Hong Kong Housing Authority

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Consultancy for Environmental Design Studies for Public Housing Development at Ying Yip Road, Tseung Kwan O

Air Ventilation Assessment – Initial Study (AVA-IS)

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1 INTRODUCTION

Background

1.1 AECOM Asia Co. Ltd. has been commissioned by the Hong Kong Housing Authority (HKHA) to undertake an Air Ventilation Assessment (AVA) Study – Initial Study (IS) using Computational Fluid Dynamics (CFD) for the potential Public Housing Development located at Ying Yip Road, Tseung Kwan O to examine the air ventilation impact of the proposed building design qualitatively and formulate effective and practicable measures enhancing the air ventilation as part of the continuous design improvement process.

Objectives

1.2 The AVA Study for the proposed Public Housing Development at Ying Yip Road (i.e. the Project Area) has been conducted in accordance with the methodology outlined in the Technical Guide for AVA for Developments in Hong Kong (the Technical Guide) annexed in HPLB and ETWB TC No. 1/06. The main purposes of this AVA Study, echoing the Technical Guide, are:

- To assess the characteristics of the wind availability (V_∞) of the Project Area;
- To give a general pattern and a rough quantitative estimate of wind performance at the pedestrian level reported using Wind Velocity Ratio (VR);
- To quantitatively assess the air ventilation performance in the neighbourhood of the Project Area; and
- To compare two design scenarios in terms of air ventilation performance aspect.

Content of This Report

1.3 Section 1 is the introduction section. The remainder of the report is organized as follows:

- Section 2 on site characteristics;
- Section 3 on assessment methodology;
- Section 4 on assessment criteria;
- Section 5 on key findings of AVA study;
- Section 6 on directional analysis; and
- Section 7 with a summary and conclusion.

2 SITE CHARACTERISTICS

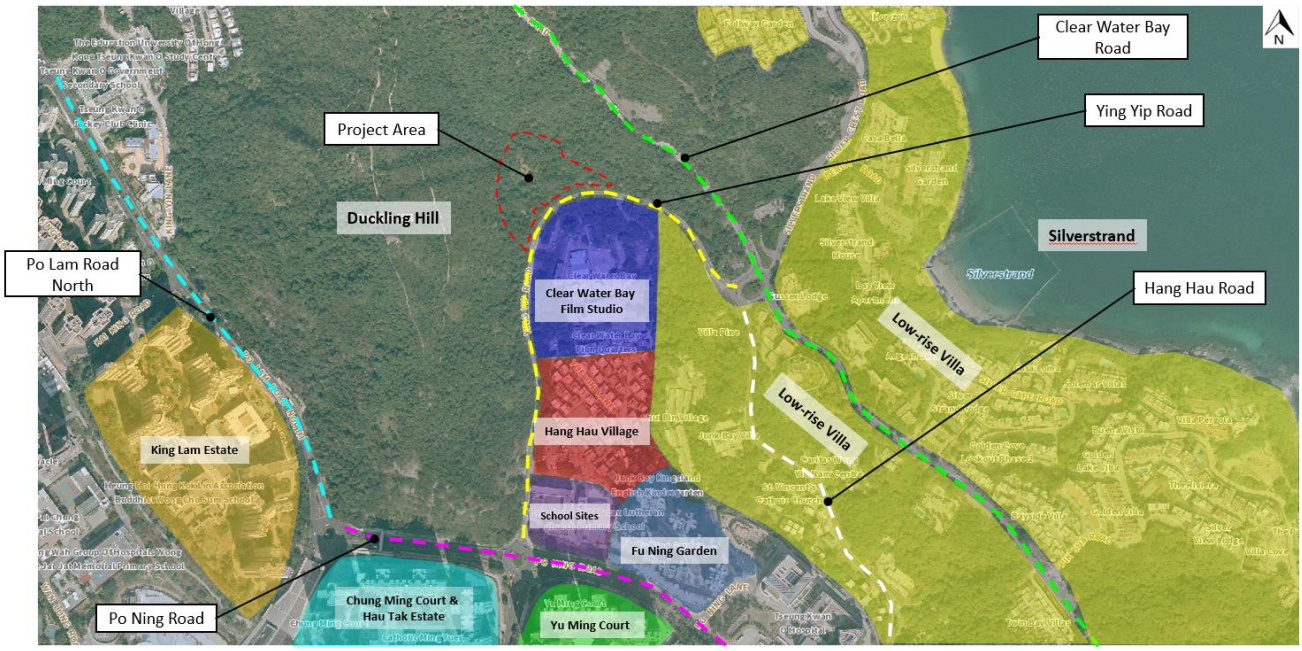
Project Area and Its Surrounding Area

2.1 The Project Area with a gross area of about 1.45 hectares (ha) is located at Ying Yip Road, Tseung Kwan O in the vicinity of Hang Hau region. The Project Area is bounded by hilly terrain of Duckling Hill in the north from south to southeast which located in a valley runs north to south as well as the elevation drops from north to south. The hilly terrain to the east and west of the Project Area drops from 160mPD to 90mPD and 150mPD to 100mPD respectively.

2.2 According to the "Approved Tseung Kwan O Outline Zoning Plan (OZP) No. S/TKO/31", the Project Area falls within "Residential Group (A)7" ("R(A)7") zone. To the immediate south of the Project Area is the low-rise clusters consisting of Clear Water Bay Film Studio, Hang Hau Village, Junk Bay Villa, and various school sites. Further step to the south nearby Po Ning Road is the high-rise development of Hang Hau, such as Fu Ning Garden, Yu Ming Court, Chung Ming Court and Hau Tak Estate included in this region. For the east side of the Project Area across the mountain ridge are numerous of low-rise villa developments, including Silverstrand Garden, Sussex Lodge, Casabella, Dragon Lake Villa, and Fullway Garden etc.

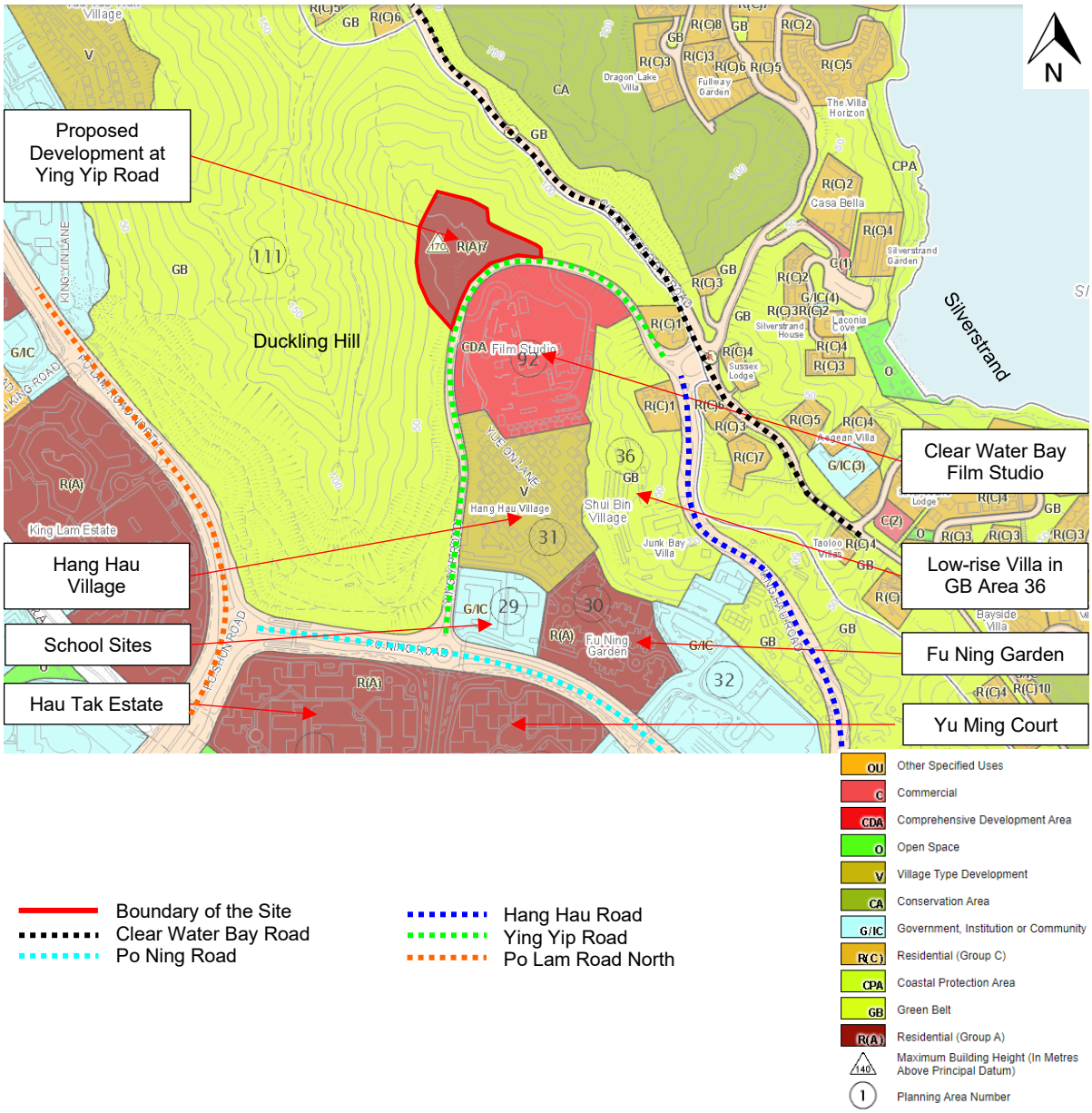
2.3 At the foothill of Duckling Hill across Po Lam Road North is the largely developed with majority of the developments being both large-scale public housing and private residential estates of Po Lam area.

Figure 2.1 Overview of the Project Area and its Surroundings (Source: GeoInfo Map)



Boundary of the Project Area

Figure 2.2 Close-up view of the Project Area and its Surroundings as shown on the OZP (Source: Town Planning Board)



Wind Environment

2.4 The site wind availability of the Project Area was simulated under at least 8 probable prevailing wind directions (which would represent occurrence of more than 75% of time) under both annual and summer condition to illustrate the change in local wind condition due to the Project Area. These prevailing wind directions were determined based on the wind availability simulation result of Regional Atmospheric Modelling System (RAMS) model published by Planning Department (PlanD from hereafter).

2.5 **Figure 2.3** shows the location of relevant wind data extraction while the wind roses representing annual and summer winds at the Project Area of this study were presented in **Figure 2.4** below. Furthermore, the summarized chosen prevailing wind directions and their related occurrence probability were listed in **Table 2.1**. Details of the wind probability table was presented in **Appendix A**.

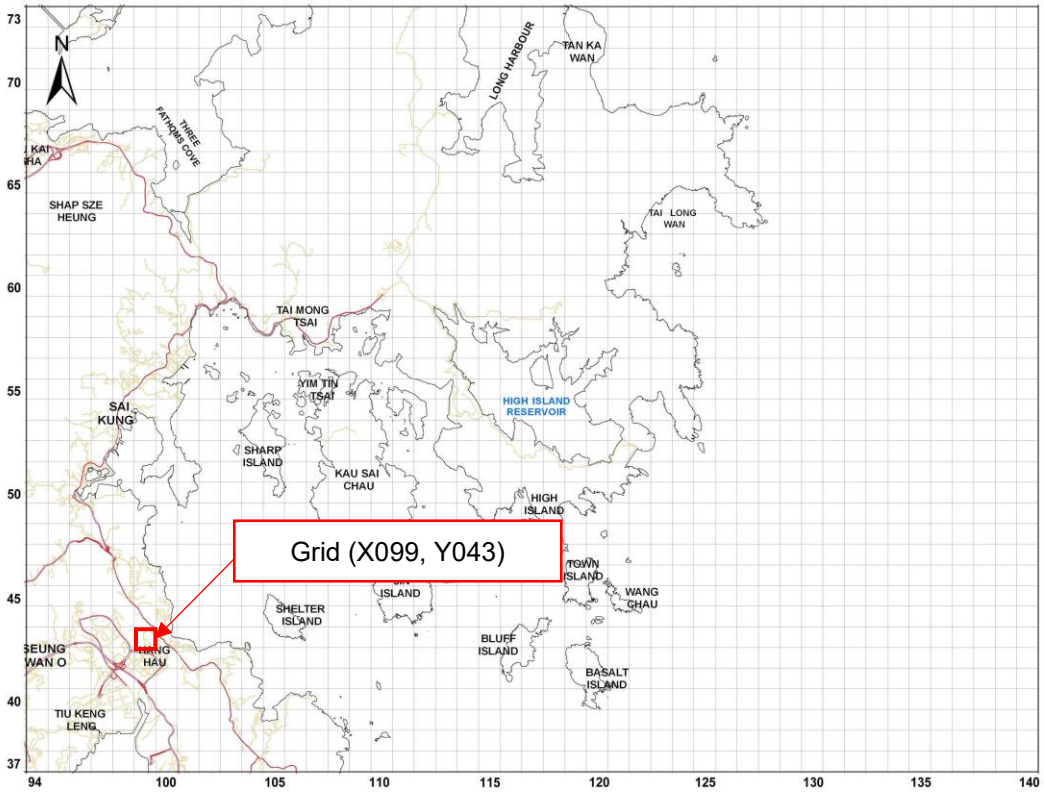
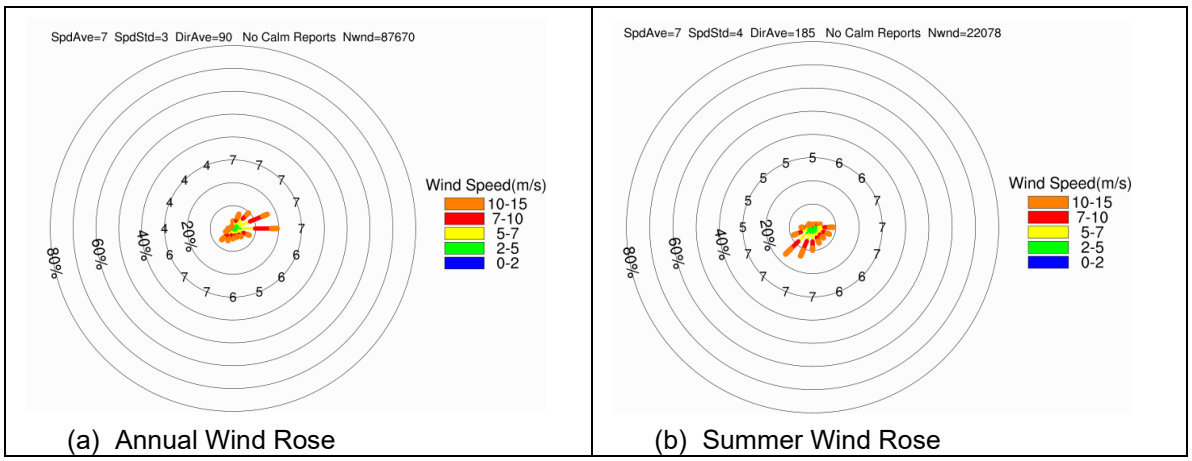


Figure 2.3 Location of Data Extraction in RAMS Model



(a) Annual Wind Rose (b) Summer Wind Rose

Figure 2.4 Wind Rose at Grid (X099, Y043)

Table 2.1 Simulated Wind Directions and their Corresponding Percentage Occurrence

Annual Wind Direction	% of Annual Occurrence	Summer Wind Direction	% of Summer Occurrence
NNE	7.0%	E	9.1%
NE	9.8%	ESE	8.0%
ENE	16.4%	SE	6.7%
E	19.6%	SSE	7.4%
ESE	7.7%	S	10.2%
SE	5.1%	SSW	13.7%
SSW	5.9%	SW	16.8%
SW	7.1%	WSW	9.0%
Total occurrence	**78.6%**	**Total occurrence**	**80.9%**

Vertical Wind Profiles

2.6 Wind environment under different wind directions was defined in the CFD environment. According to the Technical Guide (HPLB and ETWB, 2006) Para 20, wind profile for the Project Area could be appropriated from the V∞ data developed from RAMS and with reference to the Power Law or Log Law using coefficients appropriate to the site conditions. In this assessment, vertical wind profile condition below 20mPD was determined using the Log Law while the wind speed above 20mPD was adopted from the RAMS wind and wind profile in PlanD's website.

2.7 Vertical wind profile and roughness lengths were determined accordingly as follow:

$$\text{Log Law} \quad U_z = \frac{u^*}{\sigma} \ln\left(\frac{Z}{Z_0}\right)$$

Where U_Z : wind speed at height z from ground
u^* : friction velocity
σ : von Karman constant = 0.4 for fully rough surface
Z : height z from ground
Z_0 : roughness length.

2.8 The roughness length for determining vertical wind profiles under different wind direction was tabulated in **Table 2.2**. In this study, the land further away from the surrounding area were urban areas with mid to high-rise developments, as a result, a roughness length with Z_0=3 was adopted for the inflow wind profiles.

Table 2.2 Roughness Length for Determining Vertical Wind Profiles under Different Wind Directions

Land Type of Upwind Area(1)	Roughness Length(2), Z_O
Urban area with mid and high-rise developments	3
Sea or open space	0.1

Notes:
(1) The land type refers to the area upwind of the model domain further away from the Surrounding Area
(2) With reference to Feasibility Study for Establishment of Air Ventilation Assessment System (CUHK, 2005)

3 ASSESSMENT METHODOLOGY

3.1 This AVA study was carried out in accordance with the guidelines stipulated in the Technical Guide for AVA for Developments in Hong Kong with regard to Computational Fluid Dynamics (CFD) modelling. Reference was also made to the "Recommendations on the use of CFD in Predicting Pedestrian Wind Environment" issued by a working group of the COST action C14 "Impact of Wind and Storms on City Life and Built Environment" (COST stands for the European Cooperation in the field of Scientific and Technical Research). COST action C14 is developed by European Laboratories/Institutes dealing with wind and/or structural engineering, whose cumulative skills, expertise and facilities had an internationally leading position. Thus, it was considered that the COST action C14 was a valid and good reference for CFD modelling in AVA study.

Modelling Tool and Model Setup

3.2 Assessment was conducted by means of 3-dimensional CFD model. The well-recognised commercial CFD package FLUENT was used in this exercise. FLUENT model has been widely applied for various AVA research and studies worldwide. The accuracy level of the FLUENT model was very much accepted by the industry for AVA application.

Computational Domain

3.3 A 3D CFD model including major topographical features and building morphology which would likely affect the wind flow was constructed. The methodology described in the Technical Guide was adopted for this assessment. According to the Technical Guide, the Assessment Area should include the project's surrounding up to a perpendicular distance of 1H while the Surrounding Area (marked in blue) should at least include the project's surrounding up to a perpendicular distance of 2H calculating from the project boundary, H being the height of the tallest building within Surrounding Area. In this study, the value of H about 160 meters with the computational domain size of around 3000m x 3000m x 1000m. In addition, grid expansion ratio and the blockage ratio should not excess 1.3 and 3% respectively. The ground of the computational domain should include topography.

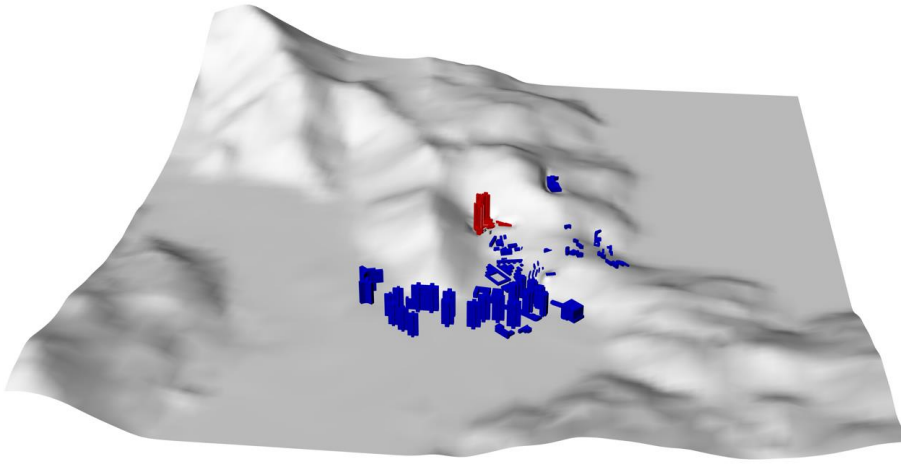


Figure 3.1 Geometry of Computational Model

Assessment and Surrounding Areas

3.4 Both the Baseline Scheme and Proposed Scheme were assessed under annual and summer wind conditions. A 3D model was built according to the GIS information obtained from Lands Department to include all existing, planned and committed development, if any, within the Surrounding Area. All other major elevated structures including the elevated road Ying Yip Road, existing high-rise residential buildings and natural slopes within the Surrounding Area were also included in the model. The Assessment Area (marked in Green) and Surrounding Area (marked in Blue) have also been incorporated in the simulation model for Air Ventilation Assessment as shown in **Figure 3.2**.

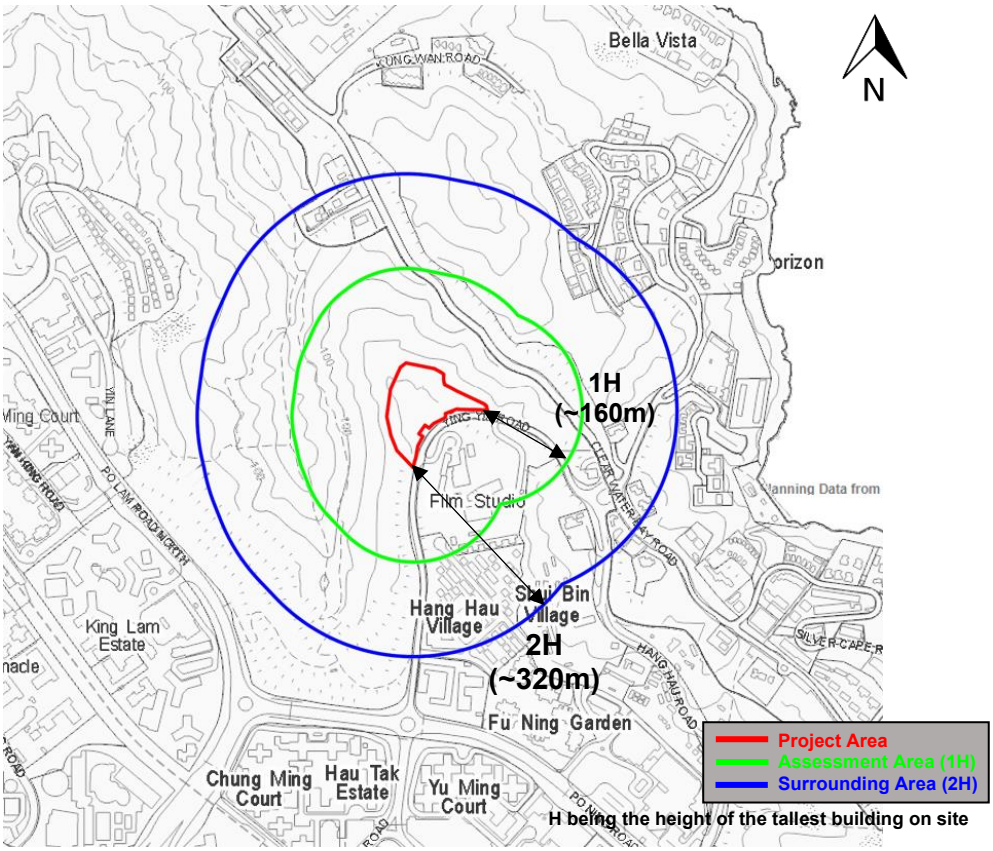


Figure 3.2 Boundaries of the Project Area, Assessment Area and Surrounding Area

Studied Schemes

3.5 The illustrative scheme of the Project Area contains 2 high-rise blocks, namely Block A and Block B bounded by Ying Yip Road to the south and the hilly terrain of Duckling Hill from the south to northeast. These 2 blocks are located on podiums with 2 to 3-storey in height and a one-storey basement.

3.6 The Project Area is zoned “R(A)7” for high-density residential developments according to the approved OZP No. S/TKO/31. The Project Area has an overall PR of 6.5 and a building height restriction of +170mPD.

3.7 **Figure 3.3** and **Figure 3.4** demonstrated model geometry of the Baseline Scheme and the Proposed Scheme in the simulation. Both schemes have considered the above constraints and development parameters.

Baseline Scheme

3.8 The Baseline Scheme consists of 2 domestic blocks with 40 domestic storeys at the maximum building height of 160mPD and a six-storey non-domestic block of 74mPD tall is situated to the east of the domestic blocks that sit on a single storey non-domestic podium of 44mPD tall. A 15m wide building gap between the non-domestic block and the domestic blocks was provided for wind to penetrate.

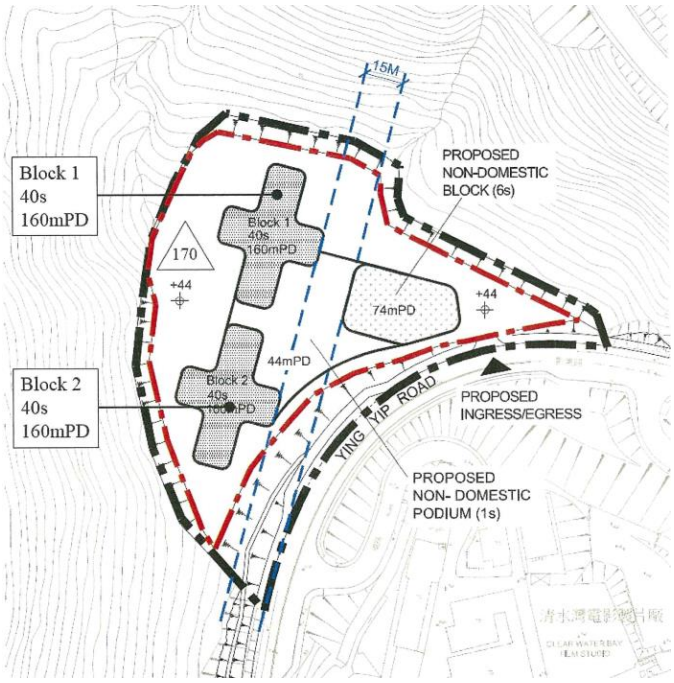


Figure 3.3 Baseline Scheme – Master Layout Plan

Proposed Scheme

3.9 The Proposed Scheme consists of 2 domestic blocks with 36 and 38 domestic storeys, at the maximum building height of 159.3mPD. The welfare and ancillary facilities are located in the two- to three-storey podium and one-storey basement.

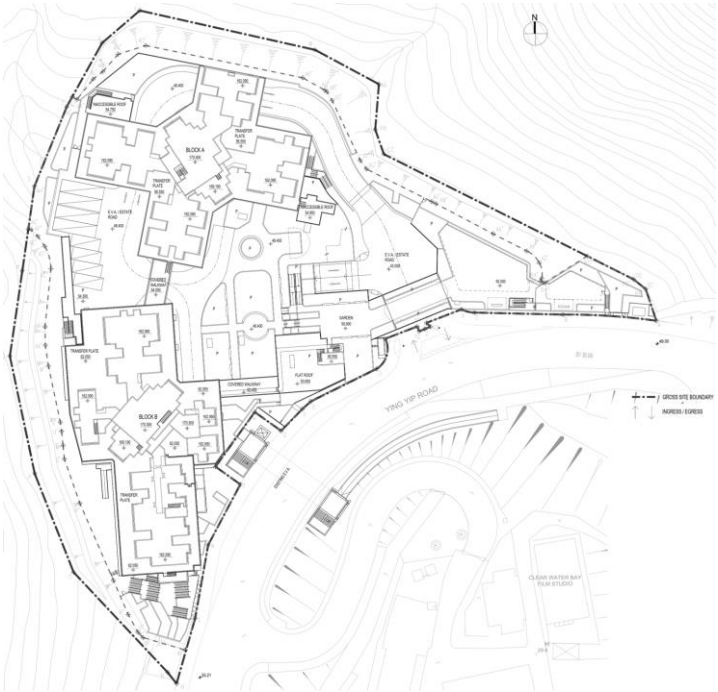


Figure 3.4 Proposed Scheme – Master Layout Plan

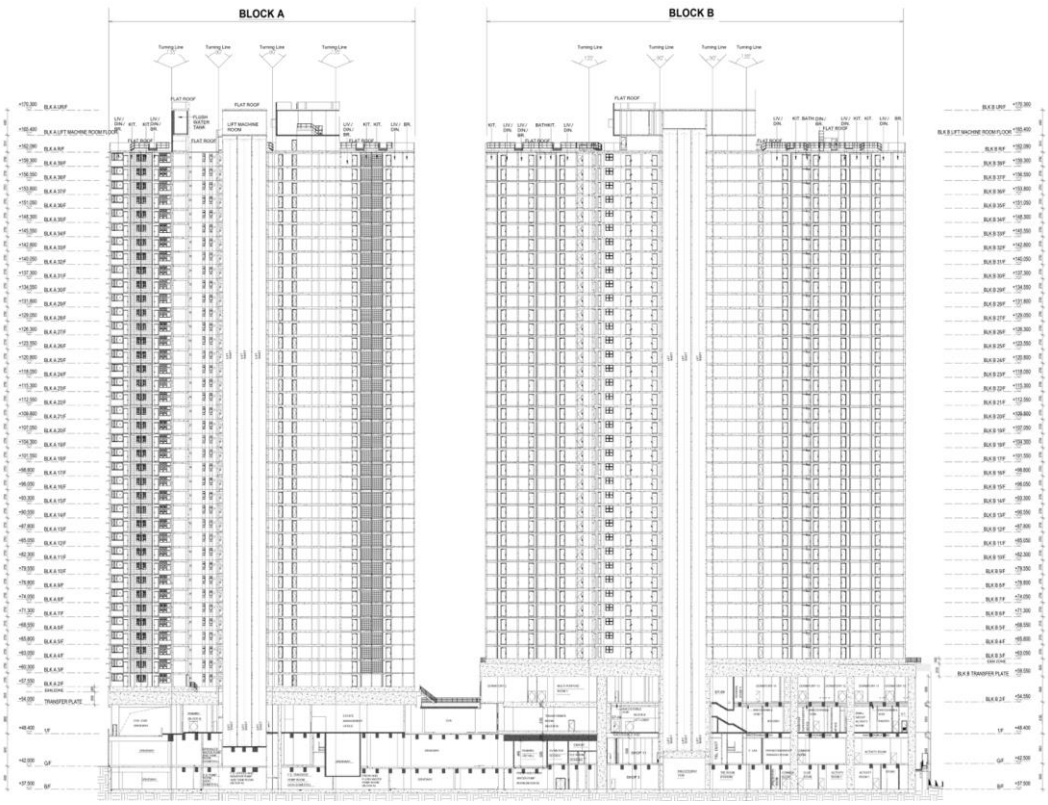


Figure 3.5 Indicative Plan of Proposed Scheme – Section

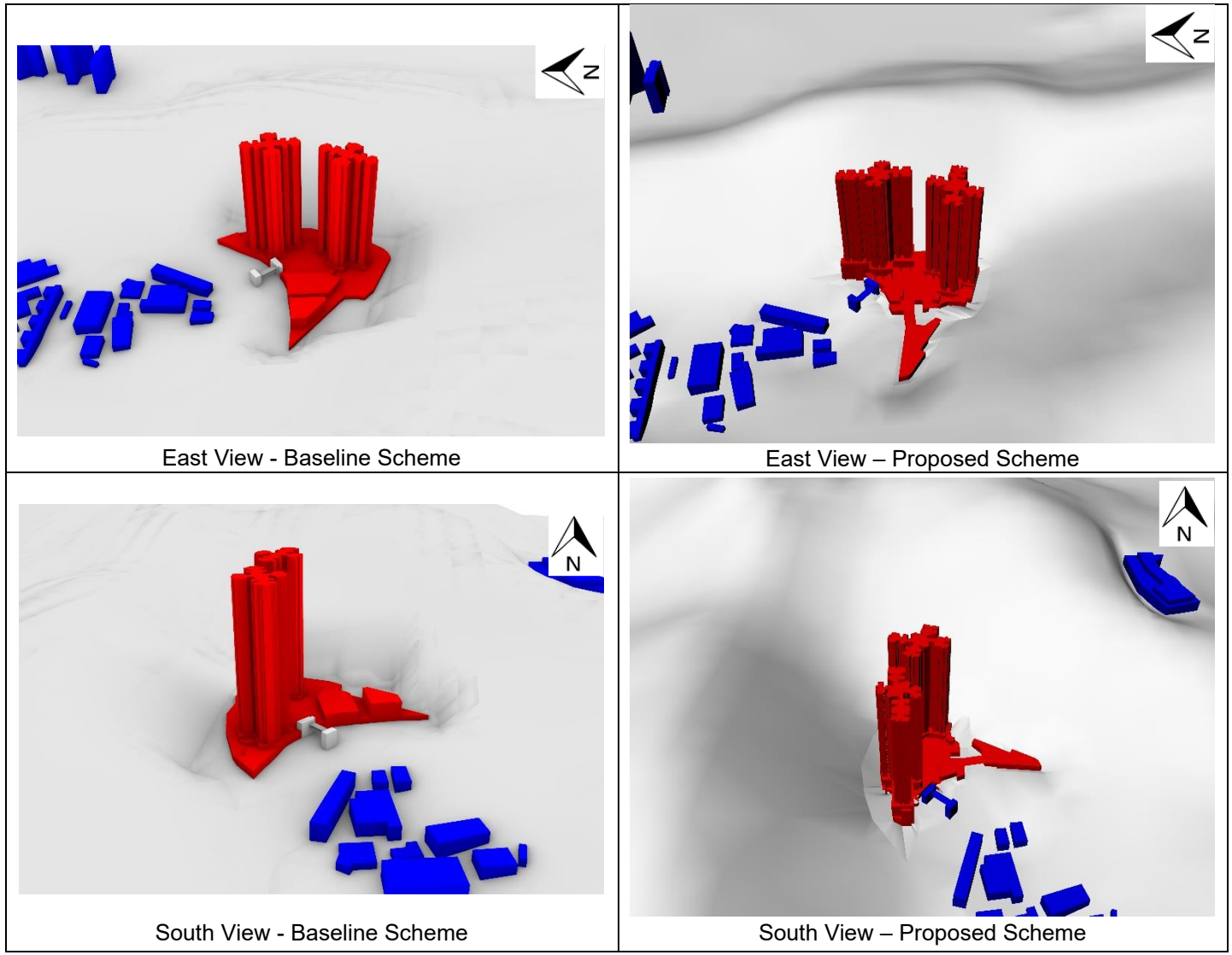


Figure 3.6 Model Geometry under East and South views

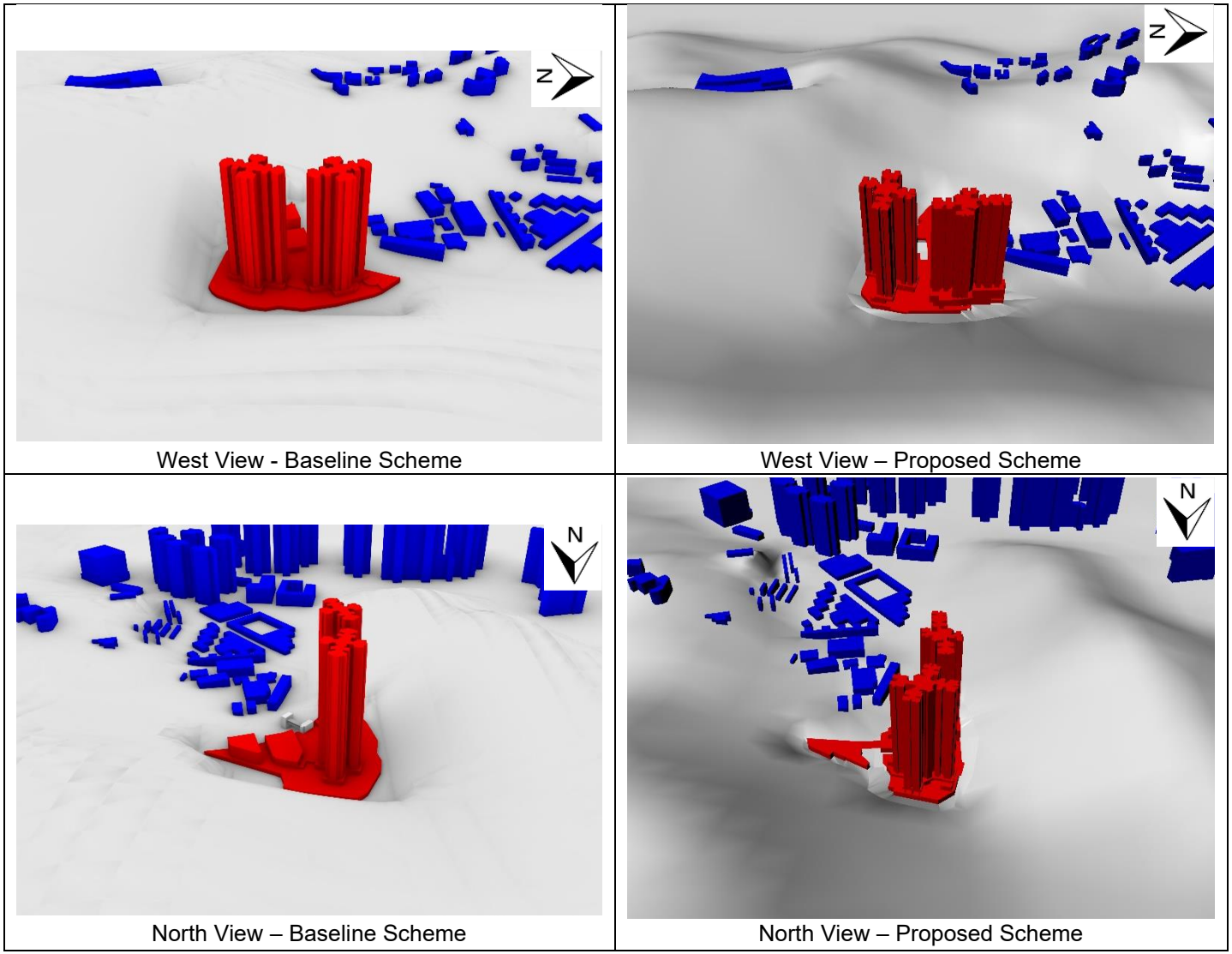


Figure 3.7 Model Geometry under West and North views

Mesh Setup

3.10 The total number of cells for this study was about 20,000,000 cells in tetrahedral mesh. Polyhedral mesh cells counted could often be much smaller than comparable tetrahedral meshes with equivalent accuracy as well as improve mesh quality and manner of convergence (Franklyn, 2006). Grids might be converted to polyhedral mesh, if necessary. The horizontal grid size employed in the CFD model in the vicinity of the Project Area was taken as a global minimum size of about 2m (smaller grid size was also employed for specific fine details) and increased for the grid cells further away from the Project Area. The maximum mesh size within the whole computational domain was about 60m. Besides, six layers of prism cells (each layer of 0.5m thick) were employed above the terrain. The blockage ratio and grid expansion ratio of this computational model was 1.2 and 3% respectively.

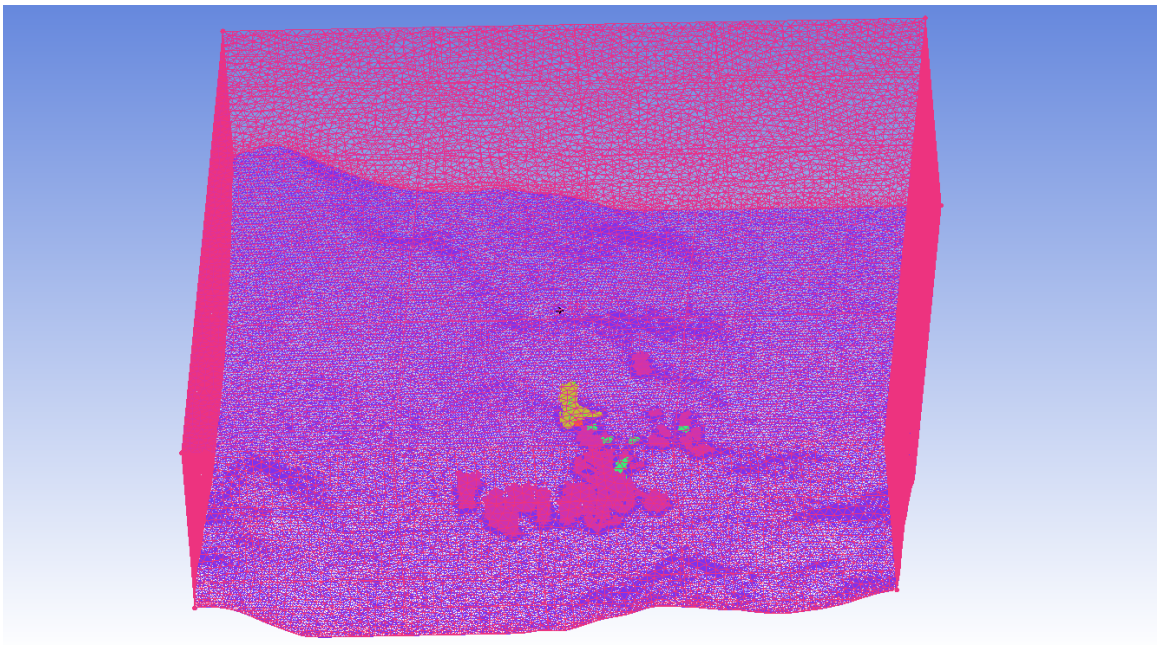


Figure 3.8 Mesh of the Simulation Domain

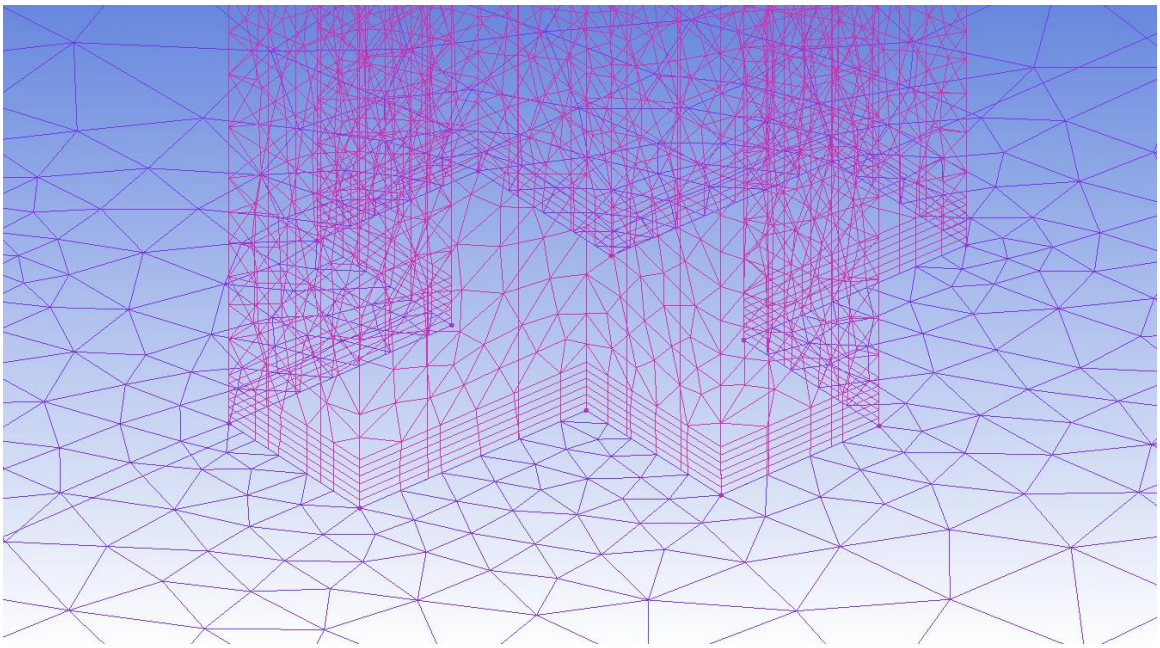


Figure 3.9 Prism Layers Near Ground

Turbulence Model

3.11 As recommended in COST action C14, realizable K-epsilon turbulence model was adopted in the CFD model to simulate the real life problem. Common computational fluid dynamics equations were adopted in the analysis.

3.12 Variables including fluid velocities and fluid static pressure were calculated throughout the domain. The CFD code captures, simulates and determines the air flow inside the domain under study based on viscous fluid turbulence model. Solutions were obtained by iterations.

Calculation Method and Boundary Condition

3.13 The advection terms of the momentum and viscous terms are resolved with the second order numerical schemes. The scaled residuals were converged to an order of magnitude of at least 1×10^{-4} as recommended in COST action C14.

3.14 The inflow face of the computational domain was set as the velocity inlet condition and the outflow face was set as the zero gradient condition. For the two lateral and top faces, symmetric boundary condition was used. Lastly for the ground and building walls, no slip condition was employed.

4 ASSESSMENT CRITERIA AND TEST POINTS LOCATION

Wind Velocity Ratio (VR)

4.1 Wind velocity ratio (VR) indicates how much of the wind availability is experienced by pedestrians on the ground which is a relatively simple indicator to reflect the wind environment of the study site. VR is defined as $VR = Vp / V_{INF}$ where V_{INF} is the wind velocity at the top of the wind boundary layer (greater than 500m in height) would not be affected by the ground roughness and local site features and Vp is the wind velocity at the 2m pedestrian level.

4.2 VRw is the frequency weighted wind velocity ratio calculated based on the frequency of occurrence of 8 selected wind directions or over 75% of occurrence for annual and summer respectively for the purpose of comparison.

4.3 For Site Air Ventilation Assessment, the Site Spatial Average Wind Velocity Ratio (SVRw) and individual VR_W of all perimeter test points were reported. SVRw was the average of VRw of all perimeter test points.

4.4 For Local Air Ventilation Assessment, the Local Spatial Average Wind Velocity Ratio (LVRw) of all overall test points and perimeter test points, and individual VRw of the overall test points were reported. LVRw was the average of all overall test points and perimeter test points.

4.5 The SVRw and LVRw were worked out so as to understand the overall impact of air ventilation on the immediate and further surroundings of the Project Area.

Test Points

4.6 Both perimeter test points and overall test points were selected within the Assessment Area in order to assess the impact on the immediate surroundings and local areas respectively. Overall test points were evenly distributed over surrounding open spaces, streets and other parts of the Assessment Area where pedestrian could or would mostly access. There were 37 Perimeter Test Points and 137 Overall Test Points.

4.7 The Test Points were further divided into 10 groups in order to analyse the respective localized wind environment performances. The coverage of the Test Points Groups was shown in **Figure 4.1** while the description of major covering regions of each group were summarized in **Table 4.1.**

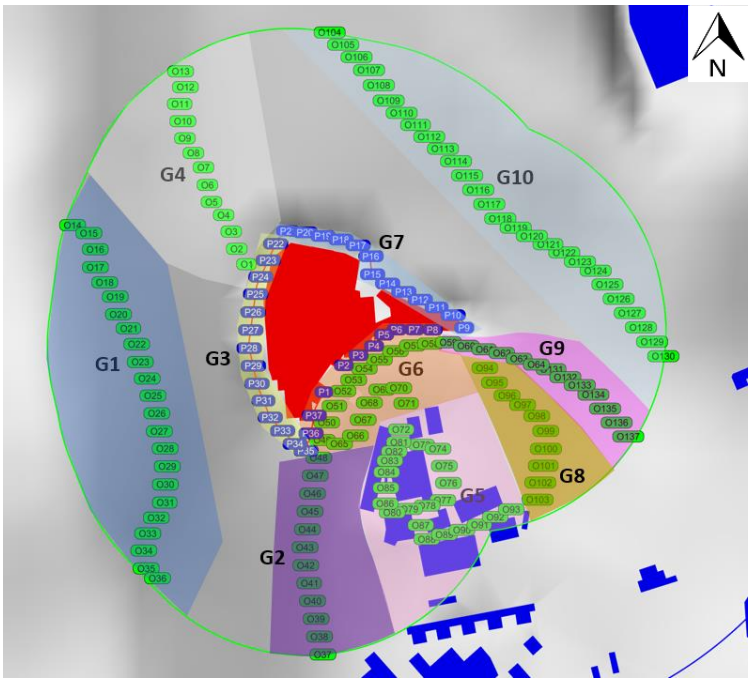


Figure 4.1 Distribution of Test Points

Table 4.1 Test Point Groups and Respective Represented Locations

Test Point Groups	Test Point Numbers	Major Location Covered
G1	O14-O36	Hiking trail connected with Duckling Hill Rest Garden
G2	O37-O48	Ying Yip Road (southern section)
G3	P22-P35	Site Boundary (western)
G4	O1-O13	Hiking trail (northwestern)
G5	O72-O93	Clear Water Bay Film Studio
G6	O49-O58, O65-O71, P1-P8, P36-P37	CDA zone nearby Clear Water Bay Film Studio
G7	P9-P21	Site Boundary (northeastern)
G8	O94-O103	Private Road connected with Clear Water Bay Film Studio
G9	O59-O64, O131-O137	Ying Yip Road (eastern section)
G10	O104-O130	Clear Water Bay Road

5 KEY FINDINGS OF AVA STUDY

5.1 Both Baseline and Proposed Scheme have reserved a 15m wide building gap between the domestic developments, which facilitates the penetration of summer and annual prevailing winds through Ying Yip Road.

5.2 A big design feature difference between Proposed Scheme and Baseline Scheme is observed. For the Baseline Scheme, the 6 storeys non-domestic block (74mPD appx.) sits on top of the single-storey non-domestic podium (44mPD appx.). Whereas the Proposed Scheme is designed to allow the podium to blend into the topography of the Project Area. As a result, the podium could utilise the space in the basement and minimize the height. The height of the non-domestic block is also lowered. Therefore, the prevailing winds could pass ventilate the Project Area more effectively and benefit the wind environment downstream.

5.3 Another difference between Proposed Scheme and Baseline Scheme is the provision of empty bays. In the Proposed Scheme, empty bays at G/F to 1/F are provided in both Block A and Block B to maximize the penetration of summer and annual prevailing winds from Ying Yip Road through the Project Area to the downwind area.

5.4 Moreover, a gap at the main entrance is provided in the Proposed Scheme that could also facilitate prevailing winds to enter the Project Area.

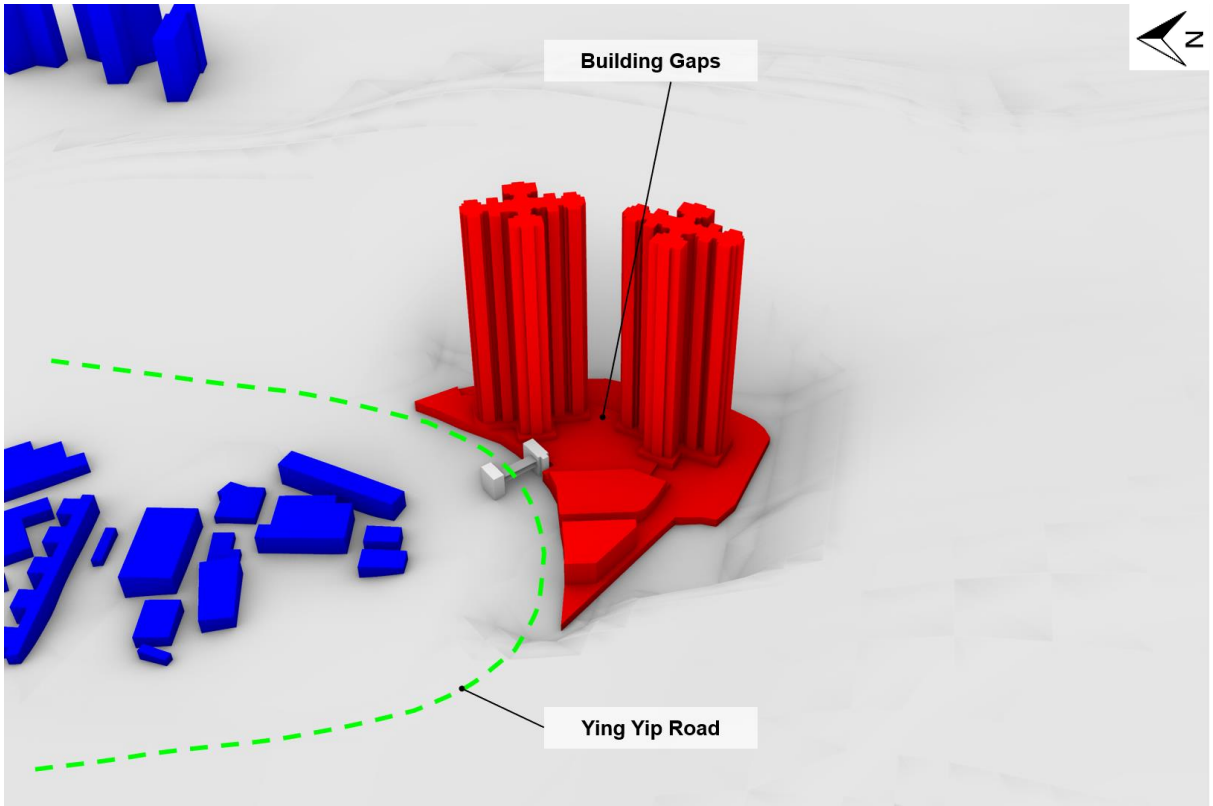


Figure 5.1 Good Design Features in Baseline Scheme

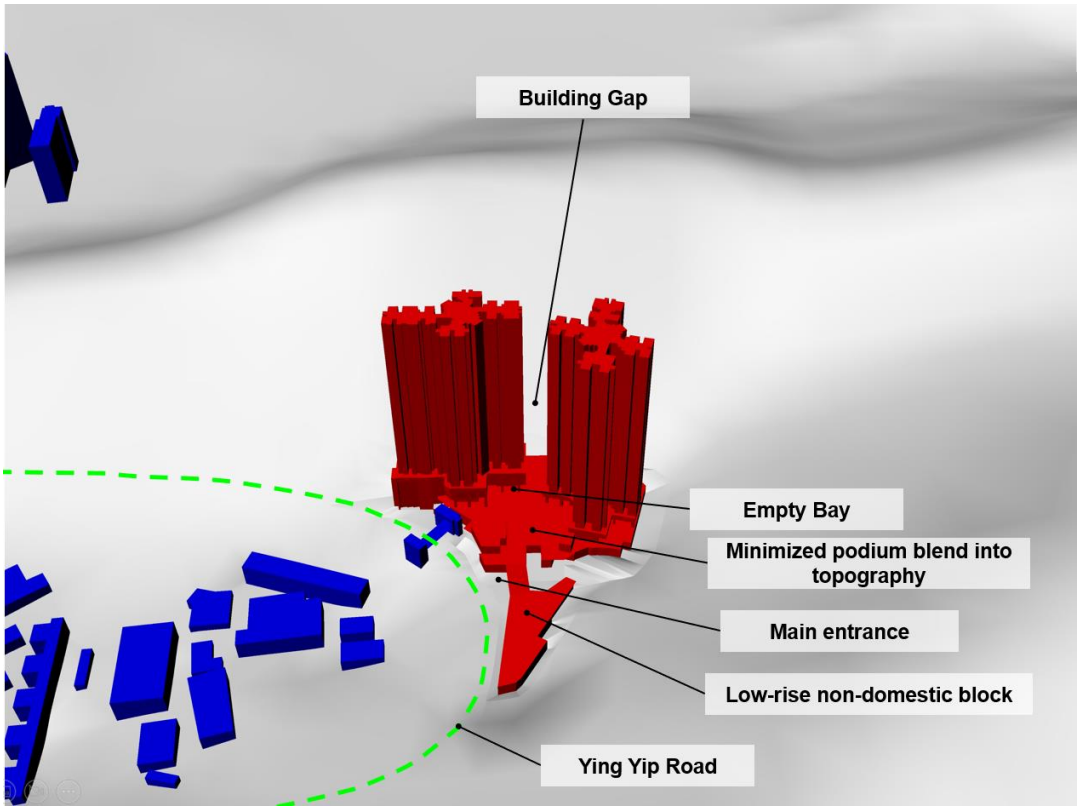


Figure 5.2 Good Design Features in Proposed Scheme

Wind Velocity Ratio Results

5.5 A summary of the predicted wind velocity ratios for the Perimeter Test Points and the Overall Test Points i.e. SVR_W and LVR_W under both annual and summer prevailing winds were presented in **Table 5.1** below. Details of the predicted wind velocity ratios were presented in **Appendix B**.

Table 5.1 Summary of Wind Velocity Ratio

	Annual Winds		Summer Winds	
	Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
SVR_W	0.273	0.331	0.221	0.262
LVR_W	0.339	0.359	0.295	0.318

5.6 The results of VRw for different groups of test points were summarized in **Table 5.2** below.

Table 5.2 Summary of Wind Velocity Ratio for Different Test Point Groups

Group	Description	Test Points	Average VR_w (Annual Winds)		Average VR_w (Summer Winds)	
			Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
G1	Hiking trail connected with Duckling Hill Rest Garden	O14-O36	0.66	0.65	0.46	0.48
G2	Ying Yip Road (southern section)	O37-O48	0.36	0.32	0.28	0.26
G3	Site Boundary (western)	P22-P35	0.34	0.43	0.21	0.29
G4	Hiking trail (northwestern)	O1-O13	0.38	0.32	0.33	0.31
G5	Clear Water Bay Film Studio	O72-O93	0.15	0.21	0.09	0.11
G6	CDA zone nearby Clear Water Bay Film Studio	O49-O58, O65-O71, P1-P8, P36-P37	0.28	0.26	0.21	0.20
G7	Site Boundary (northeastern)	P9-P21	0.21	0.32	0.18	0.23
G8	Private Road connected with Clear Water Bay Film Studio	O94-O103	0.29	0.28	0.21	0.22
G9	Ying Yip Road (eastern section)	O59-O64, O131-O137	0.29	0.33	0.24	0.27
G10	Clear Water Bay Road	O104-O130	0.35	0.39	0.37	0.40

5.7 Contour plots of wind velocity ratio at 2m above the pedestrian level of assessment area under prevailing wind directions were shown in directional analysis in Section 6.

Site Air Ventilation Assessment

5.8 The SVRw indicated how the lower portion of the buildings within the Project Area affects the wind environment of its immediate vicinity. Under annual prevailing winds, the average of predicted SVRw over these prevailing winds for the Baseline Scheme and Proposed Scheme were increased from 0.273 to 0.331, indicating a significantly better wind environment around the development site boundary. In summer, the SVRw also increased from 0.221 to 0.262 which indicated a better wind environment during summer conditions.

5.9 Test points P22 to P35 were located within the western portion of the Project Area. This focus area aligned with Ying Yip Road as a major wind corridor under the summer condition. The VRw was increased from 0.34 to 0.43 for the Baseline and Proposed Scheme under the annual condition, while they were 0.21 and 0.29 in the summer condition. The minimized height of the non-domestic block and provision of empty bays would allow more annual and summer prevailing winds flow into the Project Area.

5.10 It was expected that the Proposed Scheme would have better air ventilation performance at the north-eastern portion of the Project Area under the annual condition when compared to Baseline Scheme due to the design of blending the non-domestic podium into the topography allowing more prevailing winds to flow into the north-eastern side of the Project Area. The air ventilation performance monitored by test points P9 to P21 increased from 0.21 to 0.32 for the Baseline and Proposed Scheme under annual conditions, while in summer conditions, VR increased from 0.18 to 0.23 as the lower height of the non-domestic block and the gap at G/F main entrance would facilitate more prevailing winds to flow into this area.

Local Air Ventilation Assessment

5.11 The LVRw indicated the overall wind environment within the Assessment Area of the Baseline Scheme and Proposed Scheme under the annual and summer prevailing winds. The LVRw increased from 0.339 to 0.359 under the annual prevailing winds. During the summer seasons, the LVRw increased from 0.295 to 0.318. The results indicated that the Proposed Scheme would have a slightly improvement on the pedestrian wind environment compared to the Baseline Scheme at the Project Area boundary and throughout the Assessment Area.

5.12 The average wind velocity ratio of Group 1 test points reflected the wind environment along the hiking trail connected with Duckling Hill Rest Garden to the west of the Project Area. The Proposed Scheme maintained a similar wind environment within the Group 1 area that the average VRw in Group 1 test points were slightly reduced from 0.66 to 0.65 for the Baseline Scheme and Proposed Scheme in annual condition. While in the summer season, the average VRw for the Baseline Scheme and the Proposed Scheme were increased from 0.46 to 0.48, indicating a slightly better wind environment due to the minimized non-domestic block and the provision of empty bays allowed more prevailing winds to reach this area.

5.13 The VRw values of Group 2 Test Points indicated the air ventilation performance of the southern section of Ying Yip Road to the south of the Project Area. The results indicated that the VRw values decreased from 0.36 to 0.32 for the Baseline Scheme and the Proposed Scheme respectively for annual prevailing winds. As for summer, a slightly worse wind environment was observed between the Baseline Scheme and the Proposed Scheme with decrease in VRw from 0.28 to 0.26. It is because the gap at the main entrance in the Proposed Scheme captured a portion of incoming winds to enter the Project Area, resulting in the southern section of Ying Yip Road receiving a weaker wind environment.

5.14 The ventilation performance of the western portion within the Project Area was assessed by Group 3 test points. The VRw increased from 0.34 for the Baseline Scheme to 0.43 for the Proposed Scheme, indicating a better ventilation performance in this area under annual conditions. For the summer winds, VRw increased from 0.21 to 0.29. There was a significant ventilation enhancement for this monitoring region for the Proposed Scheme thanks to the provision of empty bays allowing the prevailing winds to penetrate the domestic developments and reach this area.

5.15 Group 4 test points located at the northwest of the Project Area, covering the hiking trail at the green belt area in Duckling Hill. It was observed that the Proposed Scheme would have worse air ventilation performance compared to Baseline Scheme with VRw decreased from 0.38 to 0.32 annually and slightly reduced from 0.33 to 0.31 in the summer condition which represented the proposed development would have negative impacts for Group 4.

5.16 The ventilation performance of the Clear Water Bay Film Studio was represented by Group 5 test points which were located in the south of the Project Area. Under the Proposed Scheme, the VRw was increased from 0.15 to 0.21 compared to the Baseline Scheme, which illustrated a better ventilation performance in the Clear Water Bay Film Studio. In summer conditions, the VRw slightly increased from 0.09 to 0.11 for the Proposed Scheme, which showed that the proposed development would have positive impacts on the Clear Water Bay Film Studio since more prevailing winds could pass through the Project Area and ventilate this area, which associated with the minimized non-domestic podium and the gap at the G/F main entrance.

5.17 Group 6 test points were located at the CDA zone nearby Clear Water Bay Film Studio to the southeast quadrant of the Project Area, and the VRw indicated a similar wind environment in this area. It was observed that the average velocity ratio was reduced from 0.28 to 0.26 for Baseline Scheme and the Proposed Scheme under annual conditions. Whereas the summer VRw slightly decreased from 0.21 to 0.20 for Baseline Scheme and Proposed Scheme.

5.18 The VRw values Group 7 test points located at the north-eastern portion within the Project Area, and the VRw indicated a better pedestrian wind environment. It was noticed that the average velocity ratio significantly increased from 0.21 to 0.32 for the Baseline Scheme and the Proposed Scheme under annual conditions. While summer VRw were 0.18 and 0.23 respectively for the Baseline Scheme and the Proposed Scheme, demonstrated that the proposed development would have positive impacts on this area due to the gap at main entrance as well as the provision of empty bays allowing the prevailing winds to the pass through the Project Area and enter this area.

5.19 The average wind velocity ratio of Group 8 test points reflected the wind environment along with the private road connected with Clear Water Bay Film Studio to the southeast of the Project Area. It was observed that the Baseline Scheme and the Proposed Scheme would have similar air movement with VRw of 0.29 and 0.28 respectively under annual conditions while with VRw of 0.21 and 0.22 respectively under summer conditions.

5.20 The ventilation performance of the eastern section of Ying Yip Road to the east of the Project Area was assessed in Group 9 Test Points. The results indicated that the VRw values of the Proposed Scheme slightly increased from 0.29 to 0.33 as compared to the Baseline Scheme in annual conditions. Similarly, the VRw values of the Proposed Scheme slightly increased from 0.24 to 0.27 during summer. It illustrated that the Proposed Scheme slightly improved the ventilation performance of this area as the empty bays and low-rise non-domestic block facilitated the wind penetration to the downstream area to the southeast of the Project Area.

5.21 Group 10 test points were located along Clear Water Bay Road to the northeast quadrant of the Project Area. Under annual conditions, the VRw increased from 0.35 to 0.39 for the Proposed Scheme compared with the Baseline Scheme. Also, the VRw under summer prevailing wind was increased from 0.37 to 0.40, which implied that more wind was diverted to this area in summer conditions. The improved wind performance was allied with the provision of empty bays and the minimized non-domestic block that allowed the prevailing winds from the southwest quadrant to flow to this area and reattached with the winds flowing along Clear Water Bay Road.

6 DIRECTIONAL ANALYSIS

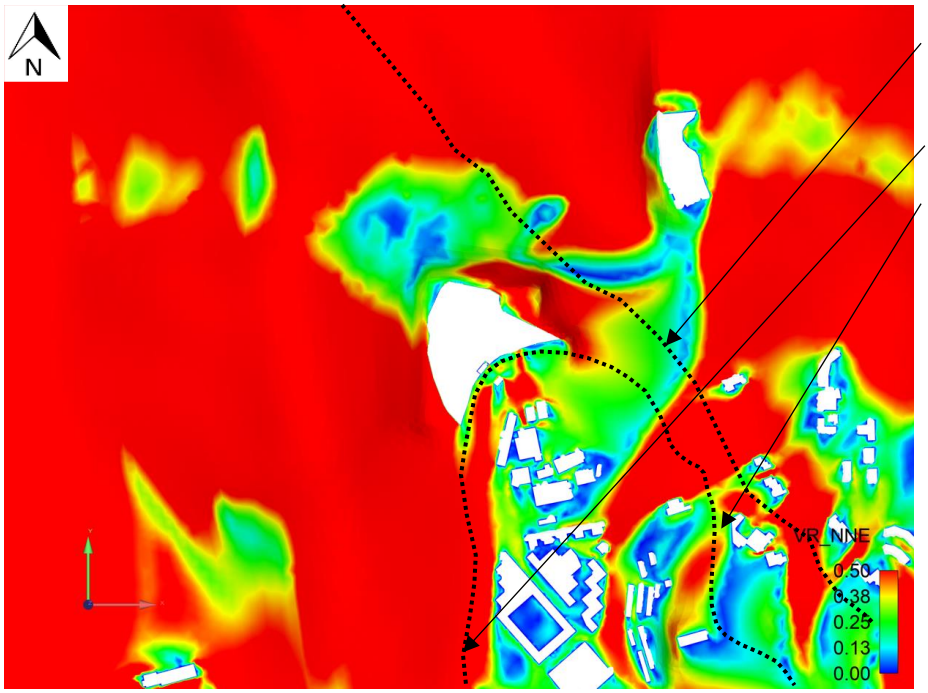
NNE: (Annual: 7.0%)

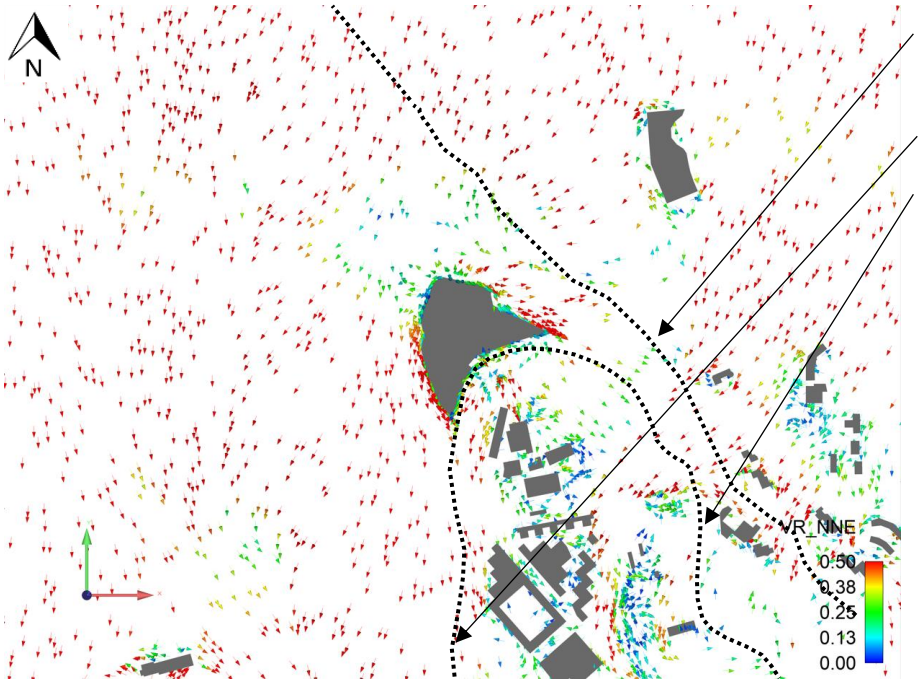
6.1 Under NNE wind, site wind availability of the Project Area mainly relied on the katabatic wind from the natural slopes of Duckling Hill to the northeast. The incoming wind was weakened by the hilly range and then flew into the valley and arrived the at Project Area.

6.2 In the Baseline Scheme, a portion of the NNE wind penetrated through the Project Area by the 15m building gap between the domestic blocks and the non-domestic block and reached Ying Yip Road to the south of the Project Area. It was observed that the downstream area of the Project Area did not exist a large wind-influencing zone thanks to the building gap. Another stream flew toward the valley, and it was noticed that the circulation wind ventilated the western portion of the Project Area.

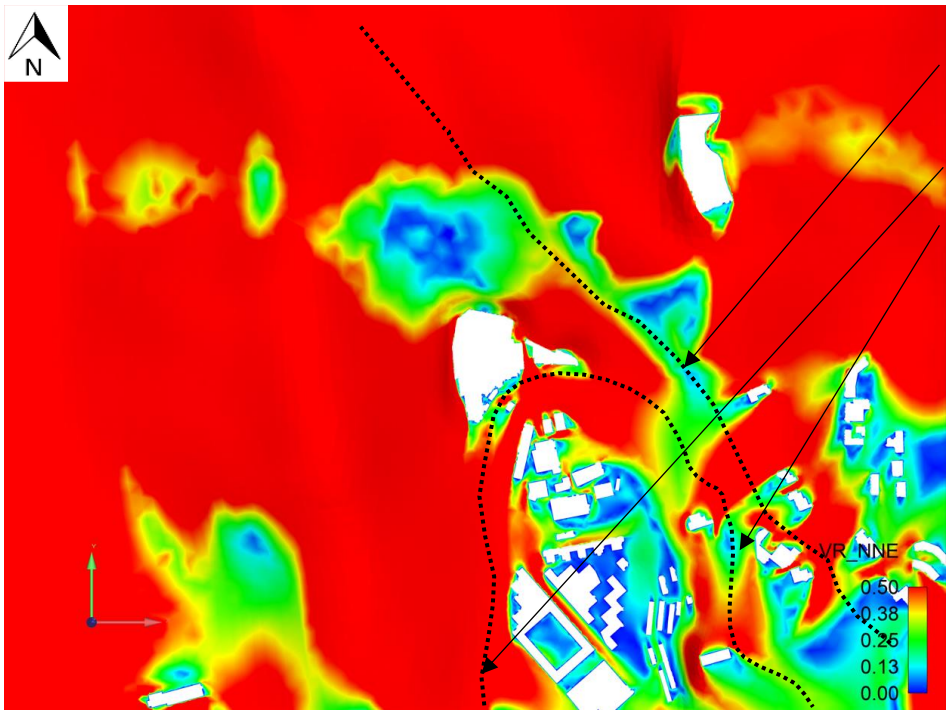
6.3 In the Proposed Scheme, a similar wind flow pattern was observed. However, a gap at the main entrance allowed the incoming winds directly flew through the middle of the Project Area. As a result, the ventilation performance in the downstream area of the Project Area, namely the CDA zone, and the Clear Water Bay Film Studio increased as compared to the Baseline Scheme.

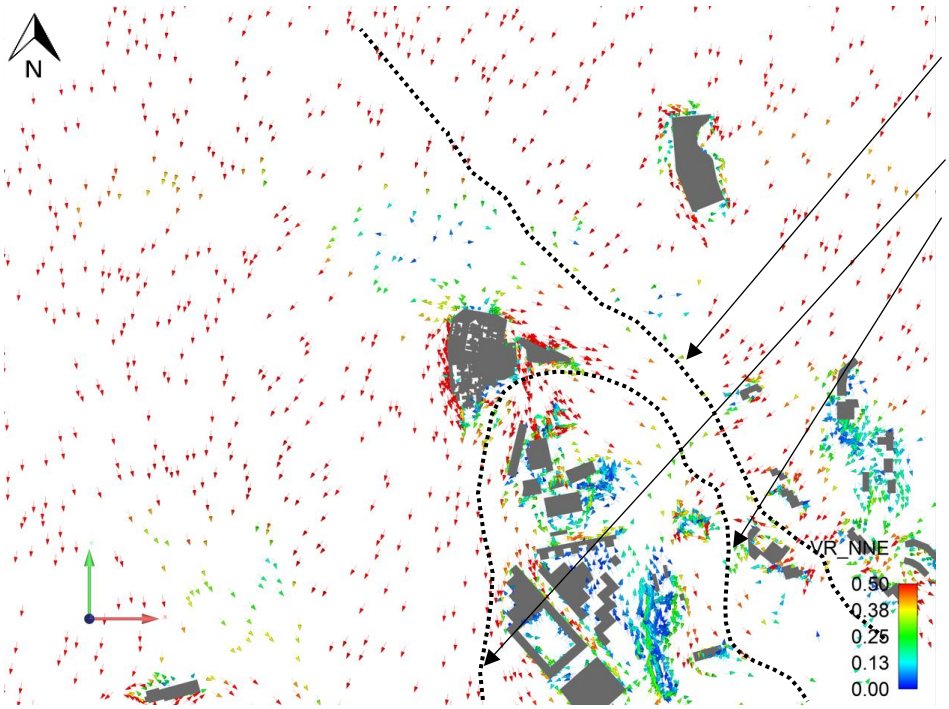
Baseline Scheme





Proposed Scheme





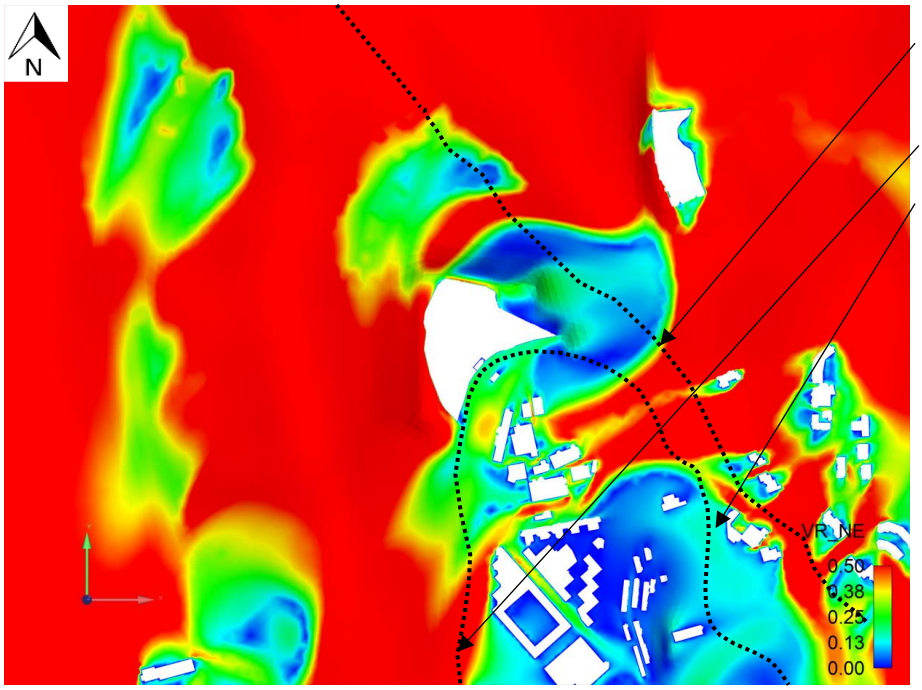
NE: (Annual:9.8%)

6.4 Similar to NNE wind, the site wind availability of the Project Area mainly relied on the incoming wind from the low ridge area near Silverstrand and part of the katabatic wind from the natural slopes of Duckling Hill to the northeast. The incoming wind was also weakened by the hilly range, a wind shadow of the hilly range was observed. While a portion of incoming wind flew along Ying Yip Road to ventilate the southern portion of the Project Area.

6.5 In the Baseline Scheme, the incoming NE winds could not penetrate the Project freely. It was noticed that Block A and the 6-storeys non-domestic block would obstruct the katabatic winds. Therefore, the wind environment in the northeastern portion of the Project Area was relatively calmer.

6.6 In the Proposed Scheme, because of the provision of empty bays and the minimized non-domestic block, more katabatic winds could enter the Project Area compared to the Baseline Scheme. As a result, the wind availability was satisfactory in the northeastern portion of the Project Area. In addition, it was observed that the wind-influencing zone at the leeward side of the podium is smaller thanks to the design of the non-domestic podium that blended into topography.

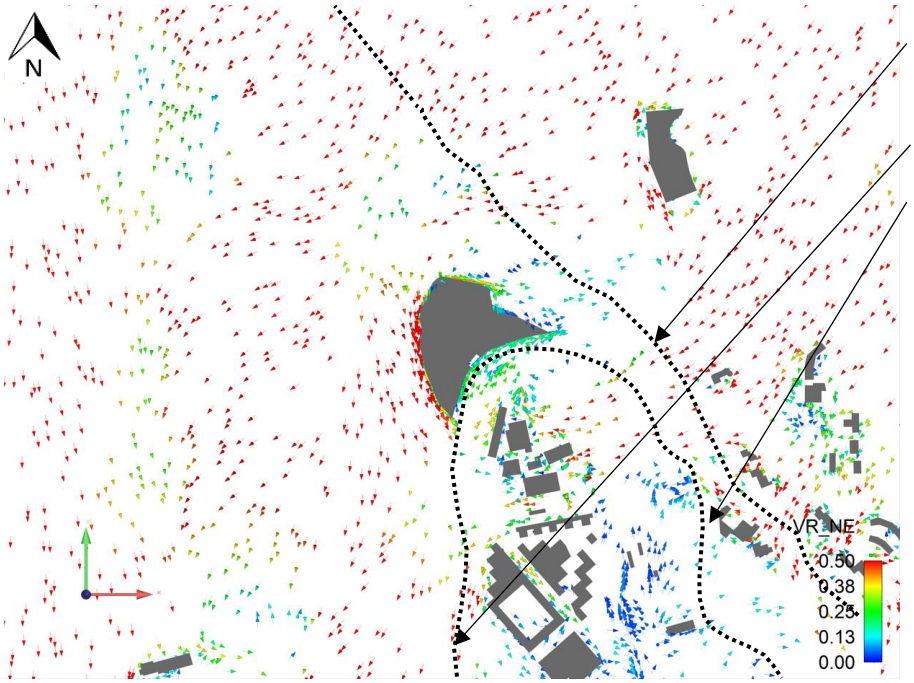
Baseline Scheme



Clear Water Bay Road

Ying Yip Road

Hang Hau Road

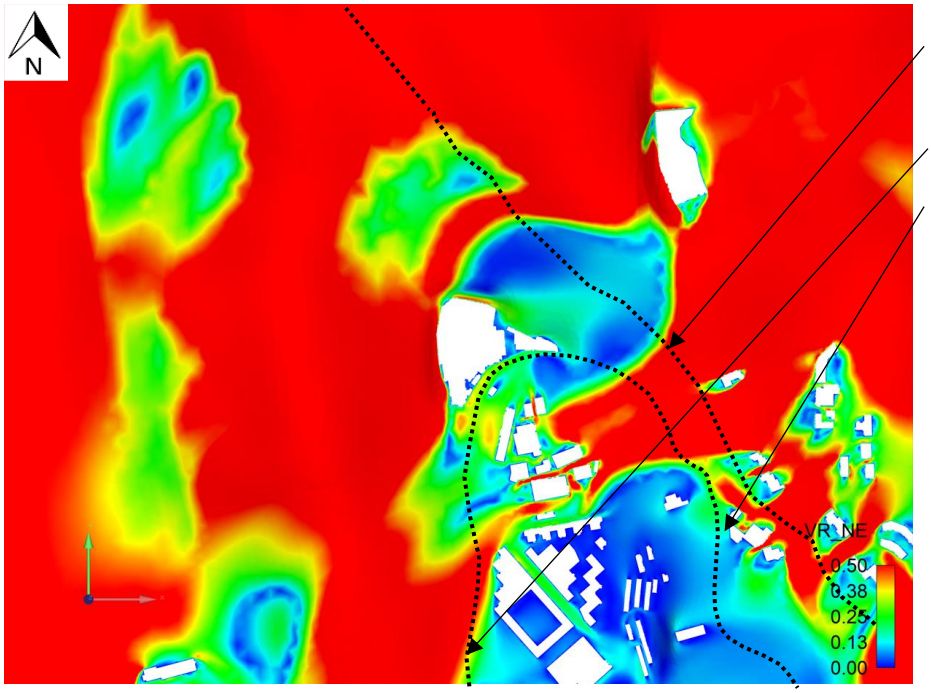


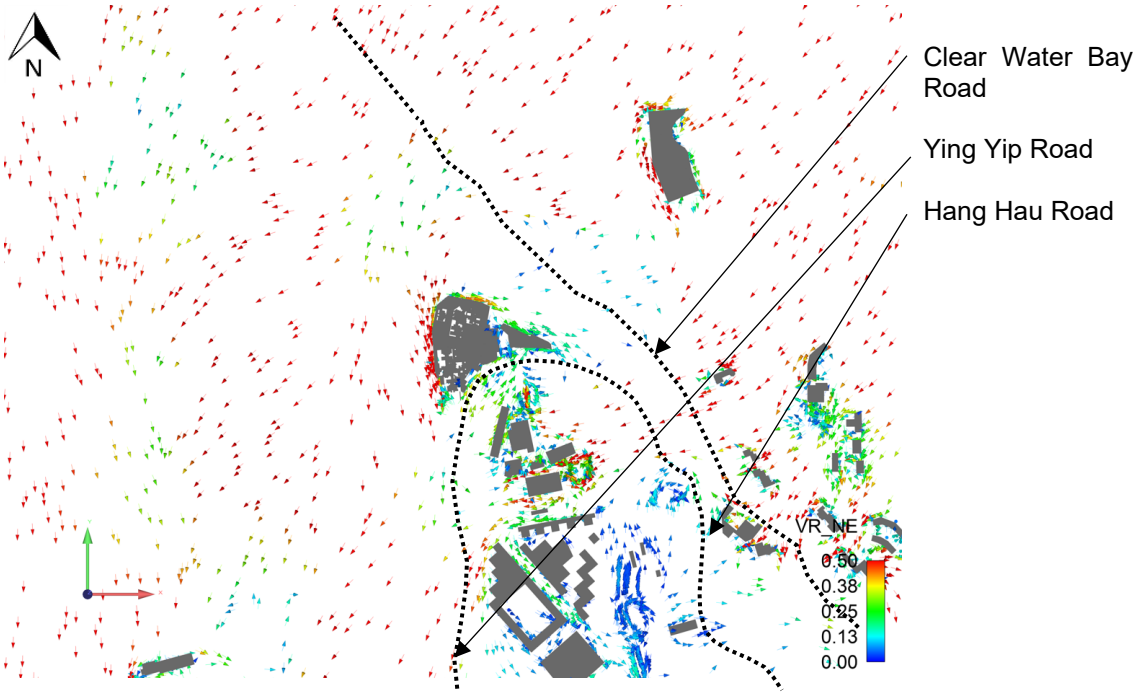
Clear Water Bay Road

Ying Yip Road

Hang Hau Road

Proposed Scheme





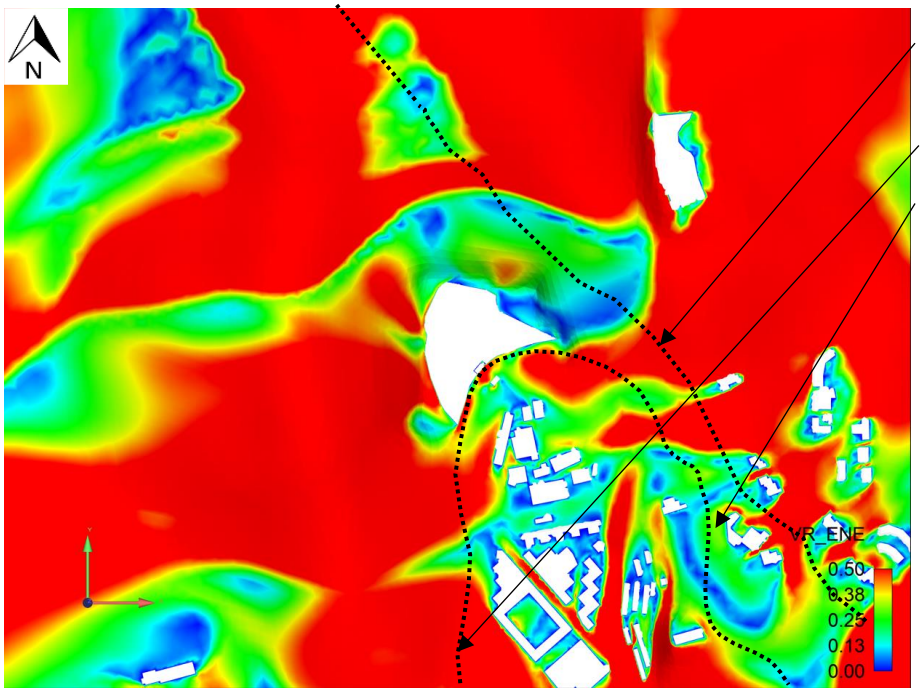
ENE: (Annual: 16.4%)

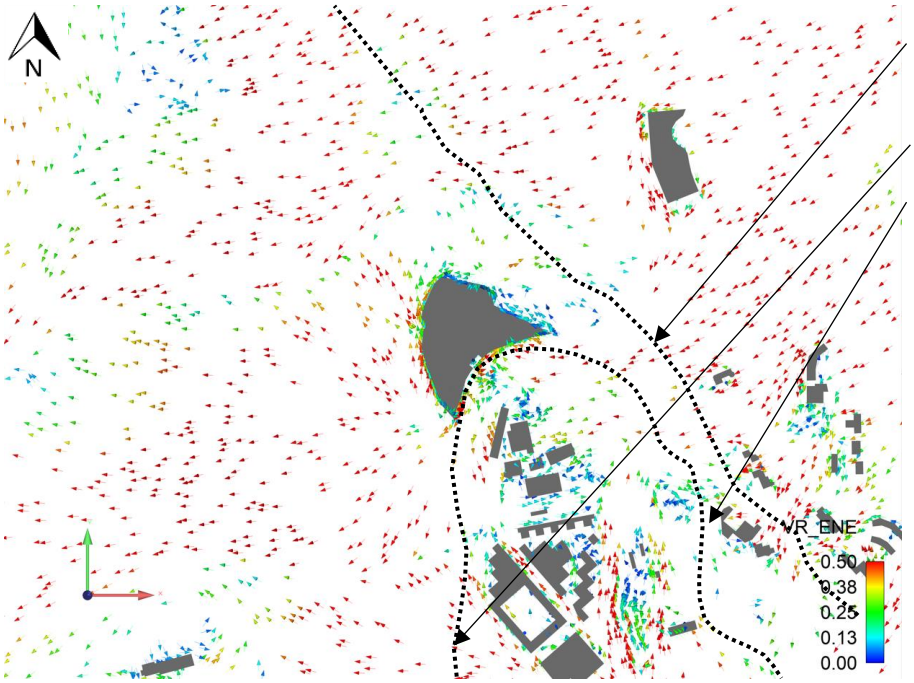
6.7 Similarly, the ENE wind was modulated by the Duckling Hill. The incoming winds mainly relied on the prevailing wind from the low ridge area near Silverstrand and part of the katabatic wind from the natural slopes of Duckling Hill. While a portion of incoming wind flew along Ying Yip Road to ventilate the southern and eastern portion of the Project Area. Another portion of incoming wind entered the building gap between the two domestic towers or the northern portion of the Project Area to reach the hilly range, thus the Project Area would be ventilated by the circulation wind coming back downwash from the hilly range.

6.8 In the Baseline Scheme, the incoming ENE winds could not penetrate the Project freely and were further weakened by the 6-storeys non-domestic block, it was observed that the wind environment at the immediate northeast of the Project Area was relatively calm. Notwithstanding, the wind environment in Ying Yip Road and the CDA zone nearby Clear Water Bay Film Studio was satisfactory, illustrating that the proposed development would not obstruct the incoming winds entering Ying Yip Road to ventilate downstream.

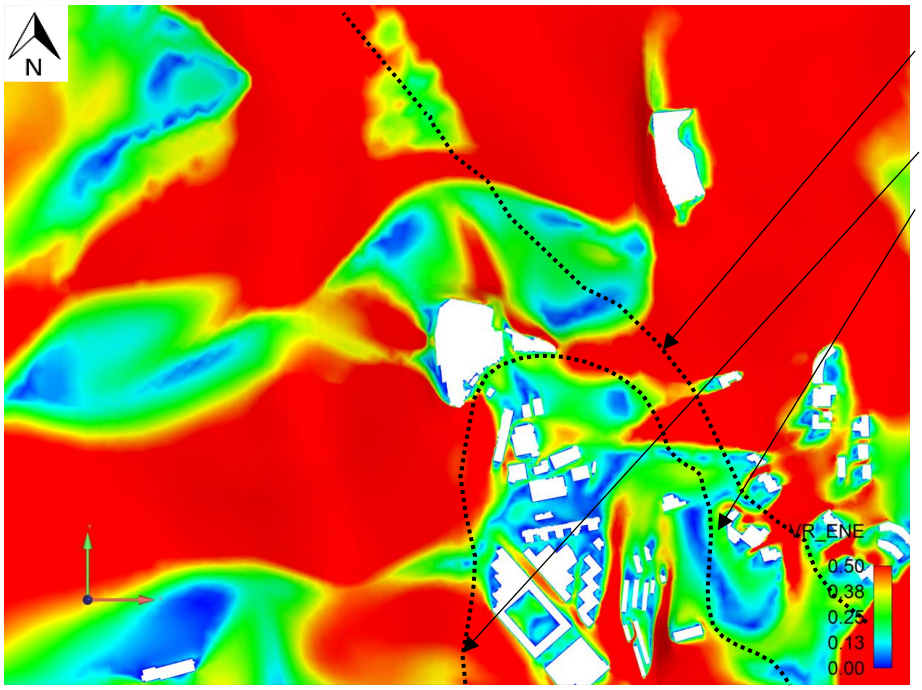
6.9 For the Proposed Scheme, due to the minimized non-domestic block, a portion of the incoming wind could flow into the northeast portion of the Project Area, the air ventilation performance was significantly better than the Baseline Scheme in this area. Similar to the Baseline Scheme, no blockage was observed for the incoming winds entering Ying Yip Road. As mentioned, a portion of incoming wind was diverted to the northeast portion of the Project Area, which was beneficial to the wind environment while resulting in a weaker flow into Ying Yip Road.

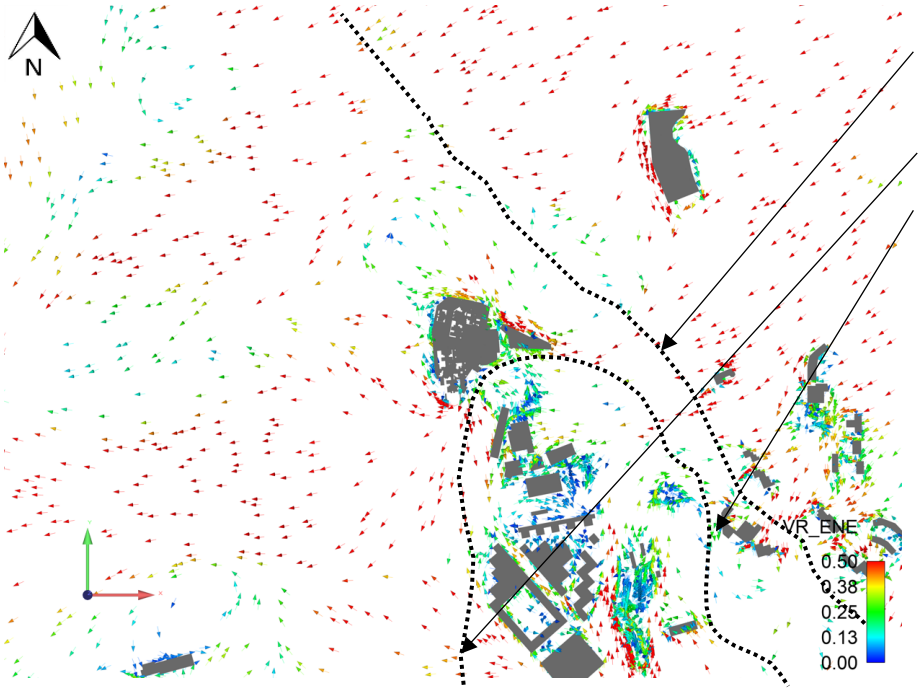
Baseline Scheme





Proposed Scheme





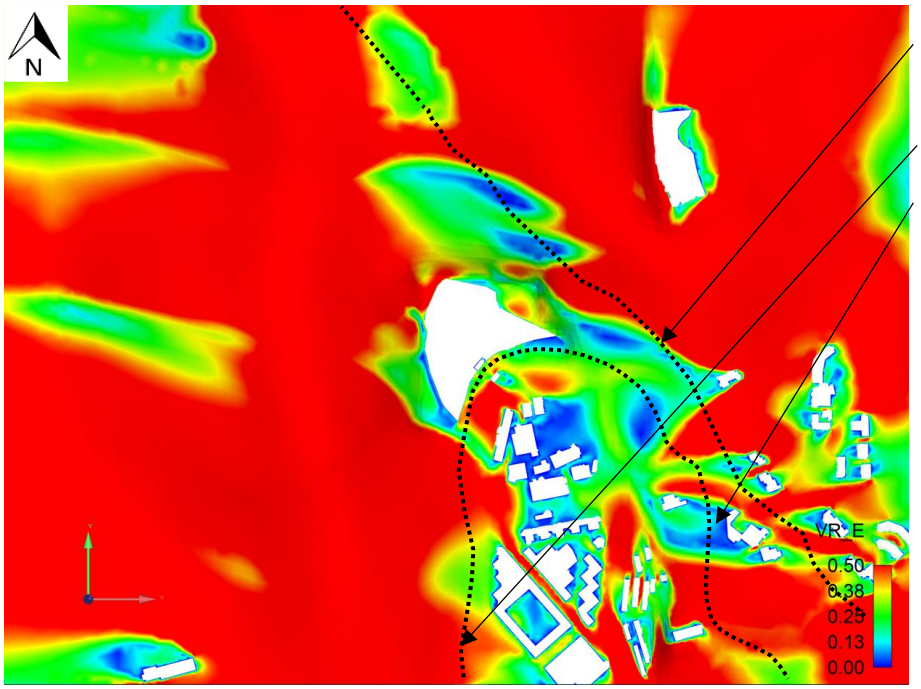
E: (Annual: 19.6% Summer: 9.1%)

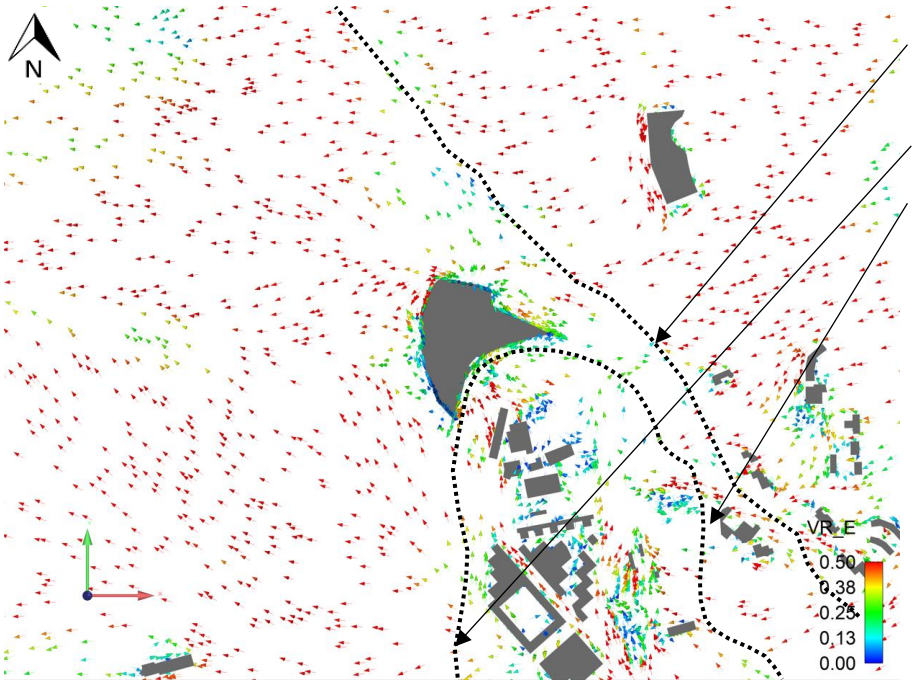
6.10 For E wind, the site wind availability of the Project Area mainly relied on the incoming winds from the low hilly range along Clear Water Bay Road. A portion of incoming wind would flow from the low-rise clusters near Silverstrand. The incoming winds were weakened by the hilly range before reaching the Project Area. Similar to the ENE wind, a portion of the incoming wind flew along Ying Yip Road to ventilate the southern and eastern portion of the Project Area. Another portion of incoming wind entered the building gap between the two domestic towers or the northern portion of the Project Area to reach the hilly range, thus the Project Area would be ventilated by the circulation wind coming back downwash from the hilly range.

6.11 In the Baseline Scheme, the non-domestic podium would align with Ying Yip Road. It was observed that the incoming wind would flow freely along Ying Yip Road. The air ventilation performance along Ying Yip Road was satisfactory. On the other hand, it was noticed that the southern portion of the Project Area had a satisfactory wind environment thanks to the circulation wind ventilating the valley.

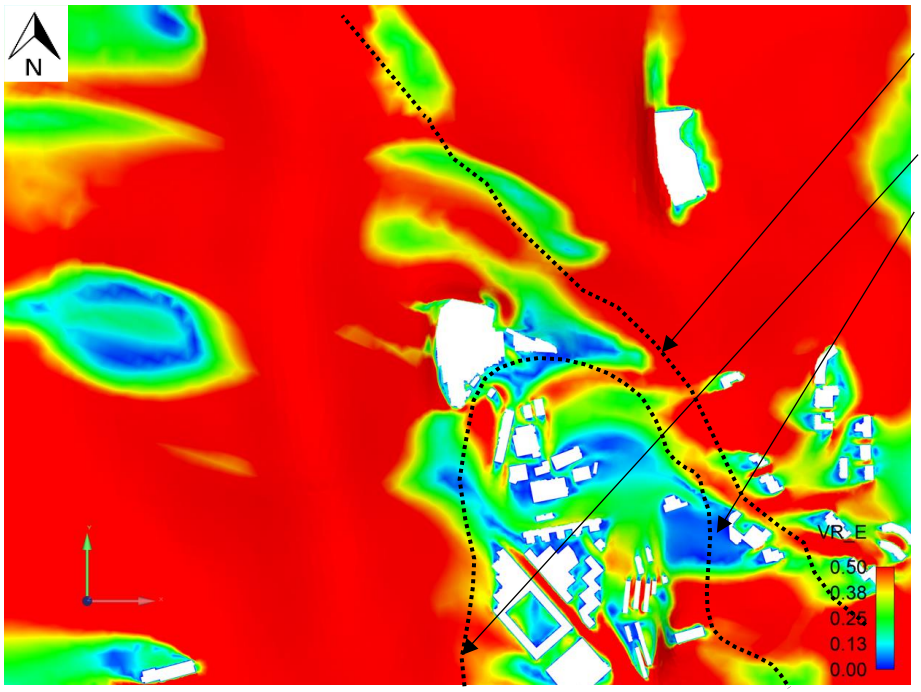
6.12 In the Proposed Scheme, the minimized non-domestic block would provide space for the E winds to enter the middle section of the Project Area. It was observed that the incoming E winds split into several directions, naming the Project Area, Ying Yip Road, as well as Clear Water Bay Film Studio. As a result, the wind environment of Clear Water Bay Film Studio was satisfactory. Notwithstanding, as the incoming winds diverted in different directions towards the Project Area and the surrounding, a weaker flow compared to the Baseline Scheme was noticed. Similarly, the circulation wind provided a satisfactory wind environment to the southern portion of the Project Area.

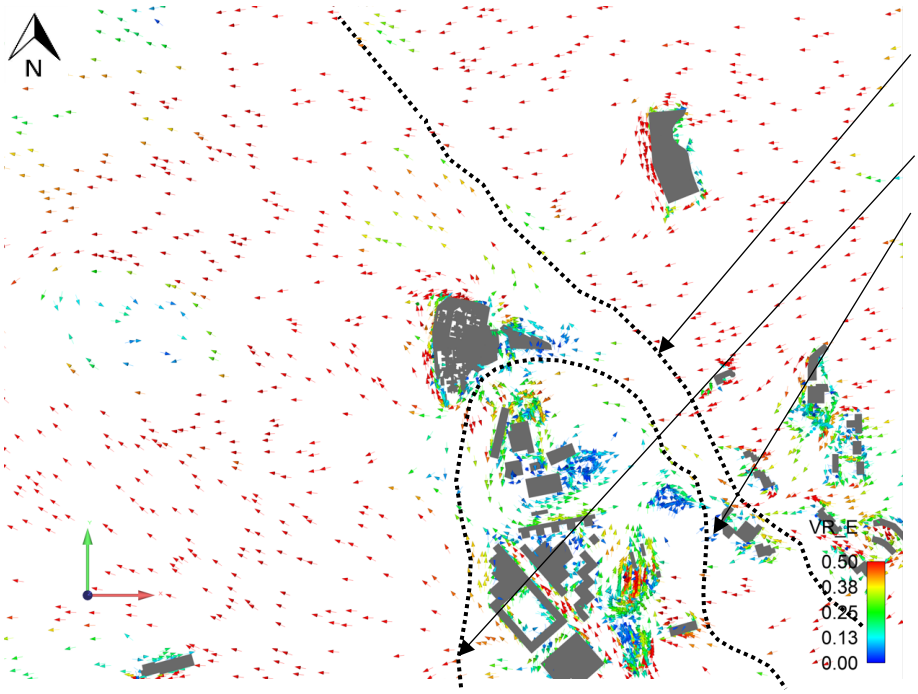
Baseline Scheme





Proposed Scheme





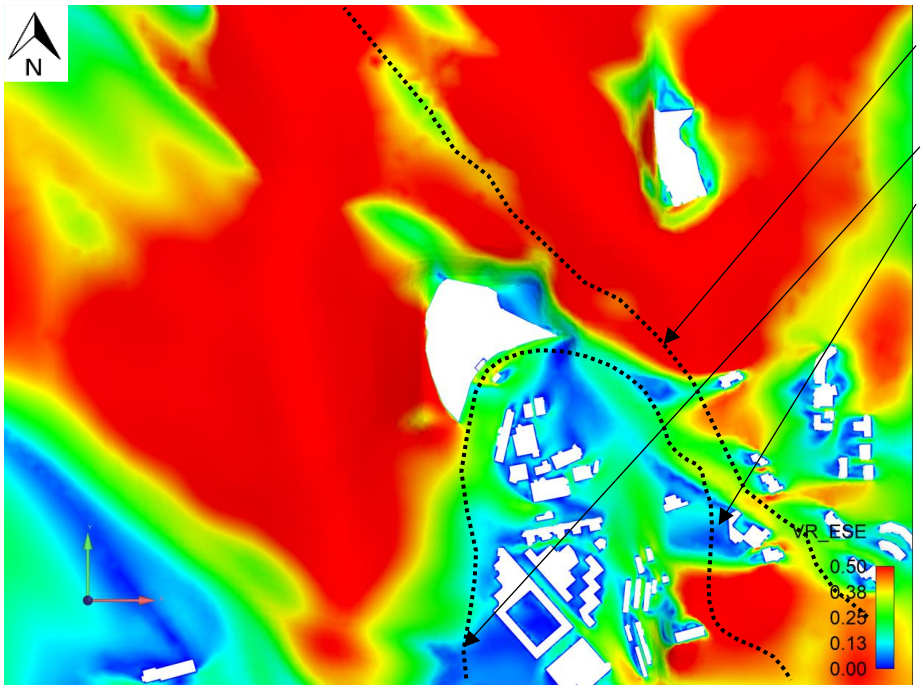
ESE: (Annual: 7.7% Summer: 8.0%)

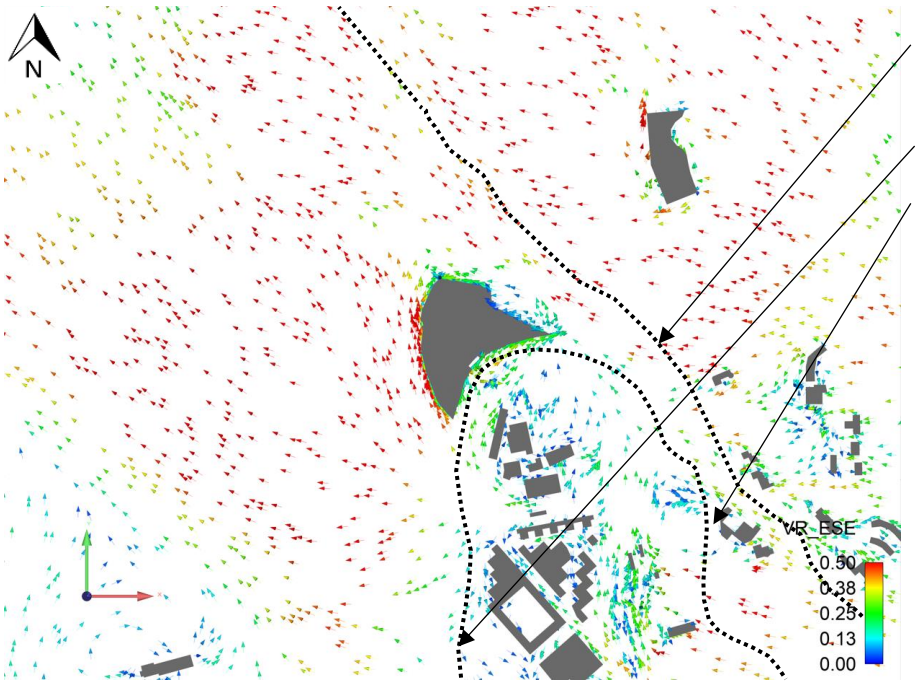
6.13 The ESE incoming winds were channelized from the low-rise cluster along Clear Water Bay Road, which would be the major wind corridor for the ESE winds. A portion of incoming wind entered Ying Yip Road to reach the Project Area. While another portion of incoming wind flew through the building gap between the two domestic towers or the northern portion of the Project Area to reach the hilly range, thus the Project Area would be ventilated by the circulation wind coming back downwash from the hilly range.

6.14 In the Baseline Scheme, the incoming winds were modulated by the 6-storeys non-domestic block and flew along the southern section of Ying Yip Road. Therefore, it was observed that the wind environment along Ying Yip Road was satisfactory. However, a portion of the incoming wind was blocked by the non-domestic block where a wind stagnant was noticed. In addition, it was noticed that the southern portion of the Project Area had a satisfactory wind environment thanks to the circulation wind ventilating the valley.

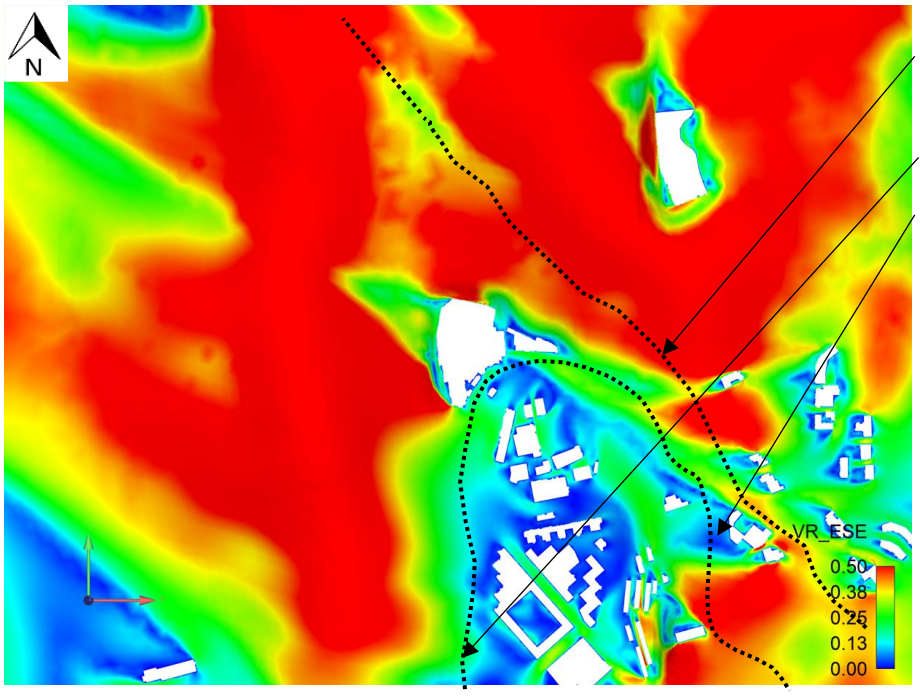
6.15 When compared to the Baseline Scheme, the gap at the main entrance under the Proposed Scheme would provide openings for the incoming winds to penetrate the Project Area. The wind stagnant was reduced significantly. Moreover, the empty bays were provided under the domestic developments allowing the incoming winds to reach the northern portion of the Project Area. It was observed that the air ventilation performance was improved in this area.

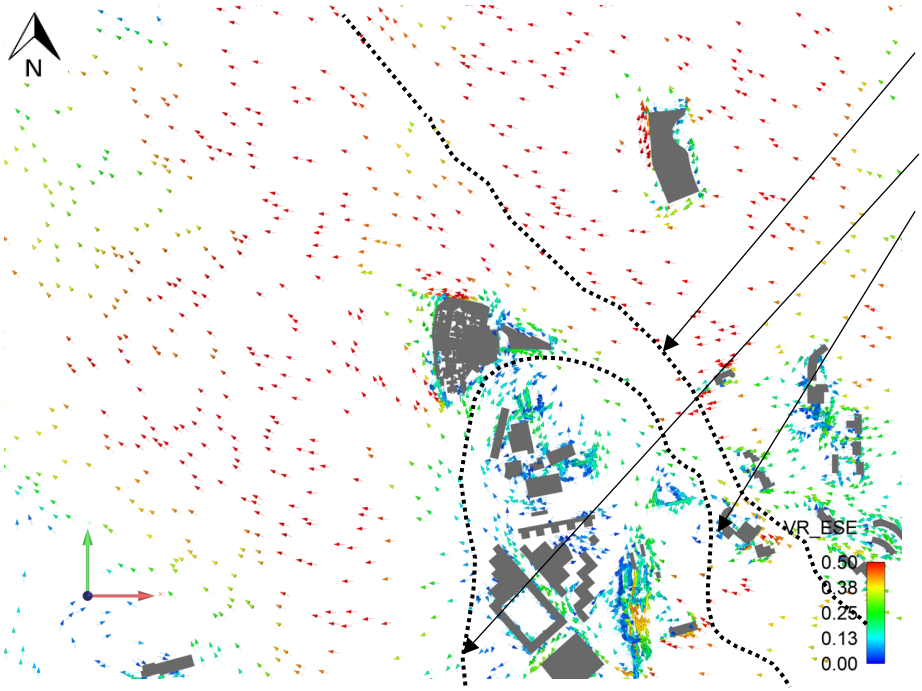
Baseline Scheme





Proposed Scheme





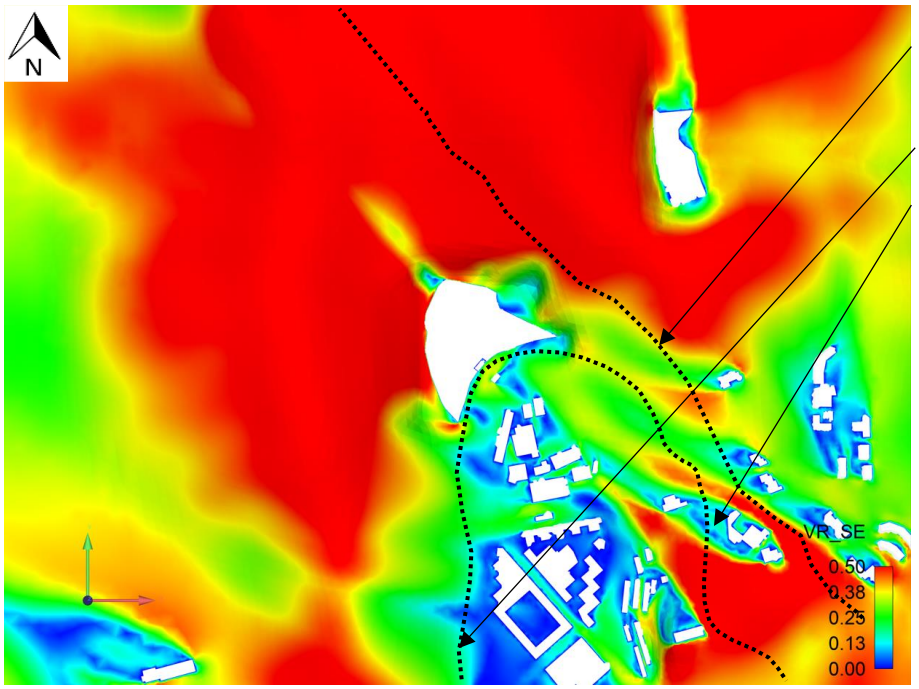
SE (Annual: 5.1% Summer: 6.7%)

6.16 It was observable that the SE winds showed similar wind performance to the ESE winds. The incoming SE winds were channelized along Clear Water Bay Road. The incoming accelerated after passing through the low-rise cluster to the southeast of the Project Area. The circulation wind coming back downwash into the Project Area from the western hilly range increased the wind availability in the western portion of the Project Area.

6.17 In the Baseline Scheme, a portion of the incoming wind was modulated by the 6-storeys non-domestic block and flew along the southern section of Ying Yip Road. While another portion of SE winds directly entered the northern portion of the Project Area and ventilated the downstream area.

6.18 For the Proposed Scheme, similar wind effects were observed, where the incoming winds entered Ying Yip Road and the northern portion of the Project Area. Whereas the Proposed Scheme would have a gap at the main entrance that could divert the winds to the Project Area. As a result, the wind environment was improved in the downstream area at the northern portion of the Project Area.

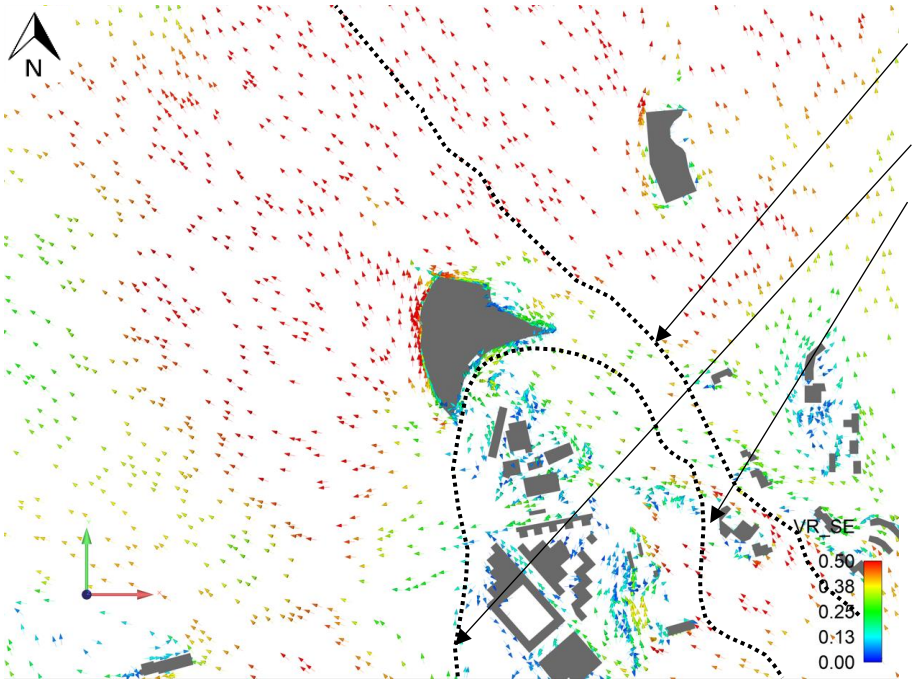
Baseline Scheme



Clear Water Bay Road

Ying Yip Road

Hang Hau Road

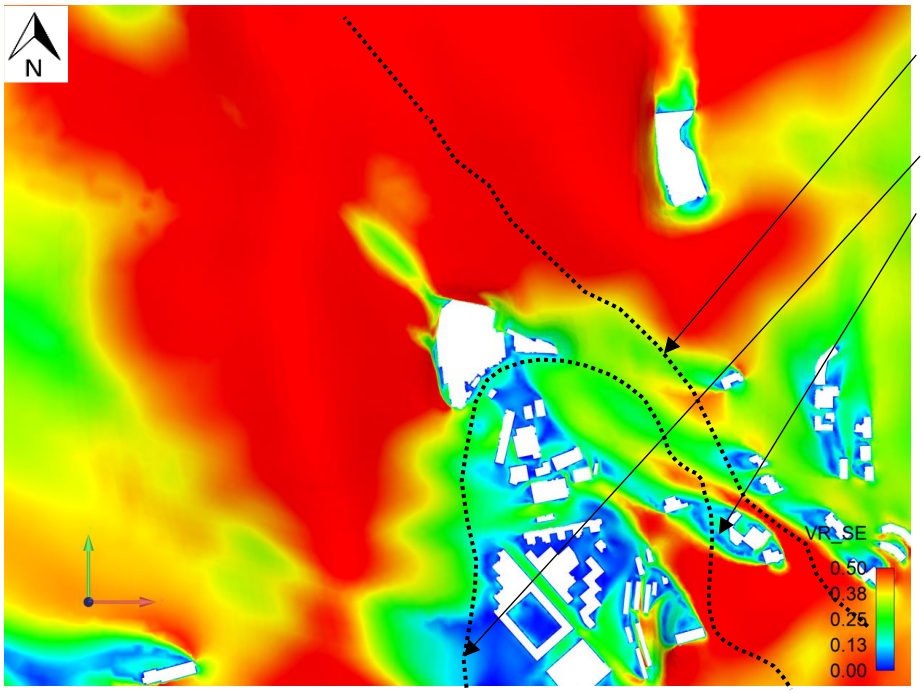


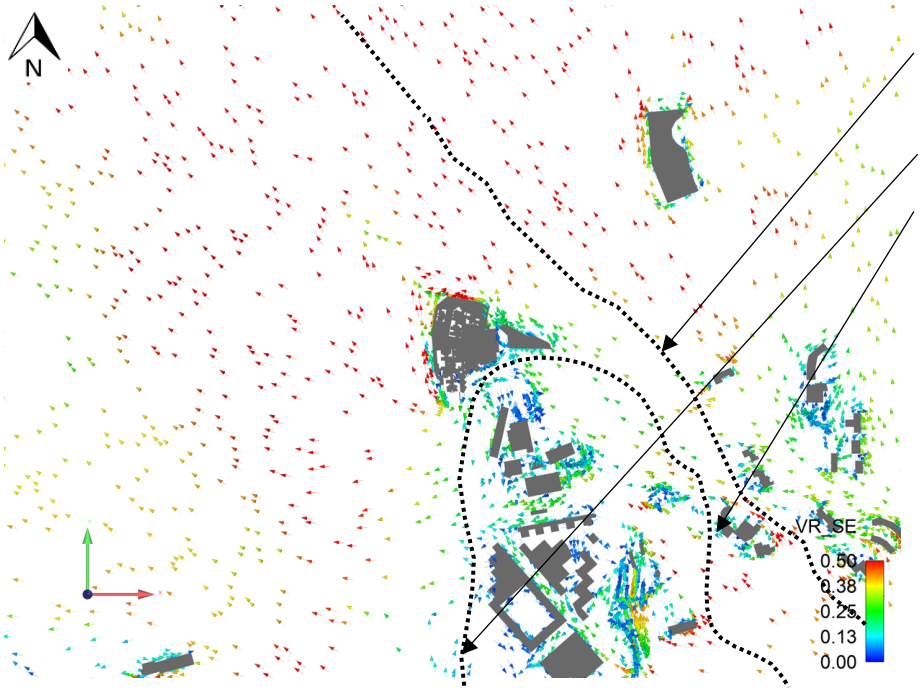
Clear Water Bay Road

Ying Yip Road

Hang Hau Road

Proposed Scheme





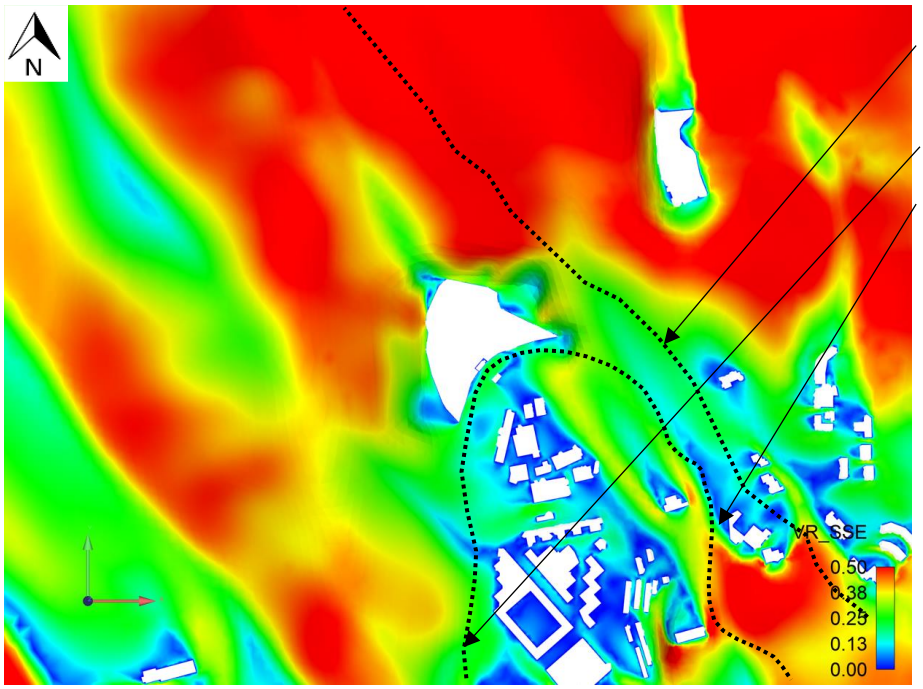
SSE (Summer: 7.4%)

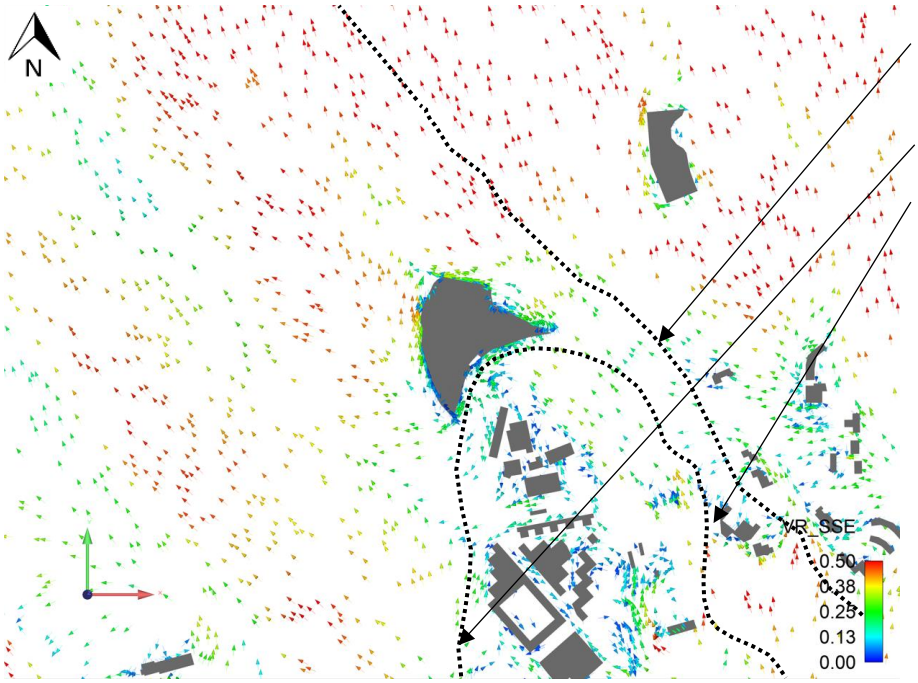
6.19 The SSE incoming wind flew along Clear Water Bay Road and Hang Hau Road as major wind corridors. A portion of incoming wind was weakened by the low-rise cluster in the SSE direction to the Project Area, including Hang Hau Village and Clear Water Bay Film Studio. A relatively calm wind environment was observed when the prevailing winds were passing through these areas at the pedestrian level as there would be no major air paths aligned with the incoming winds.

6.20 In the Baseline Scheme, a portion of incoming wind was able to reach to the eastern portion of the Project Area through Hang Hau Road. The 6-storeys non-domestic block would obstruct the incoming wind and progressively split to Ying Yip Road to ventilate downstream. Another portion of incoming wind would enter the building gaps between the domestic block and the non-domestic block. Therefore, it was observed that the site wind availability in the northern portion of the Project Area remained satisfactory.

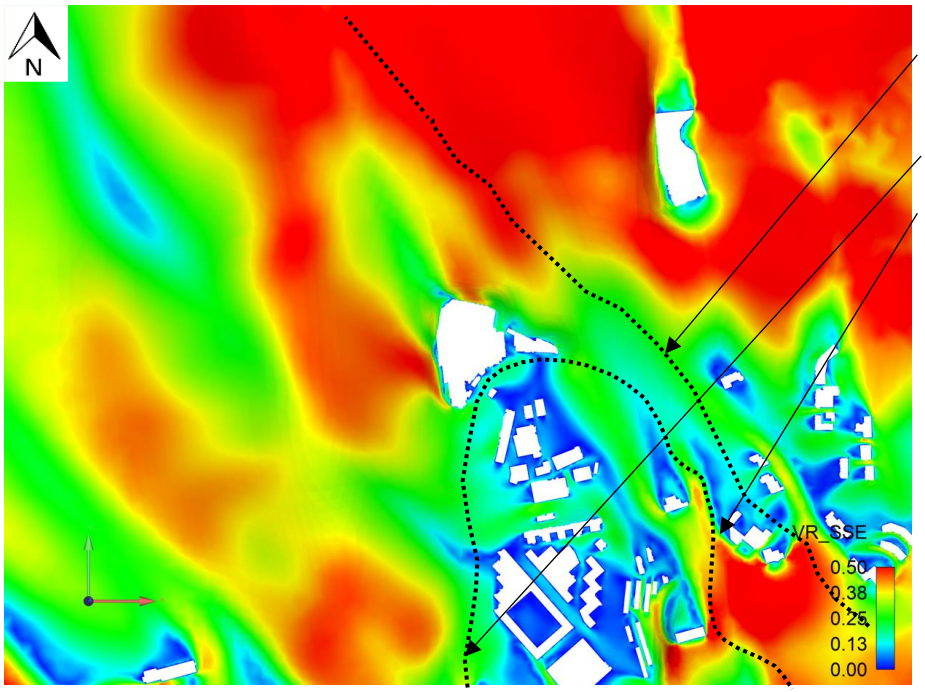
6.21 Similar VR was observed in the Proposed Scheme while the minimized non-domestic podium design and empty bays would benefit the availability of external wind in the western portion of the Project Area, where an improved wind availability was observed as compared to the Baseline Scheme. Moreover, the gap at the main entrance would allow the incoming winds to pass through the Project Area freely and ventilate downstream.

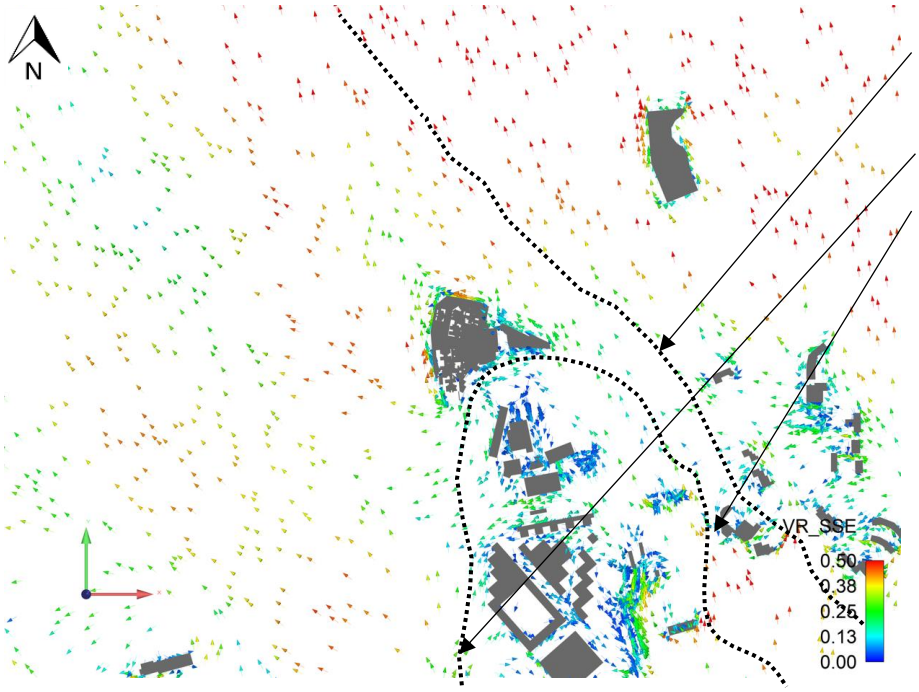
Baseline Scheme





Proposed Scheme





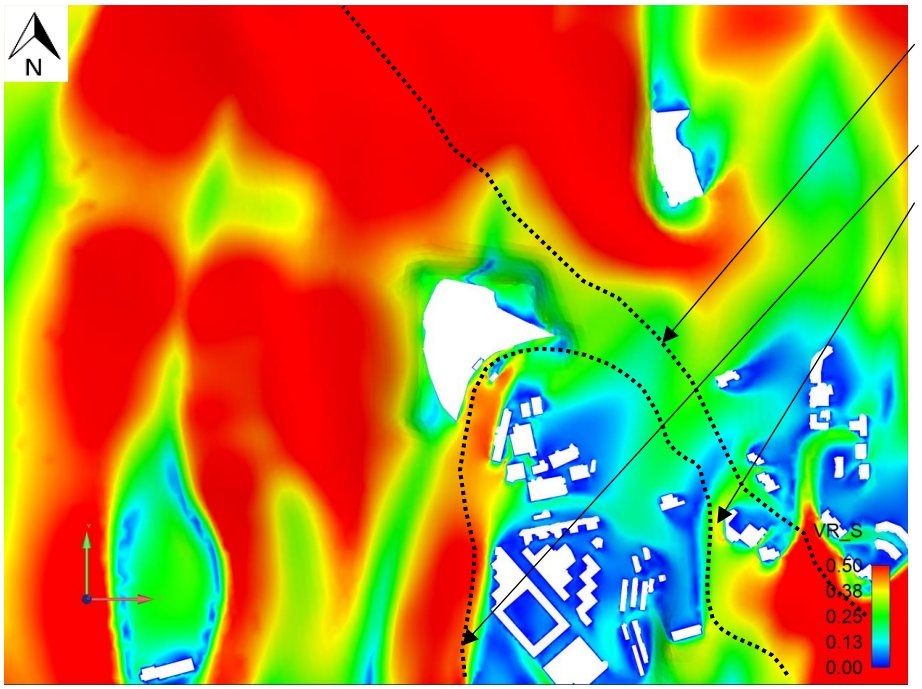
S (Summer: 10.2%)

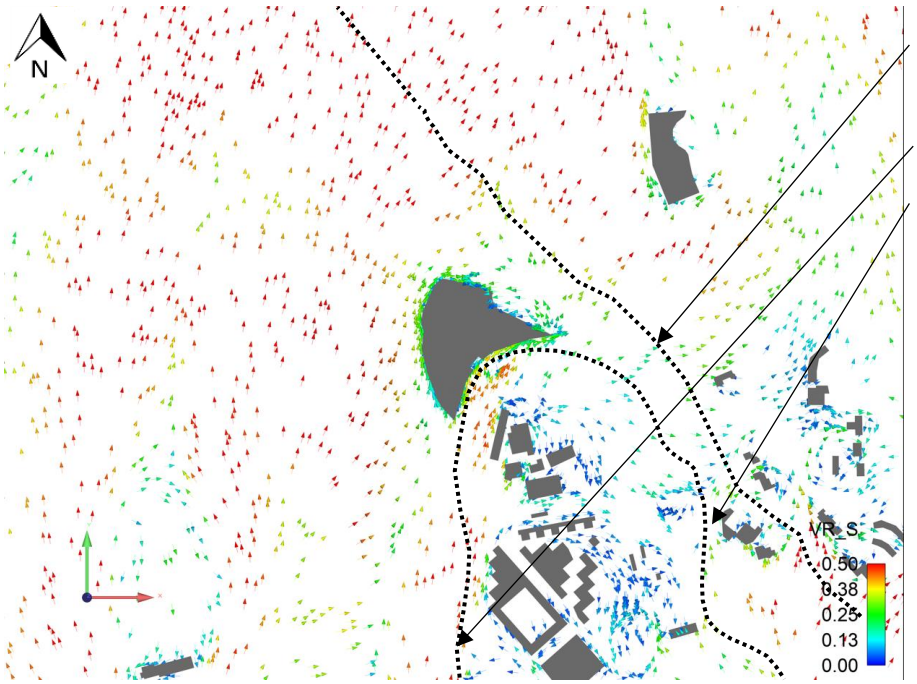
6.22 It was noticed that the S wind was weakened by Hang Hau Village and Clear Water Bay Film Studio more seriously than SSE prevailing wind. However, Ying Yip Road would be aligned in the S direction. Thus, the incoming S wind flew freely along Ying Yip Road and entered the Project Area.

6.23 In the Baseline Scheme, after the incoming winds reached the Project Area, they diverted westward to ventilate downstream along Ying Yip Road. In addition, it was observed that the non-domestic block and the podium in the Baseline Scheme obstructed a portion of incoming wind, which created a small wind stagnant on the leeward side of the development. However, with the external wind from the western portion of the Project Area, the air ventilation performance in the northern portion of the Project Area maintained satisfactory in the general.

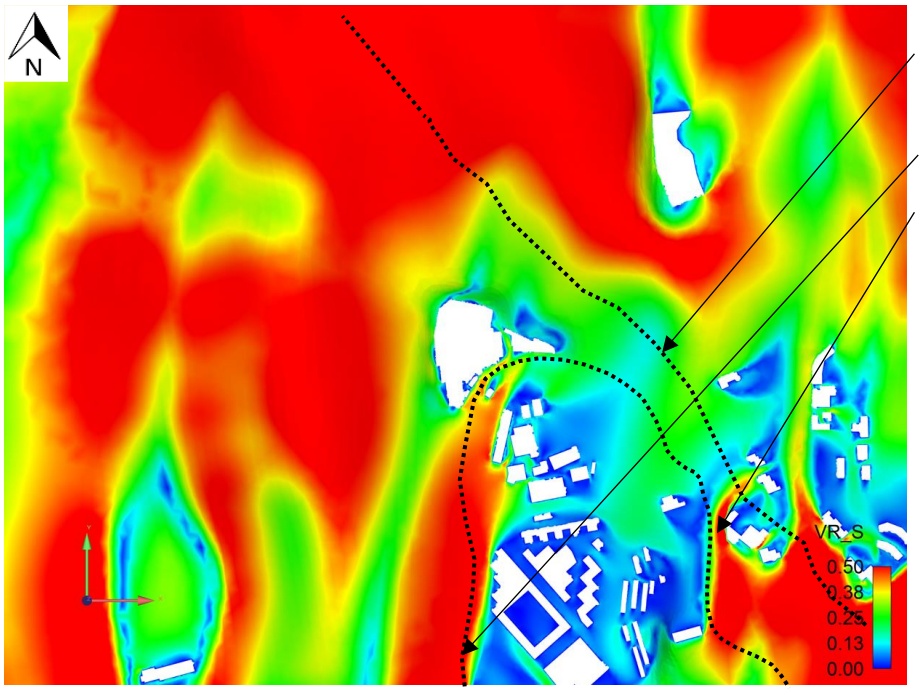
6.24 Similarly, in the Proposed Scheme scenario, the Project Area enjoyed strong wind availability from the incoming winds flowing along Ying Yip Road. A wind stagnant was also noticed on the leeward side of the podium. Notwithstanding, a satisfactory wind environment was observed in the gap at the main entrance, the gap aligned to the S direction could allow the incoming winds to flow through freely in the middle of the Project Area.

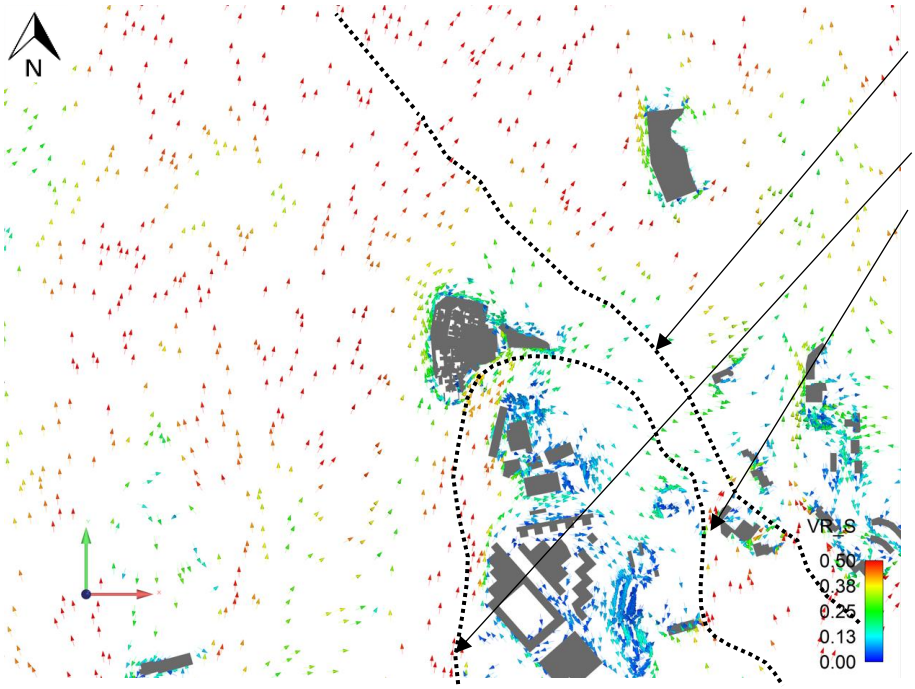
Baseline Scheme





Proposed Scheme





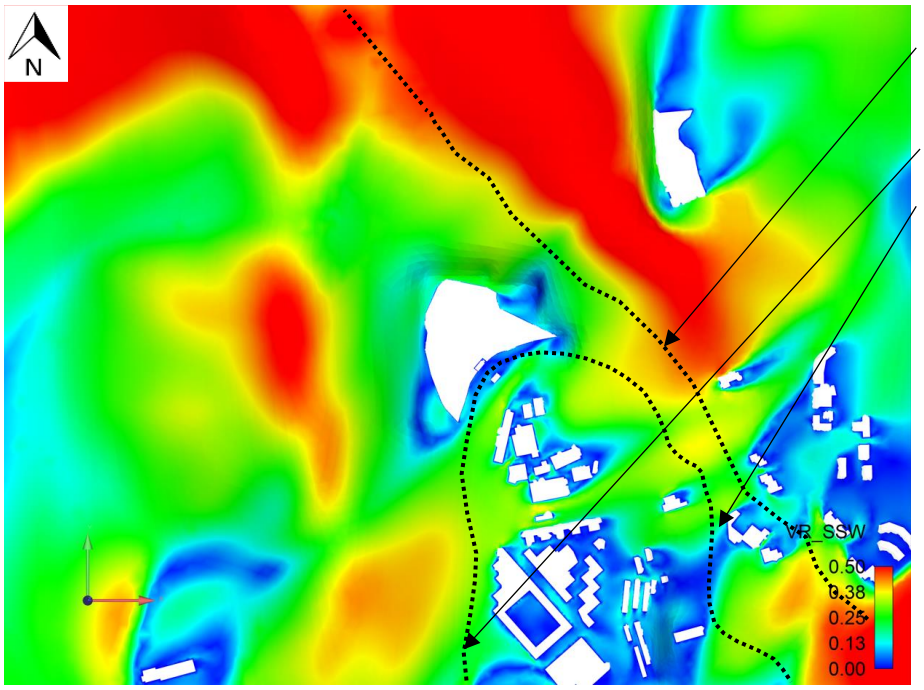
SSW: (Annual: 5.9% Summer: 13.7%)

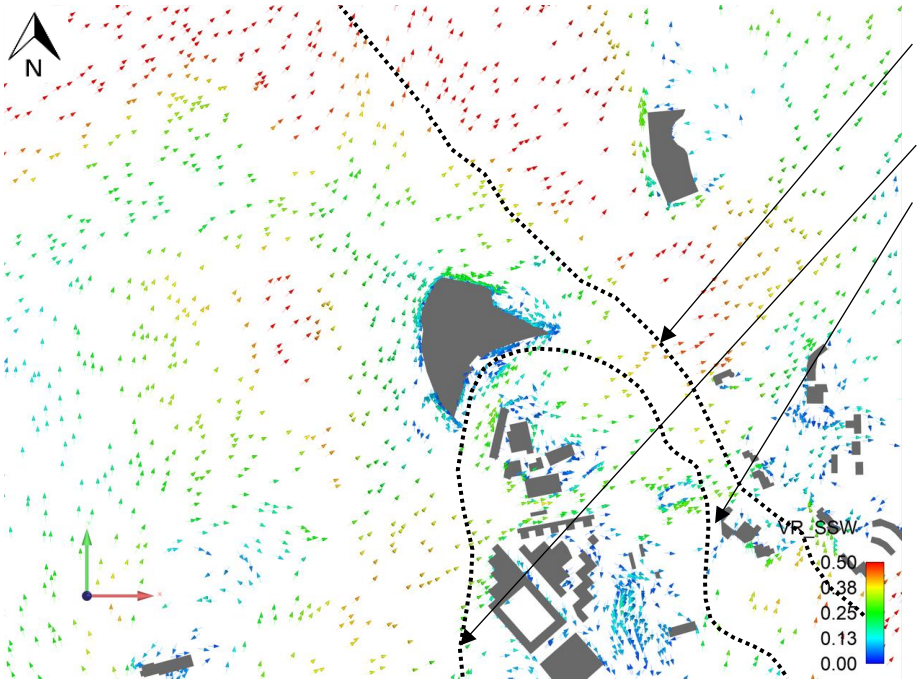
6.25 SSW incoming wind would enter the Project Area through Ying Yip Road. Moreover, it was observed that the circulation wind flew into the northern portion of the Project Area which was located in a valley, resulting in a satisfactory wind environment in this area. However, it was noticeable that in both Baseline Scheme and Proposed Scheme, the developments within the Project Area created a blockage to the incoming wind.

6.26 In the Baseline Scheme, wind stagnant was observed in both upwind and downwind areas surrounding the Project Area. For the upwind area, the Project Area was located in the shadow zone of Duckling Hill, while it was observed that the downwash wind in low level ventilated the immediate southwest of the Project Area. On the other hand, in the downwind area, the developments in the Project Area weakened the incoming wind. Thus, a calmer wind environment in the downwind area was noticed. In addition, the wind availability to the immediate southeast of the Project Area was relatively low as the prevailing winds were diverted to the CDA zone nearby Clear Water Bay Film Studio.

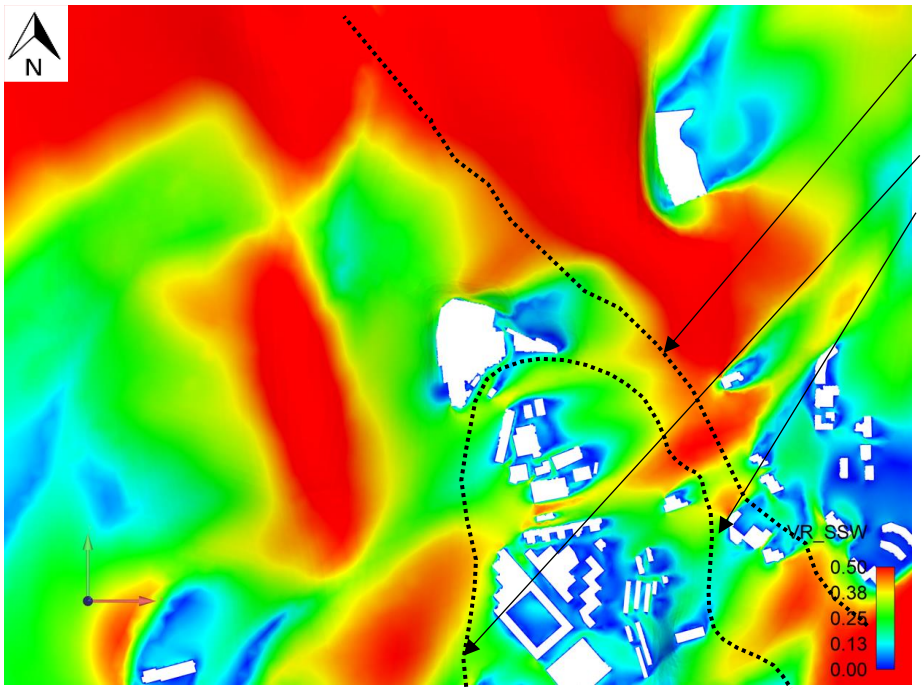
6.27 In the Proposed Scheme, the wake area was reduced as compared to the Baseline Scheme due to the design of the minimized podium and the provision of empty bays. The incoming winds flew freely through the gap in the main entrance to enter the middle of the Project Area, which favoured the wind penetration in the southeast portion of the Project Area. However, a wind stagnant was still noticed in the downwind area of the north-eastern portion of the Project Area as a portion of incoming wind was not able to pass through the non-domestic block at the pedestrian level.

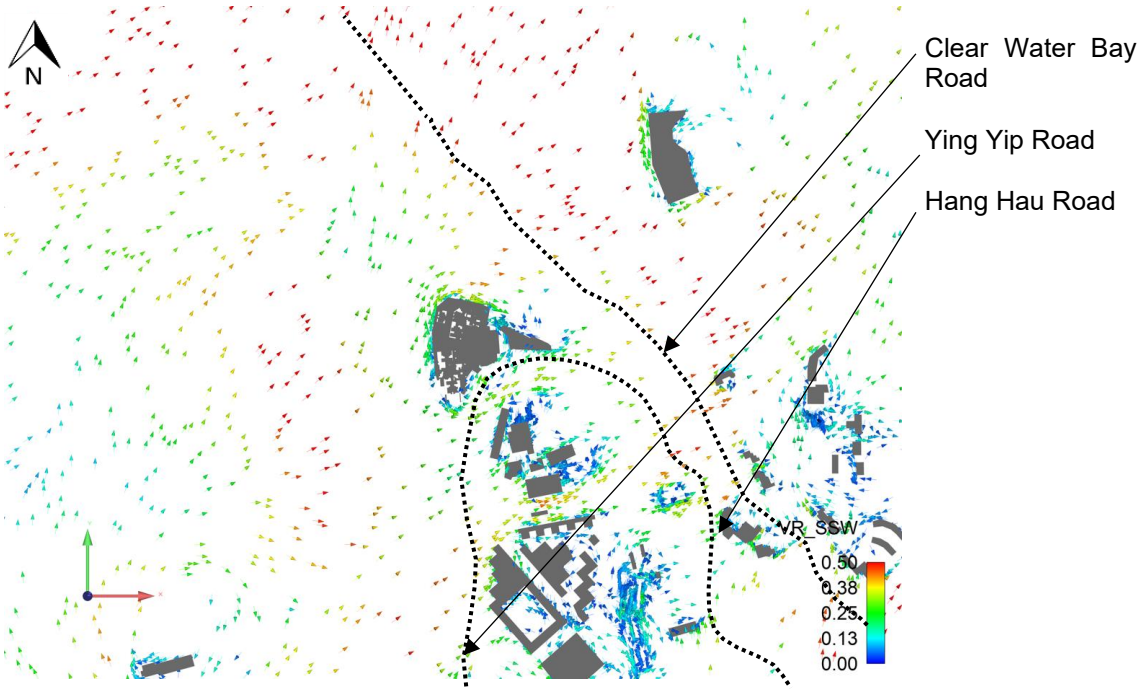
Baseline Scheme





Proposed Scheme





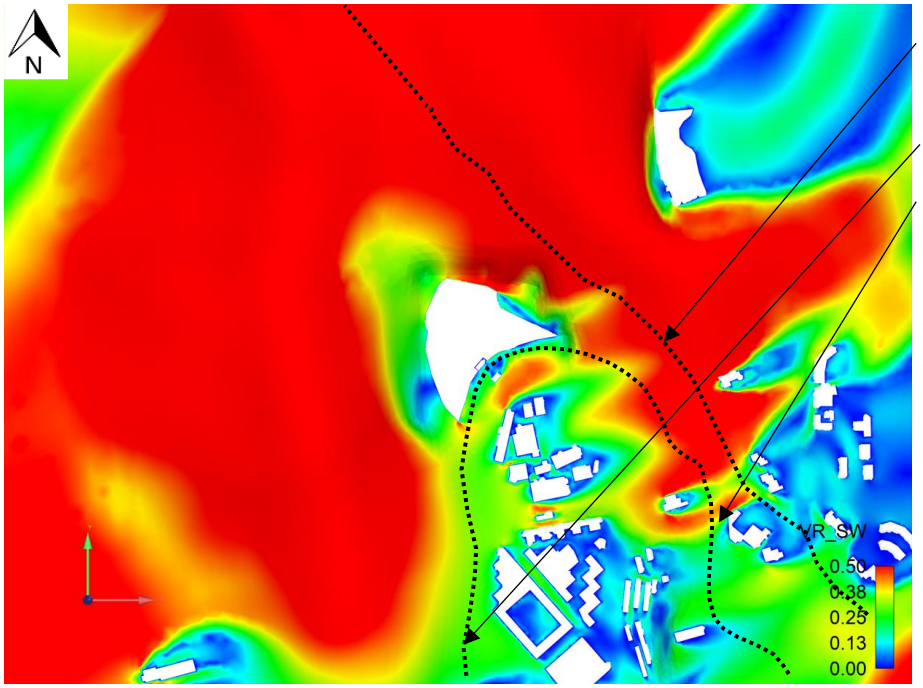
SW: (Annual: 7.1% Summer: 16.8%)

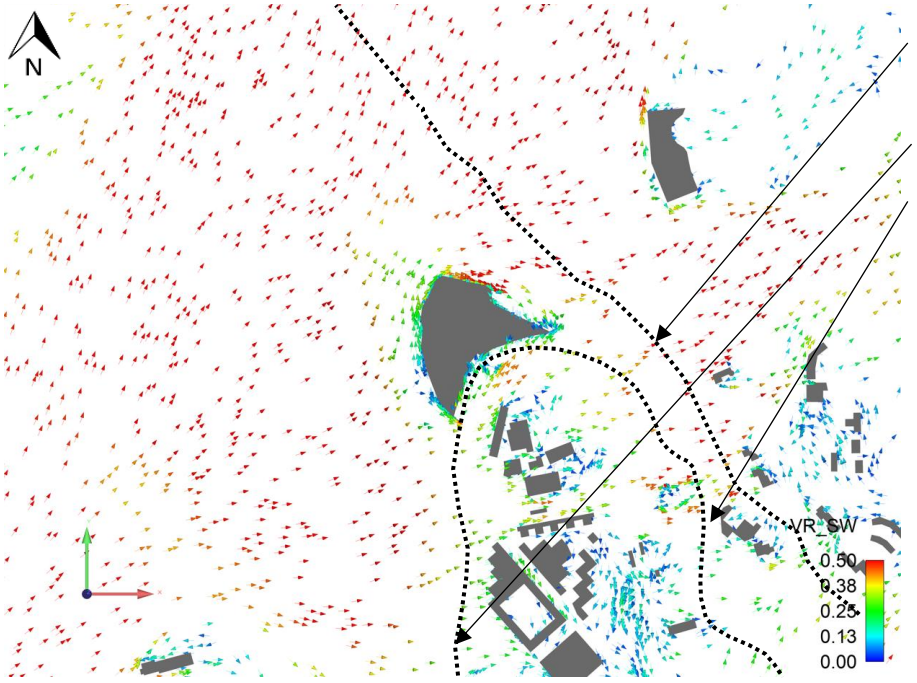
6.28 For the SW wind, the site wind availability of the Project Area mainly relied on the incoming winds that pass through the hilly range of Duckling Hill to the Southwest of the Project Area. As a result, the incoming winds would be weakened by Duckling Hill, while the katabatic winds kept the wind environment of the Project Area to remain satisfactory. Another stream of incoming wind flew freely toward the CDA zone nearby Clear Water Bay Film Studio. Moreover, it was observed that the circulation wind flew into the northern portion of the Project Area which was located in a valley, resulting in a satisfactory wind environment in this area.

6.29 In the Baseline Scheme, the incoming wind ventilated the CDA zone nearby Clear Water Bay Film Studio and ventilated downstream toward the Dragon Lake Villa. However, it was noticed that wind availability in the immediate south of the Project Area was relatively low which could be impacted by the non-domestic podium. It was because the non-domestic podium left no opening for the incoming winds to channelize northward, resulting fewer incoming winds could flow through the immediate south of the Project Area. Moreover, it was observed that a portion of the incoming wind was obstructed by the 6-storeys non-domestic block.

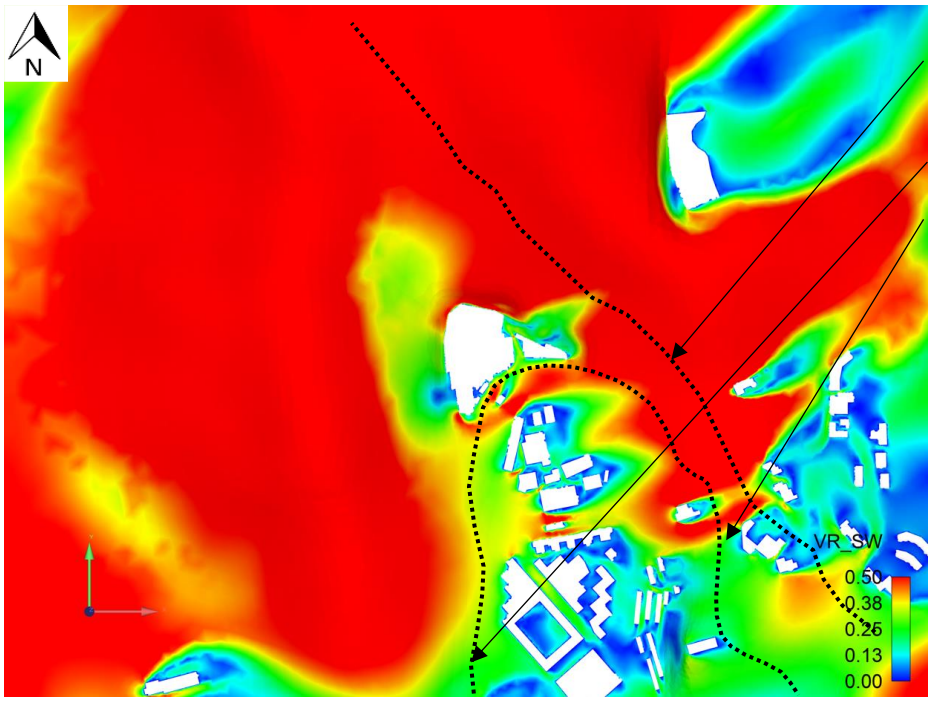
6.30 The Proposed Scheme had a better wind environment than the Baseline Scheme. A portion of incoming wind channelized northward through the gap in the main entrance to enter the middle of the Project Area, which improved the wind availability in the northern portion of the Project Area and the immediate south of the Project Area. On the other hand, the low-rise non-domestic block reduces obstruction to the incoming winds, resulting a better wind performance on the leeward side of the Project Area.

Baseline Scheme





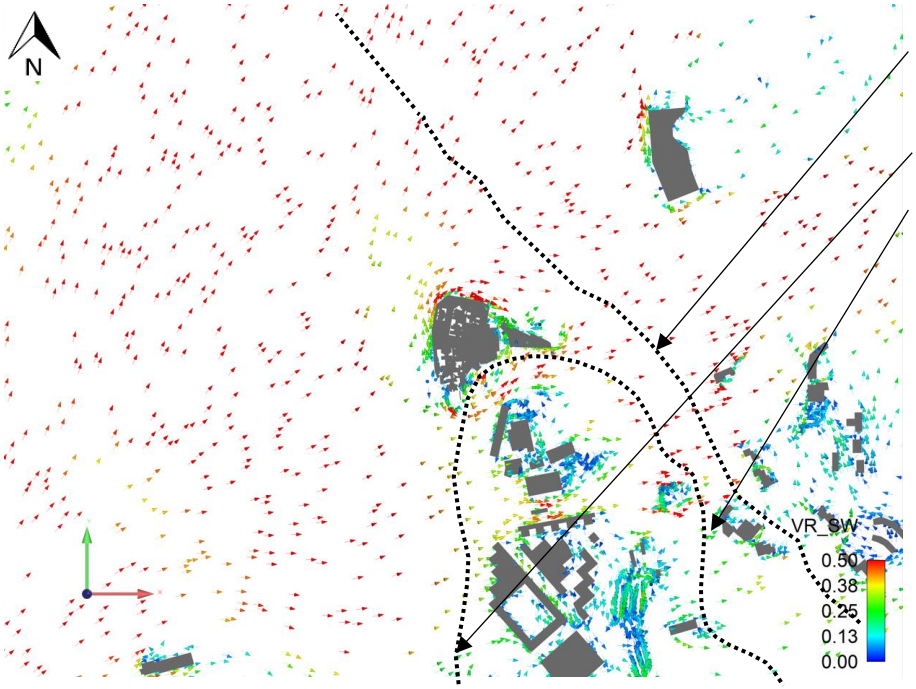
Proposed Scheme



Clear Water Bay Road

Ying Yip Road

Hang Hau Road



Clear Water Bay Road

Ying Yip Road

Hang Hau Road

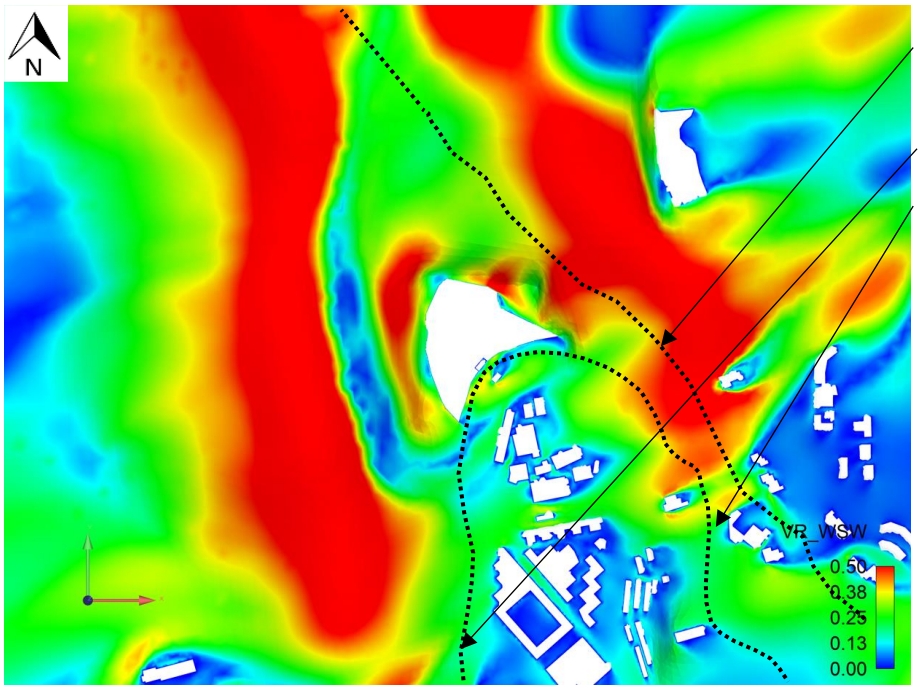
WSW: (Summer: 9.0%)

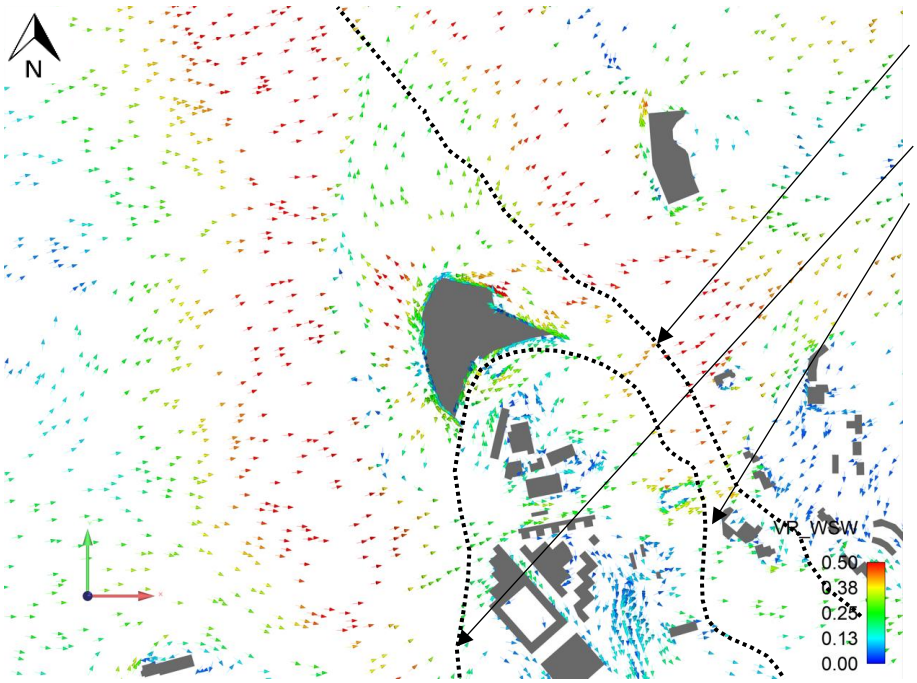
6.31 WSW incoming wind would be weakened by the hilly range of Duckling Hill. The site wind availability of the Project Area mainly relied on the katabatic winds of Duckling Hill. Also, it is observed that the circulation wind flew into the northern portion of the Project Area, which was located in a valley, resulting in a satisfactory wind environment in this area.

6.32 In the Baseline Scheme, a portion of the incoming wind was blocked by the non-domestic podium at the pedestrian level. The incoming winds would be down-washed and captured in the windward sides, resulting in higher VRs at the western side of the Project Area, and relatively lower at the eastern part of the Project Area.

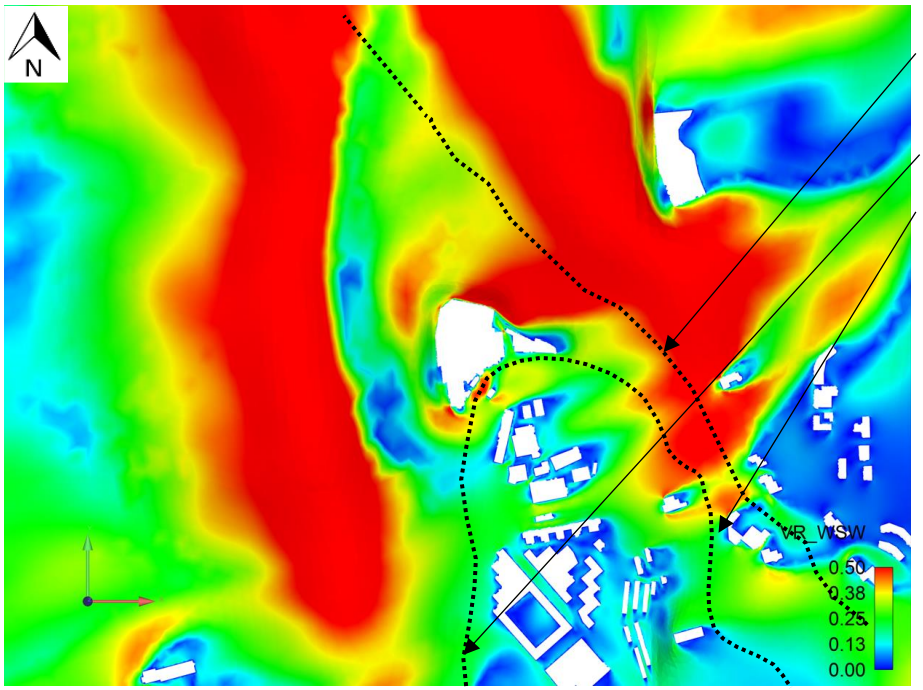
6.33 In the Proposed Scheme, similar VR results were observed, while the minimized podium provided more setbacks that allowed more incoming winds to enter the CDA zone nearby Clear Water Bay Film Studio. Moreover, the gap in the main entrance facilitated the incoming winds to channelize to the middle and the northern portion of the Project Area. Notwithstanding, a wind stagnant was observed on the leeward side of the non-domestic block.

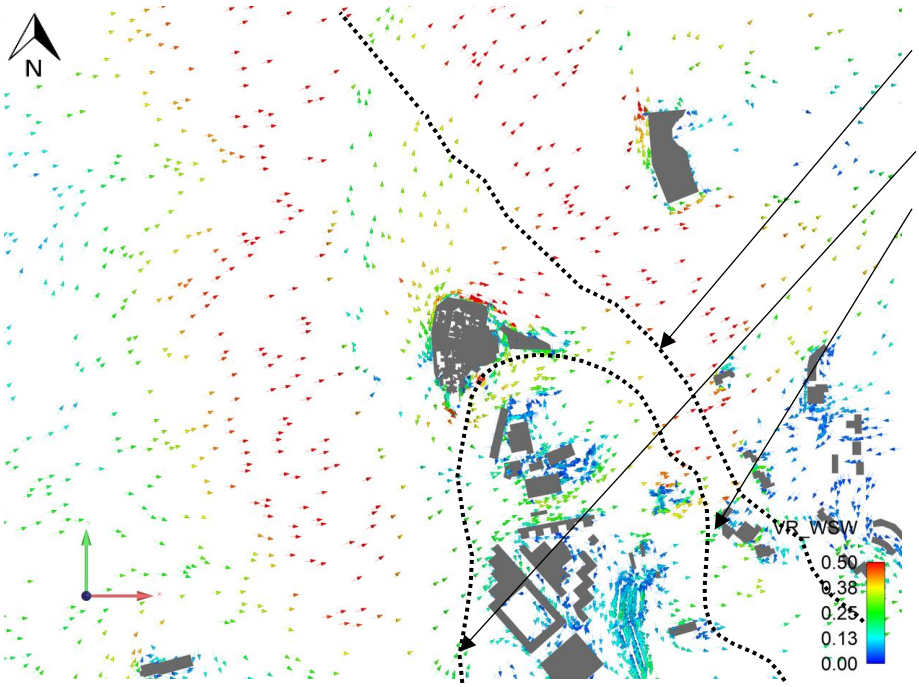
Baseline Scheme





Proposed Scheme

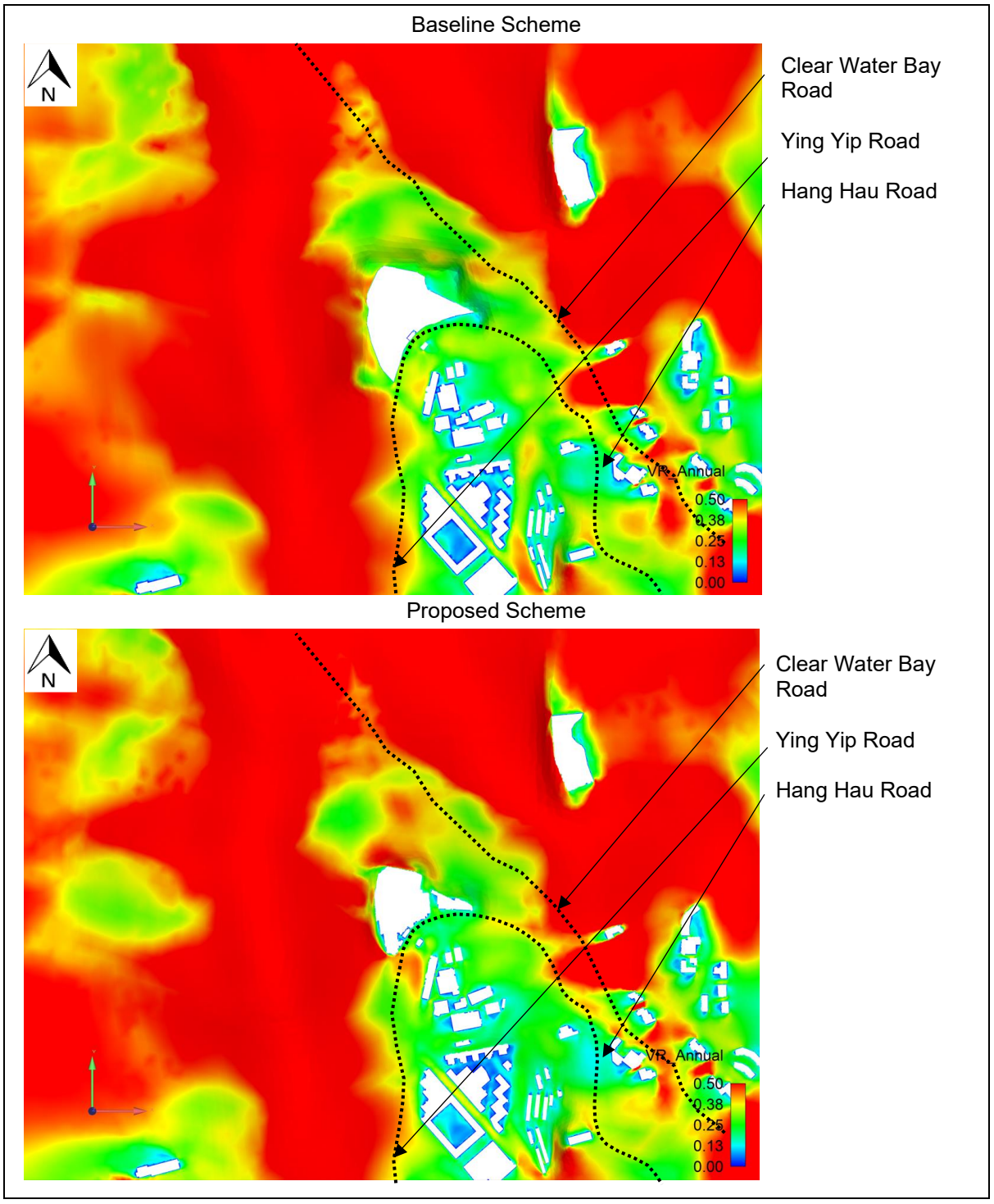




Overall Annual Frequency Weighted VR: (78.6%)

6.34 According to the overall annual frequency weighted VR plot, observable air ventilation enhancements and drawbacks were summarized as follows:

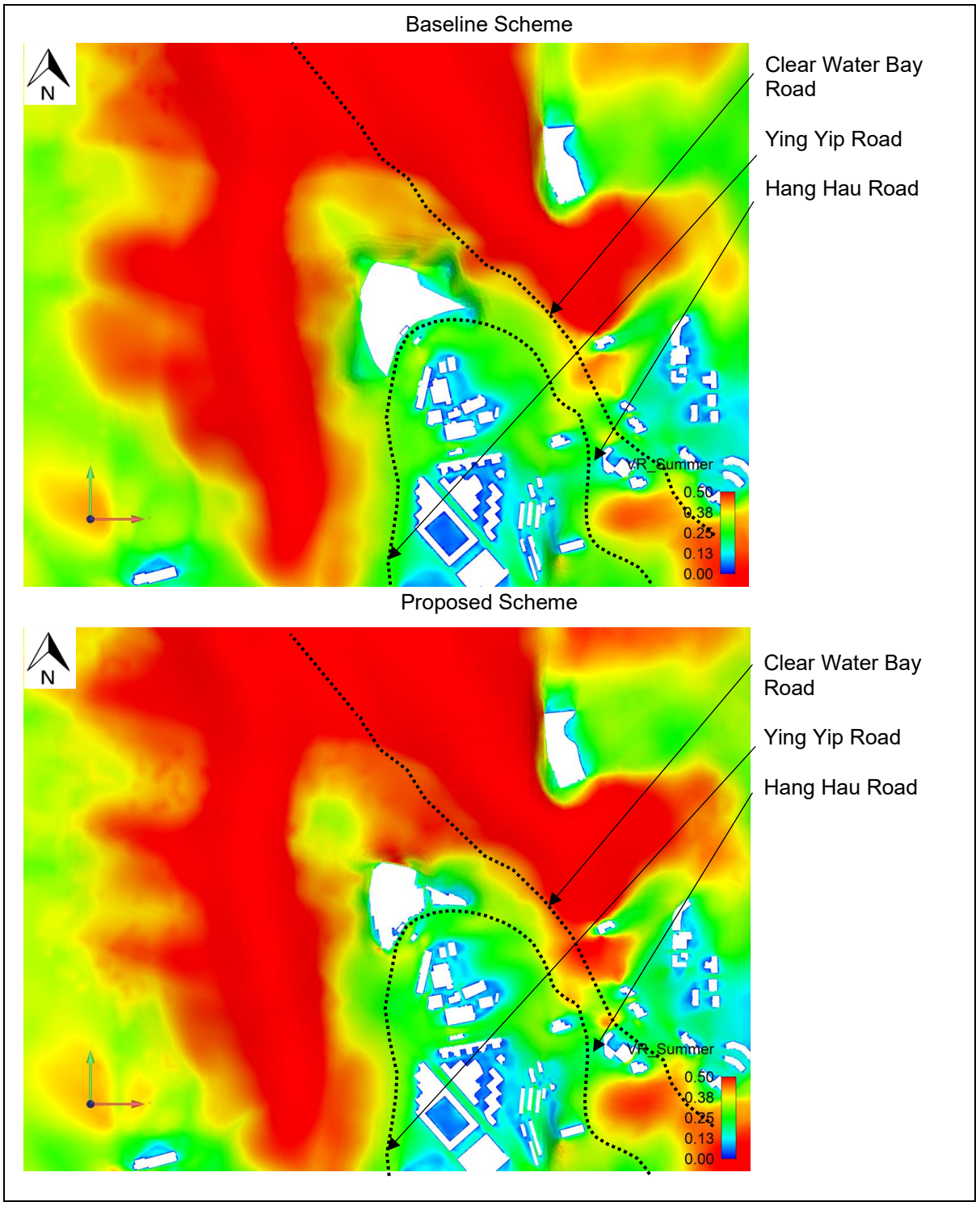
- The provision of empty bays of the Proposed Scheme could facilitate the wind penetration of easterly winds to the immediate west of the Project Area.
- The gap in the main entrance would allow easterly prevailing winds to split to the northern portion of the Project Area, while the Baseline Scheme would allow more easterly penetration to the CDA zone nearby Clear Water Bay Film Studio.



Overall Summer Frequency Weighted VR: (80.9%)

6.35 According to the overall summer frequency weighted VR plot, observable air ventilation enhancements and drawbacks were summarized as follows:

- The minimized podium and provision of empty bays allow more south-westerly winds to reach the immediate south of the Project Area.
- The gap in the main entrance would allow south-westerly prevailing winds to split to the northern portion of the Project Area, while the Baseline Scheme would allow smooth south-westerly wind flow along the CDA zone nearby Clear Water Bay Film Studio.



7 SUMMARY AND CONCLUSIONS

7.1 This AVA Study Report aimed at assessing the characteristics of the wind availability of the Project Area, providing a general pattern and a quantitative estimate of wind performance at the pedestrian level under the annual and summer wind directions with the highest occurrence and investigating the effectiveness of ventilation for the scheme designs for the Proposed Public Housing Development at Ying Yip Road, namely the Baseline Scheme and the Proposed Scheme.

7.2 To mitigate the potential air ventilation impact on site perimeter of the Project Area, several good design features were considered in the Proposed Scheme, such as minimizing the height of the non-domestic block, minimizing the podium and blend into topography, and providing empty bays and building gap to allow the penetration of prevailing wind.

7.3 It was found that both Baseline Scheme and Proposed Scheme provided building separations between the residential towers, which would allow the wind penetration of the annual and summer prevailing winds and the katabatic winds. Moreover, the 1-storey non-domestic podium in the Baseline Scheme would concentrate the prevailing winds to flow along Ying Yip Road. Whereas the Proposed Scheme provided a gap in the main entrance that would facilitate the prevailing winds to split to the northern portion of the Project Area, which was beneficial to the overall wind environment while resulting a weaker flow into Ying Yip Road. On the other hand, the Proposed Scheme provided empty bays, the minimized podium, and non-domestic block that would favour the wind availability.

7.4 From the finding of this AVA Initial Study, the SVRw for both the Proposed Scheme compared to the Baseline Scheme increased from 0.273 to 0.331 under the annual prevailing wind from NNE, NE, ENE, E, ESE, SE, SSW and SW directions accounted for about 78.6% of the whole year time, which indicated a better air ventilation performance in the vicinity of the Proposed Scheme under annual prevailing winds. This was due to the fact that the air permeability of G/F and empty bays in the Proposed Scheme would allow prevailing wind to penetrate through the Project Area to ventilate the pedestrian level around the podium.

7.5 The LVRw for the Proposed Scheme slightly increased from 0.339 to 0.359 compared to the Baseline Scheme under the annual wind directions stated above as the disposition of domestic blocks in the Proposed Scheme would allow various wind directions penetration. It could be concluded that the Proposed Scheme would not impact the air ventilation performance compared to Baseline Scheme under the major annual winds.

7.6 From the finding of this AVA Initial Study, the SVRw for the Proposed Scheme compared to the Baseline Scheme also increase from 0.221 to 0.262 under the summer prevailing wind, which indicated a better wind environment during summer conditions which associated with the good design as mentioned.

7.7 The LVRw for the Proposed Scheme increased from 0.295 to 0.318 as compared to the Baseline Scheme under summer wind conditions. It could be concluded that the Proposed Scheme would have a slightly better air ventilation performance compared to the Baseline Scheme.

7.8 In addition to the good design features identified, the followings are some general recommendations that would be adopted as far as practical in the detailed design stage of the Proposed Development to facilitate wind penetration:

- Building Permeability (refer to P in the PNAP APP-152 Sustainable Building Design Guideline);
- Building setback;
- Greenery of 30% of the gross site area with at least half of it at grade or at podium garden;
- Avoidance of long continuous facades;
- Reference could also be made to recommendations of design measures in the Hong Kong Planning Standards and Guidelines;
- Alternative approach (such as acoustic window and/ or acoustic balcony) in resolving noise exceedance to avoid the use of any noise barriers for more effective air paths; and
- Terraced podium design to further mitigate the ventilation impact at site perimeter.

APPENDIX A

Wind Probability Table

Tabulated Results – Percentage Occurrence of Directional Winds – Annual

f_01416	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.035	0.070	0.098	0.164	0.196	0.077	0.051	0.043	0.046	0.059	0.071	0.036	0.022	0.010	0.011	0.010
00_to_01	0.018	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001
01_to_02	0.043	0.002	0.003	0.003	0.003	0.006	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.003	0.002	0.002	0.002
02_to_03	0.064	0.003	0.004	0.005	0.005	0.007	0.005	0.006	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.002
03_to_04	0.087	0.003	0.006	0.010	0.009	0.011	0.006	0.007	0.007	0.005	0.005	0.006	0.004	0.003	0.001	0.001	0.002
04_to_05	0.112	0.003	0.008	0.014	0.016	0.017	0.010	0.008	0.007	0.006	0.006	0.007	0.004	0.003	0.001	0.001	0.001
05_to_06	0.126	0.004	0.007	0.014	0.021	0.024	0.012	0.007	0.006	0.006	0.006	0.008	0.004	0.003	0.001	0.001	0.001
06_to_07	0.129	0.003	0.007	0.014	0.026	0.029	0.012	0.006	0.005	0.005	0.006	0.009	0.004	0.002	0.001	0.001	0.001
07_to_08	0.118	0.003	0.007	0.011	0.025	0.029	0.010	0.004	0.003	0.005	0.006	0.009	0.003	0.001	0.001	0.001	0.000
08_to_09	0.094	0.002	0.006	0.008	0.020	0.025	0.007	0.003	0.002	0.004	0.006	0.006	0.003	0.001	0.000	0.000	0.000
09_to_10	0.070	0.002	0.005	0.006	0.015	0.019	0.004	0.002	0.001	0.002	0.005	0.005	0.002	0.000	0.000	0.000	0.000
10_to_11	0.047	0.002	0.004	0.004	0.010	0.011	0.002	0.001	0.001	0.001	0.004	0.003	0.002	0.000	0.000	0.000	0.000
11_to_12	0.031	0.001	0.004	0.003	0.005	0.006	0.002	0.001	0.001	0.001	0.003	0.003	0.001	0.000	0.000	0.000	0.000
12_to_13	0.020	0.001	0.003	0.002	0.003	0.003	0.001	0.001	0.000	0.001	0.002	0.003	0.001	0.000	0.000	0.000	0.000
13_to_14	0.014	0.001	0.002	0.001	0.002	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.000	0.000
14_to_15	0.009	0.001	0.001	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
15_to_16	0.006	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
16_to_17	0.004	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17_to_18	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18_to_19	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19_to_20	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20_to_21	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Tabulated Results – Percentage Occurrence of Directional Winds – Summer

f_01416	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.012	0.014	0.021	0.038	0.091	0.080	0.067	0.074	0.102	0.137	0.168	0.090	0.049	0.021	0.021	0.013
00_to_01	0.025	0.001	0.001	0.002	0.001	0.003	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.004	0.001	0.000	0.001
01_to_02	0.056	0.002	0.002	0.002	0.002	0.005	0.004	0.005	0.004	0.005	0.004	0.004	0.004	0.005	0.002	0.003	0.002
02_to_03	0.076	0.002	0.002	0.002	0.003	0.004	0.006	0.007	0.006	0.008	0.009	0.009	0.006	0.005	0.003	0.003	0.002
03_to_04	0.102	0.001	0.002	0.002	0.005	0.006	0.006	0.011	0.012	0.009	0.010	0.015	0.010	0.005	0.002	0.003	0.002
04_to_05	0.110	0.002	0.002	0.002	0.005	0.009	0.011	0.008	0.009	0.011	0.012	0.016	0.010	0.007	0.003	0.003	0.001
05_to_06	0.113	0.001	0.001	0.003	0.003	0.011	0.011	0.006	0.007	0.014	0.013	0.019	0.011	0.006	0.003	0.002	0.001
06_to_07	0.111	0.001	0.001	0.001	0.002	0.011	0.011	0.007	0.008	0.012	0.014	0.022	0.011	0.005	0.002	0.002	0.001
07_to_08	0.099	0.000	0.001	0.001	0.003	0.009	0.007	0.006	0.008	0.013	0.014	0.021	0.009	0.003	0.002	0.002	0.001
08_to_09	0.078	0.000	0.000	0.001	0.003	0.007	0.006	0.004	0.005	0.010	0.017	0.014	0.007	0.002	0.001	0.001	0.001
09_to_10	0.060	0.001	0.000	0.000	0.003	0.006	0.005	0.004	0.003	0.006	0.012	0.012	0.005	0.001	0.001	0.001	0.000
10_to_11	0.046	0.000	0.001	0.000	0.001	0.005	0.003	0.002	0.004	0.004	0.011	0.007	0.004	0.001	0.001	0.001	0.000
11_to_12	0.037	0.000	0.000	0.001	0.001	0.003	0.003	0.002	0.003	0.003	0.006	0.009	0.003	0.001	0.000	0.000	0.000
12_to_13	0.026	0.000	0.000	0.001	0.001	0.002	0.003	0.002	0.001	0.002	0.004	0.007	0.002	0.001	0.000	0.000	0.000
13_to_14	0.019	0.000	0.000	0.000	0.001	0.003	0.001	0.001	0.001	0.001	0.003	0.005	0.002	0.000	0.000	0.000	0.000
14_to_15	0.013	0.000	0.000	0.001	0.001	0.003	0.001	0.000	0.001	0.000	0.002	0.003	0.001	0.000	0.000	0.000	0.000
15_to_16	0.008	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000
16_to_17	0.007	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000
17_to_18	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
18_to_19	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19_to_20	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20_to_21	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

APPENDIX B

Velocity Ratio

Wind Velocity Ratio – Baseline Scheme

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Annual	Summer
Annual	7.0%	9.8%	16.4%	19.6%	7.7%	5.1%			5.9%	7.1%		78.6%	
Summer				9.1%	8.0%	6.7%	7.4%	10.2%	13.7%	16.8%	9.0%		80.9%
O1	0.26	0.63	0.46	0.41	0.48	0.63	0.34	0.30	0.16	0.36	0.35	0.43	0.36
O2	0.32	0.53	0.35	0.65	0.43	0.58	0.40	0.33	0.20	0.32	0.35	0.45	0.38
O3	0.31	0.42	0.33	0.61	0.39	0.53	0.35	0.32	0.19	0.30	0.41	0.42	0.36
O4	0.12	0.30	0.37	0.56	0.39	0.50	0.31	0.33	0.17	0.29	0.48	0.37	0.35
O5	0.17	0.34	0.41	0.56	0.43	0.56	0.36	0.37	0.17	0.30	0.53	0.40	0.38
O6	0.17	0.35	0.40	0.51	0.41	0.50	0.34	0.39	0.19	0.31	0.50	0.38	0.37
O7	0.12	0.34	0.35	0.48	0.37	0.43	0.31	0.41	0.21	0.33	0.44	0.36	0.36
O8	0.06	0.33	0.31	0.48	0.34	0.40	0.31	0.44	0.24	0.35	0.38	0.34	0.36
O9	0.06	0.27	0.12	0.49	0.31	0.38	0.32	0.46	0.25	0.37	0.33	0.29	0.36
O10	0.03	0.24	0.27	0.48	0.25	0.37	0.31	0.48	0.25	0.39	0.30	0.31	0.35
O11	0.03	0.21	0.59	0.45	0.25	0.39	0.30	0.50	0.26	0.41	0.28	0.37	0.36
O12	0.06	0.19	0.65	0.39	0.36	0.44	0.31	0.51	0.27	0.44	0.26	0.39	0.37
O13	0.13	0.19	0.65	0.37	0.45	0.47	0.33	0.53	0.28	0.46	0.26	0.40	0.39
O14	0.72	0.76	0.28	1.04	0.69	0.75	0.49	0.49	0.37	0.69	0.42	0.68	0.60
O15	0.63	0.66	0.31	0.97	0.66	0.72	0.48	0.50	0.34	0.61	0.17	0.64	0.54
O16	0.63	0.65	0.37	0.92	0.66	0.72	0.47	0.51	0.35	0.59	0.10	0.64	0.53
O17	0.68	0.67	0.41	0.86	0.68	0.72	0.46	0.52	0.36	0.61	0.10	0.64	0.53
O18	0.71	0.63	0.43	0.75	0.68	0.71	0.45	0.53	0.35	0.57	0.07	0.61	0.50
O19	0.73	0.59	0.47	0.66	0.67	0.70	0.45	0.52	0.33	0.53	0.08	0.58	0.48
O20	0.77	0.62	0.52	0.60	0.66	0.68	0.44	0.52	0.32	0.53	0.10	0.59	0.47
O21	0.78	0.63	0.58	0.52	0.66	0.67	0.44	0.51	0.30	0.51	0.10	0.58	0.45
O22	0.80	0.67	0.66	0.46	0.66	0.65	0.44	0.50	0.27	0.49	0.06	0.58	0.43
O23	0.84	0.73	0.75	0.54	0.66	0.64	0.45	0.49	0.27	0.49	0.05	0.63	0.44
O24	0.88	0.77	0.83	0.64	0.67	0.62	0.45	0.48	0.27	0.50	0.05	0.68	0.45
O25	0.92	0.80	0.88	0.70	0.66	0.59	0.44	0.48	0.28	0.50	0.07	0.71	0.45
O26	0.94	0.81	0.87	0.71	0.66	0.56	0.43	0.48	0.28	0.52	0.10	0.71	0.46
O27	0.96	0.81	0.82	0.71	0.64	0.53	0.42	0.48	0.29	0.54	0.10	0.70	0.46
O28	0.95	0.80	0.75	0.69	0.60	0.50	0.40	0.47	0.28	0.55	0.08	0.67	0.44
O29	0.95	0.79	0.72	0.69	0.57	0.48	0.37	0.47	0.27	0.56	0.07	0.66	0.44
O30	0.95	0.79	0.73	0.72	0.56	0.49	0.33	0.47	0.27	0.58	0.07	0.67	0.44
O31	0.91	0.77	0.73	0.73	0.56	0.49	0.28	0.46	0.26	0.59	0.09	0.67	0.44
O32	0.90	0.76	0.78	0.74	0.59	0.50	0.27	0.47	0.27	0.61	0.20	0.69	0.46
O33	0.90	0.76	0.84	0.76	0.63	0.51	0.30	0.49	0.28	0.64	0.44	0.71	0.51
O34	0.90	0.74	0.88	0.76	0.66	0.51	0.30	0.50	0.28	0.66	0.54	0.72	0.53
O35	0.88	0.71	0.88	0.77	0.66	0.50	0.31	0.48	0.26	0.67	0.56	0.72	0.53
O36	0.85	0.66	0.82	0.74	0.62	0.47	0.31	0.44	0.23	0.64	0.51	0.68	0.50
O37	0.60	0.29	0.14	0.36	0.15	0.14	0.06	0.50	0.34	0.31	0.25	0.29	0.28
O38	0.59	0.21	0.14	0.40	0.16	0.19	0.11	0.48	0.34	0.32	0.24	0.29	0.30
O39	0.58	0.25	0.38	0.45	0.16	0.23	0.16	0.46	0.34	0.32	0.21	0.36	0.31
O40	0.56	0.29	0.49	0.50	0.17	0.23	0.17	0.45	0.33	0.32	0.18	0.40	0.30

O41	0.55	0.30	0.55	0.53	0.20	0.23	0.19	0.43	0.32	0.32	0.14	0.42	0.31
O42	0.53	0.29	0.55	0.56	0.25	0.25	0.21	0.42	0.31	0.32	0.12	0.43	0.31
O43	0.51	0.26	0.54	0.56	0.28	0.23	0.21	0.41	0.29	0.31	0.15	0.42	0.31
O44	0.48	0.23	0.50	0.56	0.32	0.17	0.18	0.41	0.28	0.31	0.18	0.40	0.31
O45	0.45	0.20	0.44	0.56	0.34	0.11	0.16	0.42	0.27	0.32	0.16	0.38	0.30
O46	0.42	0.22	0.38	0.48	0.34	0.11	0.17	0.42	0.26	0.33	0.09	0.35	0.29
O47	0.36	0.23	0.34	0.17	0.34	0.22	0.16	0.41	0.25	0.36	0.09	0.27	0.27
O48	0.37	0.25	0.35	0.34	0.33	0.29	0.14	0.41	0.23	0.39	0.09	0.32	0.29
O49	0.43	0.25	0.34	0.46	0.30	0.20	0.13	0.41	0.16	0.30	0.15	0.34	0.27
O50	0.49	0.25	0.35	0.54	0.26	0.08	0.17	0.42	0.11	0.27	0.23	0.34	0.26
O51	0.51	0.25	0.33	0.47	0.19	0.25	0.20	0.43	0.09	0.21	0.32	0.32	0.26
O52	0.57	0.22	0.22	0.37	0.20	0.35	0.22	0.41	0.09	0.24	0.38	0.29	0.27
O53	0.26	0.20	0.44	0.30	0.36	0.33	0.21	0.40	0.09	0.27	0.35	0.30	0.28
O54	0.21	0.18	0.32	0.42	0.37	0.34	0.21	0.08	0.06	0.08	0.07	0.28	0.18
O55	0.35	0.15	0.31	0.36	0.35	0.30	0.20	0.06	0.04	0.08	0.07	0.27	0.16
O56	0.41	0.17	0.29	0.25	0.28	0.09	0.05	0.32	0.07	0.35	0.16	0.25	0.21
O57	0.16	0.21	0.49	0.24	0.21	0.19	0.17	0.33	0.17	0.36	0.24	0.28	0.25
O58	0.22	0.16	0.53	0.25	0.18	0.20	0.22	0.18	0.21	0.36	0.25	0.29	0.24
O59	0.24	0.05	0.51	0.22	0.09	0.22	0.25	0.16	0.14	0.34	0.23	0.25	0.21
O60	0.32	0.03	0.44	0.22	0.01	0.21	0.23	0.13	0.15	0.29	0.19	0.23	0.19
O61	0.42	0.04	0.51	0.29	0.07	0.32	0.33	0.21	0.22	0.34	0.23	0.30	0.26
O62	0.39	0.04	0.57	0.30	0.14	0.34	0.33	0.26	0.29	0.38	0.22	0.33	0.29
O63	0.36	0.04	0.53	0.29	0.17	0.33	0.29	0.25	0.33	0.36	0.26	0.31	0.29
O64	0.34	0.07	0.50	0.31	0.17	0.32	0.28	0.22	0.35	0.33	0.31	0.31	0.29
O65	0.57	0.38	0.26	0.54	0.27	0.07	0.09	0.43	0.27	0.33	0.11	0.37	0.28
O66	0.38	0.38	0.27	0.56	0.26	0.14	0.12	0.44	0.30	0.33	0.14	0.37	0.30
O67	0.29	0.33	0.20	0.55	0.23	0.20	0.14	0.44	0.31	0.38	0.21	0.34	0.32
O68	0.23	0.28	0.14	0.57	0.18	0.27	0.17	0.42	0.29	0.42	0.29	0.32	0.34
O69	0.53	0.29	0.11	0.31	0.22	0.15	0.09	0.39	0.29	0.44	0.33	0.28	0.30
O70	0.54	0.22	0.19	0.25	0.20	0.02	0.06	0.13	0.21	0.45	0.29	0.26	0.23
O71	0.47	0.18	0.09	0.40	0.11	0.09	0.03	0.02	0.05	0.21	0.06	0.22	0.13
O72	0.55	0.28	0.17	0.39	0.09	0.05	0.11	0.08	0.06	0.03	0.03	0.24	0.10
O73	0.24	0.26	0.25	0.06	0.09	0.10	0.03	0.10	0.12	0.14	0.10	0.16	0.10
O74	0.33	0.31	0.20	0.08	0.14	0.09	0.06	0.13	0.18	0.12	0.11	0.17	0.12
O75	0.18	0.26	0.26	0.05	0.13	0.09	0.07	0.09	0.16	0.15	0.13	0.16	0.12
O76	0.27	0.17	0.29	0.05	0.11	0.19	0.08	0.04	0.06	0.17	0.15	0.16	0.11
O77	0.35	0.31	0.30	0.07	0.13	0.22	0.10	0.03	0.09	0.21	0.20	0.20	0.13
O78	0.04	0.12	0.08	0.01	0.06	0.04	0.01	0.06	0.04	0.12	0.07	0.06	0.06
O79	0.24	0.30	0.21	0.03	0.09	0.09	0.04	0.15	0.06	0.24	0.07	0.15	0.11
O80	0.11	0.21	0.24	0.04	0.04	0.11	0.05	0.06	0.09	0.22	0.03	0.13	0.09
O81	0.20	0.20	0.15	0.06	0.04	0.05	0.01	0.05	0.06	0.14	0.05	0.11	0.07
O82	0.16	0.16	0.07	0.08	0.06	0.03	0.03	0.05	0.05	0.02	0.05	0.08	0.04
O83	0.10	0.10	0.17	0.05	0.06	0.07	0.03	0.06	0.05	0.05	0.05	0.09	0.05
O84	0.12	0.20	0.25	0.05	0.17	0.12	0.06	0.20	0.14	0.19	0.13	0.15	0.14

O85	0.03	0.14	0.33	0.19	0.16	0.26	0.07	0.18	0.11	0.22	0.13	0.19	0.16
O86	0.15	0.22	0.39	0.30	0.10	0.19	0.07	0.25	0.08	0.09	0.17	0.24	0.15
O87	0.06	0.06	0.08	0.03	0.06	0.02	0.08	0.17	0.07	0.08	0.09	0.06	0.08
O88	0.22	0.31	0.16	0.07	0.07	0.19	0.10	0.14	0.12	0.15	0.10	0.15	0.12
O89	0.17	0.24	0.11	0.02	0.09	0.17	0.09	0.03	0.07	0.07	0.06	0.11	0.07
O90	0.24	0.18	0.16	0.06	0.14	0.24	0.09	0.03	0.12	0.19	0.17	0.15	0.13
O91	0.30	0.18	0.19	0.18	0.14	0.26	0.12	0.07	0.08	0.05	0.04	0.17	0.10
O92	0.06	0.45	0.32	0.04	0.11	0.20	0.05	0.05	0.10	0.08	0.07	0.18	0.09
O93	0.07	0.45	0.27	0.10	0.21	0.20	0.07	0.05	0.07	0.09	0.08	0.19	0.10
O94	0.33	0.08	0.54	0.37	0.06	0.33	0.36	0.28	0.28	0.31	0.18	0.32	0.28
O95	0.29	0.11	0.52	0.37	0.06	0.31	0.33	0.24	0.32	0.23	0.26	0.31	0.26
O96	0.28	0.19	0.46	0.25	0.07	0.31	0.30	0.18	0.34	0.25	0.31	0.28	0.25
O97	0.26	0.31	0.35	0.21	0.09	0.29	0.27	0.14	0.35	0.32	0.34	0.27	0.26
O98	0.24	0.46	0.29	0.29	0.11	0.28	0.24	0.11	0.34	0.38	0.35	0.30	0.28
O99	0.22	0.49	0.30	0.30	0.10	0.29	0.23	0.09	0.32	0.40	0.34	0.31	0.27
O100	0.20	0.40	0.41	0.31	0.10	0.32	0.24	0.08	0.26	0.37	0.30	0.31	0.26
O101	0.21	0.39	0.50	0.28	0.11	0.33	0.28	0.08	0.18	0.31	0.26	0.32	0.23
O102	0.21	0.46	0.41	0.22	0.13	0.29	0.32	0.08	0.10	0.22	0.20	0.27	0.18
O103	0.02	0.49	0.18	0.16	0.15	0.16	0.32	0.08	0.03	0.09	0.10	0.17	0.12
O104	0.29	0.08	0.64	0.27	0.40	0.58	0.55	0.47	0.39	0.58	0.32	0.39	0.45
O105	0.23	0.08	0.59	0.14	0.39	0.57	0.53	0.42	0.38	0.57	0.33	0.34	0.42
O106	0.28	0.10	0.41	0.06	0.40	0.57	0.52	0.38	0.37	0.57	0.34	0.29	0.41
O107	0.29	0.37	0.16	0.03	0.42	0.58	0.52	0.34	0.37	0.57	0.34	0.27	0.40
O108	0.29	0.59	0.07	0.03	0.44	0.59	0.52	0.32	0.37	0.57	0.34	0.28	0.40
O109	0.30	0.56	0.12	0.15	0.46	0.59	0.51	0.33	0.37	0.57	0.33	0.32	0.42
O110	0.25	0.35	0.15	0.27	0.47	0.59	0.50	0.35	0.36	0.58	0.34	0.33	0.44
O111	0.10	0.13	0.19	0.29	0.47	0.58	0.47	0.36	0.35	0.60	0.36	0.30	0.44
O112	0.34	0.05	0.22	0.21	0.47	0.56	0.45	0.37	0.33	0.61	0.38	0.30	0.43
O113	0.47	0.04	0.24	0.05	0.46	0.54	0.43	0.38	0.28	0.62	0.40	0.27	0.40
O114	0.41	0.03	0.25	0.06	0.47	0.52	0.39	0.38	0.23	0.64	0.43	0.26	0.40
O115	0.21	0.06	0.25	0.15	0.49	0.51	0.37	0.37	0.24	0.65	0.48	0.27	0.42
O116	0.05	0.13	0.22	0.44	0.52	0.51	0.35	0.36	0.26	0.64	0.54	0.34	0.46
O117	0.17	0.16	0.18	0.59	0.53	0.50	0.33	0.35	0.26	0.61	0.56	0.38	0.47
O118	0.37	0.16	0.14	0.63	0.52	0.48	0.31	0.35	0.26	0.54	0.54	0.39	0.45
O119	0.44	0.15	0.12	0.63	0.50	0.46	0.27	0.34	0.28	0.47	0.49	0.38	0.43
O120	0.47	0.13	0.09	0.60	0.47	0.43	0.25	0.33	0.30	0.41	0.44	0.36	0.40
O121	0.46	0.11	0.07	0.56	0.44	0.41	0.24	0.32	0.32	0.42	0.42	0.34	0.39
O122	0.40	0.09	0.06	0.54	0.43	0.40	0.24	0.31	0.34	0.47	0.42	0.33	0.40
O123	0.34	0.09	0.12	0.52	0.44	0.40	0.26	0.30	0.36	0.51	0.42	0.34	0.41
O124	0.29	0.09	0.30	0.52	0.47	0.41	0.27	0.28	0.38	0.53	0.41	0.38	0.42
O125	0.26	0.07	0.44	0.47	0.52	0.40	0.26	0.25	0.39	0.55	0.39	0.40	0.42
O126	0.24	0.06	0.56	0.38	0.56	0.40	0.26	0.21	0.40	0.55	0.39	0.40	0.41
O127	0.22	0.20	0.66	0.29	0.60	0.38	0.25	0.20	0.41	0.54	0.43	0.42	0.40
O128	0.19	0.45	0.72	0.20	0.61	0.36	0.24	0.21	0.42	0.53	0.47	0.44	0.39

O129	0.13	0.61	0.78	0.14	0.59	0.32	0.22	0.23	0.43	0.54	0.51	0.45	0.39
O130	0.12	0.71	0.76	0.11	0.53	0.28	0.20	0.26	0.43	0.57	0.55	0.44	0.39
O131	0.32	0.12	0.46	0.33	0.17	0.33	0.27	0.19	0.36	0.32	0.34	0.32	0.30
O132	0.30	0.27	0.36	0.30	0.17	0.32	0.26	0.16	0.37	0.36	0.38	0.31	0.30
O133	0.28	0.46	0.28	0.22	0.16	0.34	0.25	0.15	0.37	0.41	0.41	0.30	0.30
O134	0.25	0.55	0.23	0.16	0.13	0.33	0.22	0.14	0.37	0.46	0.43	0.28	0.30
O135	0.20	0.51	0.22	0.10	0.15	0.31	0.20	0.16	0.36	0.50	0.44	0.26	0.30
O136	0.17	0.46	0.31	0.05	0.18	0.29	0.19	0.18	0.34	0.51	0.45	0.26	0.30
O137	0.43	0.56	0.49	0.07	0.22	0.27	0.19	0.20	0.31	0.51	0.46	0.34	0.31
P1	0.34	0.24	0.34	0.24	0.13	0.19	0.13	0.39	0.06	0.16	0.34	0.23	0.20
P2	0.21	0.20	0.54	0.32	0.29	0.33	0.22	0.36	0.05	0.23	0.31	0.31	0.25
P3	0.28	0.18	0.48	0.35	0.27	0.33	0.22	0.39	0.03	0.09	0.28	0.29	0.22
P4	0.18	0.19	0.40	0.37	0.22	0.28	0.19	0.35	0.05	0.14	0.30	0.27	0.22
P5	0.17	0.17	0.34	0.21	0.24	0.23	0.05	0.33	0.08	0.14	0.14	0.22	0.17
P6	0.44	0.18	0.20	0.18	0.28	0.17	0.19	0.24	0.08	0.11	0.12	0.20	0.16
P7	0.08	0.18	0.20	0.08	0.28	0.06	0.16	0.19	0.05	0.10	0.12	0.14	0.12
P8	0.12	0.19	0.32	0.07	0.29	0.10	0.09	0.29	0.07	0.16	0.11	0.17	0.15
P9	0.12	0.20	0.19	0.03	0.24	0.09	0.10	0.24	0.04	0.15	0.02	0.13	0.12
P10	0.58	0.04	0.18	0.27	0.08	0.23	0.21	0.07	0.10	0.11	0.26	0.20	0.15
P11	0.61	0.01	0.10	0.32	0.15	0.25	0.25	0.21	0.13	0.06	0.29	0.20	0.19
P12	0.58	0.05	0.13	0.36	0.10	0.26	0.28	0.04	0.11	0.15	0.35	0.23	0.19
P13	0.53	0.03	0.12	0.40	0.09	0.15	0.15	0.08	0.09	0.10	0.32	0.21	0.16
P14	0.50	0.01	0.11	0.46	0.08	0.06	0.09	0.10	0.11	0.07	0.32	0.21	0.15
P15	0.34	0.03	0.07	0.44	0.06	0.04	0.03	0.07	0.11	0.08	0.25	0.18	0.13
P16	0.20	0.11	0.02	0.31	0.06	0.10	0.11	0.11	0.08	0.13	0.14	0.14	0.13
P17	0.37	0.25	0.06	0.20	0.14	0.23	0.23	0.21	0.21	0.49	0.50	0.21	0.30
P18	0.41	0.29	0.16	0.12	0.23	0.36	0.31	0.23	0.25	0.57	0.51	0.25	0.34
P19	0.34	0.27	0.15	0.13	0.24	0.37	0.30	0.18	0.24	0.49	0.41	0.24	0.31
P20	0.20	0.28	0.10	0.27	0.30	0.45	0.34	0.23	0.25	0.46	0.34	0.26	0.33
P21	0.21	0.29	0.14	0.46	0.26	0.47	0.33	0.28	0.25	0.41	0.23	0.31	0.33
P22	0.16	0.28	0.19	0.50	0.15	0.06	0.05	0.26	0.19	0.29	0.09	0.27	0.22
P23	0.12	0.43	0.24	0.68	0.25	0.33	0.07	0.27	0.16	0.28	0.19	0.37	0.28
P24	0.21	0.53	0.33	0.68	0.39	0.52	0.15	0.29	0.17	0.32	0.31	0.44	0.34
P25	0.34	0.64	0.46	0.36	0.51	0.61	0.41	0.29	0.15	0.30	0.29	0.42	0.34
P26	0.42	0.64	0.41	0.12	0.51	0.54	0.37	0.24	0.10	0.20	0.24	0.34	0.26
P27	0.50	0.63	0.18	0.10	0.51	0.50	0.35	0.28	0.09	0.19	0.21	0.29	0.25
P28	0.61	0.65	0.37	0.16	0.54	0.53	0.33	0.30	0.07	0.21	0.19	0.36	0.26
P29	0.72	0.58	0.48	0.08	0.53	0.53	0.26	0.28	0.06	0.18	0.10	0.36	0.22
P30	0.84	0.60	0.50	0.06	0.56	0.54	0.23	0.27	0.05	0.13	0.11	0.37	0.21
P31	0.86	0.60	0.48	0.04	0.54	0.47	0.19	0.21	0.03	0.04	0.20	0.35	0.18
P32	0.87	0.55	0.55	0.06	0.51	0.38	0.13	0.15	0.11	0.08	0.27	0.37	0.18
P33	0.83	0.51	0.41	0.05	0.49	0.32	0.08	0.12	0.15	0.17	0.33	0.33	0.20
P34	0.74	0.50	0.27	0.10	0.44	0.20	0.06	0.18	0.13	0.25	0.34	0.30	0.21
P35	0.52	0.38	0.17	0.09	0.45	0.08	0.05	0.15	0.08	0.35	0.31	0.24	0.21

P36	0.32	0.11	0.49	0.43	0.25	0.16	0.20	0.36	0.12	0.31	0.12	0.32	0.25
P37	0.32	0.21	0.59	0.36	0.23	0.19	0.23	0.31	0.13	0.29	0.31	0.34	0.25

Wind Velocity Ratio – Proposed Scheme

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Annual	Summer
Annual	7.0%	9.8%	16.4%	19.6%	7.7%	5.1%			5.9%	7.1%		78.6%	
Summer				9.1%	8.0%	6.7%	7.4%	10.2%	13.7%	16.8%	9.0%		80.9%
O1	0.43	0.48	0.09	0.37	0.29	0.48	0.33	0.33	0.27	0.40	0.35	0.32	0.35
O2	0.41	0.46	0.18	0.40	0.15	0.50	0.29	0.35	0.26	0.36	0.39	0.33	0.33
O3	0.30	0.46	0.21	0.61	0.28	0.44	0.27	0.36	0.26	0.34	0.45	0.39	0.37
O4	0.18	0.43	0.20	0.58	0.36	0.40	0.25	0.37	0.26	0.33	0.46	0.37	0.37
O5	0.13	0.39	0.17	0.52	0.38	0.35	0.26	0.39	0.25	0.32	0.44	0.33	0.35
O6	0.10	0.37	0.15	0.45	0.40	0.28	0.25	0.40	0.23	0.32	0.40	0.30	0.34
O7	0.08	0.34	0.09	0.37	0.40	0.29	0.24	0.41	0.23	0.33	0.37	0.26	0.33
O8	0.07	0.30	0.05	0.32	0.40	0.32	0.26	0.43	0.22	0.34	0.33	0.24	0.32
O9	0.06	0.25	0.10	0.31	0.41	0.35	0.27	0.45	0.23	0.35	0.29	0.25	0.33
O10	0.10	0.21	0.22	0.33	0.42	0.40	0.27	0.47	0.24	0.38	0.28	0.28	0.35
O11	0.12	0.19	0.41	0.37	0.44	0.44	0.28	0.49	0.26	0.40	0.28	0.34	0.37
O12	0.13	0.19	0.49	0.42	0.44	0.44	0.28	0.50	0.28	0.43	0.30	0.37	0.39
O13	0.09	0.20	0.61	0.47	0.44	0.44	0.30	0.52	0.29	0.46	0.31	0.41	0.40
O14	0.71	0.76	0.45	0.92	0.62	0.75	0.45	0.50	0.37	0.74	0.54	0.68	0.61
O15	0.66	0.68	0.39	0.84	0.58	0.72	0.44	0.51	0.29	0.64	0.36	0.62	0.54
O16	0.65	0.67	0.41	0.80	0.60	0.72	0.44	0.53	0.31	0.63	0.29	0.61	0.53
O17	0.68	0.71	0.41	0.70	0.63	0.72	0.44	0.54	0.36	0.67	0.34	0.61	0.55
O18	0.65	0.68	0.40	0.54	0.63	0.71	0.45	0.54	0.36	0.63	0.24	0.55	0.51
O19	0.65	0.64	0.39	0.46	0.63	0.70	0.45	0.54	0.33	0.58	0.11	0.52	0.47
O20	0.70	0.65	0.37	0.52	0.64	0.70	0.45	0.53	0.34	0.57	0.12	0.53	0.48
O21	0.73	0.65	0.36	0.64	0.64	0.69	0.45	0.52	0.33	0.53	0.14	0.56	0.48
O22	0.75	0.68	0.43	0.76	0.64	0.69	0.45	0.51	0.34	0.51	0.13	0.61	0.49
O23	0.78	0.72	0.54	0.86	0.64	0.69	0.45	0.52	0.35	0.53	0.15	0.67	0.51
O24	0.80	0.76	0.64	0.91	0.64	0.68	0.45	0.51	0.35	0.52	0.18	0.71	0.51
O25	0.81	0.79	0.75	0.89	0.62	0.66	0.45	0.51	0.35	0.51	0.11	0.73	0.50
O26	0.81	0.79	0.85	0.84	0.60	0.62	0.44	0.51	0.36	0.52	0.07	0.73	0.49
O27	0.80	0.78	0.90	0.77	0.56	0.59	0.43	0.50	0.37	0.54	0.10	0.72	0.48
O28	0.77	0.76	0.88	0.71	0.53	0.55	0.42	0.49	0.38	0.53	0.09	0.69	0.46
O29	0.75	0.74	0.84	0.68	0.49	0.52	0.41	0.48	0.39	0.54	0.03	0.66	0.45
O30	0.73	0.74	0.82	0.67	0.48	0.50	0.39	0.47	0.39	0.57	0.17	0.65	0.46
O31	0.71	0.74	0.80	0.64	0.46	0.49	0.36	0.46	0.40	0.59	0.29	0.64	0.47
O32	0.72	0.75	0.82	0.65	0.49	0.51	0.33	0.47	0.41	0.65	0.43	0.66	0.51
O33	0.74	0.76	0.86	0.65	0.53	0.53	0.29	0.48	0.43	0.72	0.53	0.69	0.54
O34	0.76	0.75	0.88	0.66	0.57	0.54	0.28	0.47	0.44	0.77	0.59	0.70	0.56
O35	0.75	0.72	0.86	0.68	0.59	0.53	0.28	0.45	0.44	0.76	0.60	0.70	0.56
O36	0.72	0.65	0.79	0.66	0.54	0.50	0.28	0.42	0.42	0.69	0.54	0.65	0.52
O37	0.62	0.43	0.28	0.40	0.12	0.17	0.10	0.52	0.40	0.37	0.24	0.35	0.32
O38	0.61	0.34	0.40	0.35	0.12	0.16	0.19	0.52	0.39	0.37	0.25	0.35	0.32
O39	0.59	0.24	0.46	0.29	0.12	0.19	0.20	0.52	0.37	0.36	0.26	0.34	0.31
O40	0.58	0.09	0.50	0.25	0.13	0.22	0.20	0.51	0.32	0.36	0.25	0.31	0.30

O41	0.59	0.14	0.51	0.20	0.13	0.25	0.22	0.50	0.26	0.35	0.22	0.31	0.28
O42	0.58	0.27	0.50	0.10	0.14	0.27	0.23	0.50	0.20	0.35	0.18	0.29	0.26
O43	0.57	0.29	0.49	0.04	0.16	0.24	0.22	0.48	0.18	0.35	0.13	0.28	0.24
O44	0.55	0.23	0.48	0.11	0.17	0.19	0.20	0.47	0.18	0.35	0.12	0.28	0.24
O45	0.53	0.16	0.48	0.18	0.19	0.18	0.19	0.46	0.20	0.35	0.14	0.29	0.25
O46	0.50	0.15	0.48	0.25	0.20	0.23	0.19	0.44	0.22	0.35	0.20	0.31	0.27
O47	0.48	0.23	0.51	0.34	0.21	0.26	0.17	0.42	0.24	0.36	0.30	0.35	0.30
O48	0.45	0.33	0.54	0.45	0.24	0.20	0.17	0.41	0.28	0.40	0.37	0.40	0.33
O49	0.44	0.34	0.57	0.52	0.26	0.18	0.20	0.40	0.32	0.45	0.38	0.43	0.36
O50	0.35	0.32	0.56	0.48	0.21	0.24	0.21	0.41	0.31	0.39	0.33	0.40	0.34
O51	0.17	0.30	0.50	0.33	0.18	0.21	0.17	0.39	0.26	0.40	0.41	0.32	0.31
O52	0.50	0.31	0.30	0.23	0.16	0.18	0.15	0.45	0.30	0.50	0.49	0.30	0.33
O53	0.48	0.27	0.25	0.26	0.10	0.14	0.16	0.30	0.28	0.44	0.39	0.28	0.29
O54	0.32	0.24	0.32	0.07	0.13	0.17	0.17	0.22	0.16	0.25	0.19	0.20	0.18
O55	0.67	0.22	0.25	0.12	0.10	0.16	0.18	0.28	0.09	0.26	0.31	0.22	0.19
O56	0.64	0.20	0.20	0.20	0.06	0.08	0.18	0.33	0.13	0.38	0.34	0.23	0.23
O57	0.48	0.20	0.33	0.12	0.14	0.17	0.14	0.31	0.17	0.41	0.31	0.24	0.24
O58	0.34	0.03	0.32	0.09	0.24	0.19	0.05	0.15	0.21	0.42	0.30	0.21	0.23
O59	0.31	0.02	0.32	0.03	0.24	0.17	0.10	0.14	0.23	0.41	0.28	0.19	0.22
O60	0.33	0.05	0.38	0.06	0.26	0.20	0.19	0.15	0.26	0.43	0.28	0.23	0.25
O61	0.46	0.12	0.48	0.19	0.23	0.25	0.26	0.20	0.30	0.45	0.29	0.30	0.29
O62	0.59	0.10	0.54	0.33	0.23	0.28	0.28	0.23	0.34	0.50	0.31	0.37	0.33
O63	0.58	0.06	0.49	0.40	0.23	0.28	0.25	0.21	0.34	0.49	0.28	0.37	0.33
O64	0.56	0.09	0.45	0.43	0.22	0.28	0.22	0.18	0.33	0.47	0.25	0.37	0.32
O65	0.40	0.35	0.59	0.58	0.24	0.14	0.15	0.42	0.28	0.41	0.34	0.44	0.34
O66	0.63	0.36	0.49	0.53	0.20	0.20	0.15	0.44	0.27	0.41	0.30	0.43	0.33
O67	0.64	0.28	0.27	0.21	0.15	0.17	0.14	0.43	0.32	0.47	0.34	0.29	0.31
O68	0.64	0.23	0.17	0.33	0.12	0.05	0.03	0.45	0.34	0.50	0.40	0.29	0.32
O69	0.60	0.23	0.25	0.28	0.11	0.07	0.06	0.40	0.27	0.46	0.34	0.28	0.29
O70	0.62	0.21	0.10	0.08	0.07	0.06	0.06	0.17	0.33	0.49	0.34	0.20	0.24
O71	0.53	0.21	0.09	0.20	0.10	0.07	0.04	0.01	0.24	0.18	0.32	0.19	0.15
O72	0.56	0.19	0.11	0.38	0.18	0.08	0.07	0.04	0.03	0.03	0.03	0.22	0.09
O73	0.57	0.31	0.32	0.29	0.08	0.06	0.04	0.12	0.11	0.18	0.12	0.27	0.13
O74	0.31	0.34	0.26	0.27	0.19	0.07	0.07	0.10	0.10	0.10	0.11	0.23	0.12
O75	0.21	0.27	0.26	0.37	0.19	0.03	0.08	0.07	0.08	0.12	0.14	0.23	0.13
O76	0.37	0.15	0.33	0.38	0.17	0.15	0.08	0.03	0.04	0.17	0.13	0.26	0.14
O77	0.43	0.27	0.37	0.23	0.14	0.18	0.10	0.02	0.19	0.19	0.20	0.26	0.16
O78	0.22	0.08	0.15	0.18	0.12	0.05	0.02	0.05	0.19	0.15	0.13	0.15	0.12
O79	0.27	0.32	0.24	0.26	0.08	0.12	0.05	0.13	0.10	0.06	0.06	0.21	0.11
O80	0.23	0.26	0.33	0.25	0.10	0.12	0.07	0.06	0.06	0.11	0.07	0.22	0.11
O81	0.35	0.19	0.12	0.29	0.21	0.05	0.06	0.08	0.02	0.11	0.07	0.19	0.11
O82	0.46	0.05	0.27	0.24	0.17	0.06	0.05	0.07	0.05	0.08	0.01	0.19	0.09
O83	0.17	0.22	0.24	0.32	0.13	0.10	0.07	0.11	0.11	0.12	0.12	0.21	0.13
O84	0.13	0.36	0.24	0.27	0.17	0.20	0.08	0.19	0.17	0.30	0.21	0.24	0.21

O85	0.08	0.28	0.39	0.16	0.13	0.22	0.08	0.14	0.09	0.23	0.17	0.22	0.16
O86	0.22	0.26	0.45	0.28	0.07	0.15	0.08	0.27	0.12	0.13	0.10	0.25	0.15
O87	0.05	0.05	0.13	0.04	0.06	0.01	0.09	0.17	0.04	0.09	0.06	0.07	0.07
O88	0.16	0.58	0.18	0.07	0.05	0.18	0.11	0.18	0.07	0.10	0.05	0.17	0.10
O89	0.19	0.52	0.12	0.05	0.12	0.13	0.10	0.05	0.08	0.10	0.06	0.15	0.09
O90	0.32	0.47	0.20	0.18	0.17	0.08	0.08	0.05	0.14	0.20	0.10	0.23	0.13
O91	0.32	0.60	0.27	0.15	0.09	0.14	0.15	0.07	0.10	0.07	0.12	0.23	0.10
O92	0.03	0.62	0.30	0.07	0.22	0.09	0.06	0.09	0.08	0.08	0.08	0.20	0.09
O93	0.06	0.52	0.22	0.09	0.17	0.08	0.10	0.07	0.02	0.11	0.03	0.17	0.08
O94	0.57	0.07	0.36	0.40	0.30	0.29	0.26	0.24	0.32	0.44	0.26	0.35	0.33
O95	0.58	0.11	0.27	0.43	0.27	0.28	0.25	0.20	0.27	0.36	0.19	0.33	0.29
O96	0.57	0.25	0.22	0.37	0.25	0.28	0.25	0.15	0.22	0.30	0.18	0.31	0.25
O97	0.55	0.44	0.18	0.29	0.26	0.27	0.26	0.12	0.24	0.31	0.25	0.30	0.25
O98	0.52	0.55	0.14	0.28	0.23	0.27	0.25	0.10	0.27	0.37	0.32	0.31	0.27
O99	0.49	0.49	0.14	0.30	0.16	0.28	0.25	0.10	0.27	0.43	0.34	0.30	0.28
O100	0.49	0.44	0.20	0.19	0.11	0.31	0.24	0.10	0.24	0.43	0.28	0.28	0.25
O101	0.46	0.48	0.27	0.09	0.15	0.32	0.22	0.10	0.18	0.37	0.19	0.26	0.21
O102	0.34	0.53	0.24	0.04	0.19	0.27	0.17	0.10	0.12	0.27	0.11	0.23	0.16
O103	0.08	0.54	0.14	0.11	0.20	0.16	0.08	0.10	0.08	0.11	0.11	0.18	0.11
O104	0.35	0.16	0.56	0.26	0.40	0.56	0.51	0.46	0.44	0.61	0.35	0.39	0.46
O105	0.29	0.17	0.47	0.24	0.40	0.55	0.50	0.41	0.44	0.60	0.37	0.37	0.45
O106	0.26	0.23	0.34	0.25	0.41	0.55	0.49	0.37	0.45	0.59	0.38	0.35	0.45
O107	0.25	0.40	0.24	0.27	0.43	0.56	0.49	0.34	0.46	0.59	0.39	0.36	0.45
O108	0.25	0.56	0.18	0.31	0.46	0.57	0.49	0.34	0.45	0.58	0.39	0.38	0.46
O109	0.26	0.51	0.18	0.35	0.48	0.58	0.49	0.34	0.45	0.58	0.40	0.39	0.46
O110	0.30	0.31	0.19	0.34	0.50	0.58	0.47	0.34	0.46	0.59	0.41	0.37	0.47
O111	0.33	0.14	0.20	0.31	0.50	0.57	0.46	0.34	0.46	0.61	0.43	0.34	0.47
O112	0.33	0.06	0.19	0.28	0.50	0.55	0.43	0.33	0.46	0.64	0.44	0.32	0.47
O113	0.32	0.05	0.19	0.25	0.50	0.53	0.40	0.33	0.45	0.66	0.46	0.31	0.46
O114	0.26	0.05	0.21	0.23	0.50	0.52	0.38	0.34	0.44	0.67	0.48	0.31	0.46
O115	0.32	0.05	0.22	0.30	0.51	0.51	0.36	0.35	0.41	0.67	0.52	0.33	0.47
O116	0.31	0.06	0.22	0.41	0.52	0.49	0.34	0.35	0.35	0.65	0.56	0.35	0.47
O117	0.29	0.08	0.21	0.49	0.52	0.48	0.32	0.35	0.26	0.60	0.59	0.36	0.45
O118	0.31	0.11	0.18	0.53	0.51	0.45	0.29	0.33	0.22	0.49	0.60	0.35	0.42
O119	0.29	0.12	0.15	0.56	0.50	0.43	0.27	0.32	0.25	0.45	0.58	0.35	0.41
O120	0.22	0.12	0.09	0.55	0.47	0.40	0.26	0.30	0.29	0.50	0.54	0.33	0.42
O121	0.11	0.12	0.06	0.53	0.44	0.38	0.25	0.27	0.32	0.55	0.50	0.31	0.42
O122	0.10	0.11	0.10	0.53	0.44	0.37	0.24	0.25	0.34	0.58	0.47	0.32	0.42
O123	0.11	0.10	0.18	0.56	0.45	0.37	0.25	0.23	0.36	0.61	0.45	0.35	0.43
O124	0.13	0.08	0.30	0.61	0.48	0.38	0.26	0.20	0.38	0.64	0.45	0.40	0.44
O125	0.22	0.07	0.47	0.65	0.52	0.38	0.26	0.17	0.40	0.66	0.46	0.45	0.46
O126	0.29	0.09	0.60	0.68	0.56	0.37	0.26	0.14	0.42	0.67	0.47	0.50	0.47
O127	0.29	0.29	0.69	0.69	0.59	0.35	0.26	0.15	0.44	0.69	0.47	0.55	0.48
O128	0.23	0.54	0.75	0.70	0.61	0.33	0.26	0.19	0.46	0.69	0.46	0.60	0.49

O129	0.14	0.65	0.79	0.68	0.59	0.29	0.25	0.23	0.46	0.69	0.47	0.60	0.48
O130	0.12	0.69	0.76	0.69	0.56	0.27	0.24	0.27	0.46	0.68	0.50	0.59	0.48
O131	0.54	0.19	0.39	0.43	0.21	0.29	0.19	0.15	0.32	0.46	0.26	0.37	0.31
O132	0.50	0.38	0.27	0.42	0.20	0.29	0.16	0.14	0.31	0.44	0.29	0.35	0.30
O133	0.45	0.54	0.18	0.39	0.19	0.30	0.15	0.13	0.32	0.45	0.34	0.34	0.30
O134	0.39	0.55	0.17	0.29	0.21	0.30	0.14	0.14	0.34	0.49	0.39	0.32	0.31
O135	0.33	0.47	0.16	0.19	0.25	0.29	0.14	0.17	0.36	0.54	0.42	0.29	0.32
O136	0.28	0.50	0.21	0.26	0.34	0.27	0.13	0.20	0.36	0.58	0.41	0.33	0.35
O137	0.26	0.63	0.50	0.36	0.38	0.26	0.14	0.23	0.36	0.60	0.39	0.43	0.37
P1	0.22	0.15	0.11	0.17	0.08	0.06	0.03	0.13	0.06	0.16	0.23	0.14	0.12
P2	0.23	0.28	0.22	0.17	0.18	0.03	0.03	0.32	0.13	0.30	0.38	0.20	0.21
P3	0.17	0.30	0.37	0.12	0.15	0.13	0.12	0.33	0.14	0.26	0.27	0.22	0.20
P4	0.41	0.18	0.28	0.04	0.12	0.12	0.15	0.33	0.21	0.36	0.23	0.20	0.22
P5	0.80	0.05	0.23	0.34	0.17	0.05	0.06	0.26	0.19	0.31	0.24	0.27	0.22
P6	0.19	0.05	0.28	0.06	0.26	0.11	0.07	0.06	0.03	0.14	0.13	0.14	0.10
P7	0.35	0.15	0.09	0.12	0.18	0.04	0.02	0.11	0.02	0.07	0.08	0.13	0.08
P8	0.02	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01
P9	0.28	0.07	0.37	0.06	0.14	0.20	0.19	0.06	0.04	0.08	0.05	0.16	0.09
P10	0.17	0.05	0.42	0.12	0.03	0.04	0.05	0.07	0.04	0.17	0.02	0.16	0.08
P11	0.14	0.06	0.42	0.14	0.04	0.11	0.12	0.09	0.05	0.15	0.05	0.17	0.10
P12	0.73	0.20	0.51	0.14	0.11	0.18	0.18	0.12	0.04	0.09	0.12	0.27	0.11
P13	0.76	0.23	0.53	0.16	0.06	0.18	0.14	0.08	0.08	0.21	0.25	0.29	0.15
P14	0.64	0.25	0.44	0.39	0.03	0.17	0.10	0.20	0.14	0.30	0.29	0.33	0.21
P15	0.54	0.23	0.29	0.43	0.15	0.28	0.20	0.18	0.10	0.20	0.18	0.30	0.21
P16	0.53	0.32	0.31	0.43	0.18	0.30	0.22	0.22	0.28	0.50	0.57	0.36	0.35
P17	0.51	0.28	0.34	0.23	0.20	0.33	0.27	0.24	0.23	0.46	0.52	0.31	0.32
P18	0.40	0.18	0.48	0.30	0.36	0.45	0.38	0.24	0.28	0.54	0.56	0.37	0.39
P19	0.23	0.16	0.46	0.74	0.52	0.54	0.45	0.22	0.38	0.60	0.55	0.49	0.50
P20	0.27	0.15	0.39	0.82	0.52	0.54	0.40	0.07	0.37	0.54	0.44	0.49	0.46
P21	0.37	0.25	0.33	0.78	0.47	0.50	0.31	0.25	0.35	0.47	0.35	0.47	0.43
P22	0.32	0.26	0.27	0.44	0.19	0.17	0.21	0.20	0.32	0.47	0.35	0.32	0.32
P23	0.62	0.38	0.11	0.32	0.19	0.34	0.26	0.18	0.32	0.52	0.42	0.32	0.34
P24	0.66	0.53	0.14	0.43	0.26	0.41	0.35	0.24	0.25	0.44	0.38	0.37	0.35
P25	0.77	0.60	0.08	0.58	0.30	0.48	0.32	0.31	0.22	0.35	0.29	0.41	0.35
P26	0.84	0.59	0.31	0.34	0.20	0.24	0.25	0.33	0.21	0.30	0.25	0.38	0.27
P27	0.84	0.56	0.24	0.33	0.13	0.48	0.38	0.31	0.23	0.30	0.22	0.37	0.29
P28	0.86	0.60	0.12	0.57	0.29	0.64	0.46	0.32	0.23	0.27	0.17	0.43	0.34
P29	0.88	0.63	0.28	0.66	0.33	0.67	0.46	0.31	0.19	0.19	0.08	0.49	0.33
P30	0.86	0.63	0.43	0.70	0.41	0.66	0.45	0.25	0.11	0.07	0.08	0.52	0.29
P31	0.88	0.61	0.62	0.73	0.54	0.60	0.42	0.20	0.06	0.10	0.19	0.57	0.30
P32	0.85	0.52	0.88	0.63	0.57	0.53	0.35	0.19	0.14	0.26	0.33	0.60	0.34
P33	0.77	0.29	0.73	0.31	0.41	0.42	0.27	0.21	0.26	0.44	0.44	0.46	0.35
P34	0.26	0.34	0.59	0.24	0.32	0.32	0.25	0.32	0.29	0.43	0.42	0.36	0.33
P35	0.42	0.42	0.54	0.36	0.29	0.26	0.22	0.37	0.29	0.43	0.40	0.40	0.34

P36	0.41	0.36	0.62	0.37	0.25	0.30	0.26	0.34	0.32	0.39	0.38	0.41	0.34
P37	0.27	0.38	0.59	0.42	0.15	0.25	0.20	0.37	0.12	0.28	0.29	0.36	0.26