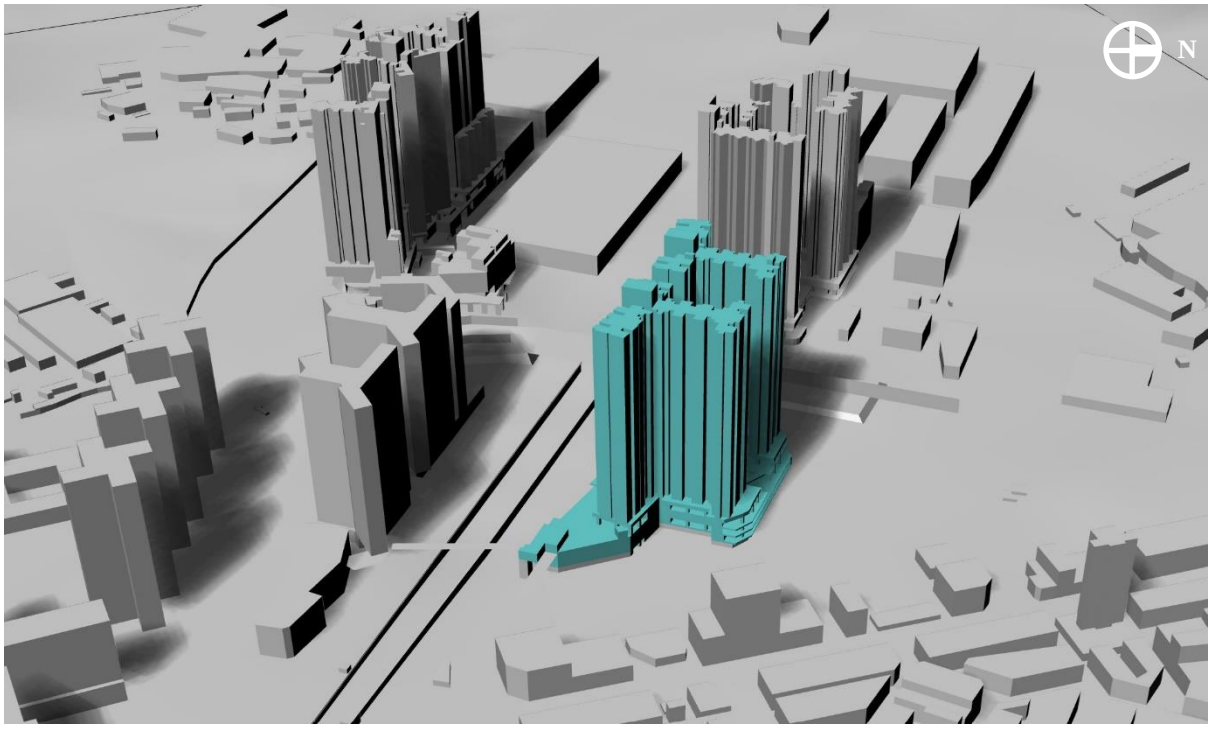


Figure 26 Easterly view of Proposed Scheme

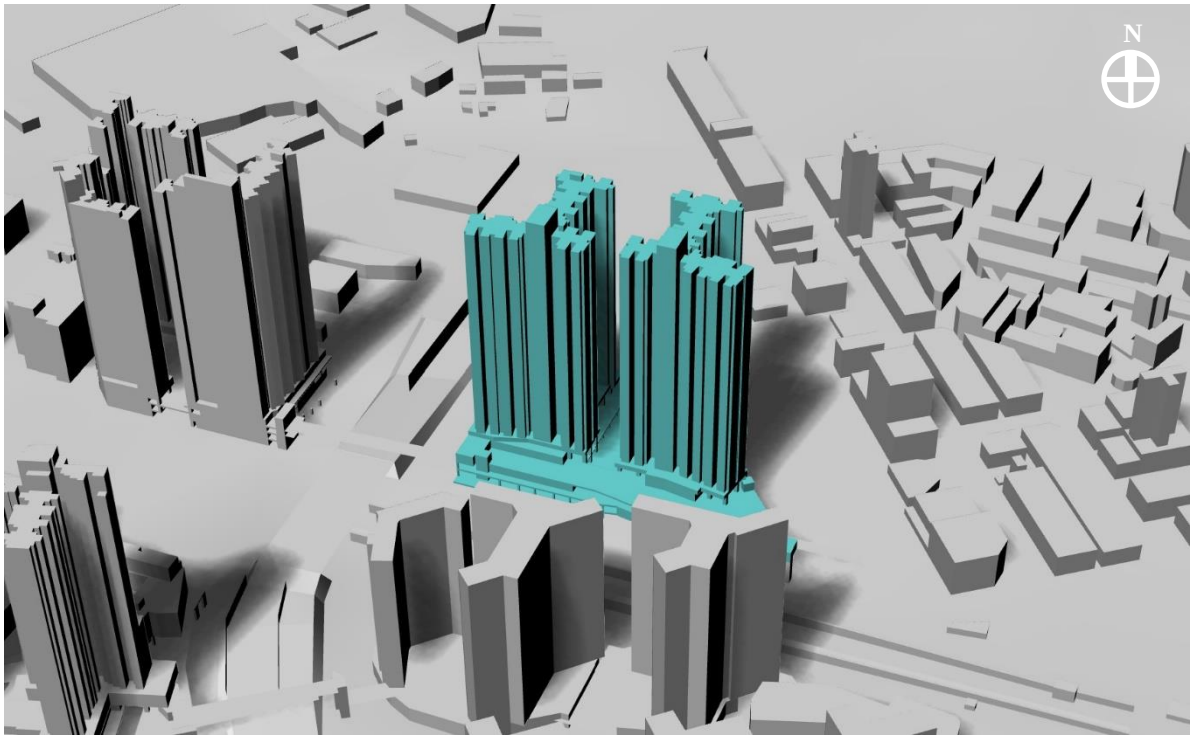


Figure 27 Southerly view of Proposed Scheme

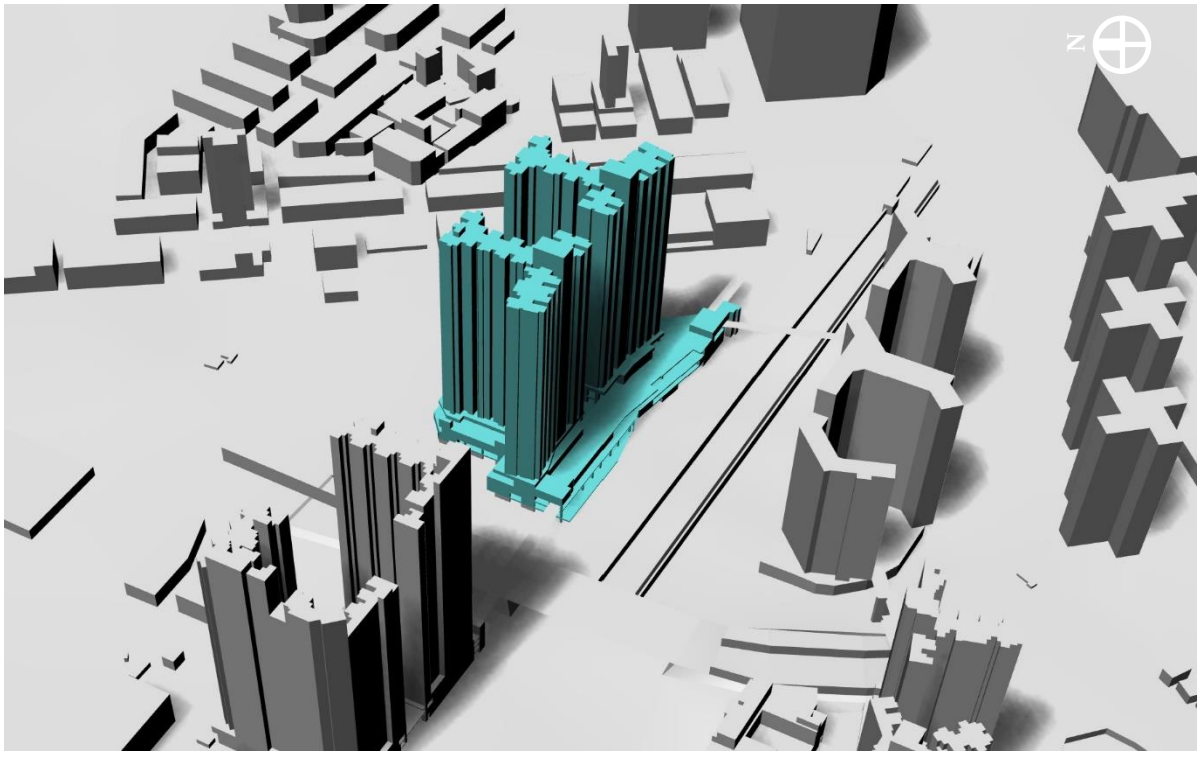


Figure 28 Westerly view of Proposed Scheme

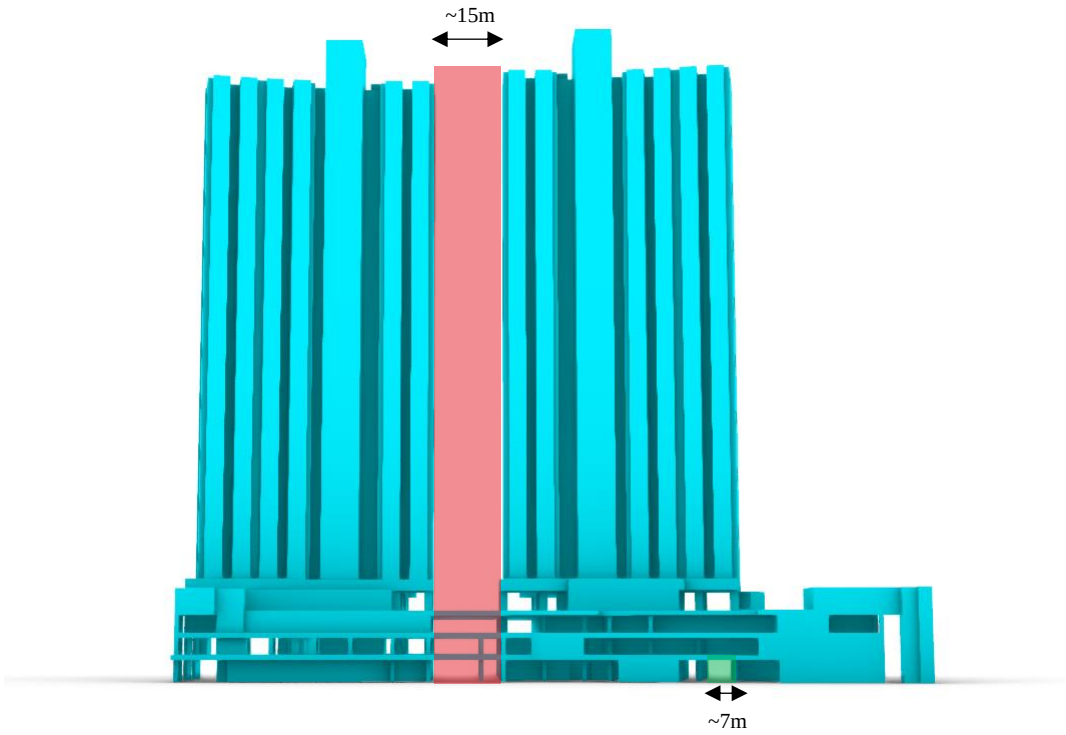


Figure 29 Wind Enhancement Features (Airpath and empty bay)

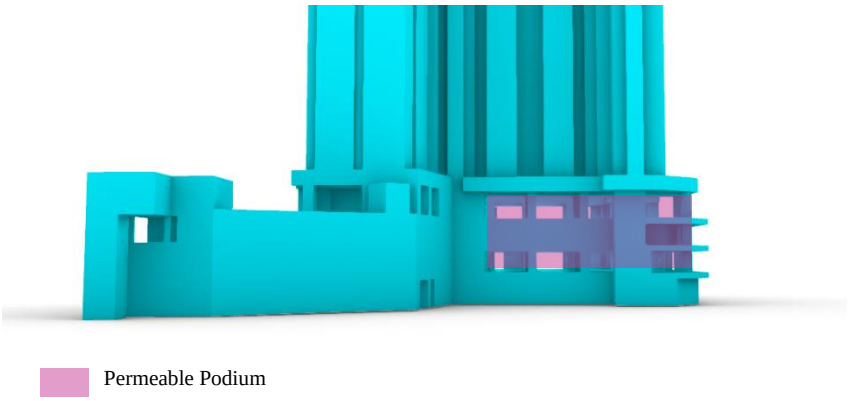


Figure 30 Wind Enhancement Features (Permeable Podium)

5. Methodology

5.1 Assessment and Surrounding Areas

The building height of the Development is around 142m, therefore the Assessment Area and the Surrounding Area are respectively 426m (3H) and 852m (6H) away from the site boundary of the Development Area. The proposed Assessment Area and the Surrounding Area are indicated in Figure 37. The computational domain would be about 6000m (L) x 6000m (W) x 1250m (H) as shown in Figure 31.

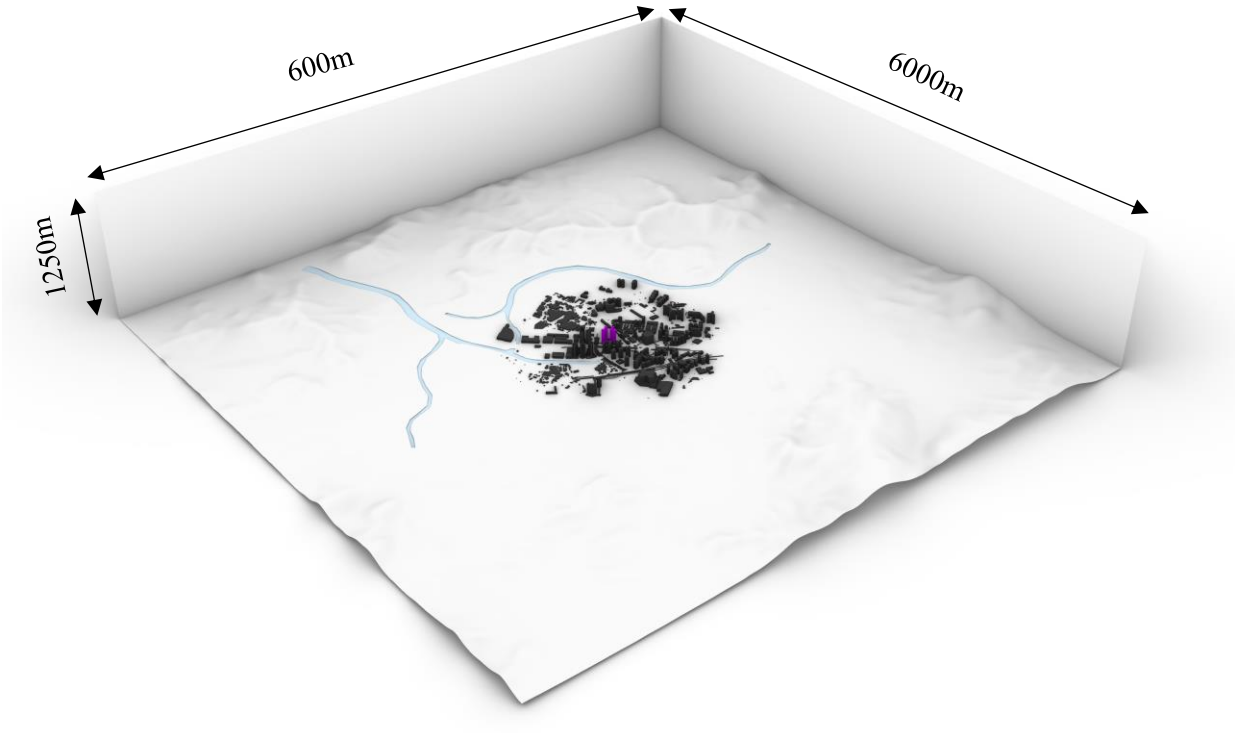


Figure 31 3D View of the Domain

5.2 Technical Details for CFD simulation

5.2.1 Assessment Tools

Computational Fluid Dynamics (CFD) technique is utilized for this AVA study. With the use of three-dimensional CFD method, the local airflow distribution can be visualized in details. The velocity distribution within the flow domain, being affected by the site-specific design and the nearby topography, will be simulated under selected wind directions for annual and summer wind conditions.

5.2.2 CFD Model

Following the AVA Technical Circular, buildings within Surrounding Area shall be built in the CFD model. In order to simulate the approaching wind turbulence effect in a more accurate manner, the CFD model is built to include the highways or bridges as they may affect the approaching wind, even it is falling outside the Surrounding Area. In addition, the model domain is built far beyond the Surrounding Area as required in the Technical Circular in order to eliminate the boundary effects. Therefore, the studied size of CFD model of the development is approximately 6000m (Length) x 6000m (Width) x 1250m (Height) which contains more than 9,000,000 cells as shown in Figure 32.

The computational domain covers the site of the Development and provides sufficient consideration on surrounding topography. The model contains information of the surrounding buildings and site topography via Geographical Information System (GIS) platform. The site topography would be modelled within the whole computational domain. Body-fitted unstructured grid technique is used to fit the geometry and reflect the complexity of the development geometry. A prism layer of 3m above ground (totally 6 layers and each layer of 0.5m thick, shown in Figure 33 is incorporated in the meshing so as to better capture the approaching wind and wind condition at pedestrian level. A mesh expansion ratio of 1.3 is adopted and the blockage ratio was less than 2%.

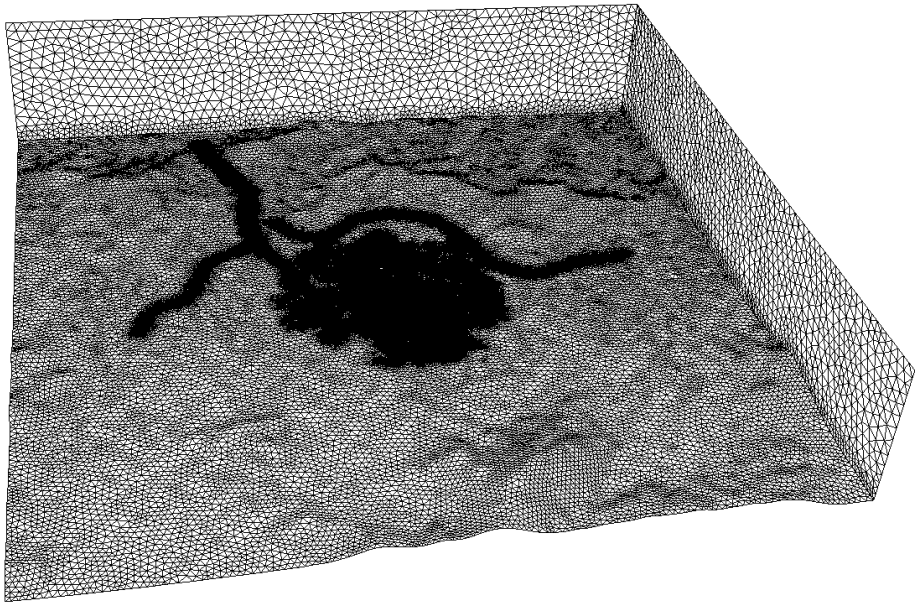


Figure 32 Mesh of Computational Domain

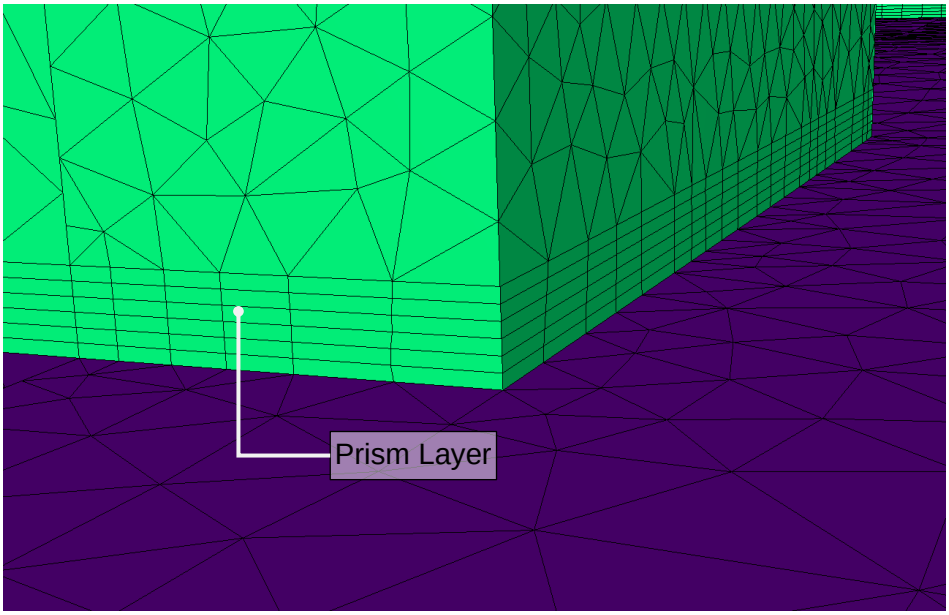


Figure 33 Prism Layers

Table 3 Detail parameters to be adopted in the CFD

	CFD Model
Model Scale	Real Scale model
Model details	Only include Topography, Buildings blocks, Streets/Highways, no landscape is included
Domain	6000m(L) x 6000m(W) x 1250m(H)
Assessment Area	≥ 3H area
Surrounding building Area	≥ 6H area
Grid Expansion Ratio	The grid should satisfy the grid resolution requirement with maximum expansion ratio = 1.3
Prismatic layer	6 layer of prismatic layers and 0.5m each (i.e. total 3m above ground)
Inflow boundary Condition	Incoming wind profile as measured from RAMS
Outflow boundary	Pressure boundary condition with dynamic pressure equal to zero
Wall boundary condition	Logarithmic law boundary
Turbulence Model	Realisable k-ε turbulence model
Solving algorithms	Rhie and Chow SIMPLE for momentum equation Hybrid model for all other equations
Blockage ratio	< 2%
Convergence criteria	Below 1.0E-4

5.3 AVA Indicator

5.3.1 5.3.1 Assessment Parameters

CFD simulations will be conducted to study the wind environment. As specified in the Technical Circular, indicator of ventilation performance should be the Wind Velocity Ratio (VR), defined as the ratio of the wind velocity at the pedestrian level (2m above ground) to the wind velocity at the top of the wind boundary layer. Site spatial average velocity ratio (SVR) and a Local spatial average velocity ratio (LVR) should be determined.

Table 4 Terminology of the AVA Initial

Terminology	Description
Velocity Ratio (VR)	The velocity ratio (VR) represents the ratio of the air velocity at the measurement position to the value at the reference points.
Site spatial average velocity ratio (SVR)	The SVR represent the average VR of all perimeter test points at the site boundary which identified in the report.
Local spatial average velocity ratio (LVR)	The LVR represent the average VR of all points, i.e. perimeter and overall test points at the site boundary which identified in the report.

5.4 Locations of Test Points

As per the technical circular, two types of test points – perimeter test point and overall test point will be adopted to assess the wind performance within the Assessment Area. Special test points are supplemented to assess the effectiveness of the air paths. The allocation of these test points will be distributed evenly as stated in the AVA Technical Circular.

5.4.1 Perimeter Test Points

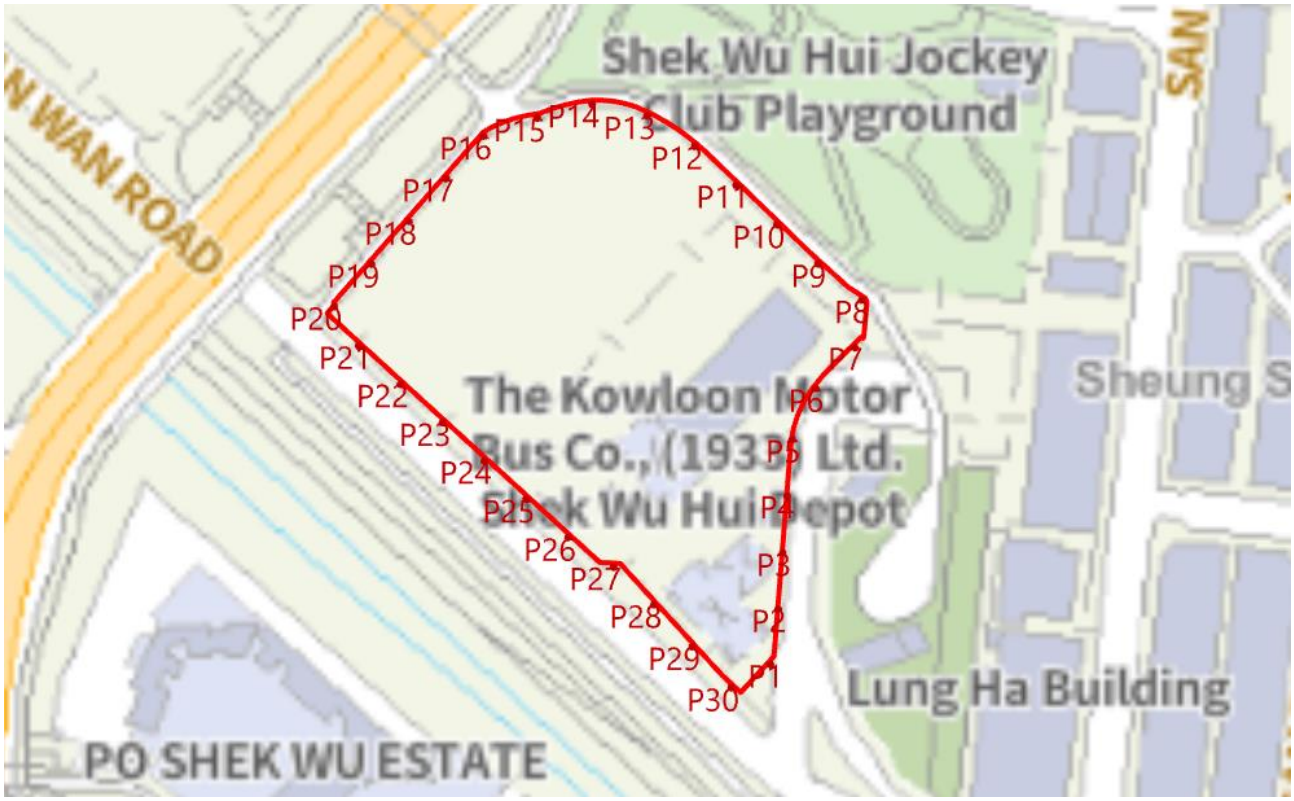
A total number of 30 perimeter test points (red spots), namely P points, are positioned at intervals of around 15m along the project site boundary in accordance with AVA Technical Circular. The locations of perimeter test points are shown below.

5.4.2 Overall Test Points

A total number of 566 overall test points (blue spots), namely O points, are evenly distributed in open areas within the assessment area, such as the streets and places where pedestrian frequently access. Their locations are shown below.

5.4.2 Special Test Points

A total number of 14 special test points (green spots), namely S points, are evenly distributed at pedestrian levels of wind enhancement features such as the air paths and empty bay. Their locations are shown below.



Site Boundary

P21 Perimeter Test Points

Figure 34 Location of Perimeter Points

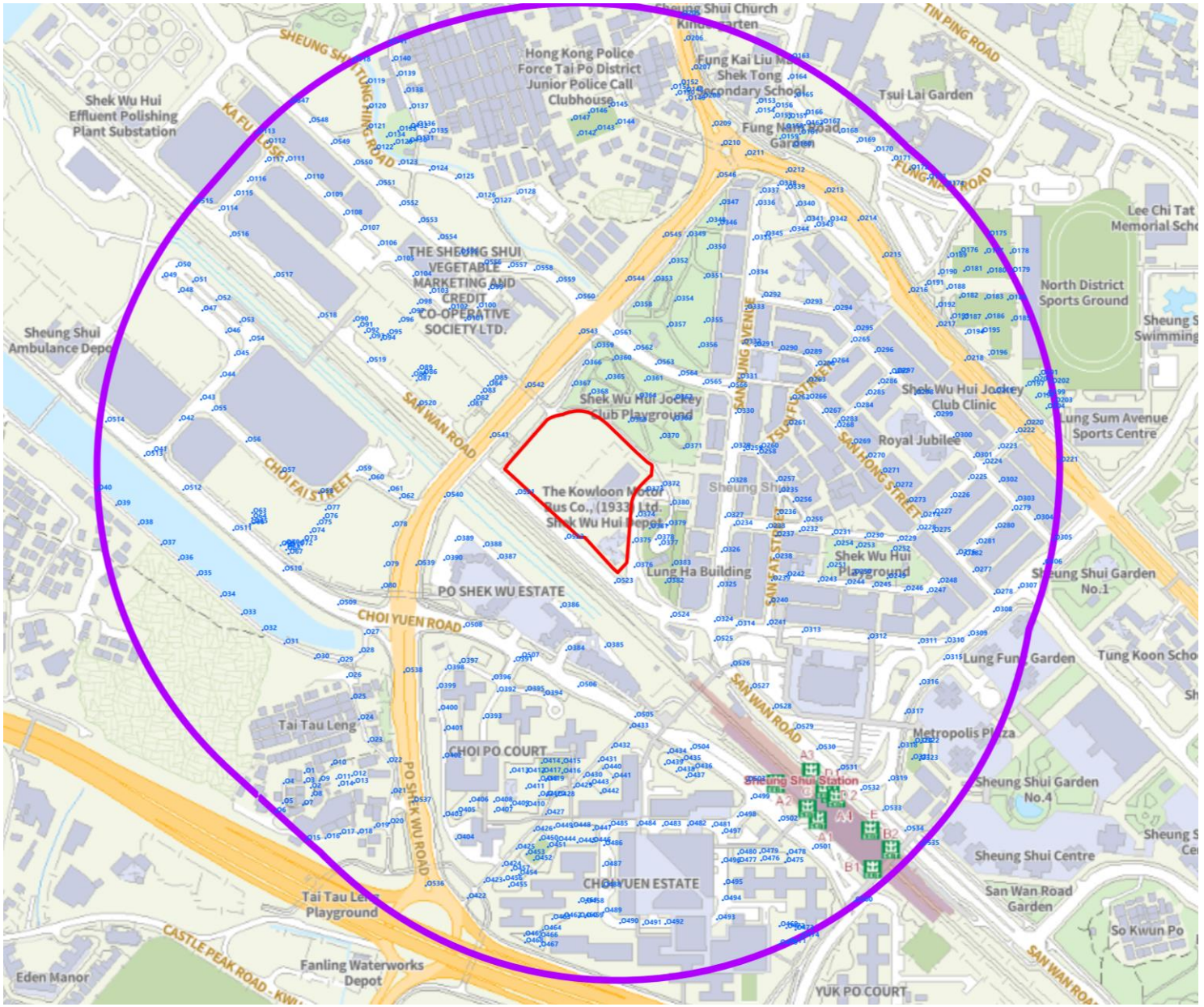
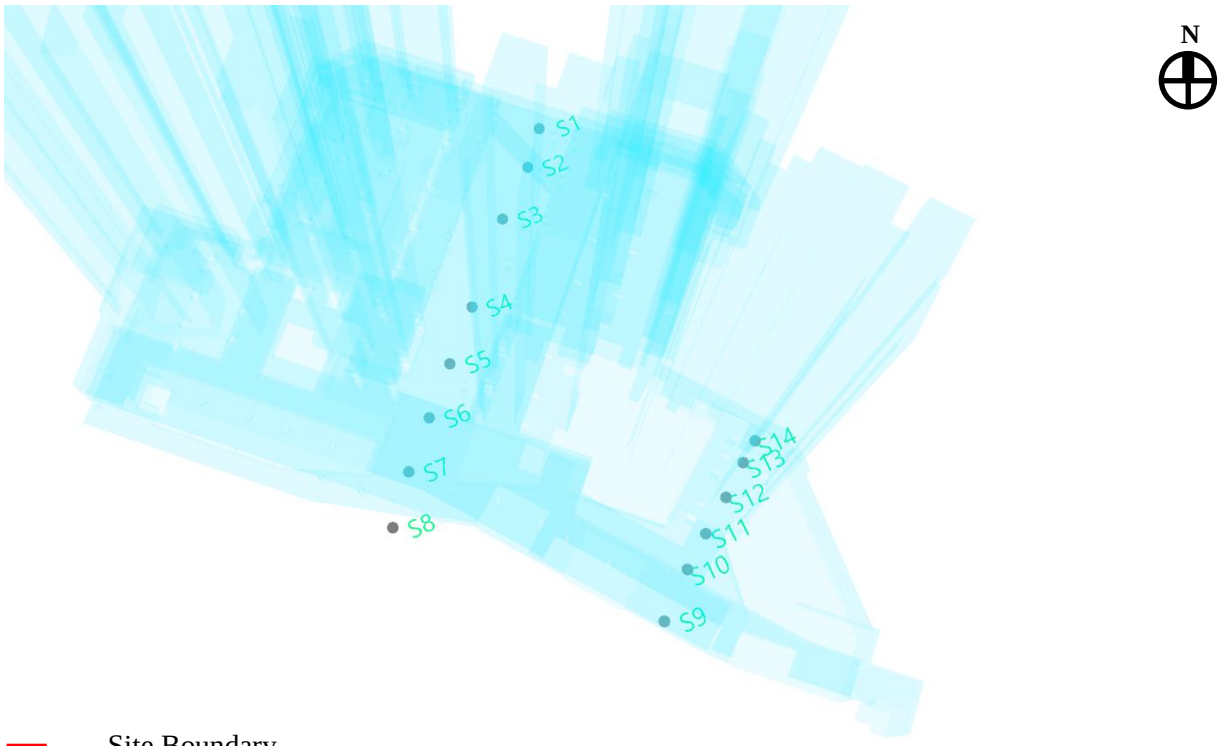

Site Boundary
Assessment Area (1H)
O13 Overall Test Points
Hong Kong Police Force Tai Po District Junior Police Call Clubhouse
Shek Wu Hui Effluent Polishing Plant Substation
THE SHEUNG SHUI VEGETABLE MARKETING AND CREDIT CO-OPERATIVE SOCIETY LTD.
Sheung Shui Ambulance Depot
Shek Wu Hui Jockey Club Playground
The Kowloon Motor Bus Co., (1933) Ltd. Shek Wu Hui Depot
PO SHEK WU ESTATE
CHOI PO COURT
CHOI YUEN ESTATE
YUK PO COURT
Tai Tau Leng
Tai Tau Leng Playground
Fanling Waterworks Depot
Eden Manor
Lung Ha Building
Shek Wu Hui Playground
Shek Wu Hui Jockey Club Clinic
Royal Jubilee
Tsui Lai Garden
Fung Nam Road Garden
North District Sports Ground
Lung Sum Avenue Sports Centre
Sheung Shui Garden No.1
Lung Fung Garden
Tung Koon School
Metropolis Plaza
Sheung Shui Station
Sheung Shui Garden No.4
Sheung Shui Centre
San Wan Road Garden
So Kwun Po
Lee Chi Tat Memorial School
Sheung Shui Swimming
Shek Wu Hui Jockey Club Clinic
SHEUNG SHUI TUNG NING ROAD
KA FU ESTATE
SAN WAN ROAD
CHOI FAI STREET
SHEUNG WAH AVENUE
SAN FUNG AVENUE
SAN HONG STREET
SAN FAI STREET
CHOI YUEN ROAD
PO SHEK WU ROAD
CASTLE PEAK ROAD - KWU
TIN PING ROAD
FUNG NAM ROAD

Figure 35 Location of Overall Points



Site Boundary

S3 Special Test Points

Figure 36 Location of Special Points

5.5 Focus Area

There are a total of 38 focus areas are within the assessment area. The associated test points for focus areas are tabulated below. The location of the focus areas area shown in Figure 37.

Table 5 Focus Areas and Corresponding Test Points

	Focus Area	Test Points
1	Tai Tau Leng	O1-O27
2	Village Road	O28-O40
3	Choi Fat Street	O41-O52
4	Choi Fai Street	O53-O62
5	Planned Sheung Shui Areas 4 and 30 Site 1	O63-O80
6	Planned Sheung Shui Areas 4 and 30 Site 2	O81-O98
7	Ka Fu Close	O99-O113
8	Cheuk Wan St	O114-O117
9	Po Sheung Tsuen	O118-O152
10	Fung Kai Liu Man Shek Tong Secondary Shool	O153-O156
11	Fung Nam Road Garden	O157-O162
12	Fu Nam Rd	O163-O174
13	North District Sports Ground Playground	O175-O204
14	Jockey Club Rd	O205-O221
15	Fu Hing St	O222-O234
16	San Fat St	O235-O241
17	San Lok St	O242-O248
18	Shek Wu Hui Playground	O249-O254
19	San Tsoi St	O255-O259
20	Tsun Fu St	O260-O265
21	San Hong St	O266-O278
22	San Cheung St	O279-O282
23	San Kung St	O283-O287
24	San Kin St	O288-O291
25	San Shing Ave	O292-O305
26	Lung Sum Avenue	O306-O314

	Focus Area	Test Points
27	Lung Wan St	O315-O319
28	North District Town Hall Basketball Court	O320-O323
29	Sun Fung Ave	O324-O345
30	Shek Wu Hui Jockey Club Playground	O346-O371
31	Bike Kiosk	O372-O383
32	Po Shek Wu Estate	O384-O390
33	Choi Po Court	O391-O421
34	Choi Yuen Estate	O422-O499
35	Choi Yuen Rd	O500-O514
36	San Wan Rd	O515-O535
37	Po Shek Wu Rd	O536-O546
38	Po Wan Rd	O547-O566
39	Wind Enhancement Measure 1	S1-S8
40	Wind Enhancement Measure 2	S9-S14

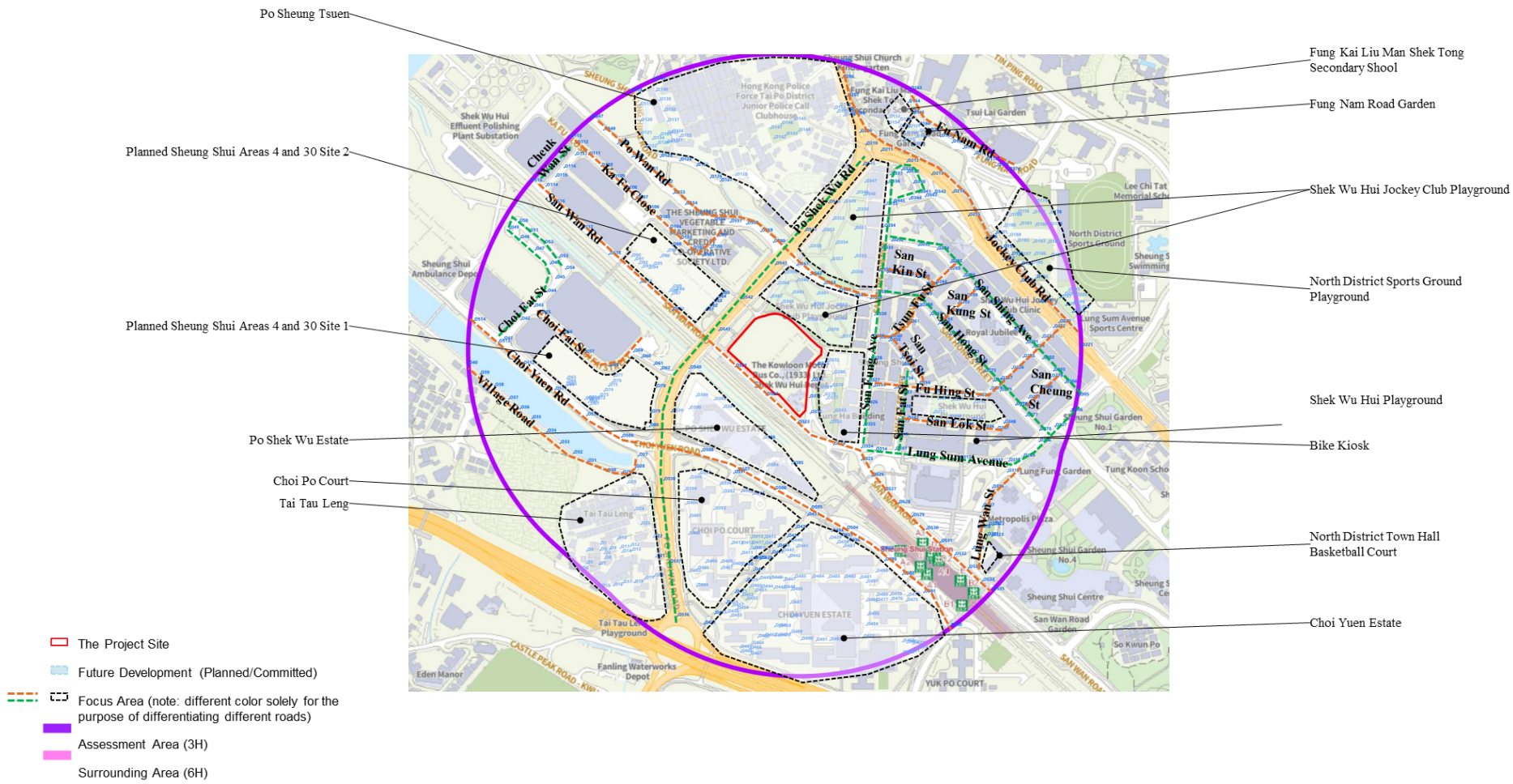


Figure 37 Location of Focus Areas outside the Application Site

6. Results and Discussion

6.1 Overview

The full set of contour and vector plots for are presented in Appendix C of the report.

6.1.1 Overall Ventilation Performance under Annual Wind Condition

The contour plots of annual weighted VR for the Baseline Scheme and Proposed Scheme are shown in Figure 38 and Figure 39.

Under annual condition, the majority of the prevailing wind would arrive at the Development from the eastern quadrant flowing over the generally low-rise eastern surroundings of the Development. A few mid-rise eastern surrounding buildings would impede a small portion of prevailing wind. Overall, the prevailing wind could reach the Development relatively freely.

The taller building under Proposed Scheme would be able to downwash more prevailing wind reaching the eastern facades of the Development, which would in turn allow for more ventilation at its immediate upwind surroundings, such as the Bike Kiosk, Shek Wu Hui Jockey Club Playgrounds etc.

Under both schemes the 15m air path between the two towers would enhance permeability of the Development and allow for prevailing to penetrate to the leeward area. However, under Proposed Scheme, the narrower tower separation in the northeastrern portion of the Development would increase the channelling effect for prevailing wind passing through, thereby accelerating the wind penetrating to the leeward area. The wind environment at the leeward area could therefore be enhanced, such as San Wan Road.

On the other hand, the provision of a 15m wide air path between Block B and the lift tower under Baseline Scheme, as compared to a 7m empty bay under Proposed Scheme, would allow for more pedestrian level wind flowing from the eastern site boundary to San Wan Road, providing a slightly higher VR there. This would however be mitigated by the naturally ventilated carpark under Proposed Scheme, which would enhance the permeability of the Development, allowing more prevailing to penetrate through the Development at low level.

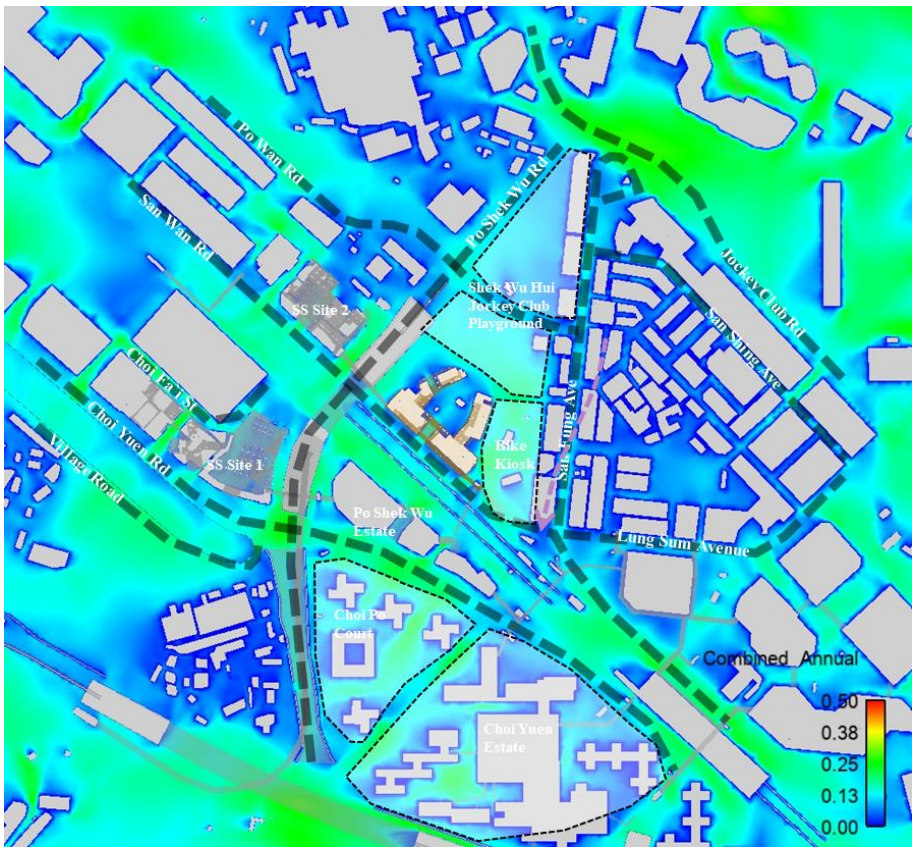


Figure 38 Contour Plot for Annual Weighted Average VR for Baseline Scheme

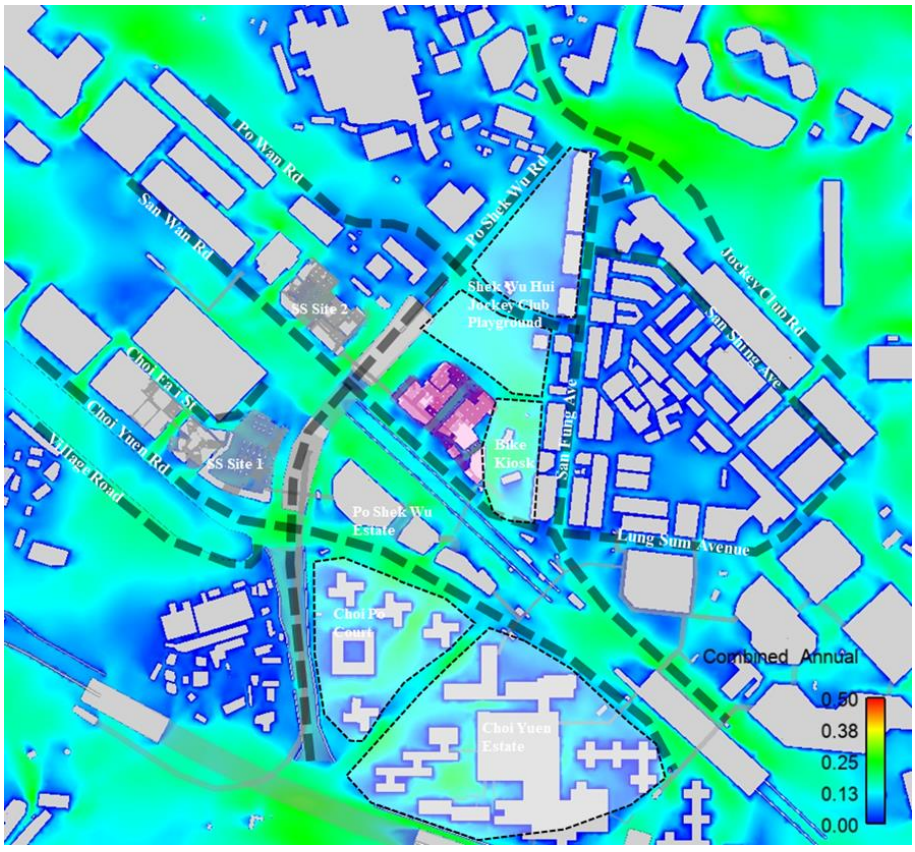


Figure 39 Contour Plot for Annual Weighted Average VR for Proposed Scheme

6.1.2 Overall Ventilation Performance under Summer Wind Condition

The contour plots of summer weighted VR for the Baseline Scheme and Proposed Scheme are shown in Figure 40 and Figure 41.

Under summer condition, prevailing wind would arrive mainly from the southwestern quadrant. As compared to annual condition, the wind environment would be relatively dominated by the windward surrounding environment as it comprises mainly of mid-rise and high-rise buildings including SS Site 1, Po Shek Wu Estate etc. A wind shadow would be created to the northeast of the Development. The wind environment would be overall relatively calm, and similar between Baseline and Proposed.

The taller building under Proposed Scheme would be able to downwash more prevailing wind reaching the southern facades of the Development, which would in turn allow for more ventilation at its immediate surroundings such as a localised portion of San Wan Road.

On the other hand, the building disposition of Baseline Scheme would allow for more wind to be diverted towards northeast, which would in ventilate the immediate northeastern surroundings of the Development such as Shek Wu Hui Jockey Club Playground and a localised portion of Po Wan Road under southwestern summer prevailing wind.

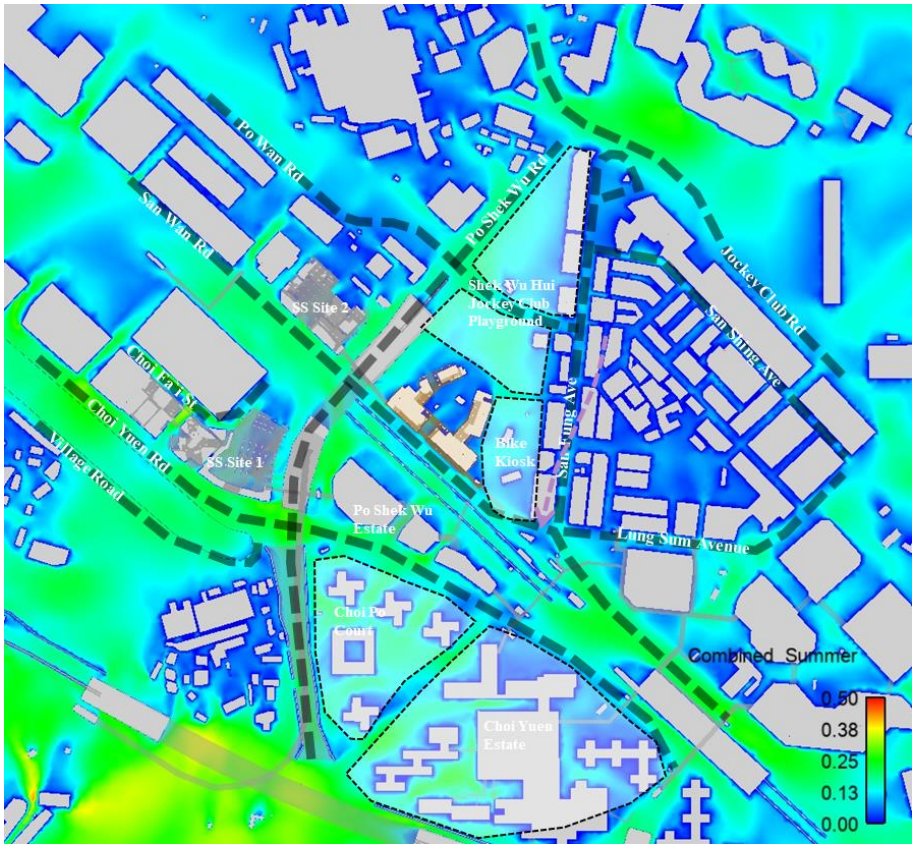


Figure 40 Contour Plot for Summer Weighted Average VR for Baseline Scheme

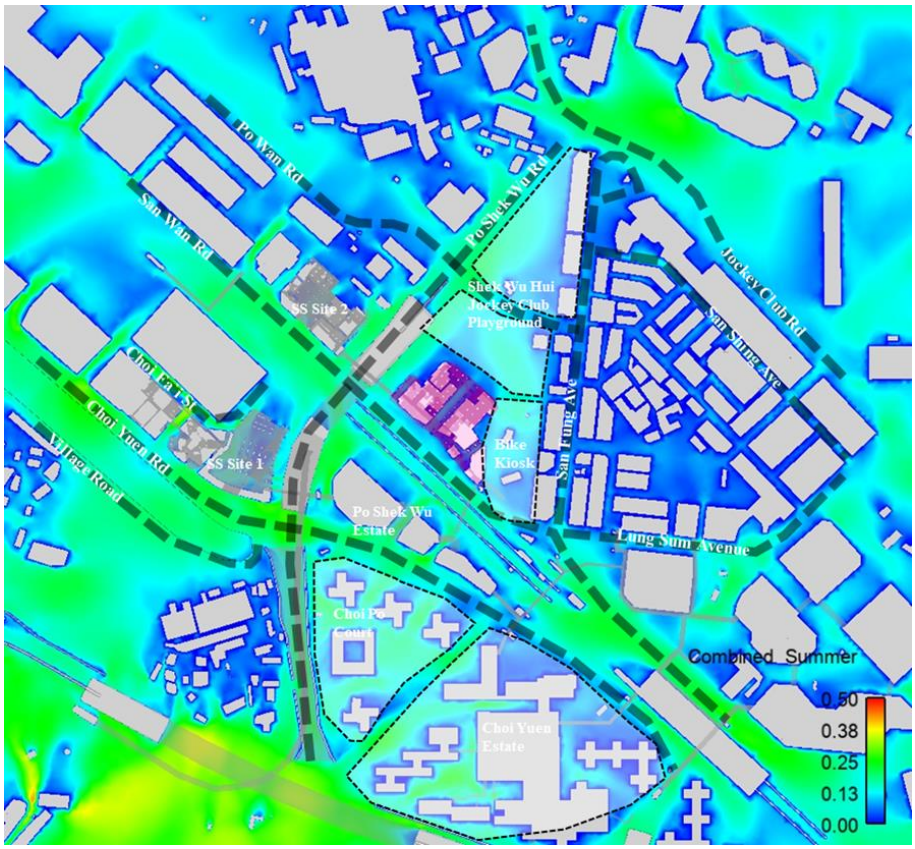


Figure 41 Contour Plot for Summer Weighted Average VR for Proposed Scheme

6.2 Directional Analysis

6.2.1 NNE Wind Direction

The NNE wind contributes to 6.4% of the annual wind and 2.3% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under NNE wind are presented below.

As the Development has an open northeastern surrounding environment, NNE wind could flow relatively freely to across open spaces such as the Shek Wu Hui Jockey Club Playground and stream along Po Shek Wu Road (**Grey Arrows**) and reach the northeast boundary of the Development.

In general the wind environment is enhanced along the site boundary under Proposed Scheme as compared to Baseline Scheme due to the increased downwashed effect from a taller Proposed Scheme; the leeward area would see a slightly calmer wind environment under Proposed Scheme as compared to Baseline Scheme.

Baseline Scheme

Under both schemes, prevailing wind would be diverted by the buildings to flow along its eastern site boundary and reach the eastern tower of Choi Po Court and be downwashed. However, under Proposed Scheme, a longer façade area along the northeastern site boundary would divert wind away from the eastern site boundary, thus allowing less wind flow to directly towards the eastern tower of Choi Po Court to be downwashed, which would in turn result in a higher VR in Choi Po court itself and Choi Yuen Road under Baseline Scheme (**Purple Arrows** & **White Circle**).

Proposed Scheme

Under both schemes, the northeastern façade of the Development would capture and downwash mid and high level prevailing wind to the pedestrian level, which would then flow around the Development on the western and eastern site boundary. Under Proposed Scheme, with taller towers, more prevailing wind could be downwashed to the pedestrian level, hence an enhanced wind environment at areas abutting the western and eastern site boundary such as Bike Kiosk and Shek Wu Hui Jockey Club Playground (**Black Circles and Black Arrows**). A portion of increased downwashed wind would also be able to penetrate through the permeable podium of the Development and reach San Wan Road to ventilate the portion of it immediate southwest of the Development (**Black Arrow**).

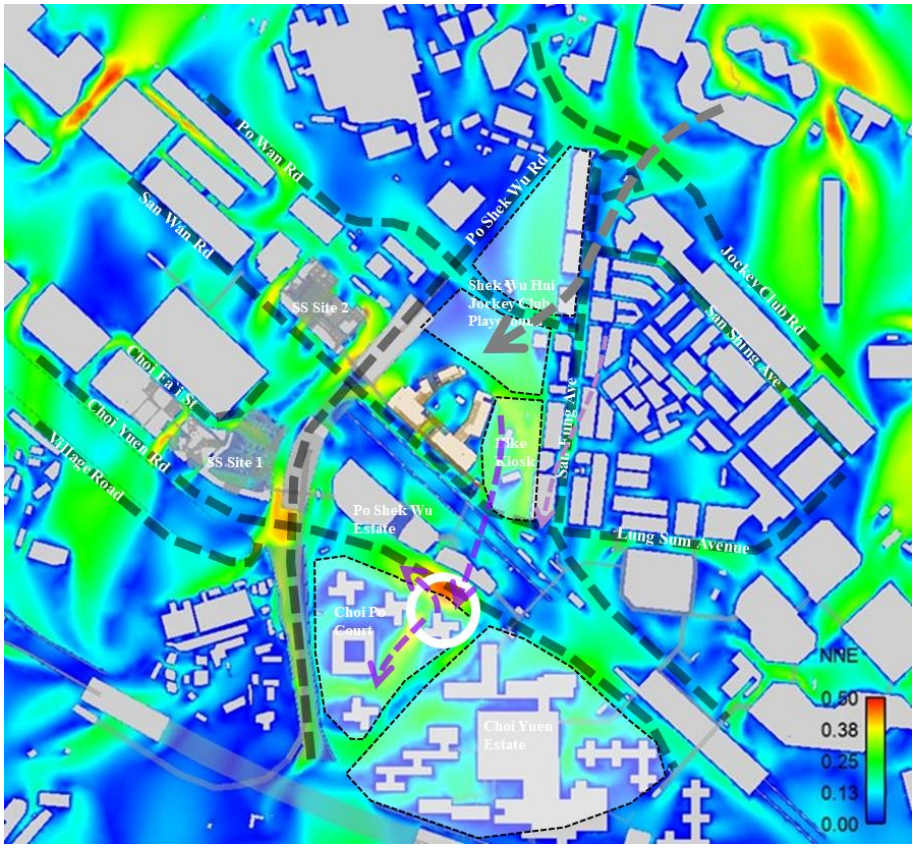


Figure 42 Contour Plot of VR for Baseline Scheme under NNE Wind

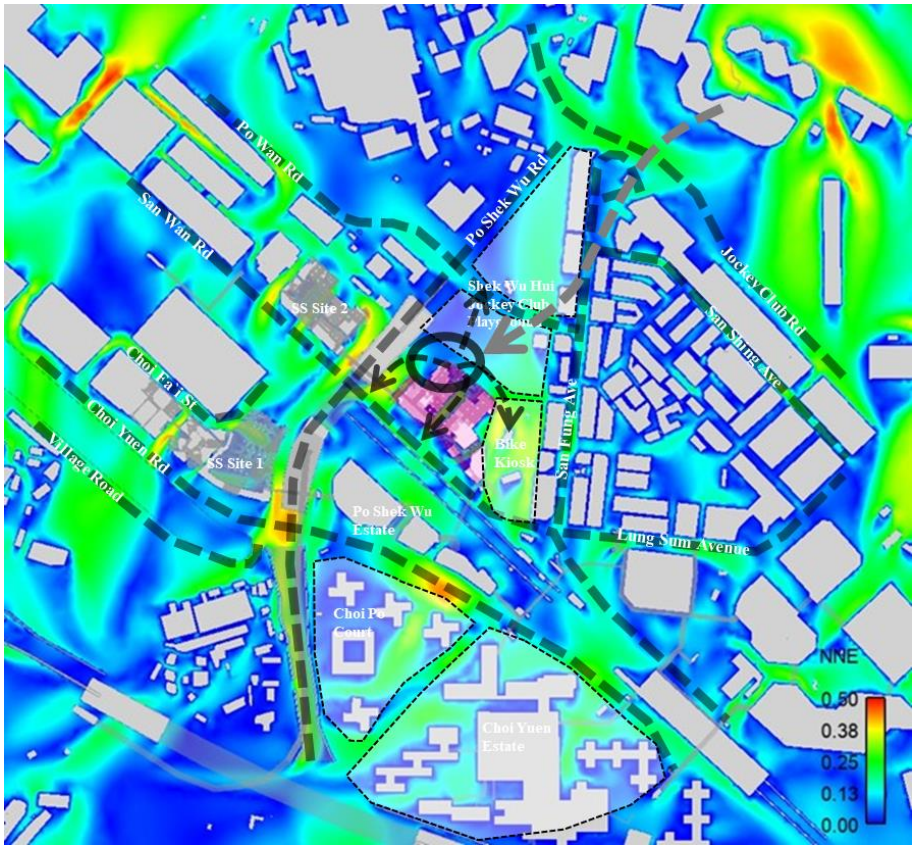


Figure 43 Contour Plot of VR for Proposed Scheme under NNE Wind

6.2.2 NE Wind Direction

The NE wind contributes to 7.5% of the annual wind and 1.5% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under NNE wind are presented below.

As the Development has an open northeastern surrounding environment, NE wind would generally reach the northeast boundary of the Development freely, from mainly Po Shek Wu Road, atop the northeastern low-rise cluster, as well as the open spaces such as the Shek Wu Hui Jockey Club Playground (**Grey Arrows**).

The general wind environment is found to be similar between the Baseline Scheme and Proposed Scheme. A different building height and disposition between the two schemes would nevertheless induce localised differences in performance in the leeward area as well as some immediate upwind locations.

Baseline Scheme

Under both schemes, a portion of prevailing wind reaching the Development would be downwashed to the pedestrian level by the northeastern façade, which would be diverted to flow along eastern site boundary of the Development and then further to San Wan Road. Under Baseline Scheme, the podium structure would be relatively less bulky with a 15m wide air path open from ground level between the lift tower and the podium, as compared to the 7m wide G/F empty bay under Proposed Scheme. Hence, under Baseline Scheme, more pedestrian level wind could penetrate through the Development to reach San Wan Road (**White Arrows**), creating a slightly higher VR there.

In addition, under both schemes, prevailing wind would be diverted by the buildings to flow along its eastern site boundary and reach the eastern portion of Po Shek Wu Estate and be downwashed. However, under Proposed Scheme, a longer façade area along the northeastern site boundary would divert wind away from the eastern site boundary, thus allowing less wind flow to directly towards the eastern tower of Choi Po Court to be downwashed, which would in turn result in a higher VR at a localised portion of San Wan Road under Baseline Scheme (**Purple Arrows** & **White Circle**).

On the other hand, under both schemes, high level prevailing wind would flow on the west of the Development and

Proposed Scheme

Under both schemes, the said downwashed wind at the northeastern façade of the Development would ventilate the immediate surroundings such as Bike Kiosk and Shek Wu Hui Jockey Club Playground. With a higher building height and a longer northeastern tower façade under Proposed Scheme, the downwash effect would be more significant (**Black Circle and Arrow**), providing said area with more ventilation.

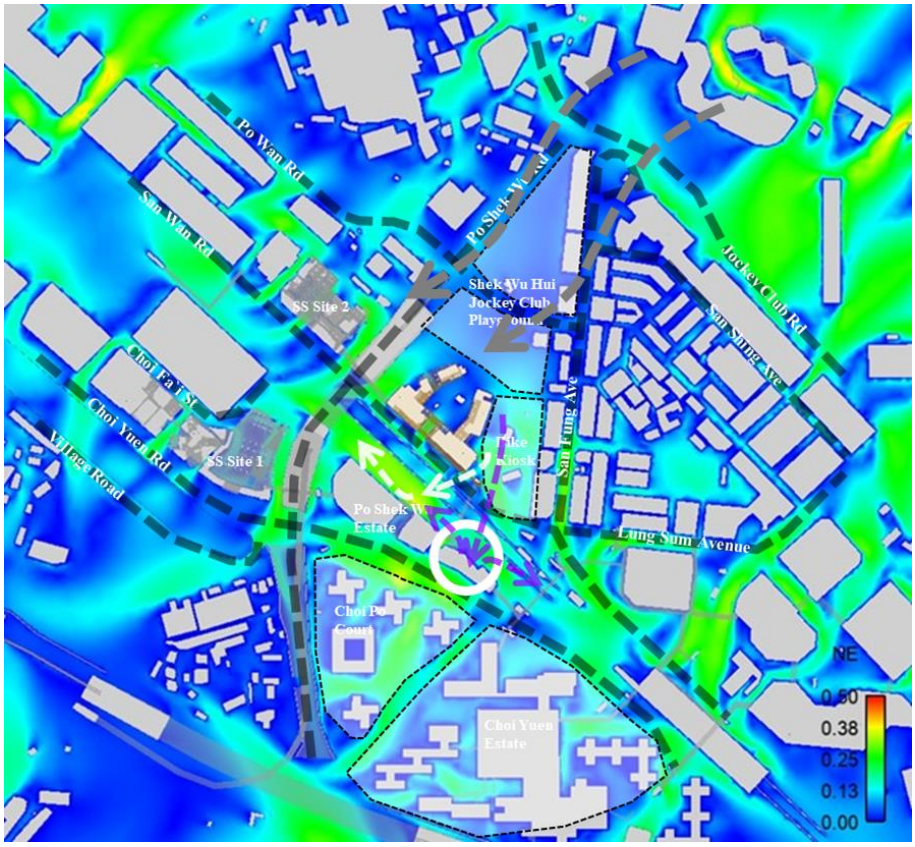


Figure 44 Contour Plot of VR for Baseline Scheme under NE Wind

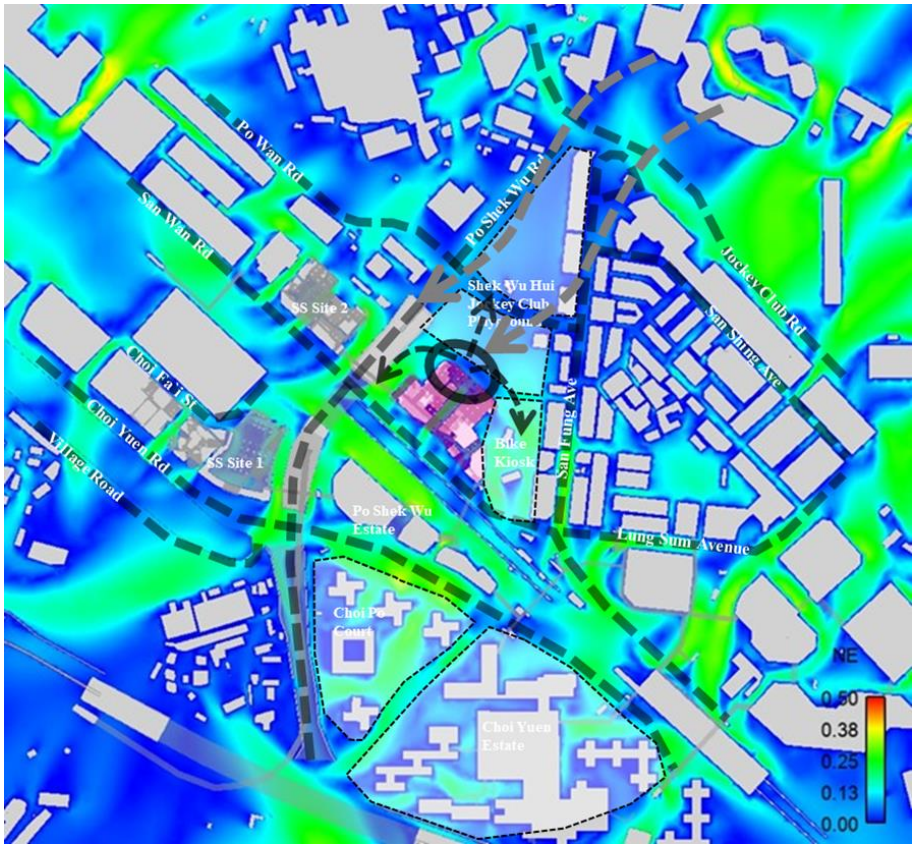


Figure 45 Contour Plot of VR for Proposed Scheme under NE Wind

6.2.3 ENE Wind Direction

The ENE wind contributes to 11.1% of the annual wind and 2.3% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under ENE wind are presented below.

Under ENE wind, a portion of incoming wind would skim over the generally low-rise cluster to the east-northeast of the Development and reach the development (**Grey Arrows**).

In general, a similar pattern and performance is found between Baseline and Proposed Scheme, a slightly enhanced wind environment can be observed under Proposed Scheme along the western and eastern site boundary.

Baseline Scheme

Under both scheme a portion of mid and high level incoming wind would penetrate through the tower separation in the development. A narrower tower separation at the center and northeast of the Development under Proposed Scheme would increase the channelling effect, thereby allowing for more mid and high level prevailing wind to pass through the tower separation (**Red Arrow**). In contrast, under Baseline Scheme, with less prevailing wind being channelled through the tower separation, more wind would be diverted to travel on the northwest of the Development; it would travel further towards the southwest where Tai Tau Leng and Village Road are located (**Purple Arrow**), thereby increasing the VR there under Baseline Scheme.

Proposed Scheme

Under both schemes, a portion of mid and high level incoming wind would be downwashed by the northeastern façade of the development to pedestrian level and would be diverted towards Bike Kiosk and San Wan Road. With a taller building height under Proposed Scheme, more downwashed wind would stream along Bike Kiosk and eastern part of San Wan Road, as well as stream towards Shek Wu hui Jockey Club Playground (**Black Arrow** & **Black circle**).

In addition, under both schemes, pedestrian level wind arriving at the Development would be diverted by Block A of the Devleopment to travel along its northwestern side. Under Proposed Scheme, the bulkier podium as comapred to that under Baselien Scheme would divert more wind towards said area, a larger acceleration around the corner of Block A is also observed. Coupled with said increased downwash effect, the VR is would be higher at tthe northwestern site boudnary as well as a localised portion of San Wan Road (**White Arrow**).

On the other hand, the aforementioned increased amount of previaling wind travelling through the tower separation under Baselien Scheme would be downwashed by Po Shek Wu Estate onto San Wan Road, thereby providing ventialtion for a localised portion of it, increasing the VR there (**Red Circle & Red Arrows**).

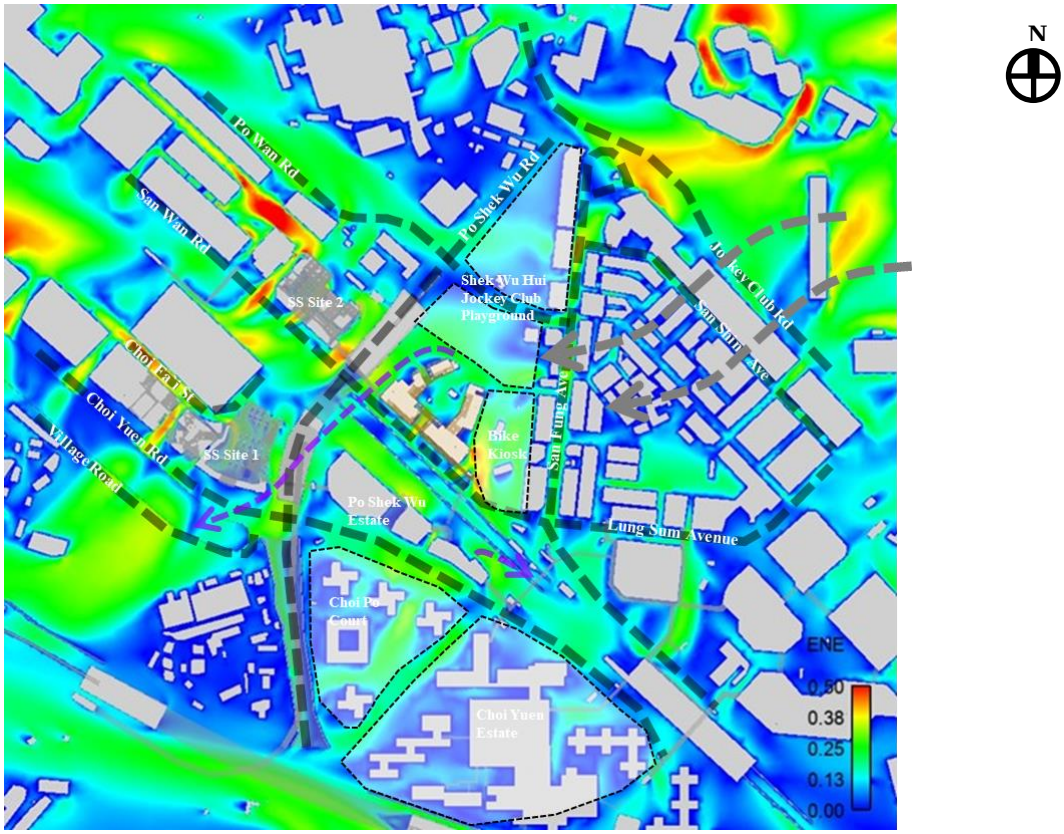


Figure 46 Contour Plot of VR for Baseline Scheme under ENE Wind

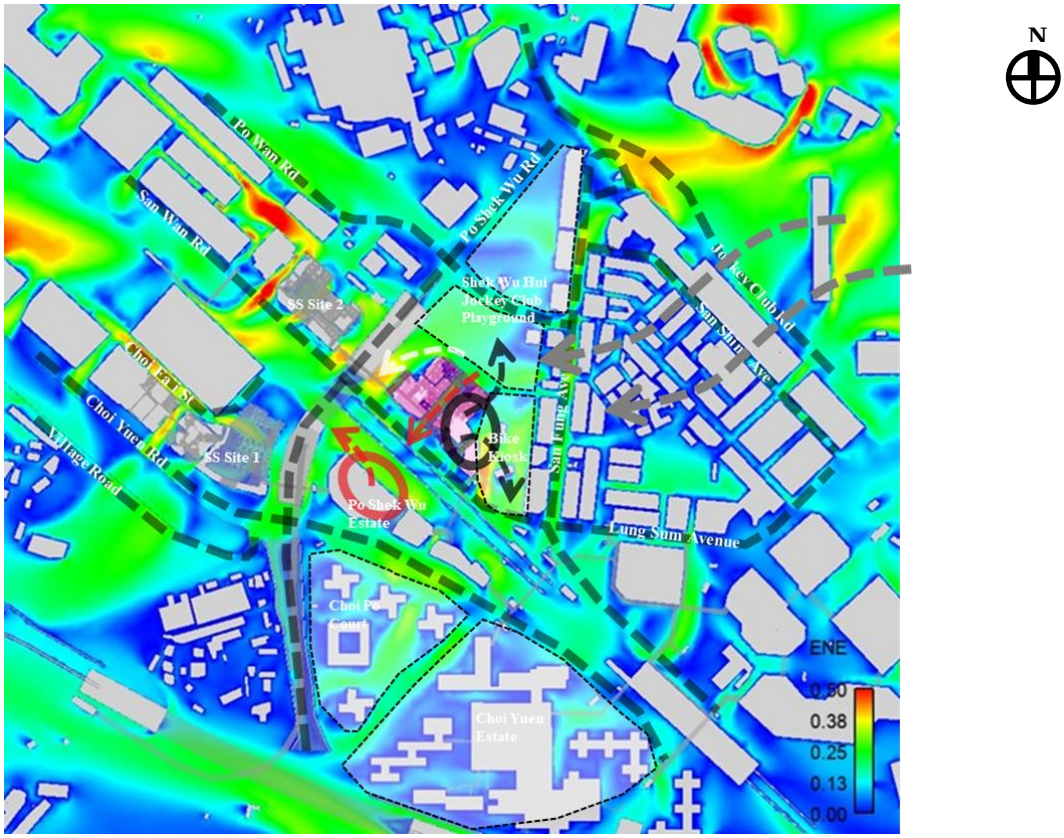


Figure 47 Contour Plot of VR for Proposed Scheme under ENE Wind

6.2.4 E Wind Direction

The E wind contributes to 17.2% of the annual wind and 7.6% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under E wind are presented below.

To the east of the Development would be mainly low-rise buildings and open area such as Bike Kiosk and Shek Wu Hui Jockey Club Playground; despite the presence of a few mid-rise buildings, prevailing wind could generally flow freely to reach the Development.

In generally the two schemes have similar flow patterns, however, the VR is observed to be slightly higher at the focus areas under Baseline Scheme.

Baseline Scheme

Better wind environment is observed along San Wan Road in Baseline Scheme. Under both schemes, a portion of prevailing wind reaching the Development would be downwashed by the eastern façade to the pedestrian level, a portion of which would be diverted to flow towards San Wan Road. Under Baseline Scheme, the downwashed wind could reach San Wan Road through a 15m wide full height air path (**White Arrows**), as compared to a 7m wide G/F empty bay under Proposed Scheme; this would allow for more wind under Baseline Scheme to penetrate through the Development to reach San Wan Road and enhance the environment there. This could be mitigated under Proposed Scheme through its permeable podium and naturally ventilated carpark design.

As the orientation of the Baseline Scheme Block B eastern façade places it against E wind more directly than it would in Proposed Scheme, the aforementioned downwashing would be relatively more significant. Because portion of the downwashed wind would flow towards the immediate eastern surroundings of the Development, including the Bike Kiosk and Shek Wu Hui Jockey Club Playground, these areas would have an increased VR under Baseline Scheme (**Black Circle and Arrow**).

Under both schemes, prevailing wind would flow across the North District Sports Ground and reach Jockey Club Road as well as Fung Kai Liu Man Shek Tong Secondary School and Fung Nam Road Garden; however, simultaneously, a portion of aforementioned downwashed wind would travel from the Development across the Shek Wu Hui Jockey Club Playground towards north, and limit the flow. Due it's the increased downwash under Baseline Scheme, the limiting effect would be greater, hence a slightly lower VR in said areas such as Fung Nam Road Garden under Baseline Scheme (**Pink Arrows** & **Pink Circle**).

Proposed Scheme

Under Proposed Scheme, however, more downwashing would be observed on the northern part of the Development (White Arrow and Circle), where the façade is facing relatively away from the prevailing wind and the height of the tower has a more significant effect. In this case, more wind would be available to northwester site boundary of the Development, thereby enhancing the wind environment there (**Purple Circle and Arrows**).

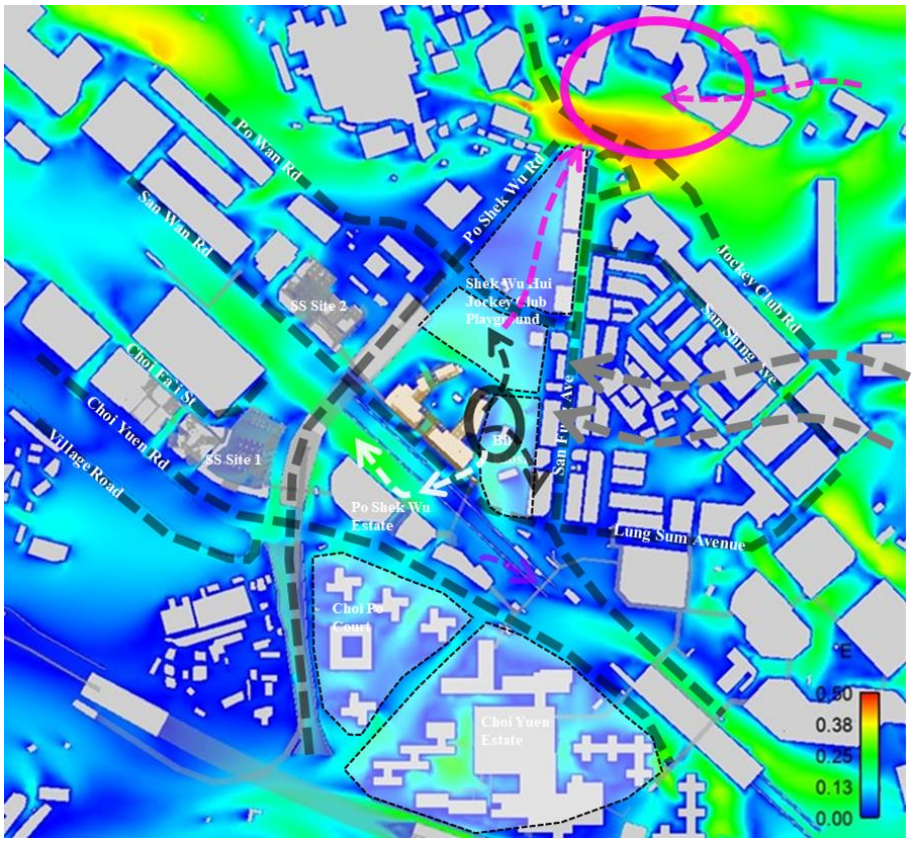


Figure 48 Contour Plot of VR for Baseline Scheme under E Wind

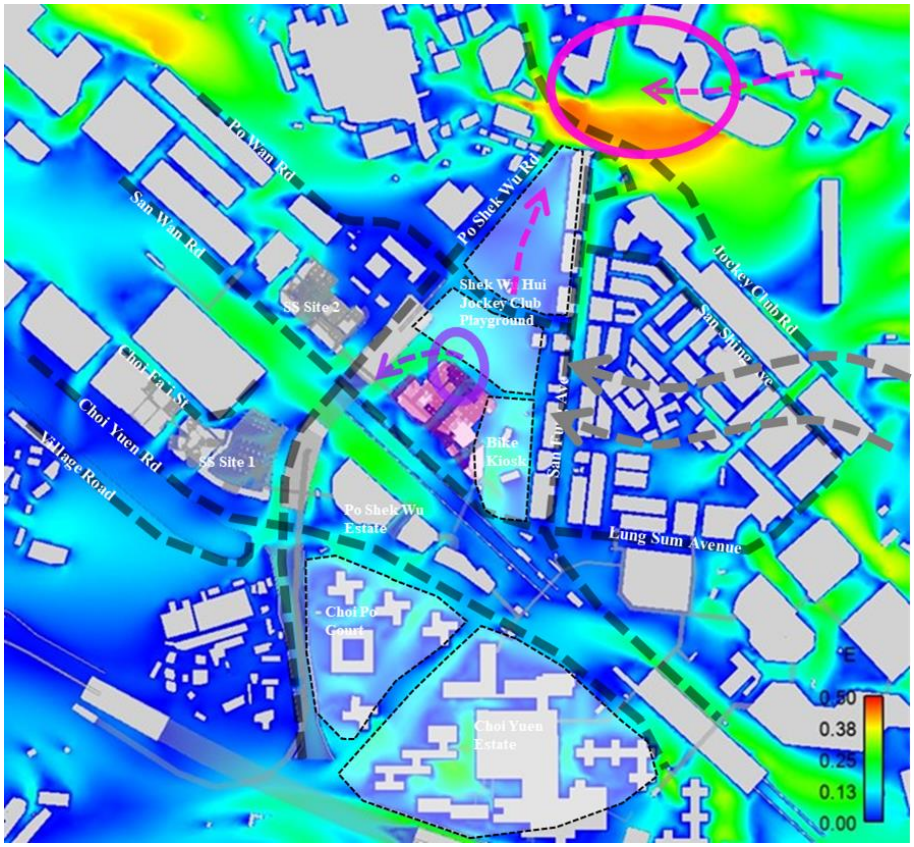


Figure 49 Contour Plot of VR for Proposed Scheme under E Wind

6.2.5 ESE Wind Direction

The ESE wind contributes to 14.7% of the annual wind and 10.2% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under ESE wind are presented below.

ESE wind would flow around the mid-rise to the east-southeast of the Development and flow towards the Development in two ways. While a portion of the ESE incoming wind would travel along San Wan Road to reach the southern boundary of the development, another portion would flow over the low-rise buildings to the east of the Development to reach it (**Grey Arrows**).

In general, the ventilation performance would be slightly enhanced under Proposed Scheme.

Proposed Scheme

Under both schemes, prevailing would be captured and downwashed by the eastern façade of Block B to the pedestrian level and be diverted towards its immediate surrounding such as the Bike Kiosk, Shek Wu Hui Jockey Club Playground, and San Fung Avenue. Since Proposed Scheme is taller than Baseline Scheme, the said downwash effect would be more significant, thus more wind would be available at the mentioned areas, creating a higher VR there (**Green Circle & Arrows**).

On the other hand, under both schemes, prevailing wind would flow on southwest of the Development along San Wan Road and on northeast of the Development across the Shek Wu Hui Jockey Club Playground towards northwest surroundings such as SS Site 2. Due to the fact that under Proposed Scheme there is increased building setback at both southwest and northeast site boundaries, increased amount of said flow would be observed, thereby increasing VR at locations reached by said flow (**Pink Arrows**), such as San Wan Road itself as well as SS Site 2 and Ka Fu Close.

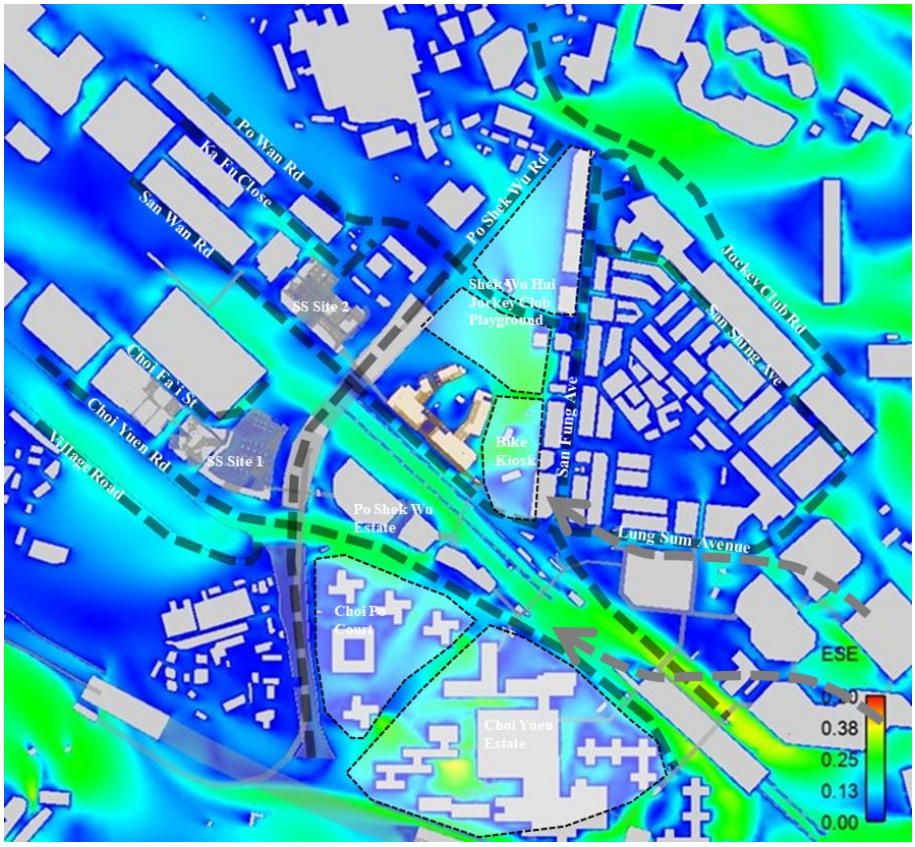


Figure 50 Contour Plot of VR for Baseline Scheme under ESE Wind.

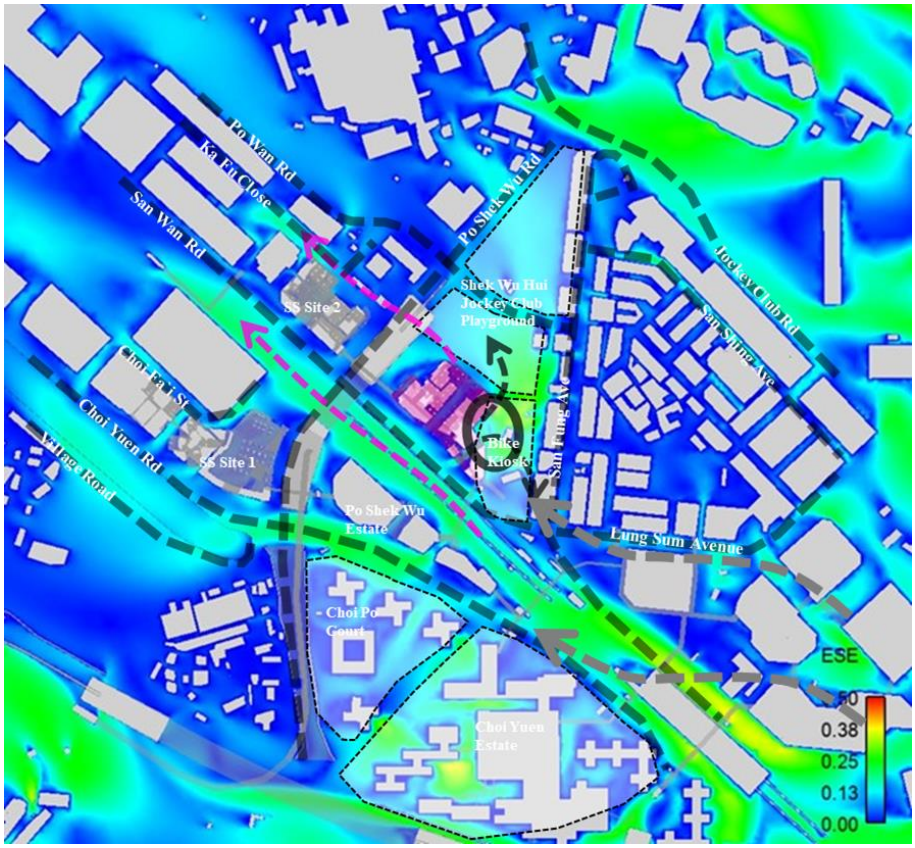


Figure 51 Contour Plot of VR for Proposed Scheme under ESE Wind

6.2.6 SE Wind Direction

The SE wind contributes to 8.7% of the annual wind and 8.7% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under SE wind are presented below.

Under SE wind conditions, the incoming wind would skim over mid-rise buildings as well as travel along San Wan Road to reach the Development (**Grey Arrows**). Leeward area is expected to have a slightly enhanced wind environment under Proposed Scheme whereas localised immediate upwind area would have a slightly higher VR under Baseline Scheme..

Baseline Scheme

In both schemes, mid and high level incoming wind could would be captured and downwashed by the eastern façade of the Development to the pedestrian level to ventilate the immediate eastern surroundings such as Bike Kiosk and a localised portion of San Wan Road. Under Proposed Scheme, due to an increased setback from the southwestern site boundary, the prevailing wind is relatively more hindered by the southwestern mid and high-rises as compared to Baseline Scheme, in that under Baseline Scheme, the prevailing could reach the eastern façade of the Development more directly (**Red Arrows**). Therefore, the downwash effect would be more significant under Baseline Scheme (**Black Circle** & **Black Arrows**), creating a higher VR at said areas.

Proposed Scheme

Similar to ESE wind, under both schemes, prevailing wind would flow on southwest of the Development along San Wan Road and on northeast of the Development across the Shek Wu Hui Jockey Club Playground towards northwest surroundings such as SS Site 2. Due to the fact that under Proposed Scheme there is increased building setback at both southwest and northeast site boundaries, increased amount of said flow would be observed, thereby increasing VR at locations reached by said flow (**Pink Arrows**), such as San Wan Road itself as well as SS Site 2 and Ka Fu Close.

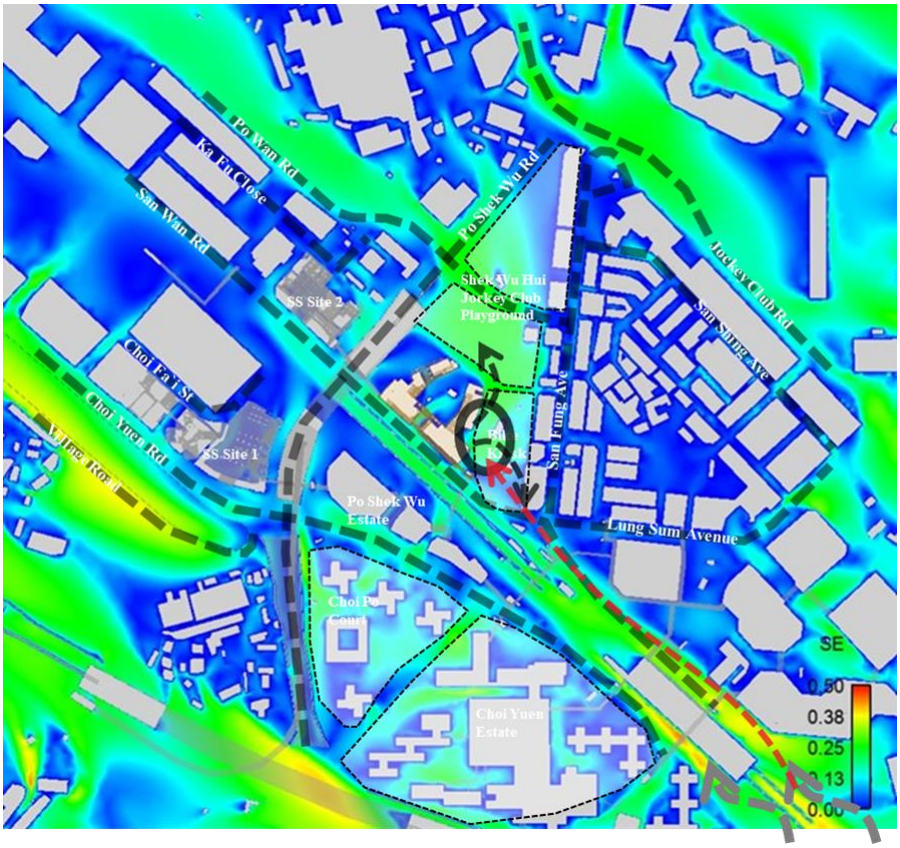


Figure 52 Contour Plot of VR for Baseline Scheme under SE Wind

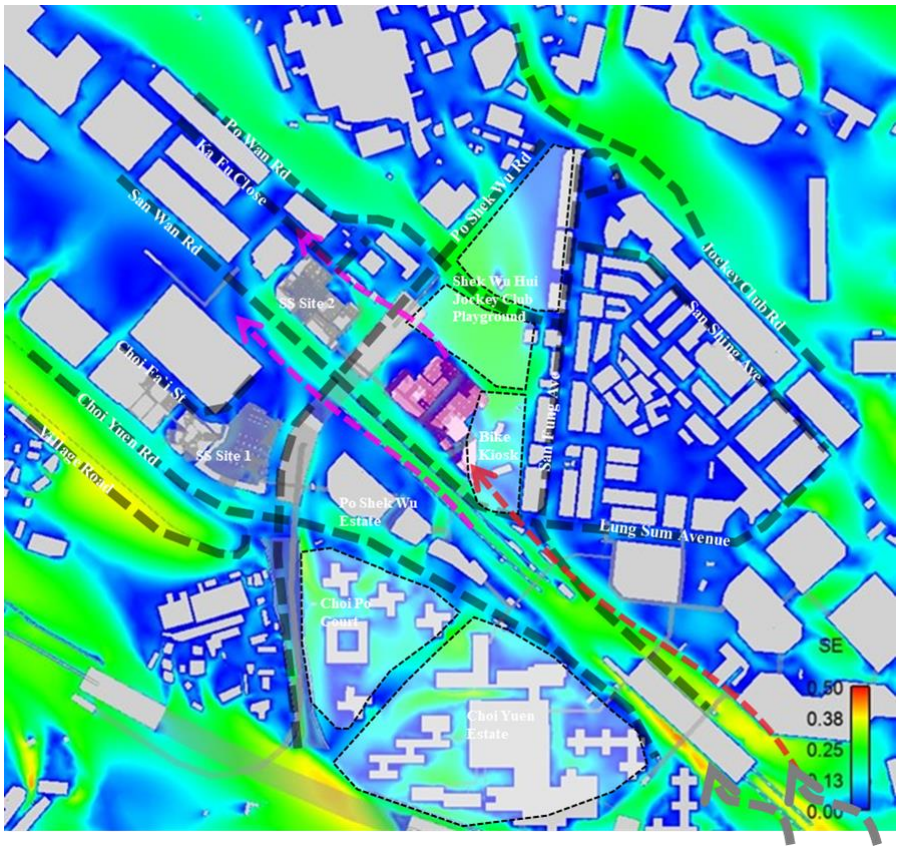


Figure 53 Contour Plot of VR for Proposed Scheme under SE Wind

6.2.7 SSE and S Wind Direction

The SSE and S wind contributes to 4.8% and 5% of the annual wind, and 8.7% and 10.2% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under SSE and S wind are presented below.

Under SSE and S wind conditions, the incoming wind would be diverted by Sheung Shui Centre to stream along San Wan Road to reach the development. On the other hand, mid and high level wind could reach the southwestern and eastern site boundary of the Development directly (**Grey Arrows**).

Baseline Scheme

On the other hand, under both schemes, prevailing wind would flow along San Wan Road. However, under Proposed Scheme, a stream of wind downwashed by Block B eastern façade would flow through 7m G/F empty bay to reach San Wan Road, which would then limit the prevailing wind along San Wan Road to flow only near the noise barrier; whereas, under Baseline Scheme the prevailing wind on San Wan Road could flow more freely (**White Arrow**). Therefore, San Wan Road would have a slightly higher VR under Baseline Scheme.

Under both scheme a portion of prevailing wind flowing along San Wan Road would be diverted to penetrate through the tower separation as well as the permeable podium structure in the development. A narrower tower separation at the center and northeast of the Development under Proposed Scheme would increase the channelling effect, thereby allowing for more mid and high level prevailing wind to pass through the tower separation (**Red Arrow**). The effect is further enhacned by the more permeable podium design under Proposed Scheme. In contrast, under Baseline Scheme, with less prevailing wind being channelled through the Development, more wind would travel along San Wan Road further, subusequently diverted to travel along the northwest site boundary and Po Shek Wu Road towards Po Sheung Tseun (**Purple Arrow**), thereby increasing the VR in areas including localised portions of Po Wan Road and Po Shek Wu Road, as well as Po Sheung Tsuen. under Baseline Scheme.

Proposed Scheme

In both schemes, mid and high level incoming wind along San Wan Road would be captured and downwashed by the eastern façade of the Development to the pedestrian level to ventilate the immediate eastern surroundings such as Bike Kiosk and a localised portion of San Wan Road. Since Proposed Scheme is taller than Baseline Scheme, the said downwash effect would be more significant, thus more wind would be available at the mentioned areas, creating a higher VR there (**Black Circle & Arrows**).

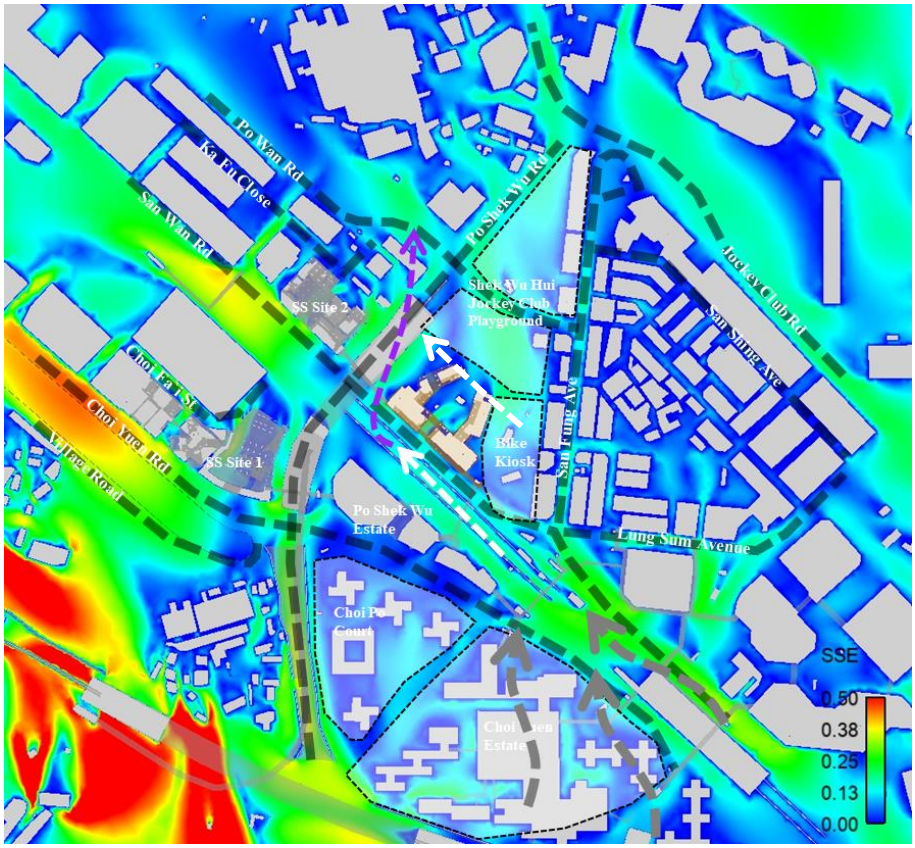


Figure 54 Contour Plot of VR for Baseline Scheme under SSE Wind

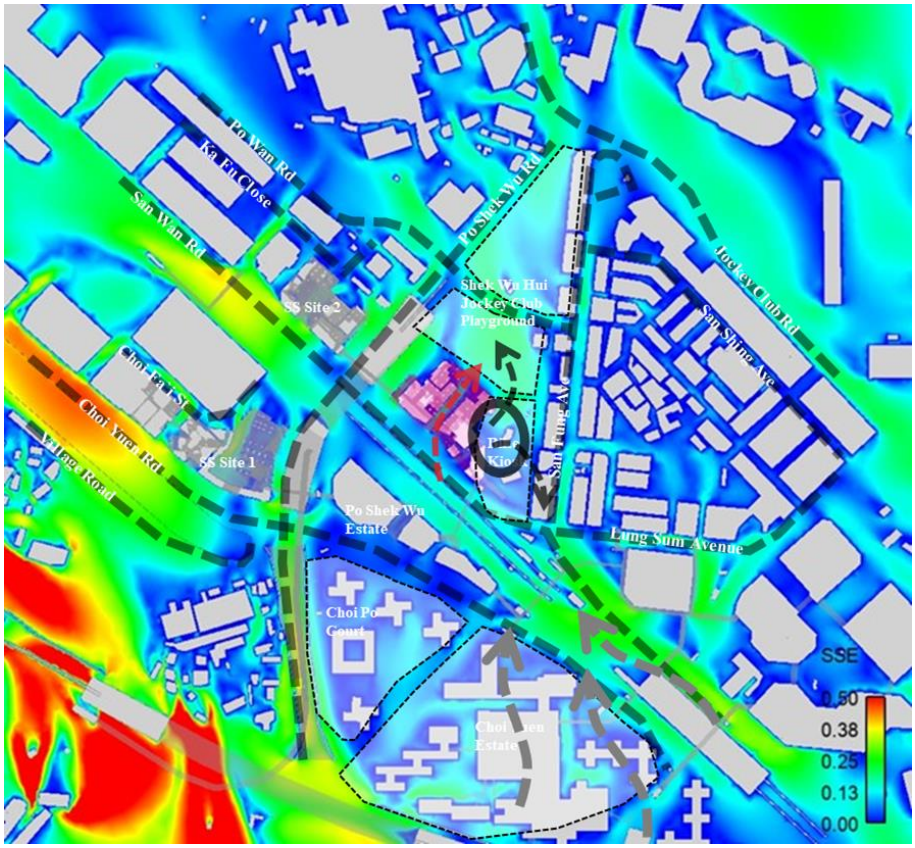


Figure 55 Contour Plot of VR for Proposed Scheme under SSE Wind

6.2.8 SSW Wind Direction

The the SSW wind contributes to 6.1% of the annual wind and 13.4% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under S wind are presented below.

The incoming SSW wind would be hindered by the mid-rise southwestern surroundings, prevailing wind at these levels would flow around the mid-rise buildings on their west to reach the southwest boundary of the development, they would then continue to flow around the Development on its west. High level wind, on the other hand, would reach the Development freely flowing over the mid-rise surroundings. In addition, a portion of mid-level wind would be captured by Landmark North and downwashed onto San Wan Road, which would then flow northwest along San Wan Road to reach the Development (**Grey Arrows**)

Overall, the ventilation performance of the Baseline and Proposed Schemes under S and SSW wind conditions would be dominated by the mid-rise southern surroundings such as Po Shek Wu Estate and Chui Po Court, which would cast a wind shadow over the Development. The wind environment would generally be similar under both schemes.

Baseline Scheme

Under both schemes, a portion of high level S and SSW wind reaching the Development would be captured and downwashed to the pedestrian level, ventilating San Wan Road. As the Proposed Scheme is taller, creating a larger height difference between it and its southwestern surroundings such as Po Shek Wu Estate, more high level wind would be captured and downwashed. The downwashed wind would, however, limit the prevailing wind flowing along San Wan Road under Proposed Scheme, therefore a slightly higher VR at a localised portion of San Wan Road immediate southwest of the Development would be observed under Baseline Scheme (**Black Circle**).

Proposed Scheme

Under both schemes, prevailing wind flowing along San Wan Road would be diverted north towards Bike Kiosk and Shek Wu Hui Jockey Club Playground. The aforementioned increased downdating effect under Proposed Scheme would limit prevailing travelling further down San Wan Road, consequentially, more wind would be diverted north towards said area, increasing the VR there (**Red Arrow**)

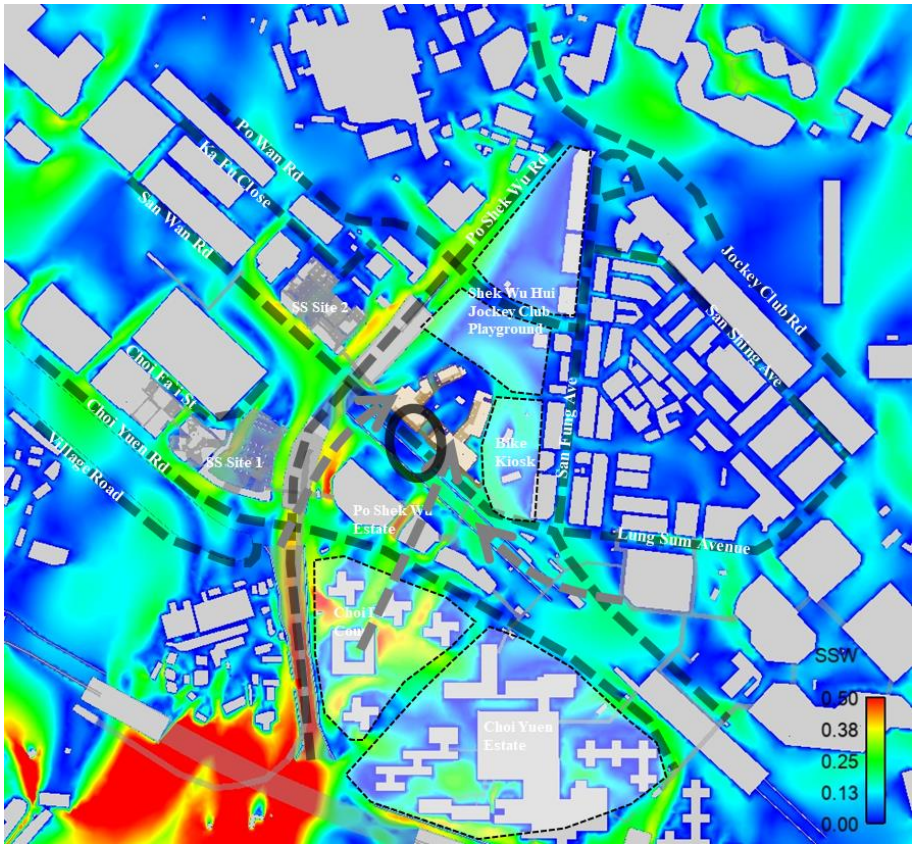


Figure 56 Contour Plot of VR for Baseline Scheme under SSW Wind

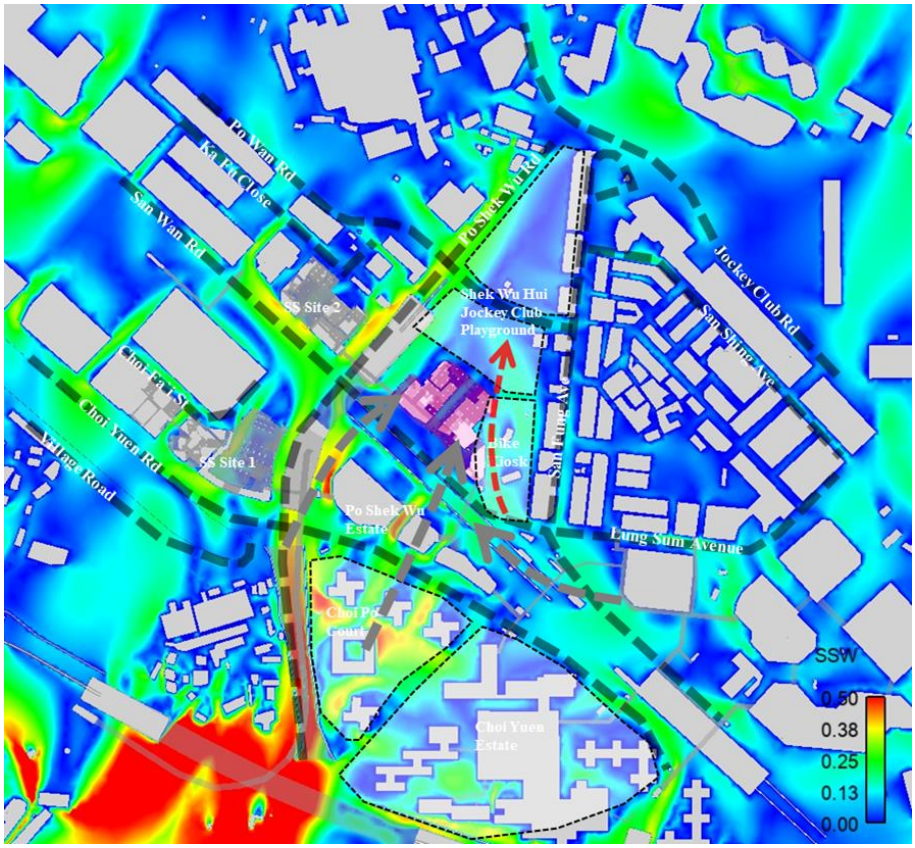


Figure 57 Contour Plot of VR for Proposed Scheme under SSW Wind

6.2.9 SW Wind Direction

The SW wind contributes to 3.3% of the annual wind and 8.4% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under SW wind are presented below.

The incoming SW wind would be hindered by the mid-rise Choi Po Court and Po Shek Wu Estate at low and mid-level, prevailing wind would mainly stream along Po Shek Wu Road to reach the Development at its western site boundary. A small portion of low and mid-level SW wind could on the other hand flow between the towers of Po Shek Wu Estate to reach San Wan Road and the Development. In addition, high level SW wind could reach the Development freely flowing over the mid-rise surroundings. Furthermore, a portion of mid-level wind would be captured by Landmark North and downwashed onto San Wan Road, which would then flow northwest along San Wan Road to reach the Development (**Grey Arrows**)

Similar to S and SSW wind, the overall ventilation performance would be comparable under the two schemes as the wind environment would be dominated by the upwind surrounding environment consisting of said mid-rise buildings.

Baseline Scheme

Under both schemes, wind reaching the Development from Po Shek Wu Road can flow further towards the northeastern surrounding of the Development such as the Shek Wu Hui Jockey Club Playground. The tower disposition under Baseline Scheme would allow for more wind to flow northeast, thereby creating a higher VR at Shek Wu Hui Jocket Club Playground as well as areas further downwind such as Jockey Club Road and Fung Nam Road Garden (**Black Arrows**).

Proposed Scheme

Under SW wind, a portion of high level incoming wind would be captured and downwashed by the southwest façade of the Development to the pedestrian level, which would then be diverted to flow along San Wan Road. Since the taller Proposed Scheme would be produce a more significant downwash effect, an enhanced wind environment at a localised portion of San Wan Road would be observed in Proposed Scheme (**White Circle and Arrow**). This however would in turn limit some prevailing wind on San Wan Road from flowing towards the Development. Localised upwind portion of San Wan Road and the Bike Kiosk would therefore have a slightly higher VR under Baseline Scheme (**Red Circle**). A stream of prevailing wind flowing along Po Shek Wu Road towards SS Site 2 would be affected by said phenomenon, thereby creating a higher VR under Baseline Scheme at San Wan Road immediate southwest of SS Site 2 (**Purplr Circle**).

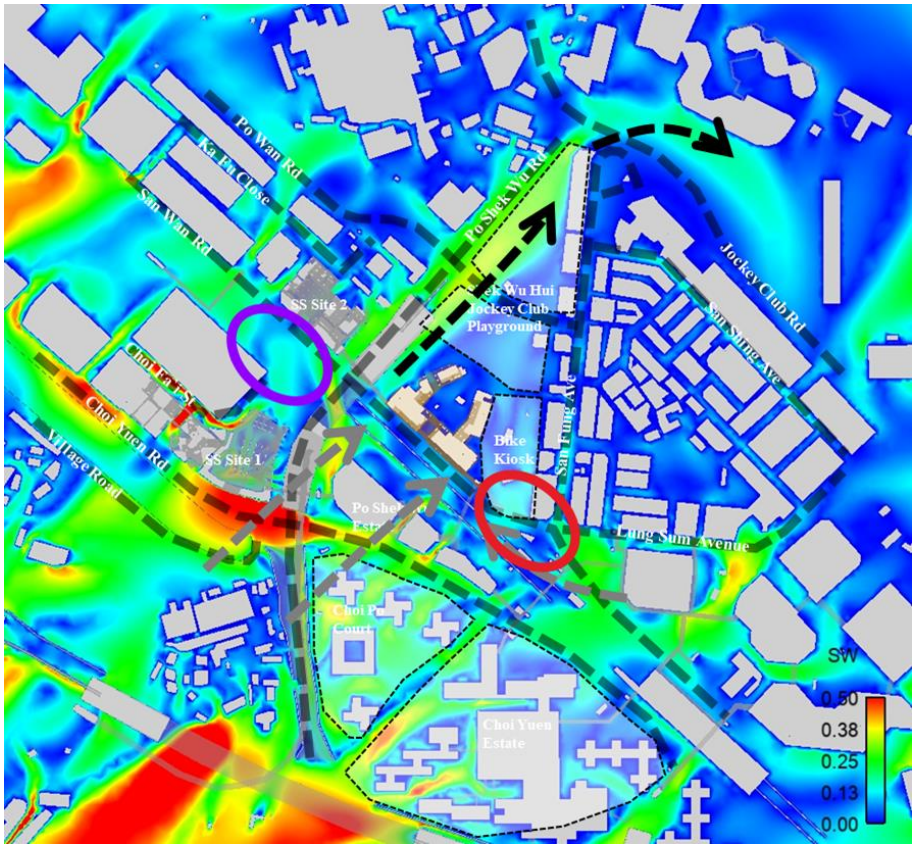


Figure 58 Contour Plot of VR for Baseline Scheme under SW Wind

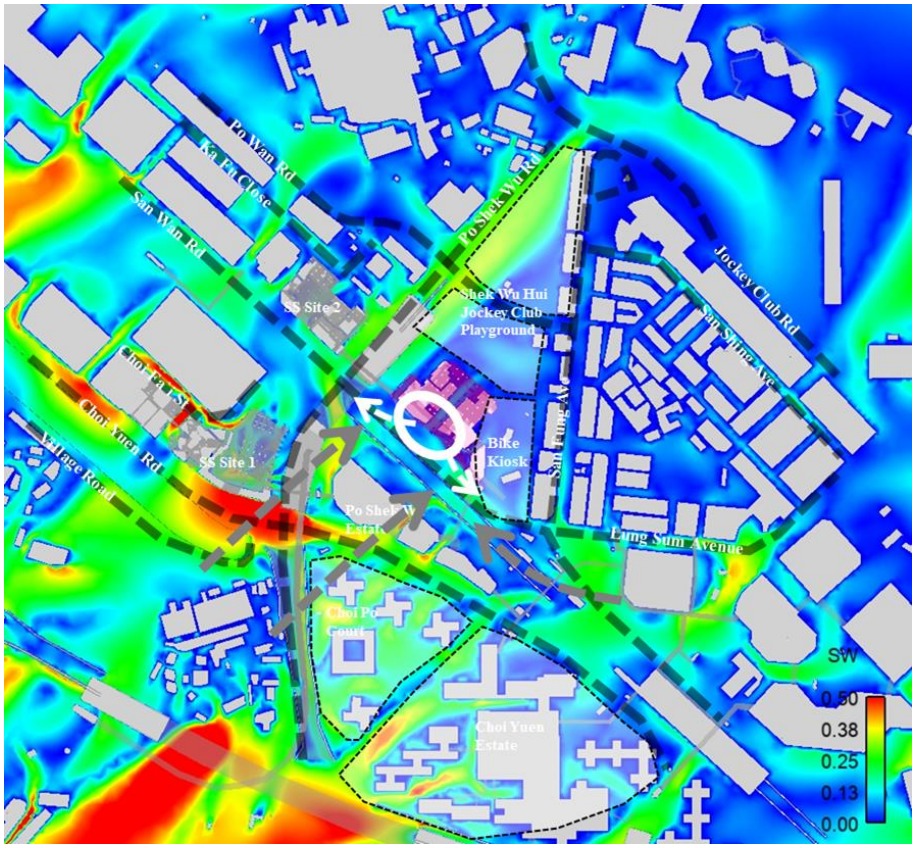


Figure 59 Contour Plot of VR for Proposed Scheme under SW Wind

6.2.10 WSW Wind Direction

The WSW wind contributes to 3.3% of the annual wind and 8.4% of summer wind rose. The overall ventilation performance of Baseline and Proposed Schemes under WSW wind are presented below.

Under WSW wind condition, the incoming wind would first reach SS Site 1 and Po Shek Wu Estate, which would then flow between the two Development to enter Po Shek Wu Road, subsequently reaching the southwestern site boundary of the Development. On the other hand, a small portion of wind could flow between the towers of Po Shek Wu Estate and stream across San Wan Road to reach the southwestern site boundary of the Development. In addition, some incoming high level wind would be able to flow over Po Shek Estate to reach the Development directly. (**Grey Arrows**)

Baseline Scheme and Proposed Scheme

Under both scheme, a portion of wind arriving at the southwestern site boundary would flow further northeast along the site boundary and another portion would be diverted by the southwestern façade of the Development to be diverted into San Wan Road. Under Proposed Scheme, there is a larger building setback from the southwestern site boundary, which would allow for more prevailing wind to be diverted into San Wan Road, creating a higher VR there under Proposed Scheme (**White Circle and Arrows**). A portion of wind would continue to flow along San Wan Road and diverted north into the Bike Kiosk after passing the Development, creating also a higher VR there. Areas further southwest such as Lung Sum Avenue and Lung Wan Street would experience an enhanced VR under Proposed Scheme as well (**White Arrows**).

Consequently, under Baseline Scheme, as less wind would be diverted into San Wan Road, more wind would continue to flow along the western site boundary of the Development and continue east-northeast, ventilating Shek Wu Hui Jockey Club Playground. It should be noted the disposition of Block A would divert the wind more towards east-northeast under Baseline Scheme, as compared to the Proposed Scheme where the wind would flow to the northeast. This would result in a higher VR at Shek Wu Hui Jockey Club Playground and San Fung Avenue under Proposed Scheme (**Black Arrow**). The disposition of Proposed Scheme, on the other hand, would direct the wind more towards northeast, the wind would travel along Po Shek Wu Road and the western portion of the Shek Wu Hui Jockey Club Playground, and would eventually be captured and downwashed by the development northeast of Jockey Club Road, enhancing the VR at areas there such as Fung Nam Road Garden and a localised portion of Jockey Club Road (**Purple Circle and Arrows**).

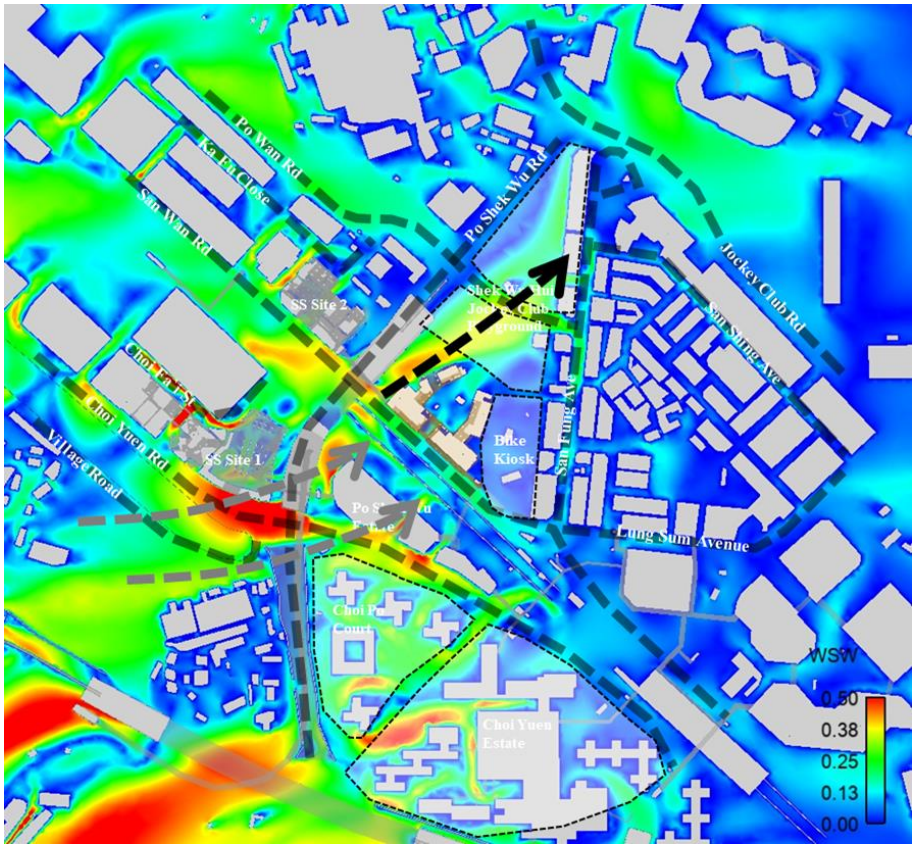


Figure 60 Contour Plot of VR for Baseline Scheme under WSW Wind

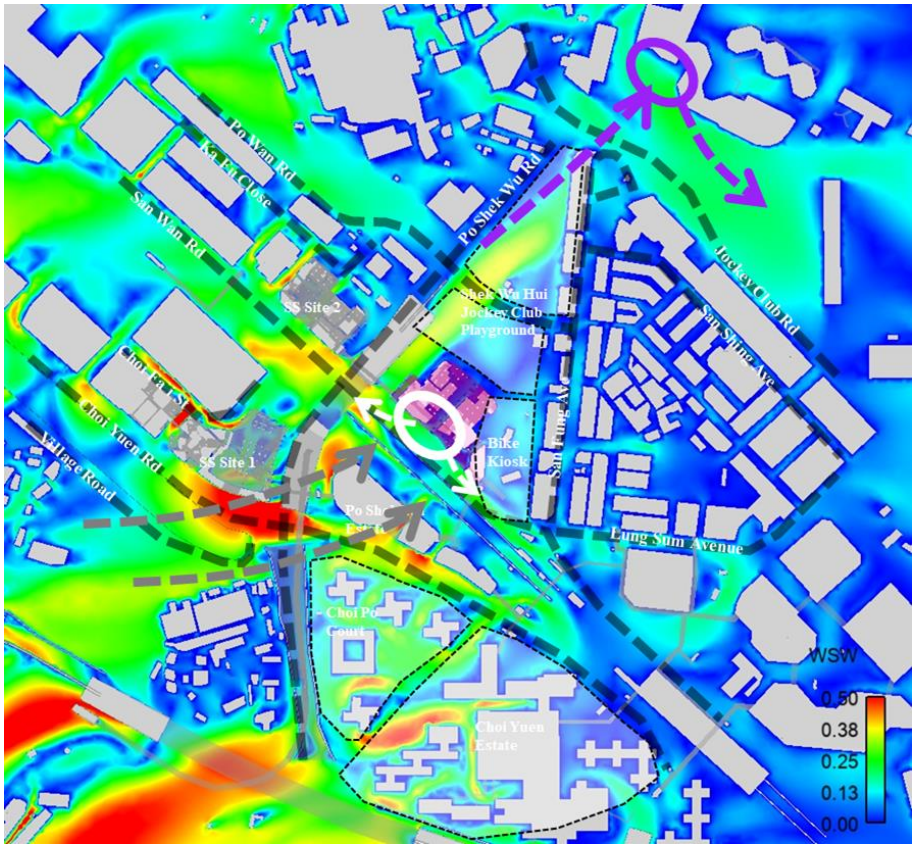


Figure 61 Contour Plot of VR for Proposed Scheme under WSW Wind

6.3 VR Results of Test Points

Table 6 summarises the value of SVR and LVR among Baseline Scheme and Proposed Scheme. The VR of individual test points may be referred to in Appendix.

Table 6 Comparison of the SVR and LVR among Baseline Scheme and Proposed Scheme

	Annual Weighted VR		Summer Weighted VR	
	Baseline Scheme	**Proposed Scheme**	**Baseline Scheme**	**Proposed Scheme**
SVR	0.12	0.13	0.11	0.11
LVR	0.12	0.13	0.13	0.13

Under annual condition, the Proposed Scheme would obtain a slightly higher SVR and LVR as compared to Baseline Scheme. The result indicate that the Proposed Scheme would achieve a slightly better wind environment at close proximity and within the Assessment Area.

Under summer condition, the Proposed Scheme and the Baseline Scheme would obtain the same SVR and LVR, indicating a similar ventilation performance eat close proximity and within the Assessment Area.

6.4 Focus Areas

There are a total of 38 focus areas identified in this study, which are summarised below the Spatial Average VR (SAVR) for each focus areas under annual and summer conditions.

Focus Area		Annual Condition		Summer Condition	
		Baseline Scheme	**Proposed Scheme**	**Baseline Scheme**	**Proposed Scheme**
1	Tai Tau Leng	0.06	0.06	0.10	0.10
2	Village Road	0.15	0.15	0.17	0.17
3	Choi Fat Street	0.12	0.12	0.13	0.13
4	Choi Fai Street	0.12	0.12	0.13	0.13
5	Planned Sheung Shui Areas 4 and 30 Site 1	0.15	0.15	0.17	0.17
6	Planned Sheung Shui Areas 4 and 30 Site 2	0.15	0.16	0.16	0.16
7	Ka Fu Close	0.14	0.14	0.09	0.09
8	Cheuk Wan St	0.11	0.11	0.15	0.15
9	Po Sheung Tsuen	0.11	0.11	0.10	0.10
10	Fung Kai Liu Man Shek Tong Secondary Shool	0.11	0.12	0.13	0.13
11	Fung Nam Road Garden	0.22	0.23	0.23	0.22

Focus Area		Annual Condition		Summer Condition	
		Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
12	Fu Nam Rd	0.19	0.20	0.20	0.20
13	North District Sports Ground Playground	0.15	0.15	0.11	0.11
14	Jockey Club Rd	0.17	0.17	0.14	0.15
15	Fu Hing St	0.11	0.11	0.08	0.08
16	San Fat St	0.06	0.06	0.06	0.06
17	San Lok St	0.07	0.07	0.05	0.05
18	Shek Wu Hui Playground	0.09	0.09	0.07	0.07
19	San Tsoi St	0.07	0.07	0.05	0.05
20	Tsun Fu St	0.07	0.07	0.06	0.06
21	San Hong St	0.08	0.08	0.07	0.07
22	San Cheung St	0.06	0.06	0.05	0.05
23	San Kung St	0.07	0.07	0.08	0.08
24	San Kin St	0.07	0.07	0.07	0.07
25	San Shing Ave	0.12	0.11	0.10	0.10
26	Lung Sum Avenue	0.11	0.11	0.13	0.13
27	Lung Wan St	0.11	0.12	0.14	0.15
28	North District Town Hall Basketball Court	0.09	0.09	0.10	0.10
29	Sun Fung Ave	0.13	0.13	0.09	0.09
30	Shek Wu Hui Jockey Club Playground	0.12	0.12	0.13	0.13
31	Bike Kiosk	0.16	0.17	0.11	0.11
32	Po Shek Wu Estate	0.15	0.16	0.15	0.15
33	Choi Po Court	0.14	0.13	0.15	0.15
34	Choi Yuen Estate	0.13	0.13	0.14	0.14
35	Choi Yuen Rd	0.15	0.15	0.17	0.17
36	San Wan Rd	0.14	0.14	0.18	0.18
37	Po Shek Wu Rd	0.14	0.14	0.19	0.19

Focus Area		Annual Condition		Summer Condition	
		Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
38	Po Wan Rd	0.11	0.11	0.11	0.10
39	Wind Enhancement Feature 1	0.12	0.13	0.08	0.10
40	Wind Enhancement Feature 2	0.18	0.16	0.09	0.10

6.4.1 Annual Condition

Under annual condition, generally the focus areas exhibit a similar VR, indicating a similar ventilation performance in most focus areas.

It could however be observed that Planned Sheung Shui Areas 4 and 30 Site 2, Fung Kai Liu Man Shek Tong Secondary School, Fung Nam Road Garden, Fu Nam Road, Lung Wan Street, Bike Kiosk and Po Shek Wu Estate would have a slightly higher VR under Proposed Scheme. This indicates that the ventilation would be slightly enhanced in these areas under Proposed Scheme.

It can also be observed the Baseline Scheme would have a slightly higher VR at San Shing Avenue and Choi Po Court. This indicates that the ventilation would be slightly calmer in these areas under Proposed Scheme.

It can be observed that under annual condition, the wind enhancement feature 1, which is the airpath between the two towers, would perform better under Proposed Scheme, this is due to the relatively narrower tower separation in the central portion of the Development accelerating the wind flow along the air path. However, Wind Enhancement Feature 2, which is the air path between Block B and Lift tower in Baseline Scheme and a G/F empty bay in Proposed Scheme, the ventilation performance would be relatively calmer under Proposed Scheme, this is due to the wider separation provided under Baseline Scheme (~15m) as compared to Proposed Scheme (~7m) .

6.4.2 Summer Condition

Under summer condition, the majority of focus areas exhibit a similar VR, indicating a similar ventilation performance in most focus areas. The greatly similar wind environment is due to the wind environment being mainly dominated by the southwestern surrounding development which are mostly mid and high rises.

It could however be observed that Lung Wan Street and Jockey Club Road would have a slightly higher VR under Proposed Scheme. This indicates that the ventilation would be slightly enhanced in these areas under Proposed Scheme.

It can also be observed that Po Wan Road and Fung Nam Road Garden would have a slightly higher VR under Baseline Scheme. This indicates that the ventilation would be slightly calmer in these areas under Proposed Scheme.

It can be observed that under summer condition, similar to annual condition, the wind enhancement feature 1, which is the airpath between the two towers, would perform better under Proposed Scheme, this is due to the relatively narrower tower separation in the central portion of the Development accelerating the wind flow along the air path. Wind Enhancement Feature 2, under summer condition, would also have a relatively enhanced ventilation performance under Proposed Scheme. This is due to the increased tower height under Proposed Scheme inducing more downwashed wind, thereby allowing for more wind to reach the Wind Enhancement Feature 2 of Proposed Scheme, whereas under Baseline Scheme, the wind flow available to flow through the Wind Enhancement Feature 2 would be mostly hindered by the southwester surroundings.

7. Conclusion

7.1 Overview

An Air Ventilation Assessment (AVA) – Initial Study was conducted to assess the ventilation performance of Baseline Scheme and Proposed Scheme in accordance with the AVA Technical Circular No. 1/06.

Two schemes were assessed using Computational Fluid Dynamics (CFD) techniques. A series of CFD simulation using Realizable k-ε turbulence model was performed under annual and summer wind conditions with reference to the AVA Technical Circular No. 1/06. For annual wind condition, NNE, NE, ENE, E, ESE, SE, SSW and SW were selected which gives total wind frequency of 77.8% over a year while E, ESE, SE, SSE, S, SSW, SW and WSW were selected for summer condition, which gives total wind frequency of 81.9%.

The Velocity Ratio (VR) as proposed by the AVA Technical Circular No.1/06 was employed to assess the ventilation performance under different schemes and its impact to the surroundings.

With reference to the AVA Technical Circular No. 1/06, 30 perimeter test points and 176 overall test points were allocated to assess the local and overall ventilation performance in the Assessment Area.

7.2 Results

Upon the CFD simulation Proposed Scheme achieved higher SVR and LVR both by 0.01 comparing to Baseline Scheme under annual condition and a similar SVR and LVR under summer condition respectively.

The results of the SVR, LVR are summarized as below.

Table 7 SVR and LVR Summary

	Annual Weighted VR		Summer Weighted VR	
	Baseline Scheme	**Proposed Scheme**	**Baseline Scheme**	**Proposed Scheme**
SVR	0.12	0.13	0.11	0.11
LVR	0.12	0.13	0.12	0.13

8. Reference

[1] “Annex A of Technical Circular No. 1/06 issued by the Housing, Planning and Lands Bureau pertaining specifically to Air Ventilation Assessments, 19th July, 2006,” [Online]. Available: https://www.devb.gov.hk/filemanager/en/content_679/hplb-etwb-tc-01-06.pdf.

[2] “Planning Department RAMS Data,” [Online]. Available: http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/.