ARUP

Appendix I

Revised Air Ventilation Assessment

Planning Application for Proposed Application for Permission Under Section 16 of the Town Planning Ordinance (Cap. 131) for Proposed Comprehensive Development including Flats, Retail and Community Facilities and Minor Relaxation of Plot Ratio and Building Height Restriction in "Comprehensive Development Area" Zone at Various Lots in S.D.4 and Adjoining Government Land, Kau Wa Keng, Kwai Chung

Air Ventilation Assessment – Initial Study

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Contents

1 Introduction

Ove Arup & Partners Hong Kong limited (Arup) was instructed to conduct an Air Ventilation Assessment (AVA) – Initial Study for the Planning Application for Proposed Application for Permission Under Section 16 of the Town Planning Ordinance (Cap. 131) for Proposed Comprehensive Development including Flats, Retail and Community Facilities and Minor Relaxation of Plot Ratio and Building Height Restriction in "Comprehensive Development Area" Zone at Various Lots in S.D.4 and Adjoining Government Land, Kau Wa Keng, Kwai Chung (the Application Site).

The Study was carried out in accordance with the "*Technical Circular No. 1/06 on Air Ventilation Assessments*" (the *AVA Technical Circular*[1],) jointly issued by the Housing, Planning and Lands Bureau (HPLB) and the Environment, Transport and Works Bureau (ETWB) on 19th July 2006 (termed as *AVA Technical Circular*[1] hereafter).

1.1 Objectives of the Study

The Application Site is currently zoned as "Comprehensive Development Area" ("CDA") on the Approved Kwai Chung Outline Zoning Plan (OZP) No. S/KC/32 with maximum building height of +120mPD. This document is to support the Section 16 application.

An AVA Initial Study was conducted by using Computational Fluid Dynamics (CFD) techniques. It aims to achieve the following tasks:

- Initially assess the characteristics of the wind availability of the site;
- Give a general pattern and a rough quantitative estimate of the wind performance at the pedestrian level reported using wind Velocity Ratio (VR);
- Identify the air paths within the site and ascertain their effectiveness; and
- Identify good design features and problem areas, if any, and recommend mitigation measures.

2 Application Site

2.1 Characteristics of Application Site and its Surrounding Area

The Application Site is located to the south-west of Kam Shan Country Park (>+200mPD) at the valley of Kau Wa Keng and generally surrounded by mountains (+70~100mPD) except the south.

To the north of the Application Site are the Kau Wa Keng San Tsuen (+10~40mPD) and open space sloping up to the Castle Peak Road – Kwai Chung (+79mPD). To the east are the low-rise residential buildings (+30~60mPD). To the south are the Lai Yan Court (+120mPD), Happy Villa (+75mPD), Wah Lai Estate (+121mPD), Kai Chi Kok Bay Garden (+60~89mPD), CCC Kei Chun Primary School (+35mPD) and Nob Hill (+118mPD). To the south-west are also open space sloping up to the Kwai Chung Hospital (+90~120mPD) and Princess Margaret Hospital (+80~150mPD). To the north-west is the Lai King Correctional Institution (+102~110mPD). The locations of major building blocks are indicated in Figure 1.

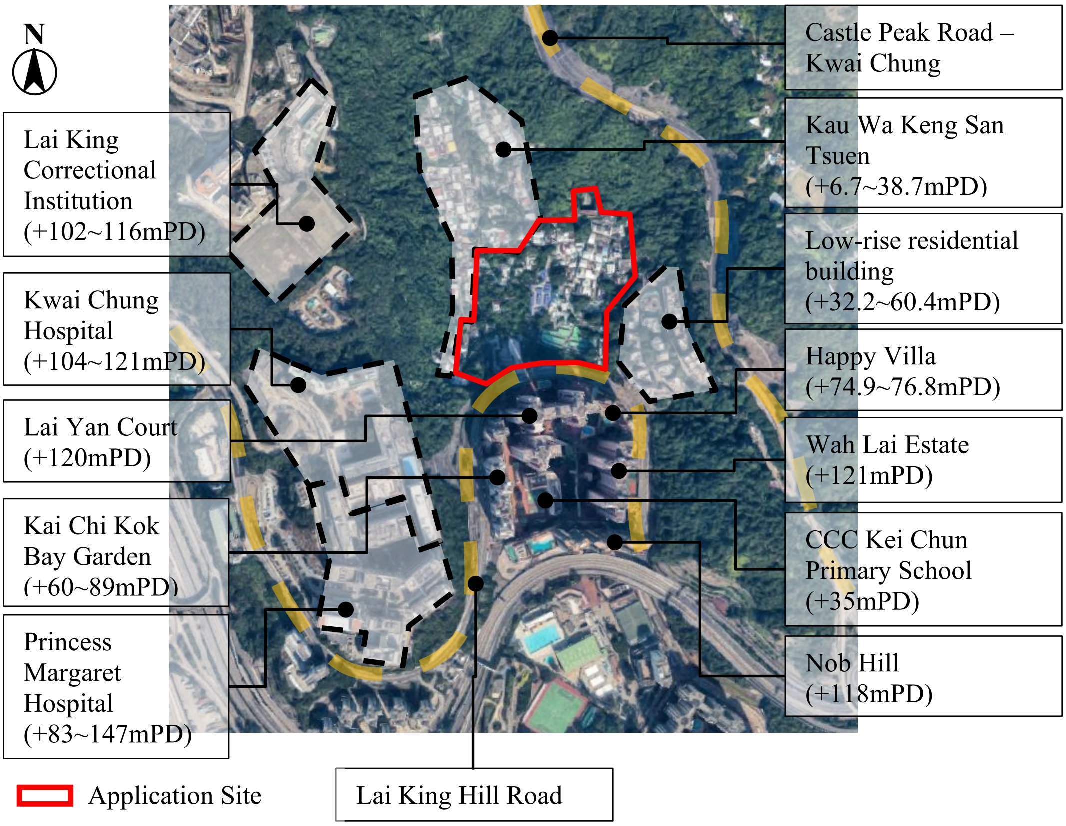


Figure 1 Site Location and Existing Surrounding Developments (Source: Google Map)

2.2 Studied Schemes

Two schemes, namely Baseline Scheme and Proposed Scheme, were studied under the AVA Initial Study. Each Scheme will be briefly described in following sub-sections.

2.2.1 Baseline Scheme

Baseline scheme is based the previously approved scheme under Planning Application No. A/KC/489. The Baseline Scheme consist of 14 nos. of high-rise blocks, 3 nos. of low-rise club houses and 1 no. of low-rise refuse depot. In addition, 13 nos. of low-rise historic buildings are identified and preserved within the Application Site. The layout plan is shown in Figure 2. Detailed drawings are show in Appendix A. The 3D model of Baseline Scheme was constructed as shown in Figure 3 to Figure 6.

Wind enhancement measures have been provided to alleviate the ventilation impact created by the Baseline Scheme. These features are listed as below:

1. 15m air path on the western side of the Application Site. It is aligned with South-North direction, allows wind penetration along the western side of Lai King Hill Road into the Kau Wa Keng San Tsuen.
2. Two 15m air paths on the middle and eastern side of the Application Site. They are aligned with South-North direction, allows wind flow from Lai King Hill Road to the Kau Wa Keng San Tsuen.
3. One diagonal 15m air path on podium level aligned in NE-SW direction, allows wind penetration along the western side of Lai King Hill Road into the Application Site.
4. 30m building setback on the eastern side of the Application Site near the Lai King Hill Road

Table 1 Development Parameters of the Baseline Scheme

Development Parameters	Baseline Development
Building Block	14 nos. of high-rise Blocks 7 nos. of 3-storeys Houses 13 nos. of Historic Buildings
Maximum Building Height	+120mPD of high-rise Blocks +16.5mPD of 3-storeys Houses +10.3mPD to +25.7mPD of Historic Buildings
Plot Ratio	5

Figure 2 Master Layout Plan – Baseline Scheme

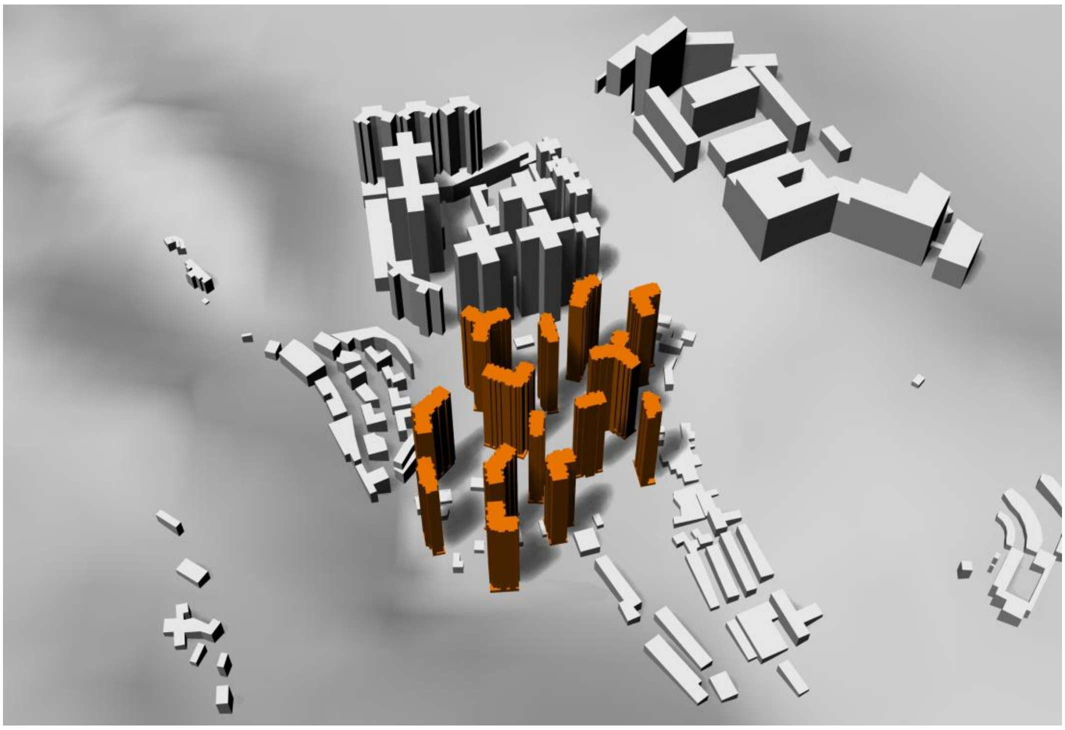


Figure 3 Northerly View of Baseline Scheme

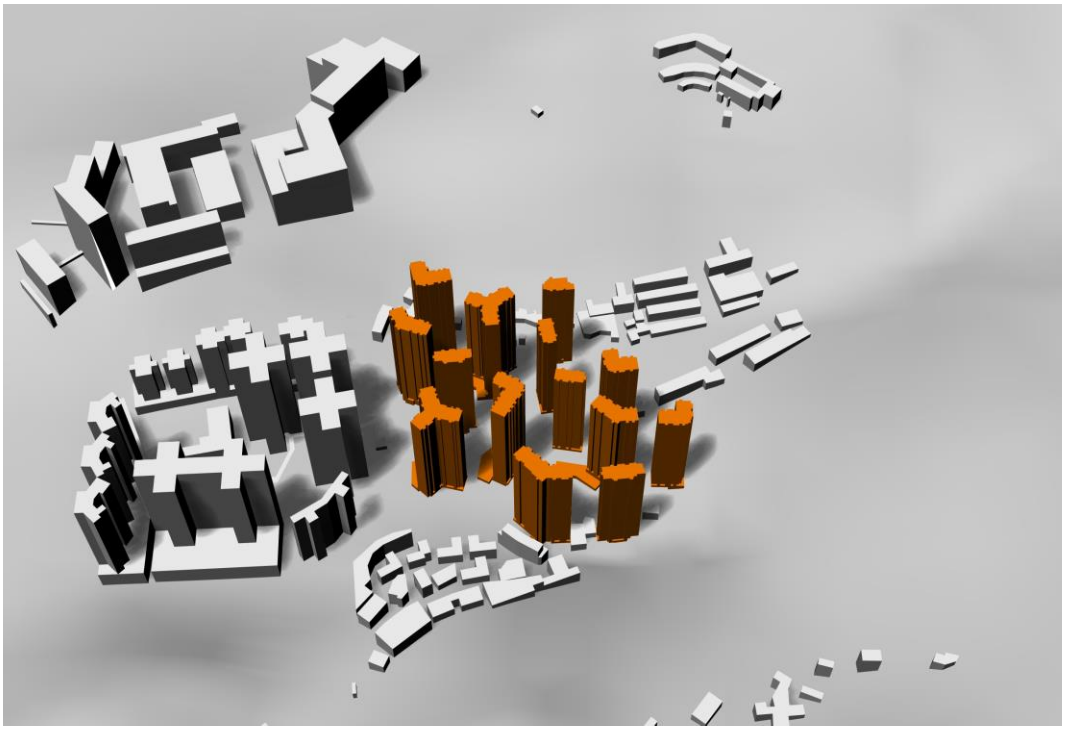


Figure 4 Easterly view of Baseline Scheme

Figure 5 Southerly view of Baseline Scheme

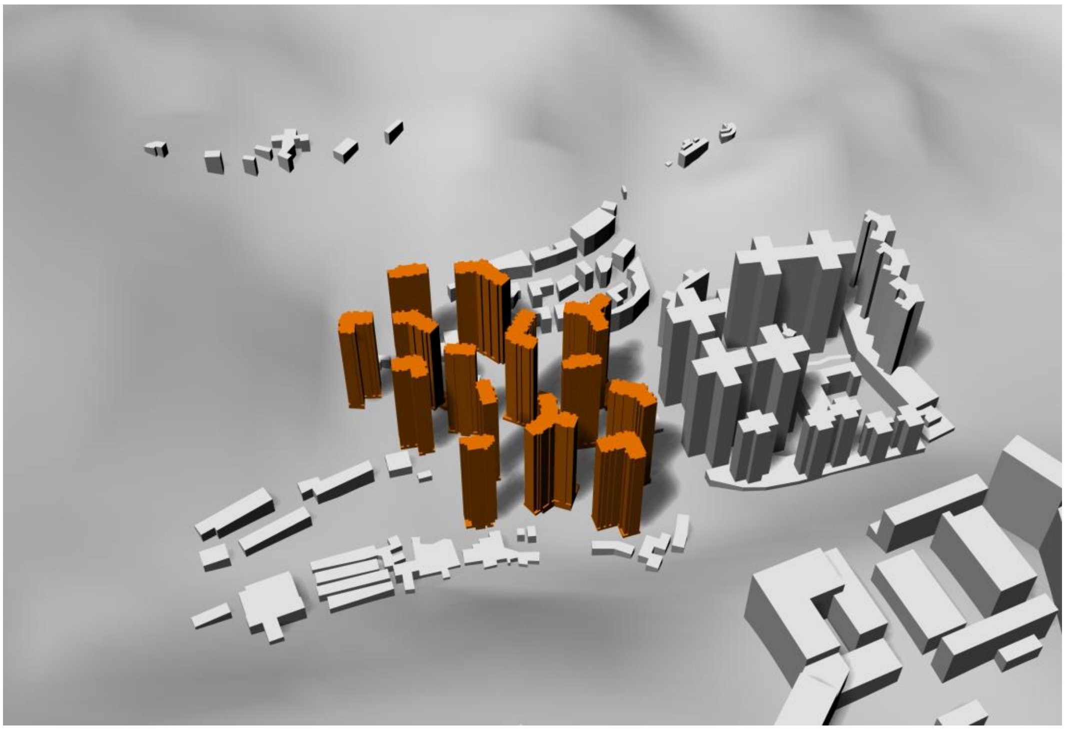


Figure 6 Westerly view of Baseline Scheme

2.2.2 Proposed Scheme

The Proposed Scheme is formed by increasing the Plot Ratio to accommodate for larger population and provide more non-domestic facilities. The increased building façade areas would be beneficial to capture incoming wind to pedestrian level especially the Project Site is surrounded by hilly terrain and high-rise development.

The Proposed Scheme consist with 14 nos. of high-rise blocks, 1 no. of low-rise block and 5 podium structures served as retail and GIC. In addition, 12 nos. of low-rise historic buildings are identified and preserved within the Application Site. The layout plan is shown in Figure 7. Detailed drawings are show in Appendix A. The 3D model of Proposed Scheme was constructed as shown in Figure 8 to Figure 11.

Wind enhancement measures have been provided to alleviate the ventilation impact created by the Proposed Scheme. These features are listed as below:

1. 15m air path on podium level on the western side of the Application Site. It is aligned with South-North direction, allows wind penetration along the western side of Lai King Hill Road into the Kau Wa Keng San Tsuen.
2. Two 15m air paths on the middle and eastern side of the Application Site. They are aligned with South-North direction, allows wind flow from Lai King Hill Road to the Kau Wa Keng San Tsuen.
3. One diagonal 15m air path on podium level aligned in ESE-WNW direction, allows wind penetration along the western side of Chung Shan Terrace to the Kau Wa Keng San Tsuen.
4. 30m high-rise block setback on the eastern side of the Application Site near the Lai King Hill Road

Table 2 Development Parameters of the Proposed Scheme

Development Parameters	Proposed Development
Building Blocks	15 nos. of Blocks 5 nos. of Podium Structures 12 nos. of Historic Buildings
Maximum Building Height	+136.85mPD to +147.55mPD of high-rise Blocks +11.5mPD to +15.5mPD of low-rise Blocks +11mPD to +26mPD of Podium Structures +10.3mPD to +21.5mPD of Historic Buildings
Plot Ratio	6 (Domestic) 0.5 (Non-domestic)

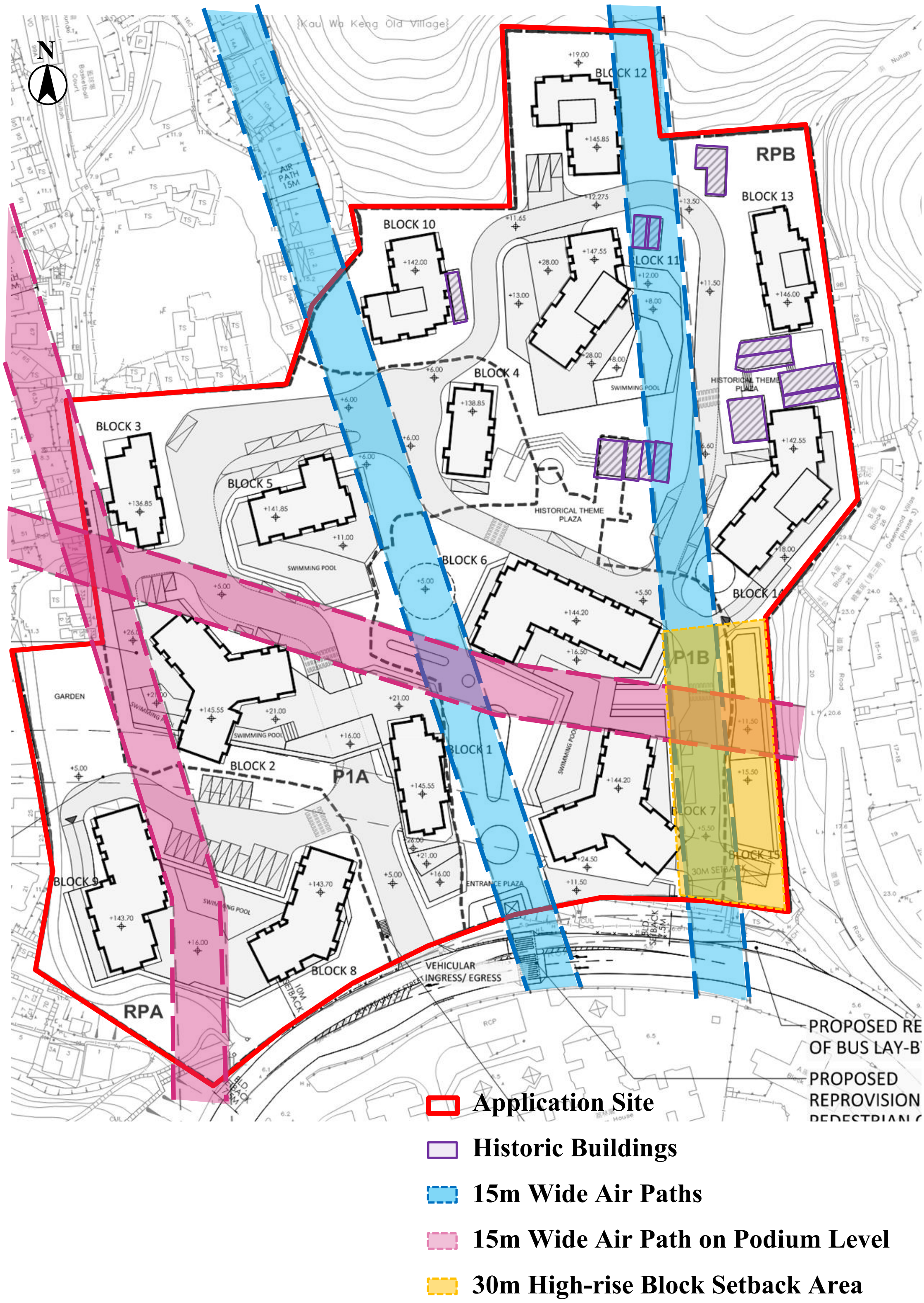


Figure 7 Master Layout Plan - Proposed Scheme

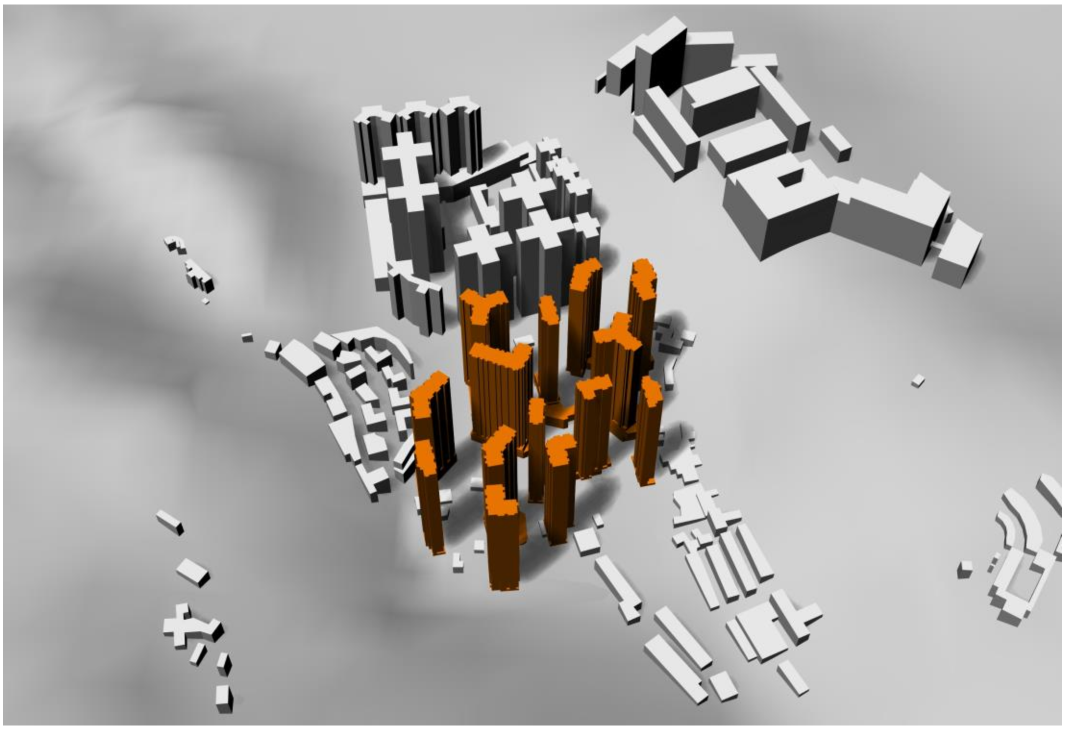


Figure 8 Northerly View of Proposed Scheme

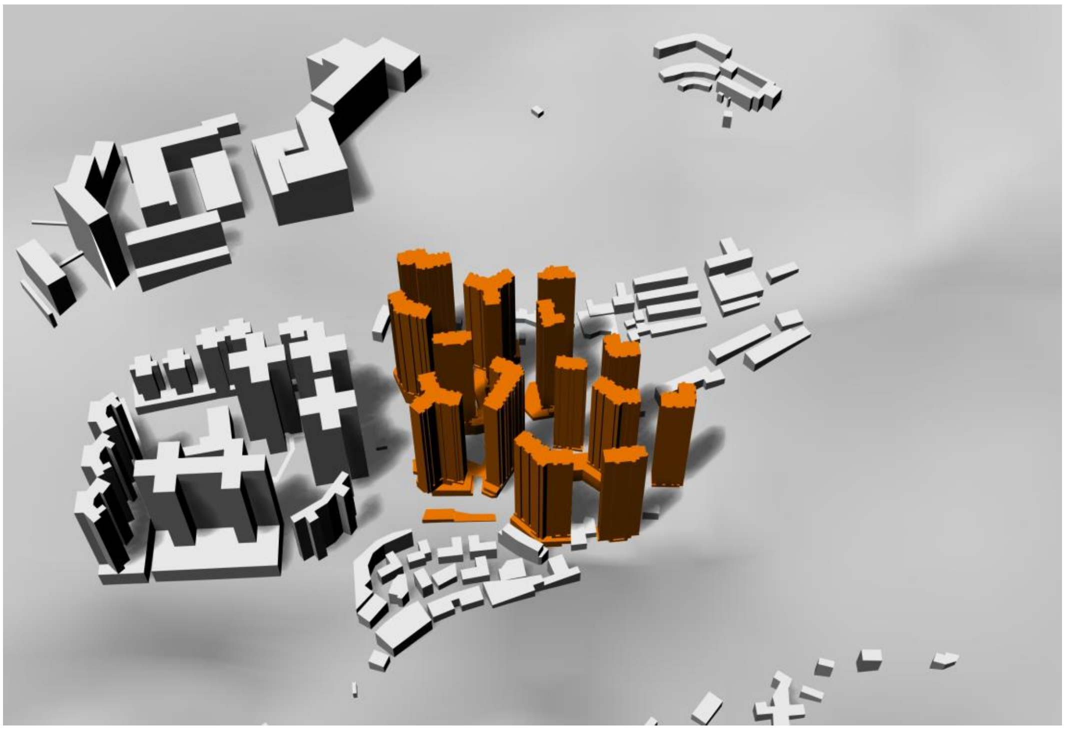


Figure 9 Easterly View of Proposed Scheme

Figure 10 Southerly View of Proposed Scheme

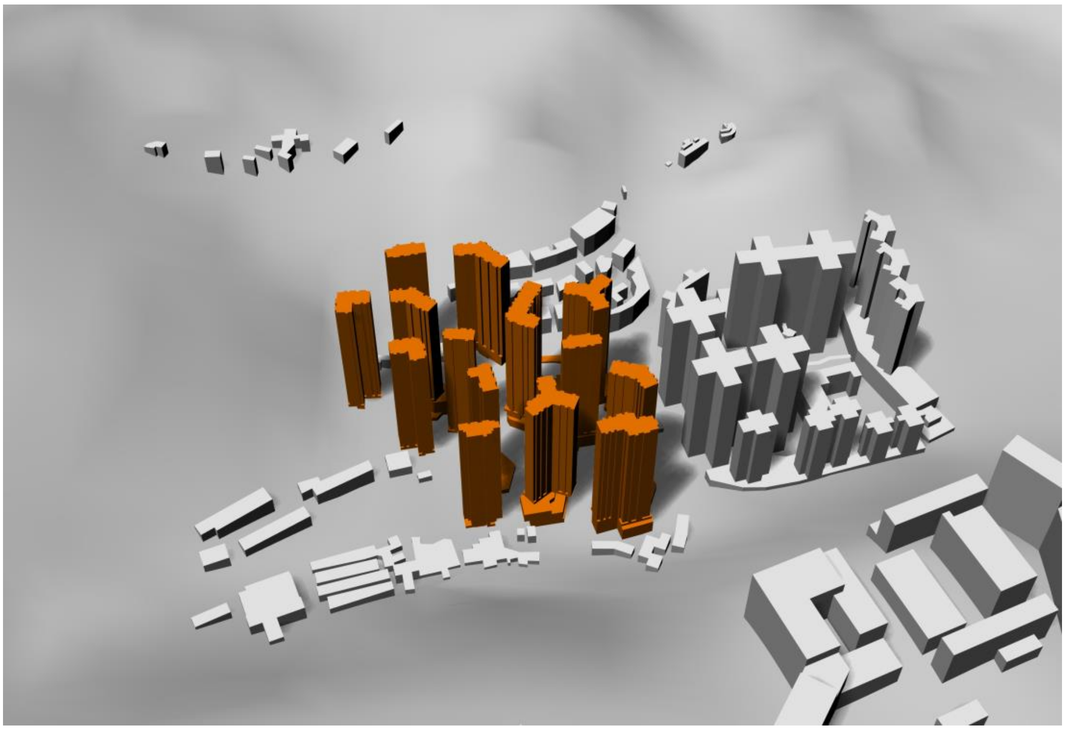


Figure 11 Westerly View of Proposed Scheme

2.2.3 Interim Scheme

The Interim Scheme is the scenario upon early phase development of the Proposed Scheme including Phase 1A (P1A) and Phase 1B (P1B), where the Remaining Phase A (RPA) and Remaining Phase B (RPB) are not yet implemented and no development including existing village, but except for historic building, are assumed for these two phases.

The Interim Scheme consist with 7 nos. of high-rise blocks and 3 podium structure served as retail and GIC facilities. In addition, 1 nos. of low-rise historic buildings are identified and preserved within the Interim Scheme. The layout plan is shown in Figure 12. Detailed drawings are show in Appendix A3. The 3D model of Interim Scheme was constructed as shown in Figure 13 to Figure 16.

Wind enhancement measures have been provided to alleviate the ventilation impact created by the Interim Scheme. These features are listed as below:

1. One 15m air paths on the middle on street level aligned in South-North direction, allows wind flow from Lai King Hill Road to the Kau Wa Keng San Tsuen.
2. One diagonal 15m air path on podium level aligned in ESE-WNW direction, allows wind penetration along the western side of Chung Shan Terrace to the Kau Wa Keng San Tsuen.

Table 3 Development Parameters of the Interim Scheme

Development Parameters	**Proposed Development**
Building Blocks	7 nos. of high-rise Blocks 3 nos. of Podium Structures 1 nos. of Historic Building
Maximum Building Height	+136.85mPD to 145.55mPD of high-rise Blocks +11mPD to +24.5 mPD of Podium Structures +13.8mPD of Historic Building
Plot Ratio	6 (Domestic) 0.5 (Non-domestic)

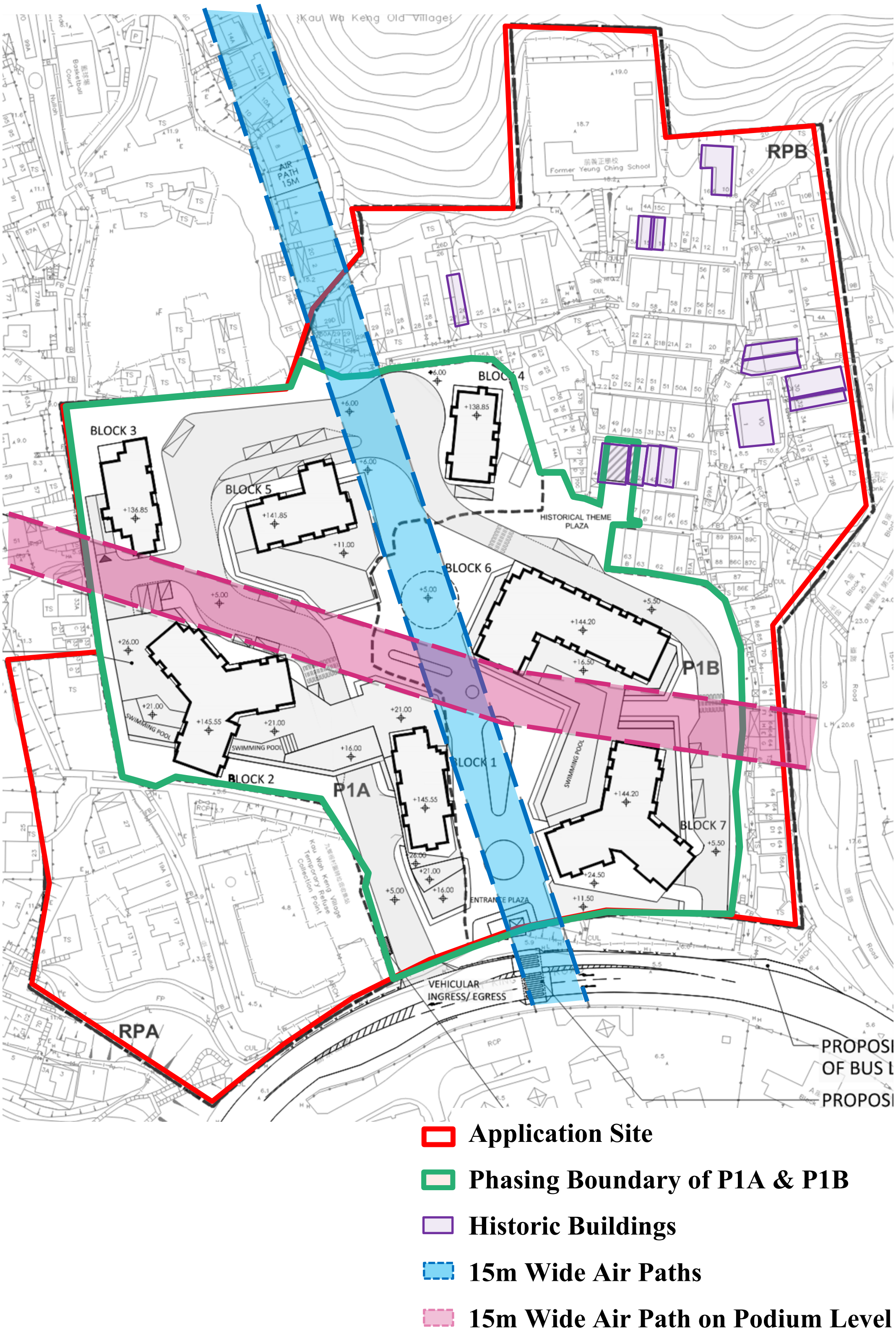


Figure 12 Master Layout Plan - Interim Scheme

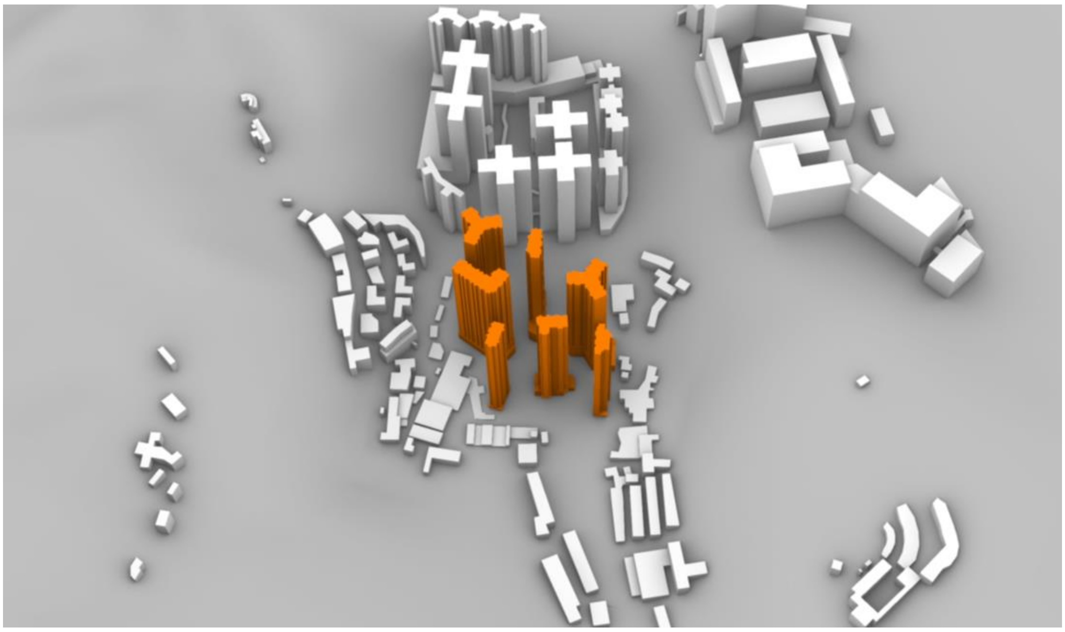


Figure 13 Northerly View of Proposed Scheme

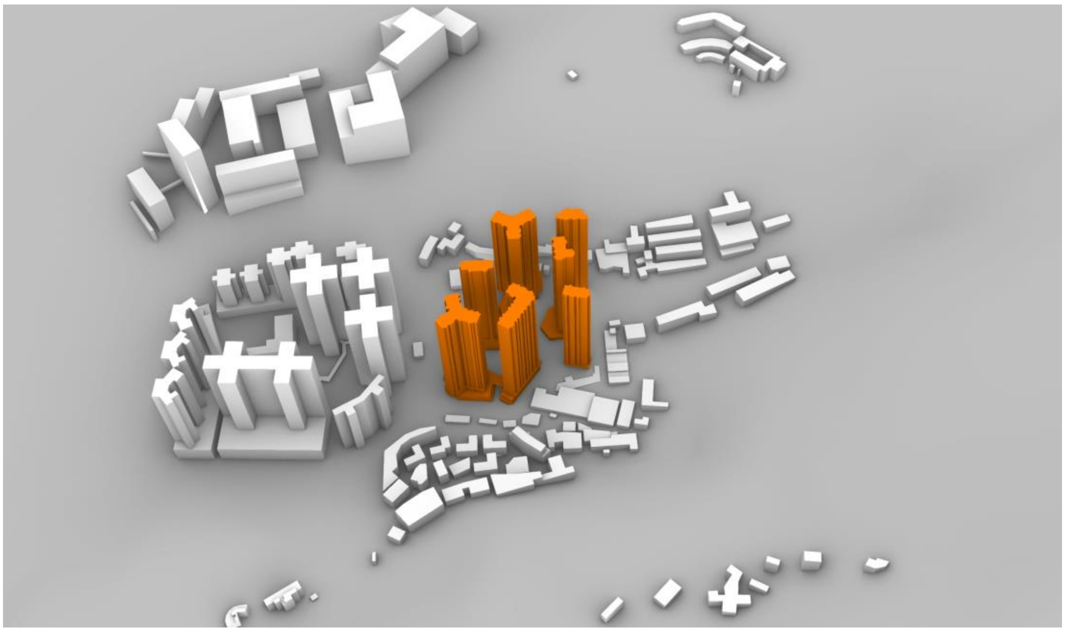


Figure 14 Easterly View of Proposed Scheme

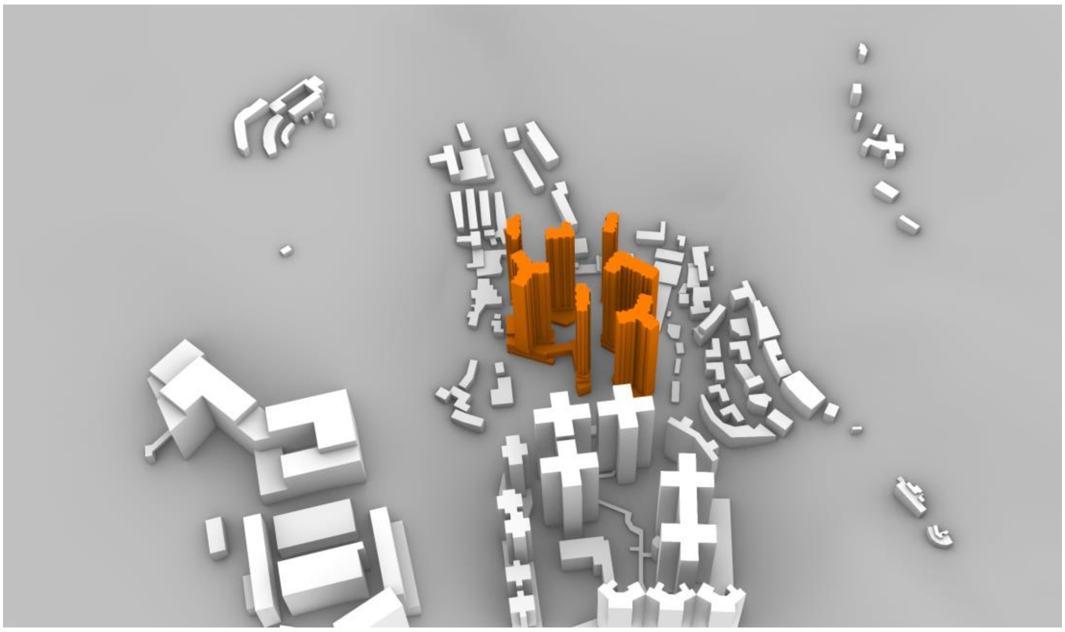


Figure 15 Southerly View of Proposed Scheme

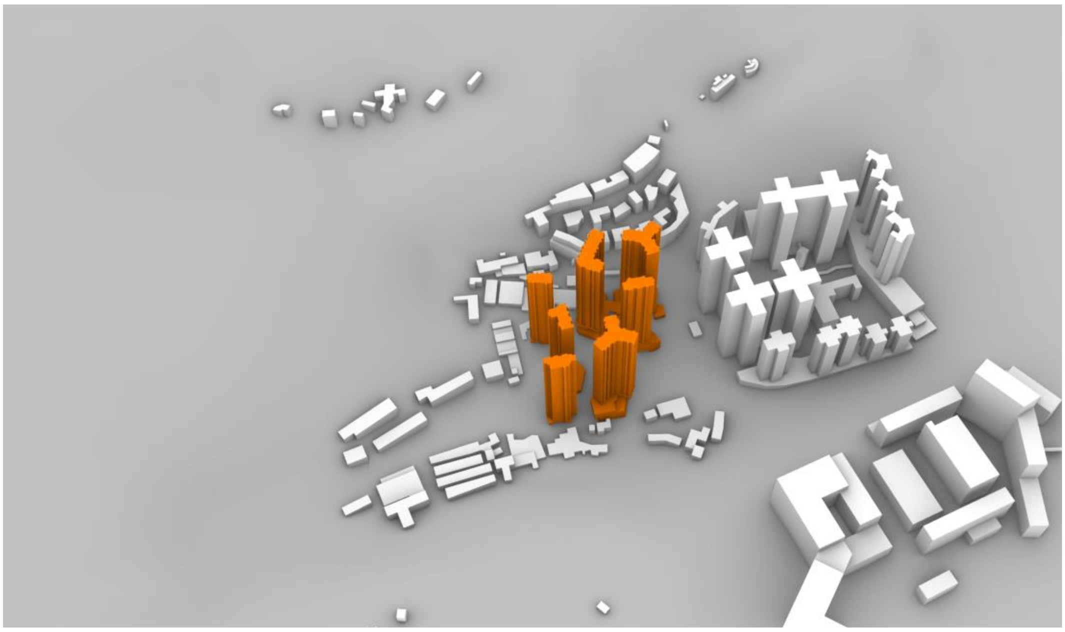


Figure 16 Westerly View of Proposed Scheme

3 Methodology

As per the *AVA Technical Circular*[1] at least 75% of the time in a typical reference year (frequency of occurrence) would be studied under both annual and summer wind conditions in the AVA Initial Study by using a Computational Fluid Dynamics (CFD) modelling technique. Since the CFD approach was adopted for the AVA Initial Study, the criterion together with the following selected wind data were applied as the methodology.

3.1 Wind Availability Data

The site wind availability data of the Application Site and its surrounding are an essential parameter for AVA. As stipulated in the *AVA Technical Circular*[1] the site wind availability would be presented by using appropriate mathematical models. Planning Department (PlanD) has set up a set of simulated meso-scale data of Regional Atmospheric Modelling System (RAMS) of the territory for AVA Study, which can be downloaded from Planning Department Website [2]. The location of the Application Site falls within the location grid (x: 072, y:048) in the RAMS database as indicated in Figure 17. The annual and summer wind roses at 500m at the selected grid are shown in Figure 18 and Figure 19.

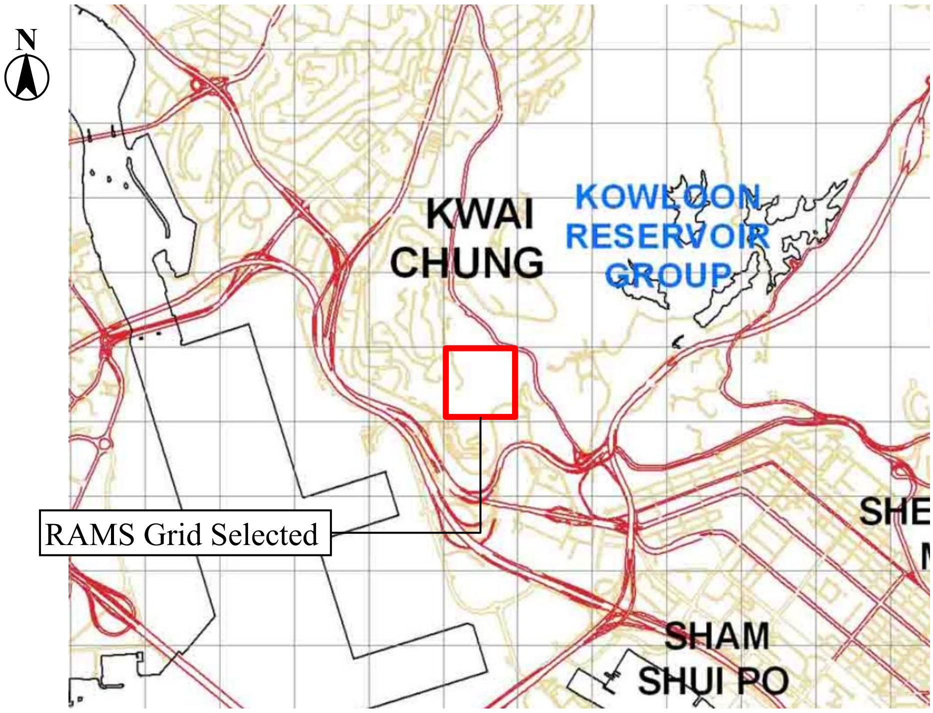


Figure 17 RAMS Grid and the Application Site Location

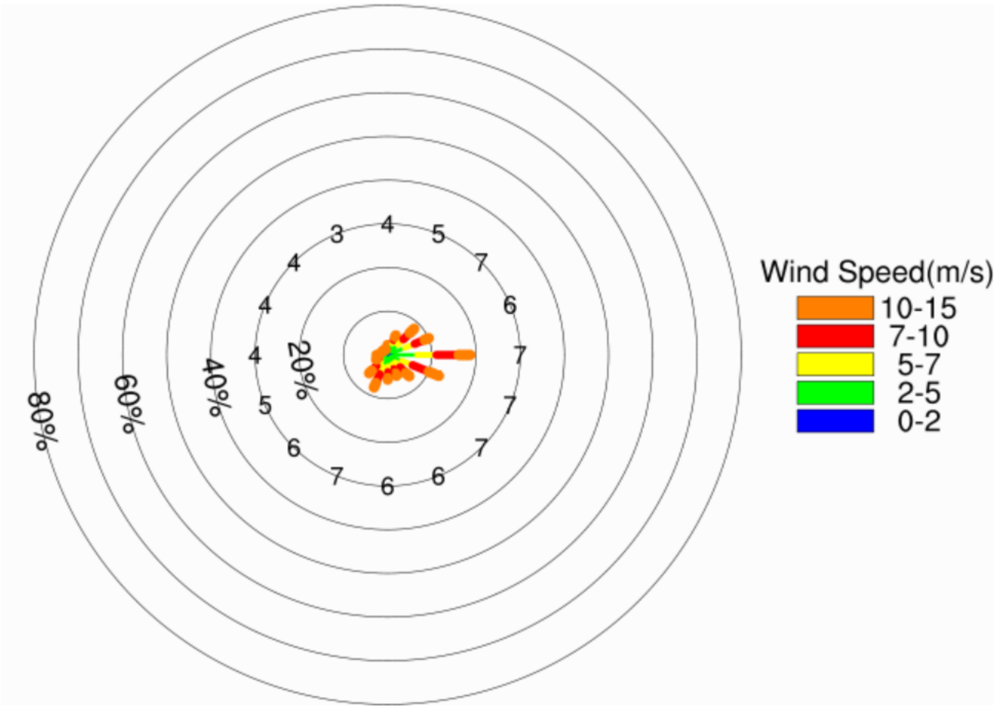


Figure 18 RAMS Annual Wind Rose at 500m

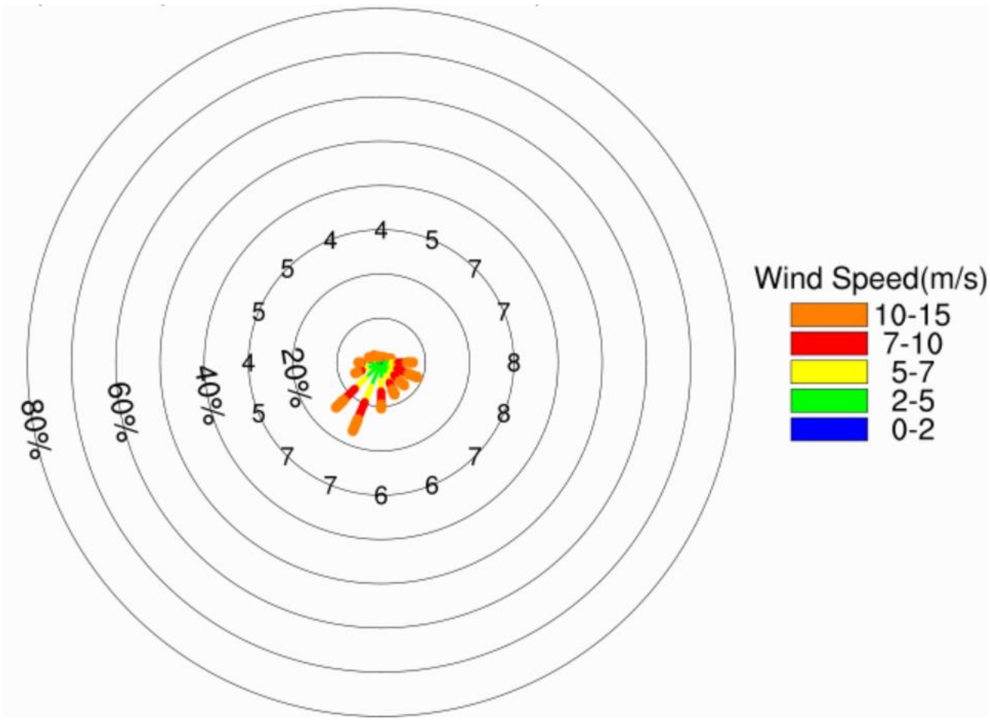


Figure 19 RAMS Summer Wind Rose at 500m

3.1.1 Annual Prevailing Wind

According to the selected set of wind data from the RAMS, eight prevailing wind directions (highlighted in red colour in Table 4) are considered in this AVA Study which covers 77.9% of the total annual wind frequency. They are north-easterly (8.7%), east-north-easterly (10.3%), easterly (19.1%), east-south-easterly (12.9%), south-easterly (7.0%), southerly (5.8%), south-south-westerly (8.1%) and south-westerly (6.0%).

Table 4 Annual Wind Frequency

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	2.3%	5.0%	8.7%	10.3%	19.1%	12.9%	7%	5.2%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	5.8%	8.1%	6.0%	2.8%	2.5%	1.5%	1.4%	1.3%	77.9%

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

3.1.2 Summer Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 5) are considered in this AVA Study which covers 81.2% of the total summer wind frequency. They are easterly (7.6%), east-south-easterly (9.5%), south-easterly (7.6%), south-south-easterly (7.9%), southerly (10.7%), south-south-westerly (17.0%), south-westerly (14.6%) and west-south-westerly (6.3%).

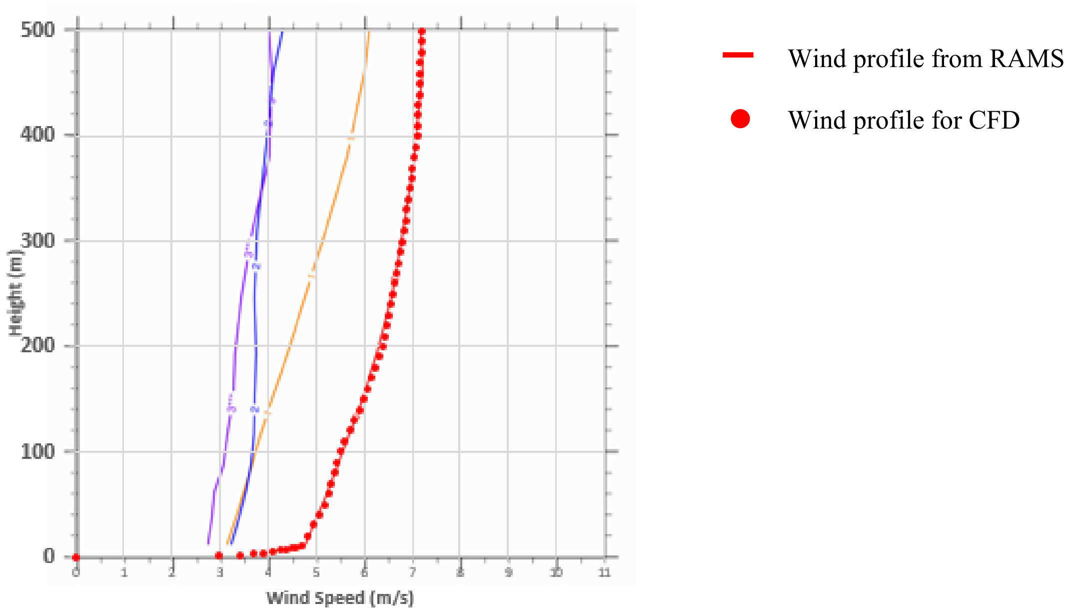
Table 5 Summer Wind Frequency

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	1.2%	1.3%	1.6%	2.5%	7.6%	9.5%	7.6%	7.9%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	10.7%	17.0%	14.6%	6.3%	5.1%	3.0%	2.2%	1.5%	81.2%

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

3.1.3 Wind Profiles

The vertical wind profiles from the RAMS data (x:072, y:048) are extracted and inputted into CFD model. The exact profiles are extracted and modelled for each corresponding win direction to be studied. For wind data above 500m height, the velocity is assumed to be the same as the data at 500m. The vertical wind profile for all win directions to be studied are shown in Figure 20 to Figure 22.



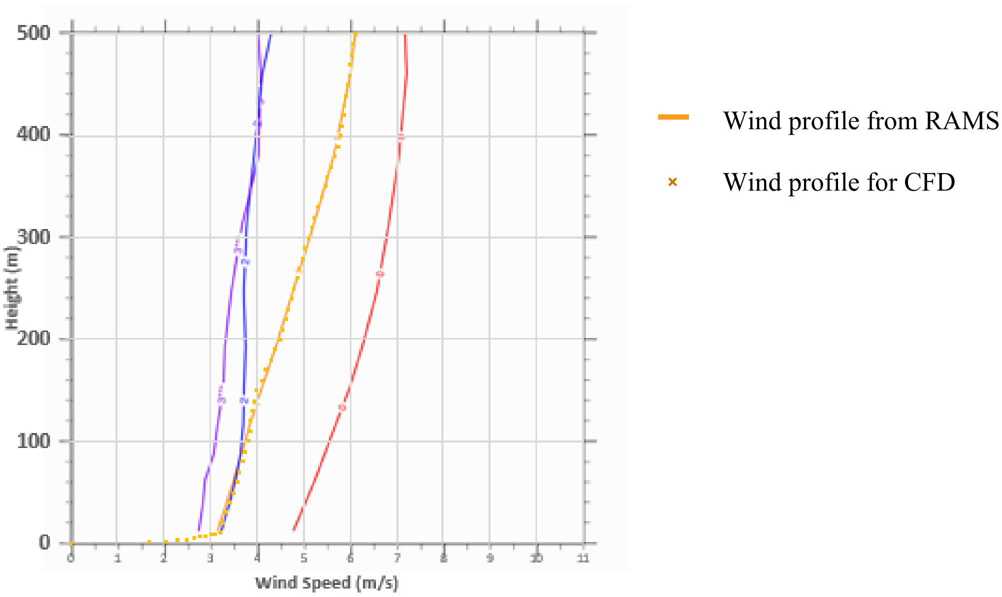
0: 22.5º-112.4º

1: 112.5º-202.4º

2: 202.5º-292.4º

3: 292.5º-22.4º

Figure 20 Vertical Wind Profile of 22.5˚ – 112.4˚ Winds



0: 22.5º-112.4º

1: 112.5º-202.4º

2: 202.5º-292.4º

3: 292.5º-22.4º

Figure 21 Vertical Wind Profile of 112.5˚ – 202.4˚ Winds

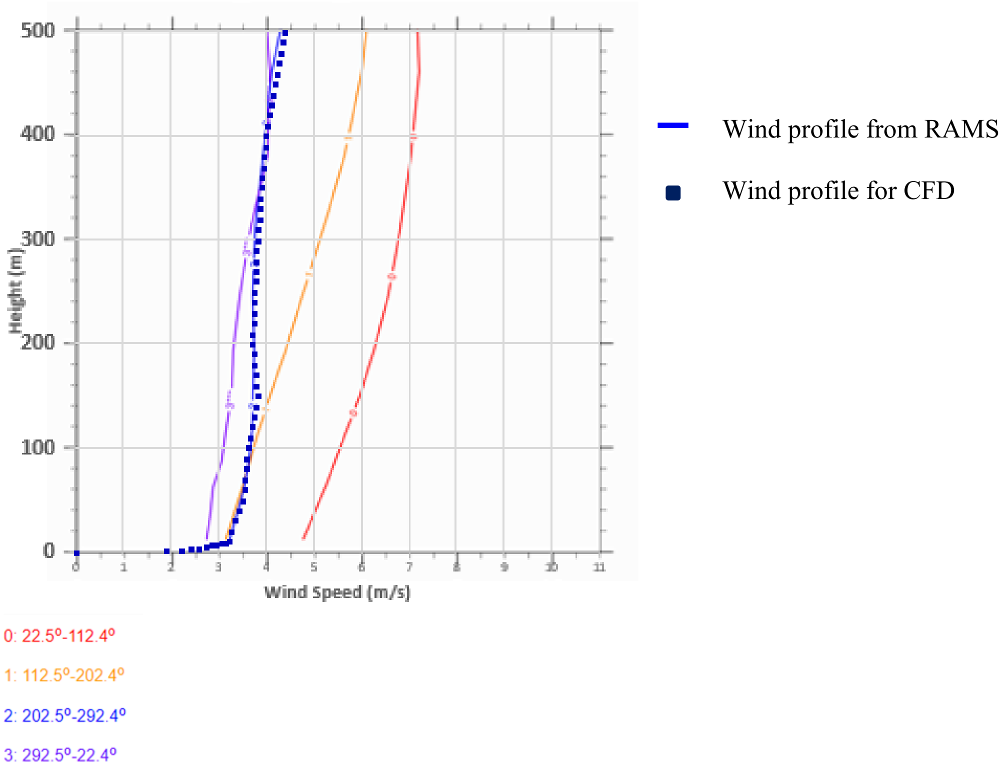


Figure 22 Vertical Wind Profile of 202.5˚ – 292.4˚ Winds

3.2 Assessment and Surrounding Area

With reference to the AVA Technical Circular[1], the assessment should include all areas within the Application Site, as well as a belt up to 1H, where H is the height of the tallest building within the Application Site, around the site boundary.

The maximum building height within the Application Site is about 140m, thus H being around 140m. The Assessment Area and Surrounding Area are 140m and 280m away from the site boundary of the Application Site respectively. The Assessment Area and Surrounding Area are indicated in Figure 23. The computational domain is about 2700m (L) x 2600m (W) x 2000m (H), as shown in Figure 24.

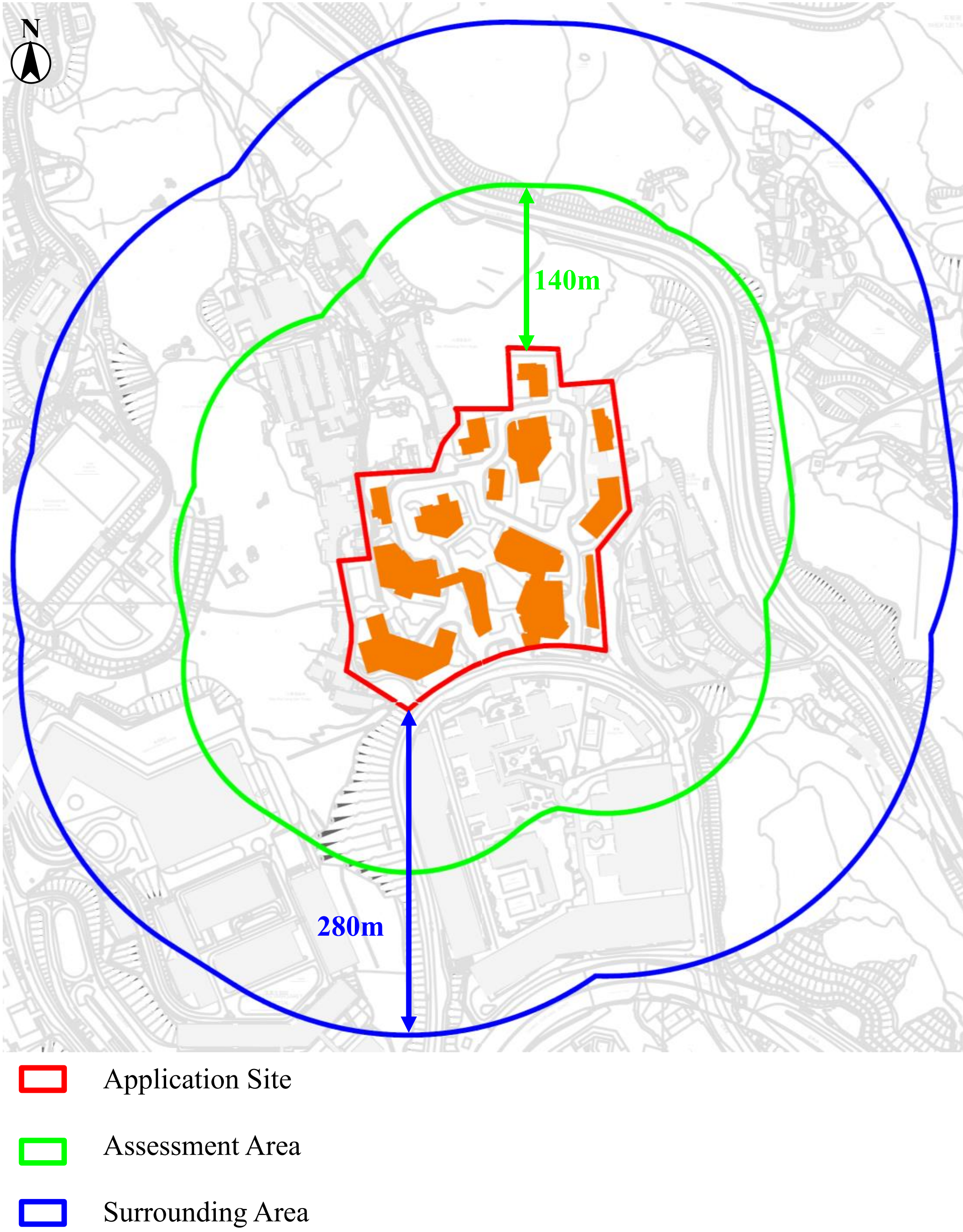


Figure 23 Application Site (red), Assessment Area (green) and Surrounding Area (blue)

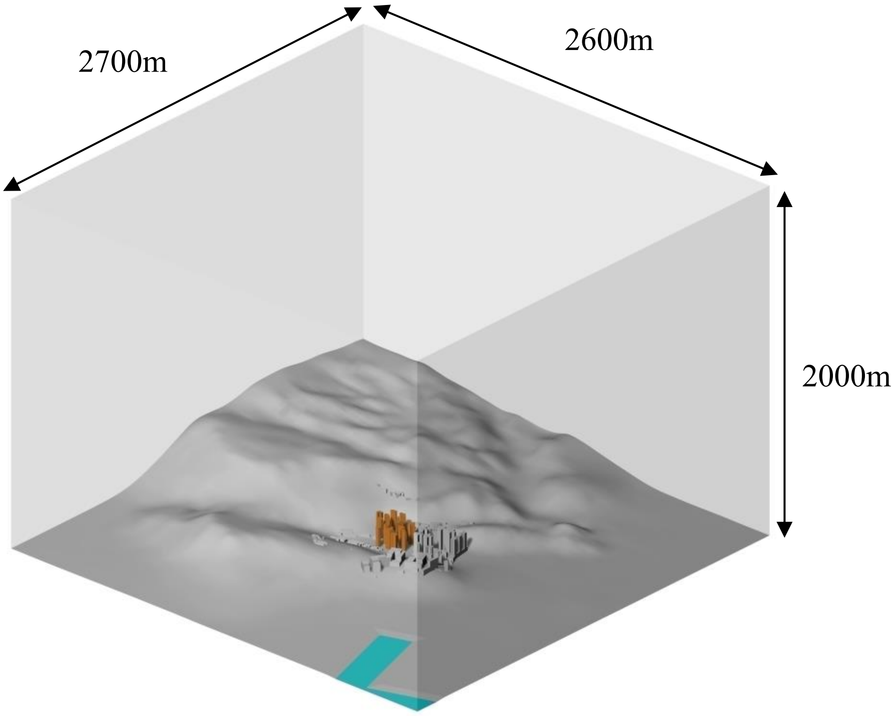


Figure 24 3D View of the Domain

3.3 Identified Committed Development

According to the GIS data and GeoInfo Map[1], there is a work-in-progress (WIP) sites near the Application Site, which will also be considered in this AVA – Initial Study. The location of the WIP site is shown in Figure 25.

- Kwai Chung Hospital, 3-15 Kwai Chun Hospital Road, Kwai Chung; Planning Application No. A/KC/451.
- Proposed Residential Development, Castle Peak Road, Kwai Chung; Planning Application A/KC/504

[1] http://www2.map.gov.hk/gih3/view/index.jsp

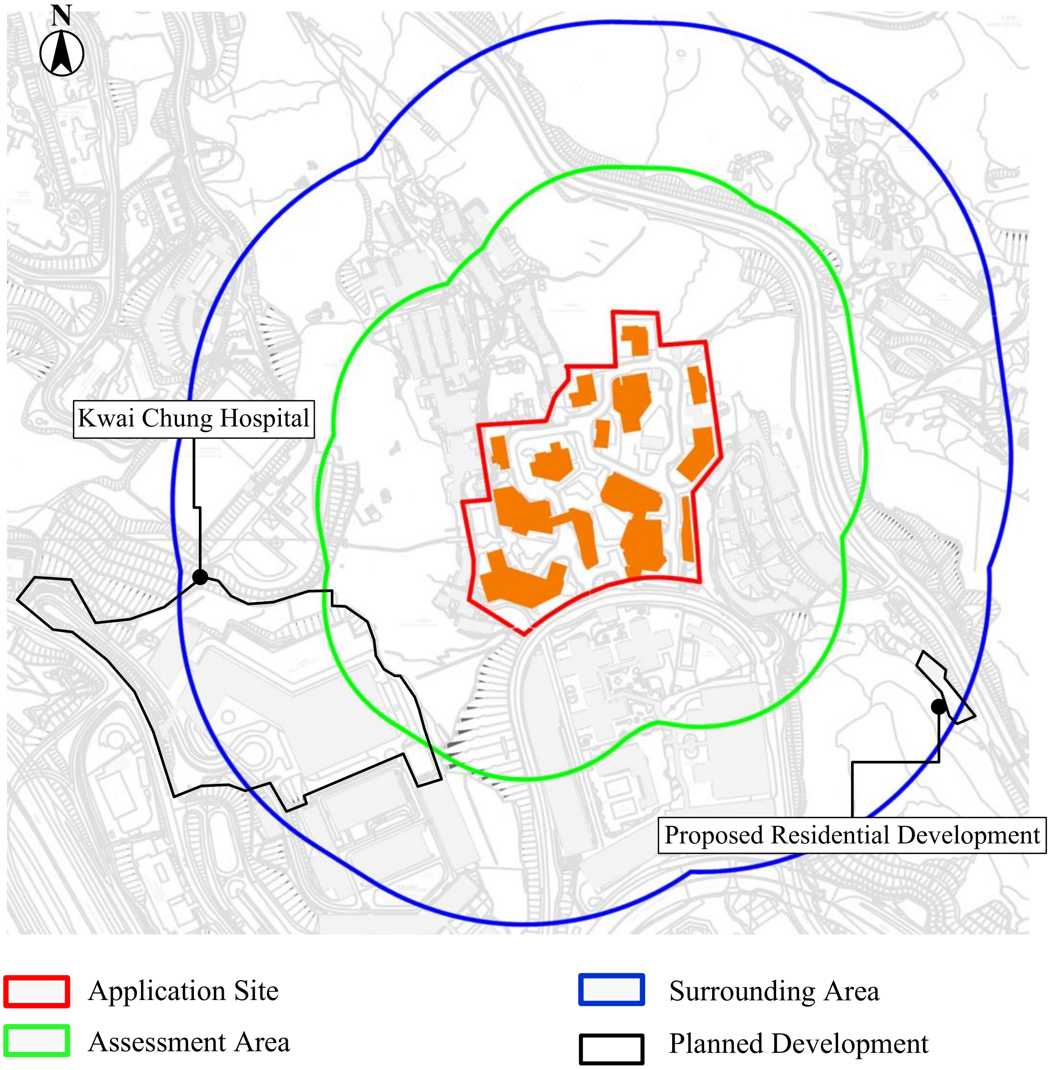


Figure 25 Location of the WIP Site around the Application Site

3.4 Views on the 3D Models

Four different views of the 3D model of the Surrounding Area for this AVA Initial Study are shown in coming subsections.

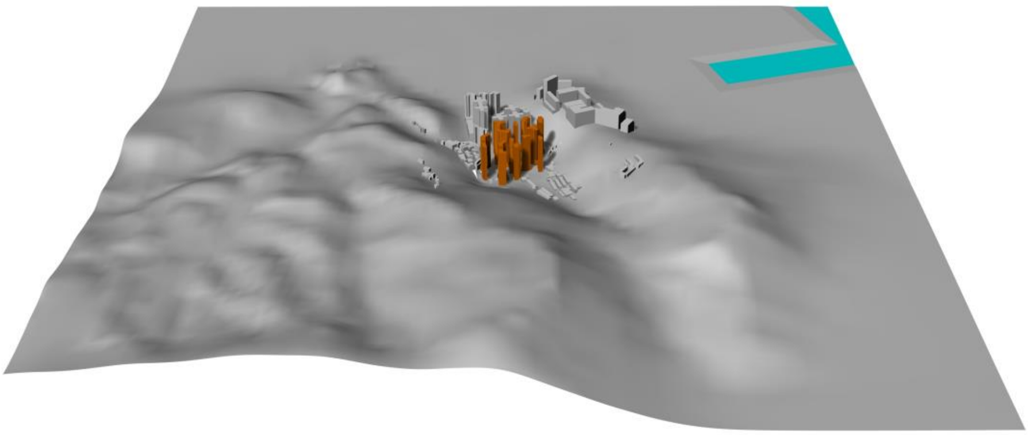


Figure 26 Surrounding Area – Northerly View

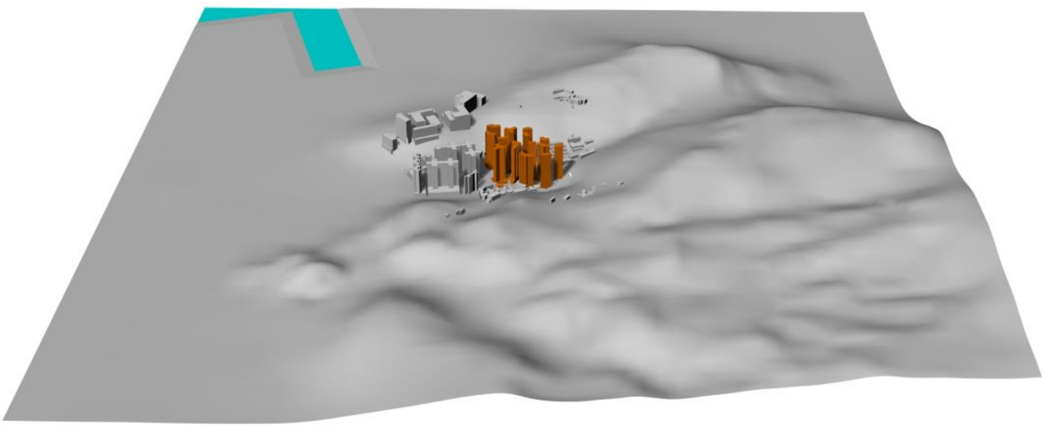


Figure 27 Surrounding Area – Easterly View

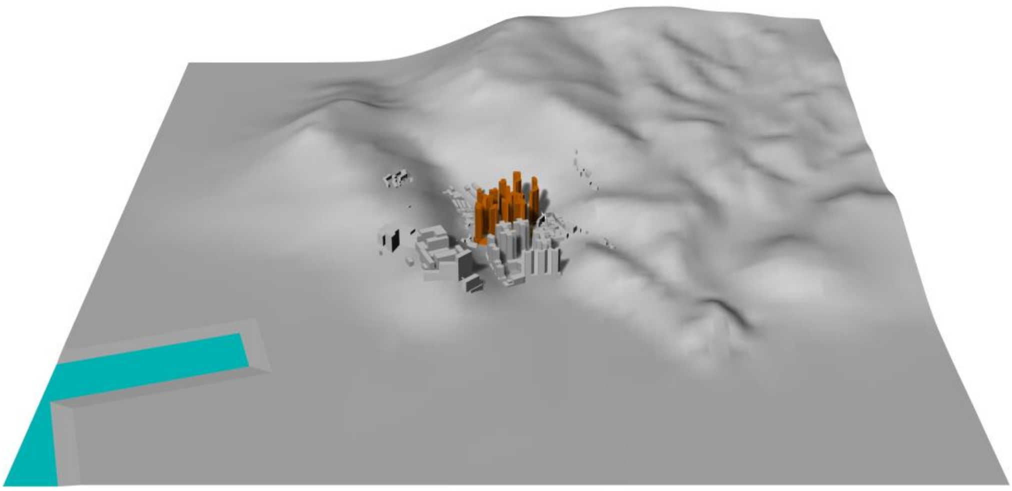


Figure 28 Surrounding Area – Southerly View

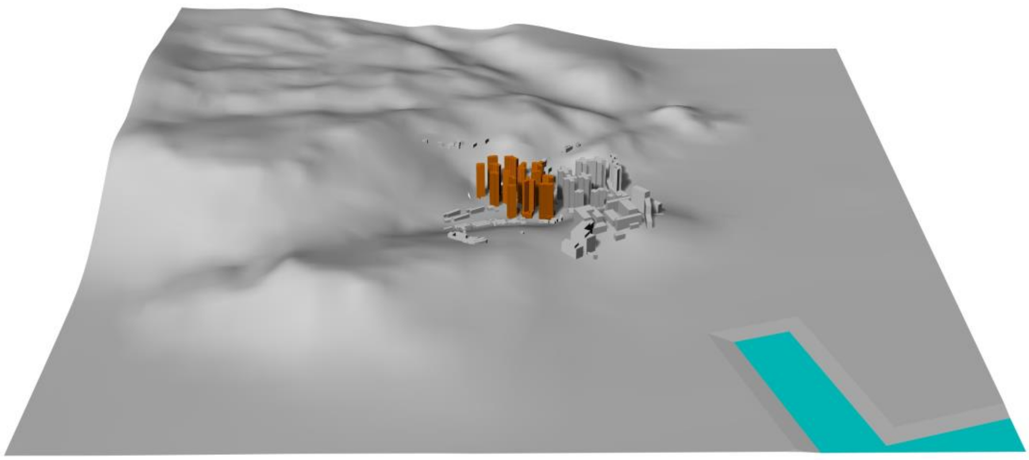


Figure 29 Surrounding Area – Westerly View

3.5 Technical Details for CFD Simulation

3.5.1 Assessment Tool

Computational Fluid Dynamics (CFD) technique is adopted for the AVA Initial Study. A well-recognised commercial CFD package ANSYS ICEM-CFD and Ansys-Fluent are used. Both software is widely used in the industry for AVA studies. With the use of three-dimensional CFD method, the local airflow distribution can be visualised in detail. The air velocity distribution within the flow domain, being affected by the site-specific design and the surrounding buildings, is simulated under the prevailing wind condition in a year.

3.5.2 Mesh Setup

Body-fitted unstructured grid technique is used to fit the geometry to reflect the complexity of the Application Site geometry. Prism layers of 3m above ground (totally 6 layers and each layer is 0.5m) are incorporated in the meshing to better capture the approaching wind as shown in Figure 30 . The expansion ratio is 1.2 while the maximum blockage ratio is 3%.

Finer grid system is applied to the most concerned area based on preliminary judgement, while coarse grid system is applied to the area of surrounding buildings for better computational performance while maintaining satisfactory result. The mesh for the computational model is shown in Figure 31.

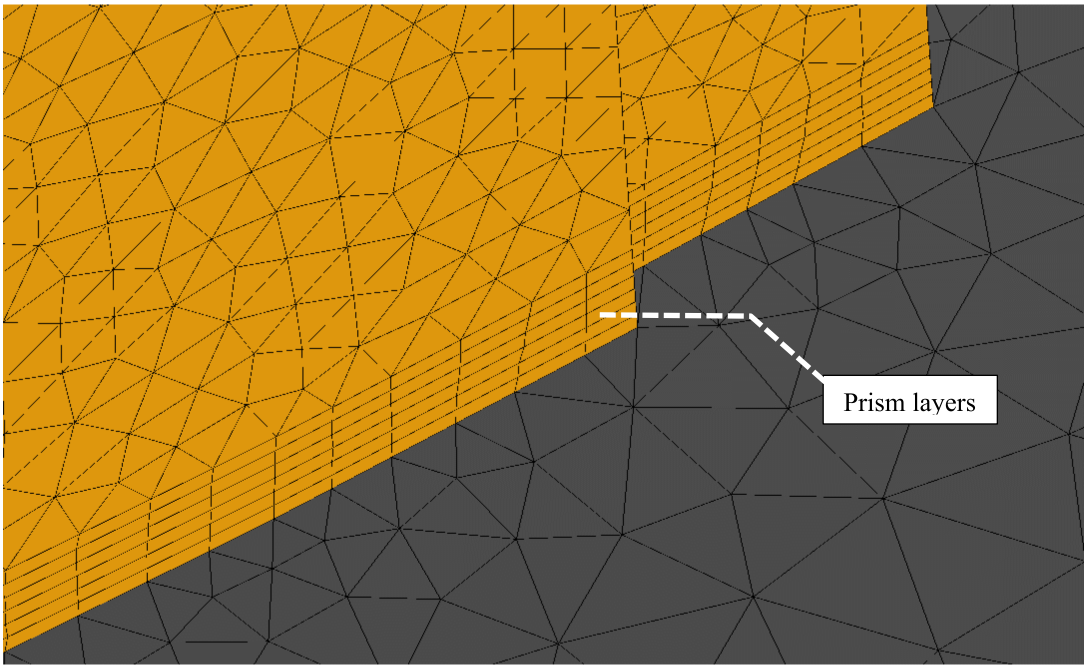


Figure 30 Prism Layers Near Pedestrian Level

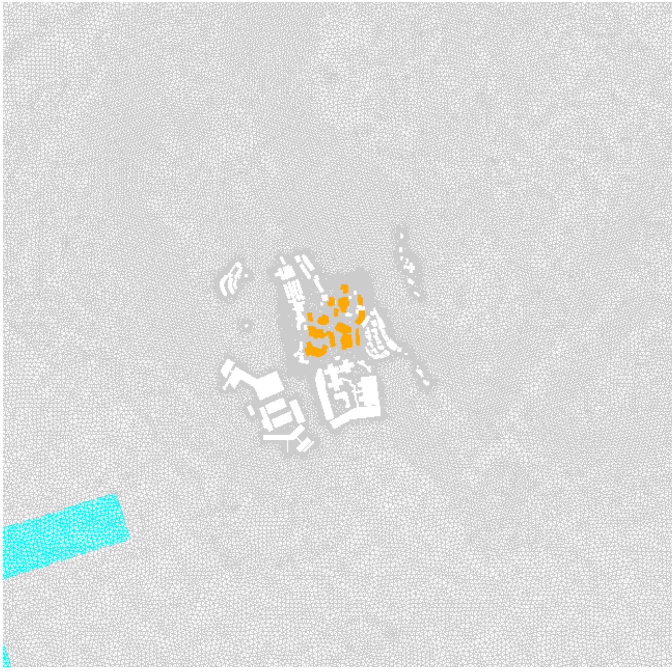


Figure 31 Mesh of the Computational Model.

3.5.3 Turbulence Model

As highlighted in the recent academic and industrial research literatures by CFD practitioners, the widely used Standard k - ε turbulence model technique may not adequately model the effects of large-scale turbulences around buildings and ignored the wind gusts leading to the relatively poor prediction in the recirculation regions around buildings. Therefore, in this CFD simulation, realizable $k - \varepsilon$ turbulence modelling method is applied. This technique provides more accurate representation of the levels of turbulence that can be expected in an urban environment.

3.5.4 Calculation Method

The Segregated Flow model solves the flow equations in a segregated manner. The linkage between the momentum and continuity equations is based on the predictor-corrector approach. A collocated variable arrangement and a Rhie-and-Chow-type pressure-velocity coupling combined with a SIMPLE-type algorithm is adopted. A higher order differencing scheme is applied to discretize the governing equations. The convergence criterion is set to 0.0001 on mass conservation. The calculation repeat until the solution satisfies this convergence criterion.

The prevailing wind directions are set to inlet boundaries of the model with wind profile as detailed in Section 3.1.3. The downwind boundaries are set to pressure with value of atmospheric pressure. The top and side boundaries are set to symmetry. In addition, to eliminate the boundary effects, the computational domain is built beyond the Surrounding Area as required in the Technical Circular.

3.5.5 Summary

Since there is no internationally recognized guideline or standard on using CFD for outdoor urban scale studies, reference was made to other CFD guidelines on different wind flow aspects to suggest a study approach for current study. The detail parameters are summarized in Table 6.

Table 6 Detail Parameters Adopted in the CFD Model

	CFD Model
Model Scale	1:1 to real environment
Model details	Only include Topography, Buildings blocks, Streets/Highways. No landscape feature is included
Domain	2700m(Length) x 2600m(Width) x 3000m(Height)
Assessment Area	150m from site boundary of Study Area
Surrounding Area	300m from site boundary of Study area
Grid Expansion Ratio	The grid should satisfy the grid resolution requirement with maximum expansion ratio = 1.2
Prismatic layer	6 layers of prismatic layers and 0.5m each (i.e. total 3m above ground)
Inflow boundary Condition	Incoming wind profiles from RAMS
Outflow boundary	Pressure boundary condition with dynamic pressure equal to zero
Wall boundary condition	Logarithmic law boundary
Solving algorithms	Rhie and Chow SIMPLE for momentum equation Hybrid model for all other equations Realisable k-ε turbulence model
Blockage ratio	< 3%
Convergence criteria	Below $1\text{x}10^{-4}$

3.6 AVA Indicators

The wind Velocity Ratio (VR) as defined in *AVA Technical Circular*[1] was employed to assess the ventilation performances of the proposed Development and surrounding area. The calculation of VR is given by the following formula:

$$VR = \frac{V_p}{V_\infty}$$

where V_p is the wind speed at the pedestrian height (2m above ground) and

V_∞ is the wind velocity at the top of the boundary layer (defined as the height where wind is unaffected by urban roughness and determined by the topographical studies).

Higher VR implies that less impact due to Proposed Development on ventilation performance. The averaged VR is defined as the weighted average VR with respect to the percentage of occurrence of all considered wind directions, which gives a general idea of the ventilation performance at the considered location under both annual and summer wind conditions. Site spatial average velocity ratio (SVR) and a Local spatial average velocity ratio (LVR) are determined as shown in Table 7.

Table 7 Terminology of the AVA Initial Study

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

3.7 Locations of Test Points

As per the technical circular, two types of test point – perimeter test point and overall test point will be adopted to assess the wind performance. The allocation of these test points will be distributed evenly as per the requirement stated in the *AVA Technical Circular*[1].

3.7.1 Perimeter Test Points

A total number of 48 perimeter test points (**Brown spots**), namely P points, are positioned at intervals of around 20m along the project site boundary at 2m above street level in accordance with the *AVA Technical Circular*[1]. The locations of perimeter test points are shown in Figure 32, Figure 33 and Figure 34 for Baseline, Proposed and Interim Schemes respectively.

3.7.2 Overall Test Points

A total number of 106 overall test points (**Blue spots**), namely O points, are evenly distributed in open areas at 2m above street level within the assessment area, such as the streets and places where pedestrian frequently access and their locations are shown in Figure 35.

3.7.3 Special Test Points

A total number of 38 special test points (**Pink spots**), namely S points, are evenly distributed in open areas at 2m above street level within the Application Site. Special attentions are paid to the proposed air path, high-rise block/building setback area and suggested non-building area. Their locations are shown in Figure 32, Figure 33 and Figure 34 for Baseline, Proposed and Interim Schemes respectively.

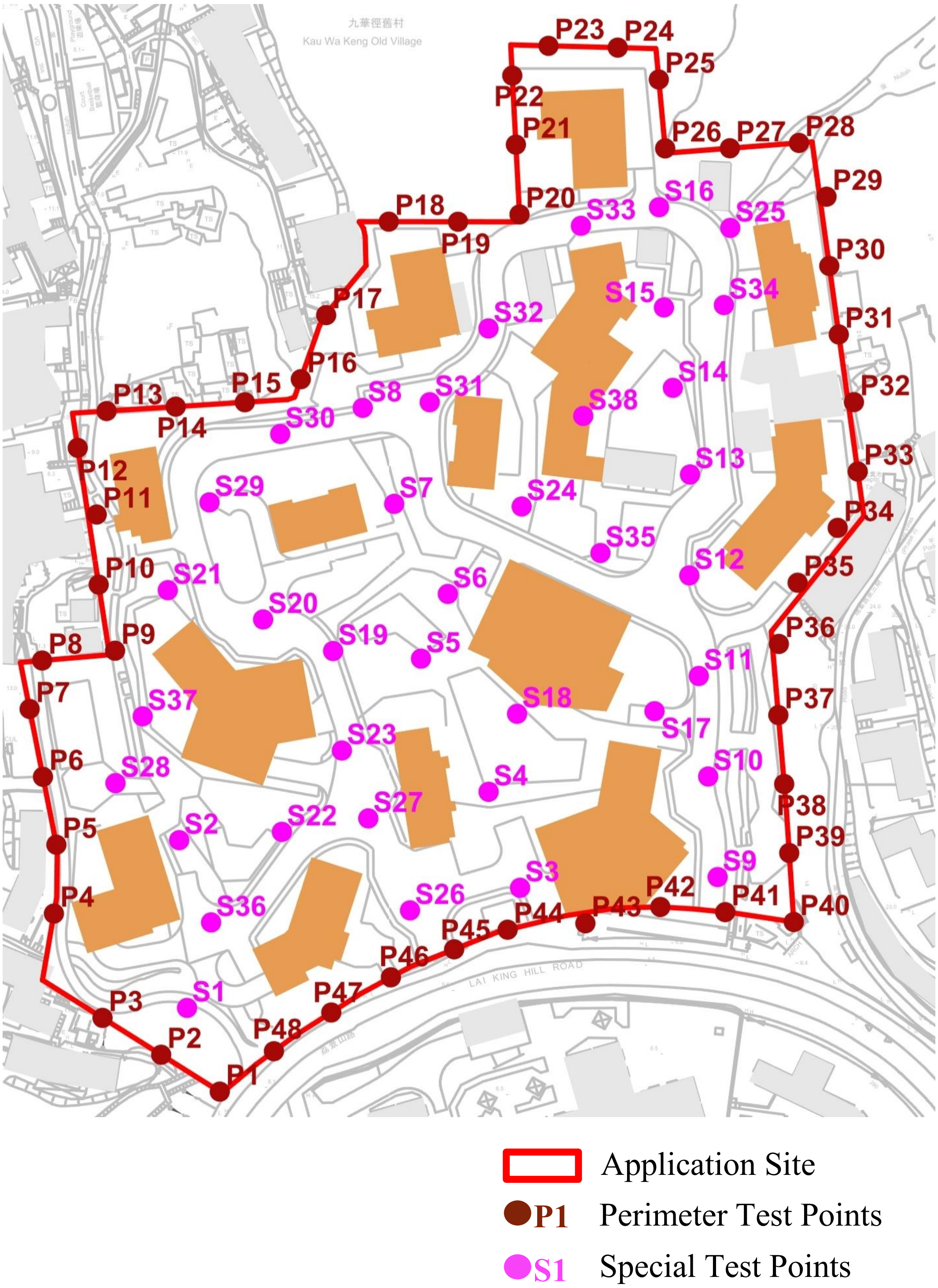


Figure 32 Locations of Perimeter and Special Test Points Under Baseline Scheme

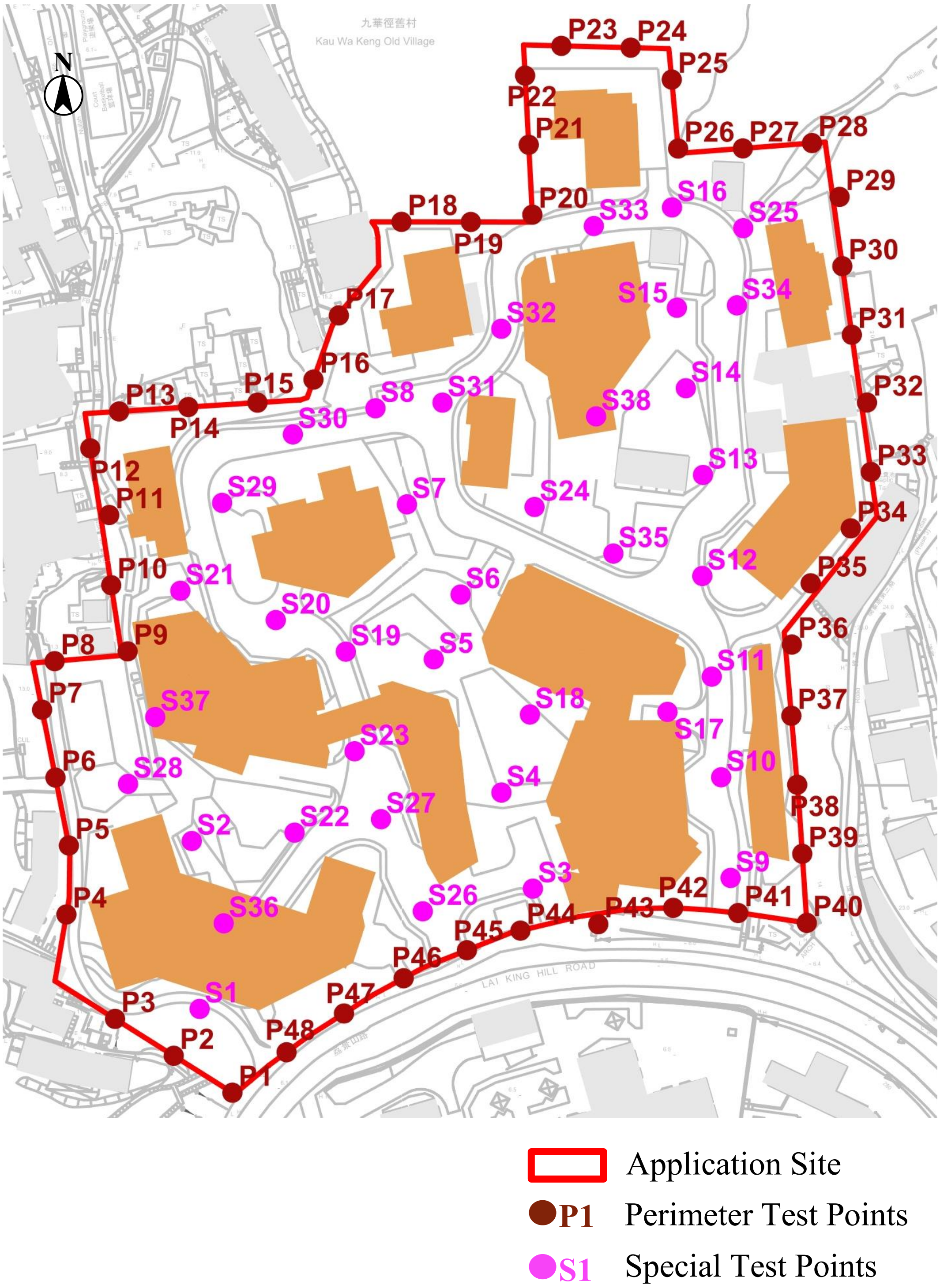


Figure 33 Locations of Perimeter and Special Test Points Under Proposed Scheme

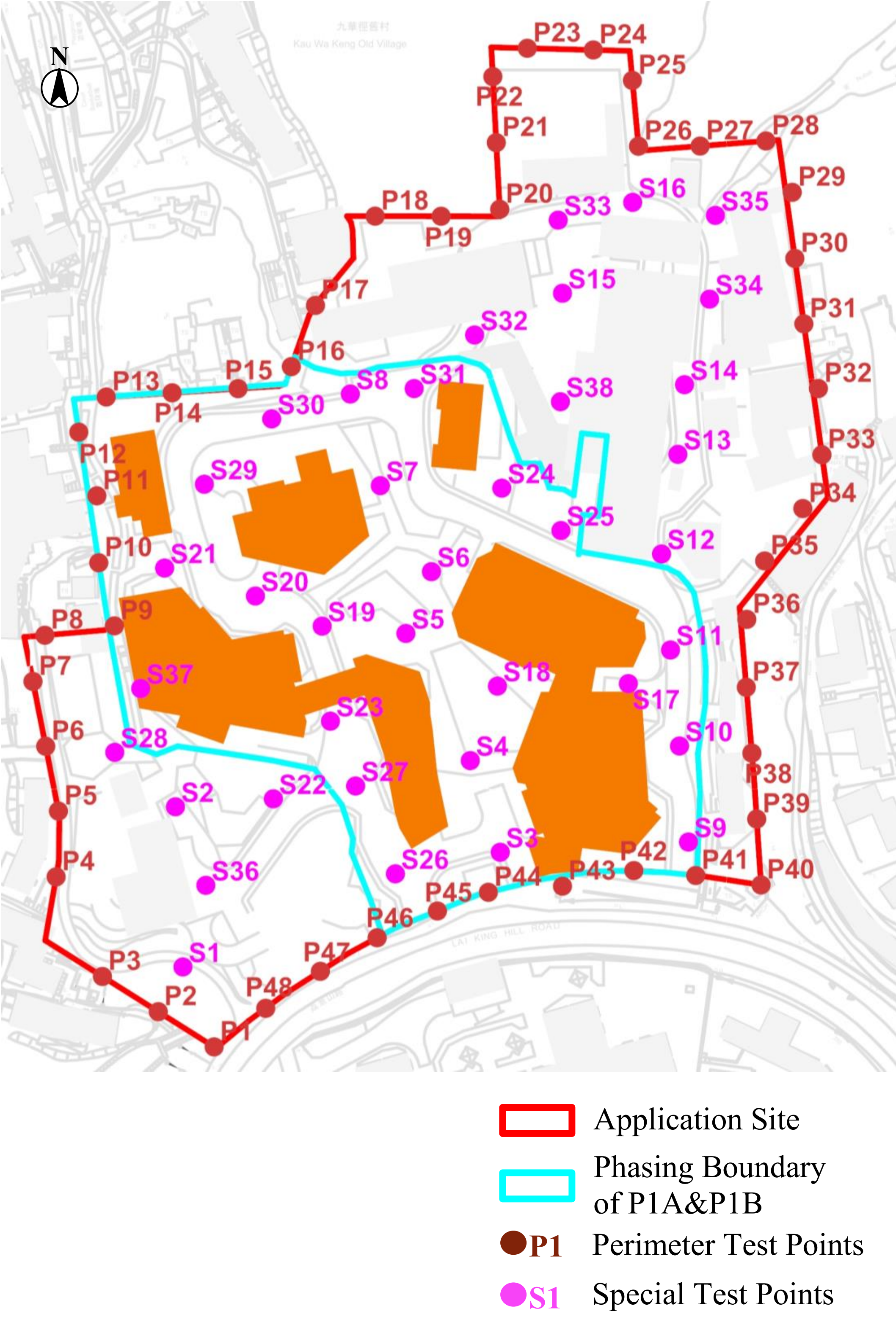


Figure 34 Locations of Perimeter and Special Test Points Under Interim Scheme

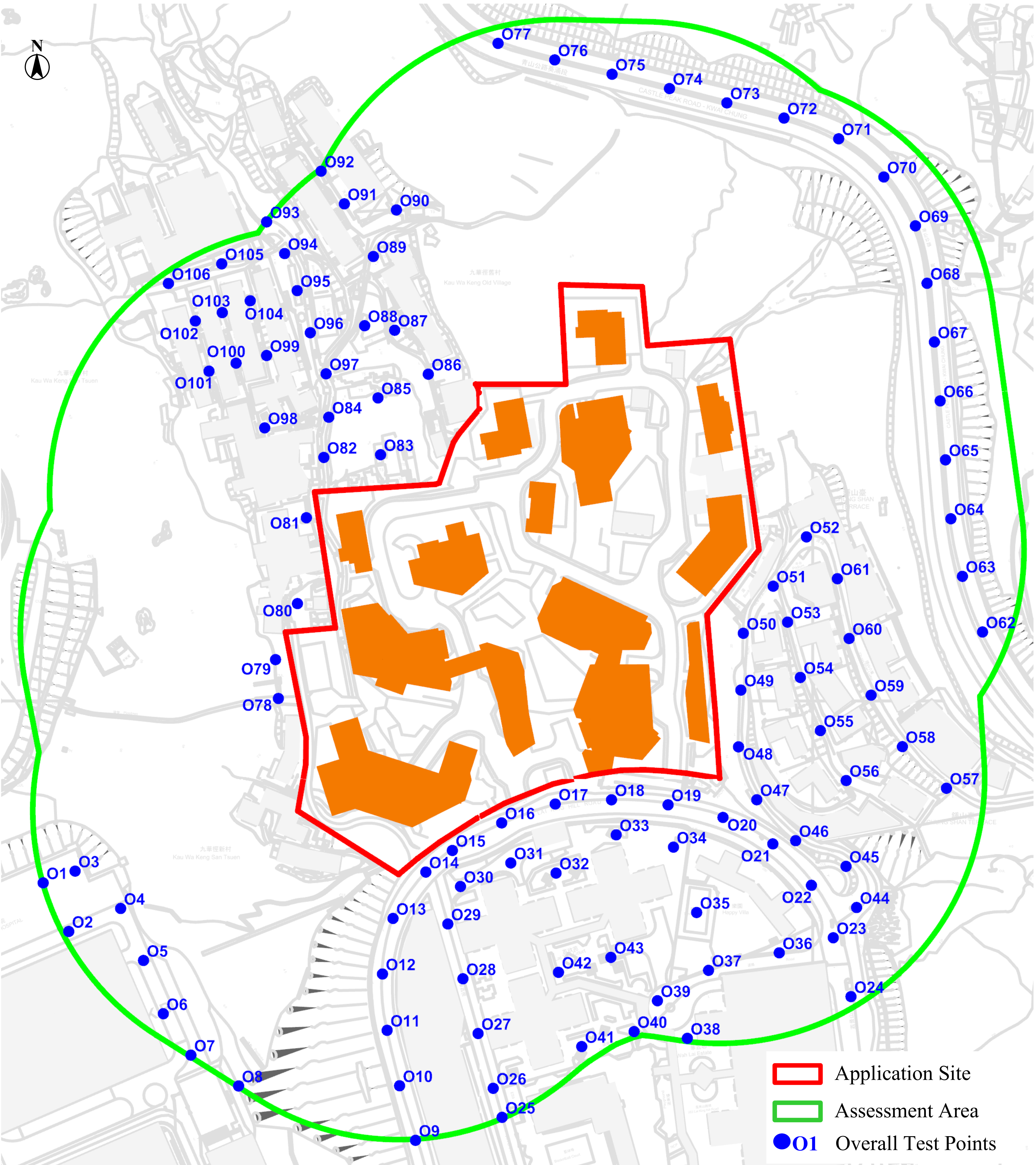


Figure 35 Location of Overall Test Points

4 Results and Discussion

The detailed contour and vector plots for each wind directions are shown in Appendix C and Appendix D

4.1 Overall Pattern of Ventilation Performance under Annual Wind Condition

The overall wind performance of Baseline, Proposed and Interim Schemes under annual wind condition is presented in Figure 36, Figure 37 and Figure 38, respectively. The SVR and LVR are summarized in Table 8.

Table 8 Annual SVR and LVR for Baseline and Proposed Schemes

	Baseline Scheme	Proposed Scheme	Interim Scheme
SVR	0.21	0.22	0.19
LVR	0.22	0.23	0.22

The slightly higher SVR and LVR under Proposed Schemes is due to the more prominent downwash effect which slightly enhanced the ventilation performance along the site boundary and within assessment area under annual condition. The Interim Scheme achieved similar SVR and LVR even with less prominent downwash effect is due to the higher wind permeability on north-eastern and south-western site boundary.

The prevailing wind under annual condition mostly come from E quadrant. The Application Site is at the leeward side of Kam Shan Country Park (>+200mPD). The wind environment in surrounding area is generally dominated and diverted by the hilly terrain in this area. High-level wind would reach the site from prevailing wind direction and induced downwash effect on facades of the Application Site. Low-and mid-levels wind would reach the site through the Lai King Hill Road from the south and through the Kau Wa Keng San Tsuen from the north. The incoming wind directions are illustrated by **Black** arrows in Figure 36, Figure 37 and Figure 38, respectively.

Under Proposed Scheme, the larger frontal area would induce more prominent downwashed wind.

Downwashed wind from B6 and B14 would travel through building separation of B4/B5 to ventilate the central and northern parts of Kau Wa Keng San Tsuen (**Red** arrow in Figure 37). Downwashed wind from B6 and B7 would travel along diagonal air path to ventilate the southern part of Kau Wa Keng San Tsuen (**Blue** arrow in Figure 37). Downwashed wind from B1 and B8 would travel through building separation of B2/B9 to ventilate the southern part of Kau Wa Keng San Tsuen (**Purple** arrow in Figure 37). And downwashed wind from B7 and B8 would utilize the eastern air path and central air path to ventilate the Lai King Hill Road (**Pink** arrow in Figure 37).

However, downwashed wind from B7 would also limit the northbound incoming wind from Lai King Hill Road, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 37.

Under Interim Scheme, due to the absent of high-rise development on the north-eastern site boundary, incoming wind would skim over to ventilate the central and northern part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 38.

However, due to the less prominent downwash effect, less downwashed wind would reach the south-western site boundary, southern part of Kau Wa Keng San Tsuen and Lai King Hill Road, where slightly lower VR would be observed, illustrated by **Black** circles in Figure 38.

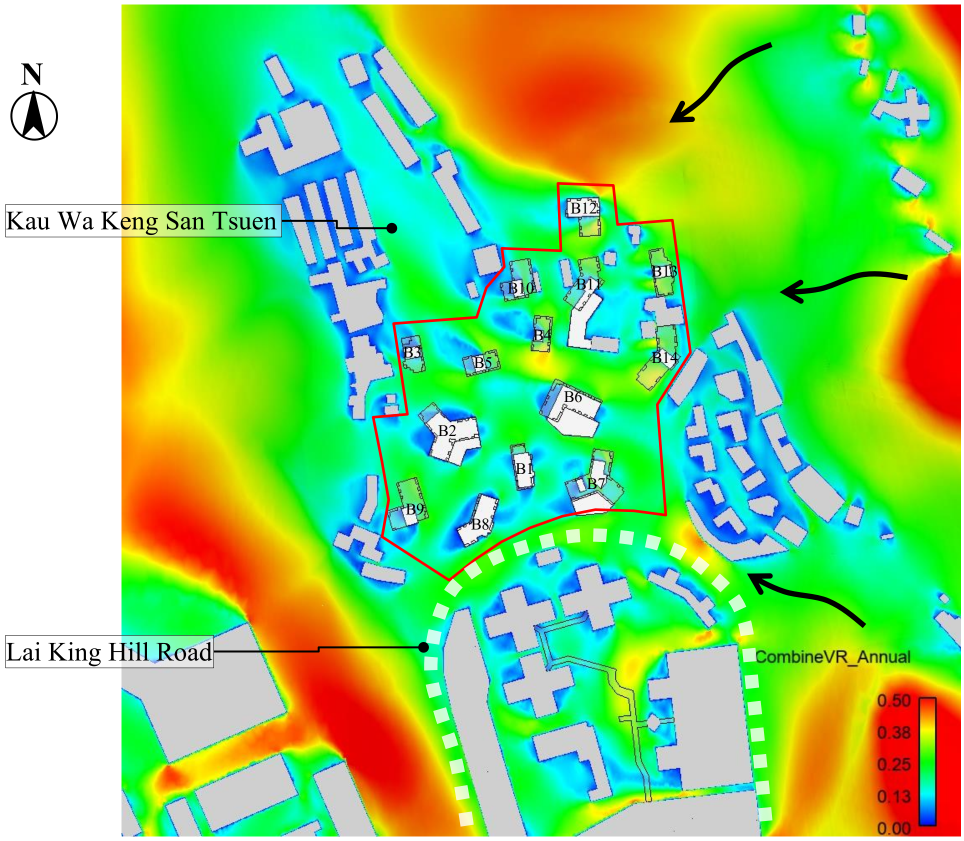


Figure 36 Contour plot of annual weighted VR under Baseline Scheme

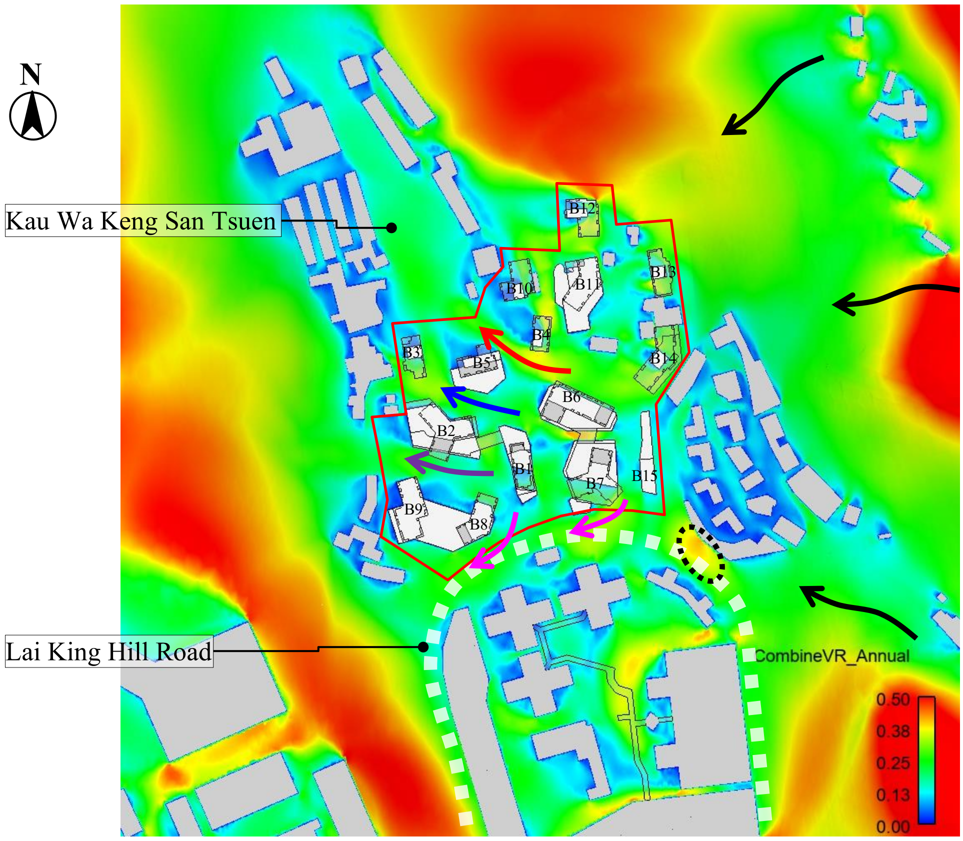


Figure 37 Contour plot of annual weighted VR under Proposed Scheme

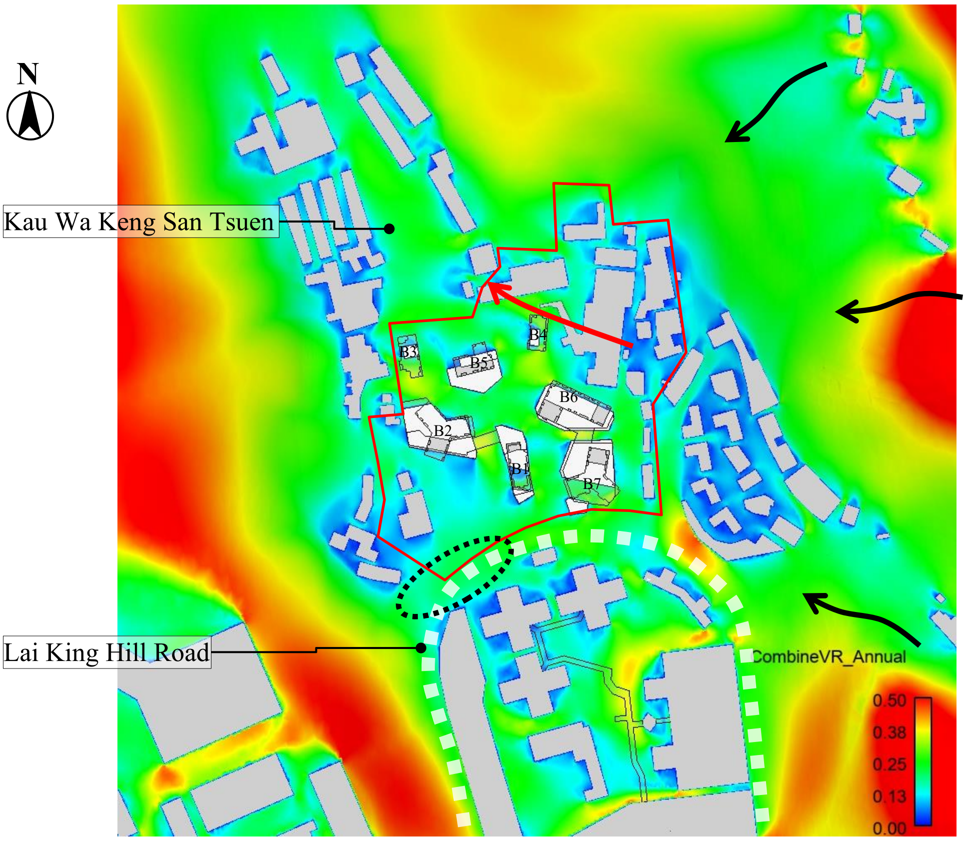


Figure 38 Contour plot of annual weighted VR under Interim Scheme

4.2 Overall Pattern of Ventilation Performance under Summer Wind Condition

The overall wind performance of Baseline, Proposed and Interim Schemes under summer wind condition is presented in Figure 39, Figure 40 and Figure 41 respectively. The SVR and LVR are summarized in Table 9.

Table 9 Annual SVR and LVR for Baseline and Proposed Schemes

	Baseline Scheme	Proposed Scheme	Interim Scheme
SVR	0.18	0.19	0.18
LVR	0.21	0.22	0.21

The slightly higher SVR and LVR under Proposed Schemes is due to the more prominent downwash effect which slightly enhanced the ventilation performance along the site boundary and within assessment area under annual condition. The Interim Scheme achieved slightly higher SVR and similar LVR even with less prominent downwash effect is due to the higher wind permeability on north-eastern and south-western site boundary.

The prevailing wind under summer condition mostly come from SW quadrant. The Application Site is at the leeward side of high-rise residential development (+120mPD) and hilly terrain (+80mPD) with Kwai Chung Hospital (+120mPD) and Princes Margaret Hospital (+147mPD). The wind environment in surrounding area is generally dominated and diverted by the hilly terrain in this area. Incoming wind mostly reach the Application Site through the Lai King Hill Road from the south and through Kau Wa Keng San Tsuen from the north. Incoming wind directions are illustrated by **Black** arrows in Figure 39, Figure 40 and Figure 41, respectively.

Under Proposed Scheme, the larger frontal area would induce more prominent downwashed wind.

Downwashed wind from B6 and B14 would travel through building separation of B4/B5 to ventilate the central and northern parts of Kau Wa Keng San Tsuen (**Red** arrow in Figure 40). Downwashed wind from B6 and B7 would travel along diagonal air path to ventilate the southern part of Kau Wa Keng San Tsuen (**Blue** arrow in Figure 40). Downwashed wind from B2 and B9 w ould be diverted by the podium under B2 and B9 to ventilate the southern part of Kau Wa Keng San Tsuen (**Purple** arrow in Figure 40). And downwashed wind from B7 and B8 would also ventilate the Lai King Hill Road (**Pink** arrow in Figure 40).

However, the continuous podium structure between B8/B9, would hinder the incoming wind from Lai King Hill Road from penetrating into the Application Site, where slightly lower VR would be observed, illustrated by **Red** circle in Figure 40.

Also, bulky podium under B6/B7 reduced wind permeability, together with the B15 near the south-eastern boundary, incoming wind would be restricted to penetrate the south-eastern side of the Application Site, illustrated by **Black** circle in Figure 40. This restriction would further lead to low wind availability reaching Chung

Shan Terrace, where slightly lower VR would be observed, illustrated by **Pink** circle in Figure 40 .

Under Interim Scheme, due to the absent of high-rise development on the south-western site boundary, incoming wind would skim over to ventilate the central and northern parts of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 41

However, due to less prominent downwash effect, less wind would reach pedestrian level of south-western site boundary and southern part of Kau Wa Keng San Tsuen, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 41.

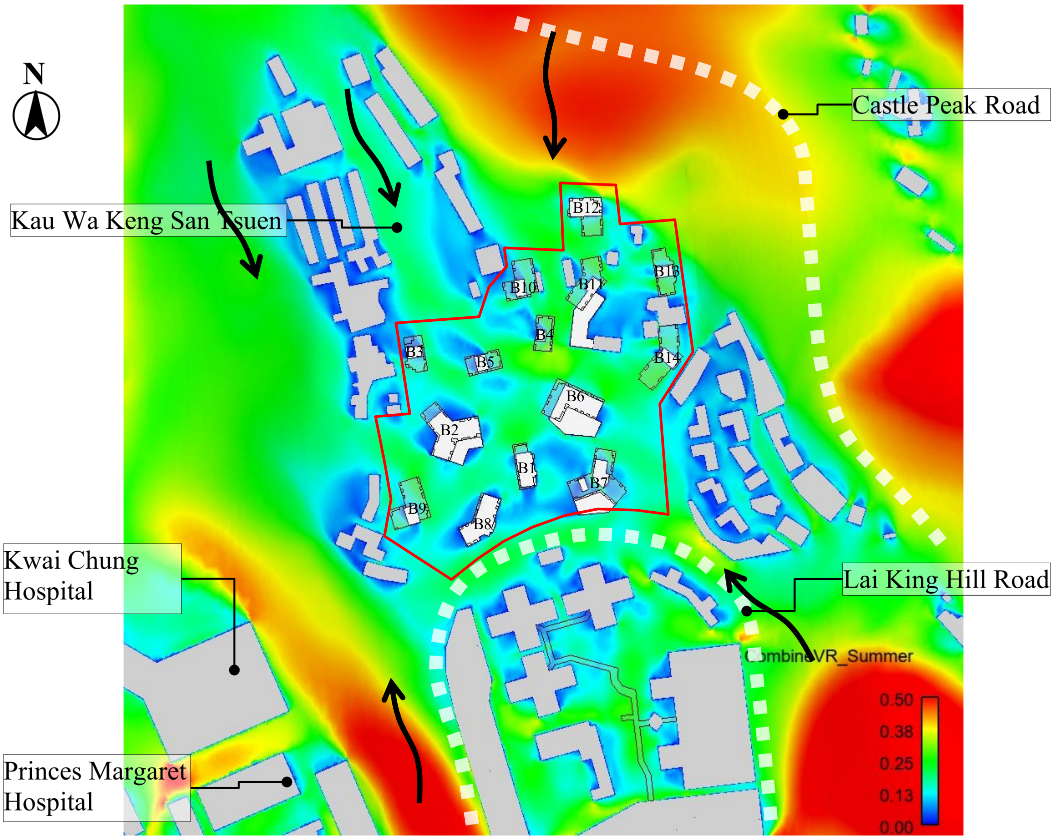


Figure 39 Contour plot of summer weighted VR under Baseline Scheme

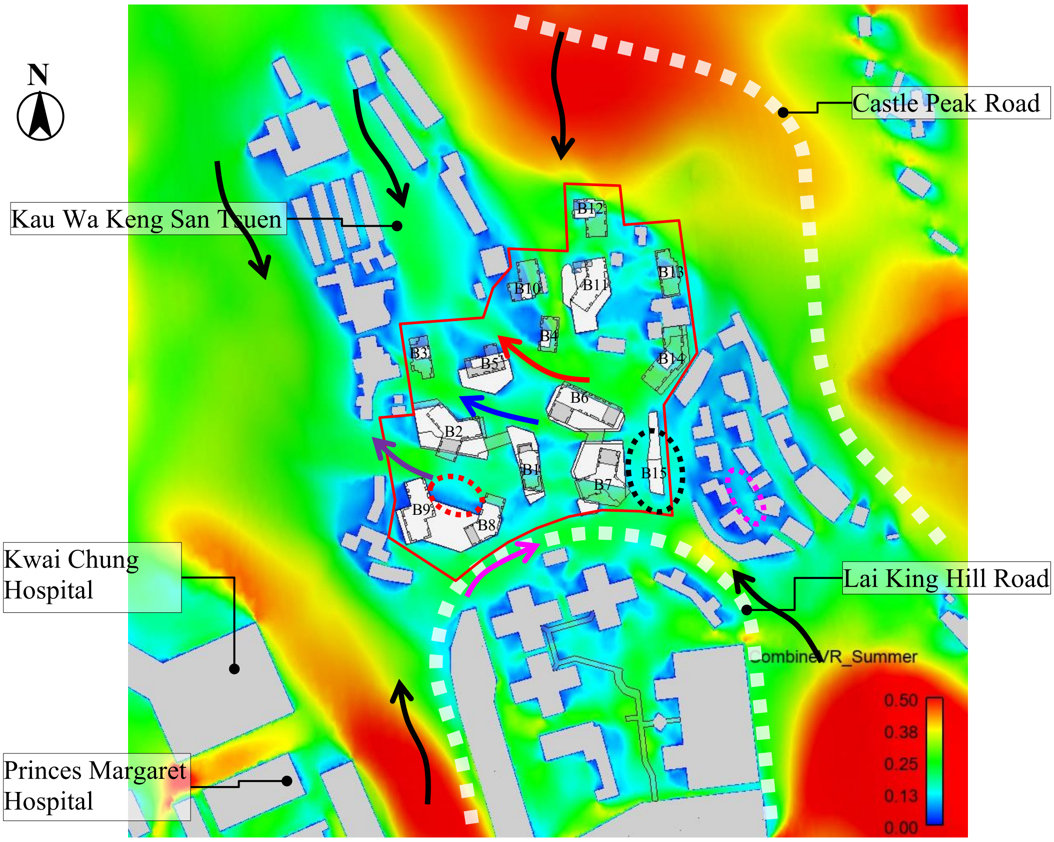


Figure 40 Contour plot of summer weighted VR under Proposed Scheme

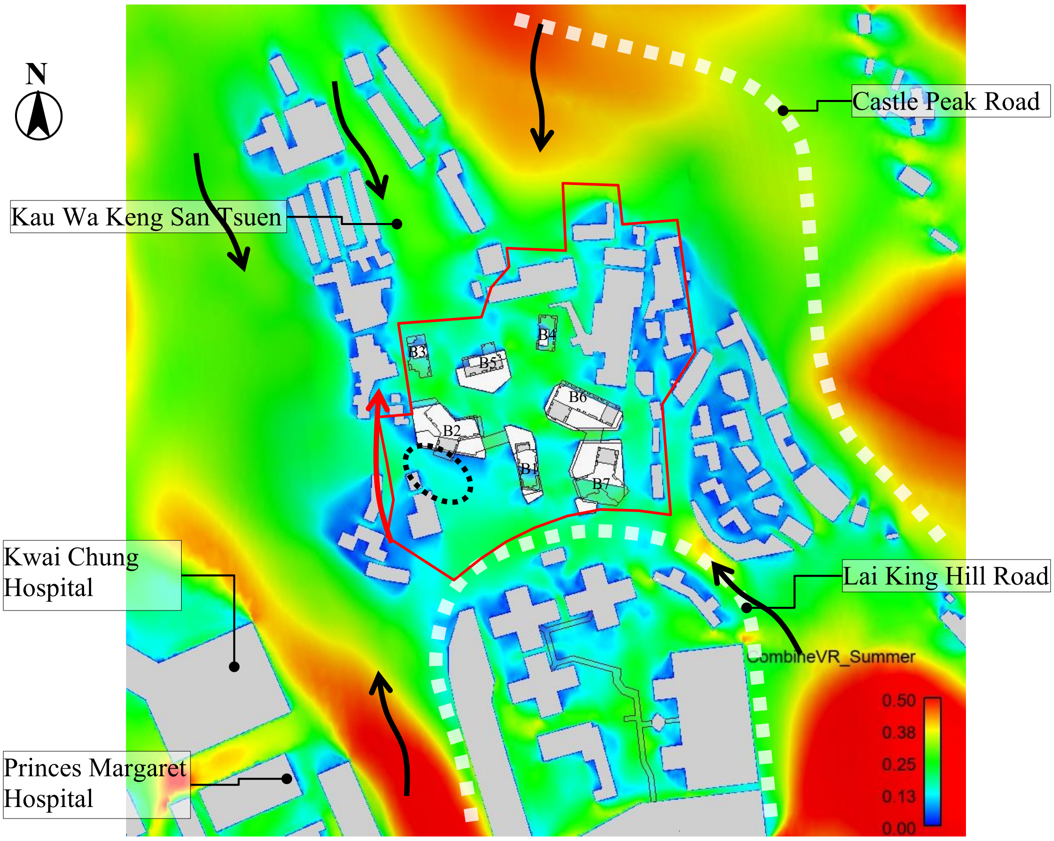


Figure 41 Contour plot of summer weighted VR under Interim Scheme

4.3 Directional Analysis

4.3.1 NE Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under NE winds are presented in Figure 42, Figure 43 and Figure 44, respectively.

The Application Site is in a valley and at the leeward side of the Kam Shan Country Park (>+200mPD). Although the upstream surrounding is relatively open, low- and mid-level incoming winds would be diverted by the terrain to reach the Application Site from the north through the Kau Wa Keng San Tsuen. High-level wind would still reach the Application Site from the NE direction. The incoming wind directions are illustrated by **Black** arrow in Figure 42, Figure 43 and Figure 44 respectively.

Under Baseline Scheme, the diagonal air path is aligned with incoming wind direction, incoming wind would flow across the air path to ventilate the open space within Application Site and Lai King Hill Road, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 42.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

Due to the larger frontal area of B12, B13 and B14, more downwashed wind would be induced to ventilate pedestrian level, slightly higher VR on the central part of Kau Wa Keng San Tsuen would be observed, illustrated by **Red** arrow in Figure 43.

However, the downwashed wind would flow against the low-level incoming wind from Castle Peak Road where slightly lower VR would be observed, illustrated by **Black** circle in Figure 43.

In addition, larger frontal area of B7 would induce more downwashed wind and exit from eastern air path to ventilate Lai King Hill Road where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 43.

Under Proposed Scheme, the B15 on south-eastern reduced the wind permeability, less downwashed wind from Happy Villa would be able to reach the pedestrian level, where slightly lower VR would be observed, illustrated by **Blue** circle in Figure 43.

Under Interim Scheme, downwash effect is less prominent due to the absent of high-rise building on the north-eastern site boundary, slightly lower VR on central part of Kau Wa Ken San Tsuen would be observed, illustrated by **Black** circle in Figure 44.

On the other hand, the increased wind permeability allows incoming wind to penetrate the Application Site to reach the southern part of Kau Wa Keng San Tsuen, were slightly higher VR would be observed, illustrated by **Red** circle in Figure 44.

Also, incoming wind skim over north-eastern site boundary would push the incoming wind from Chung Shan Terrace to induce downwash effect, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 44.

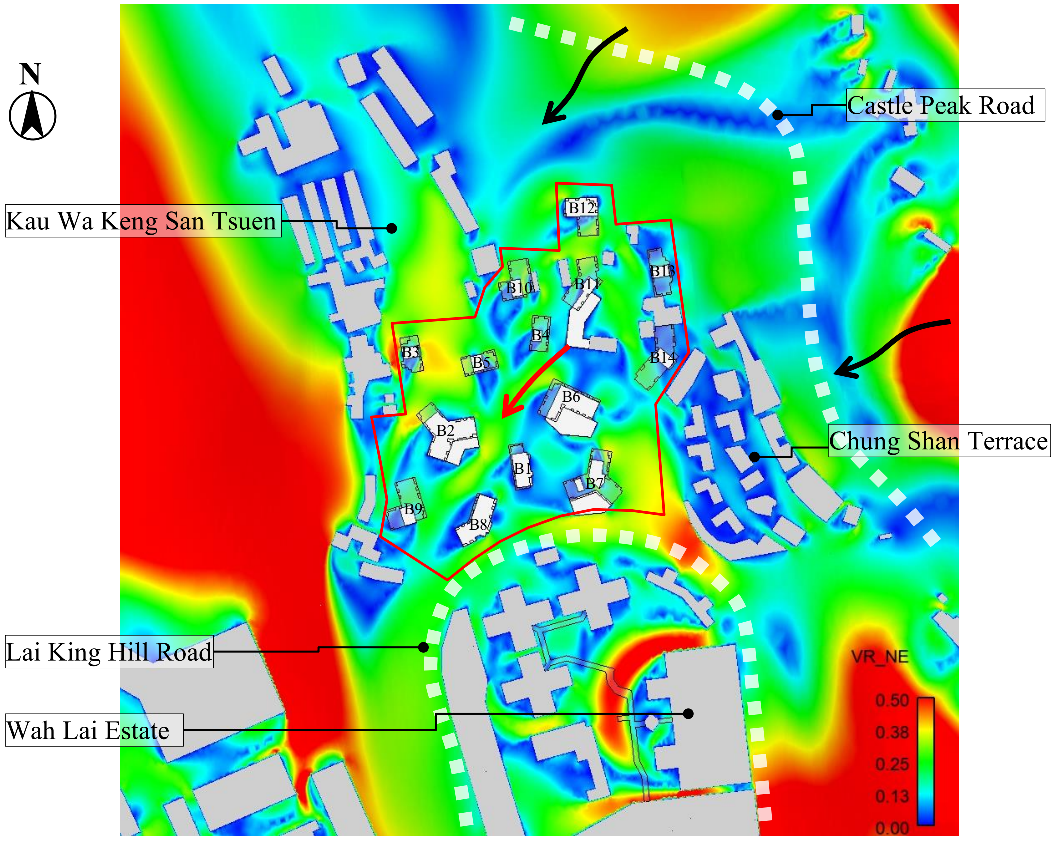


Figure 42 Contour plot of VR of Baseline Scheme under NE wind.

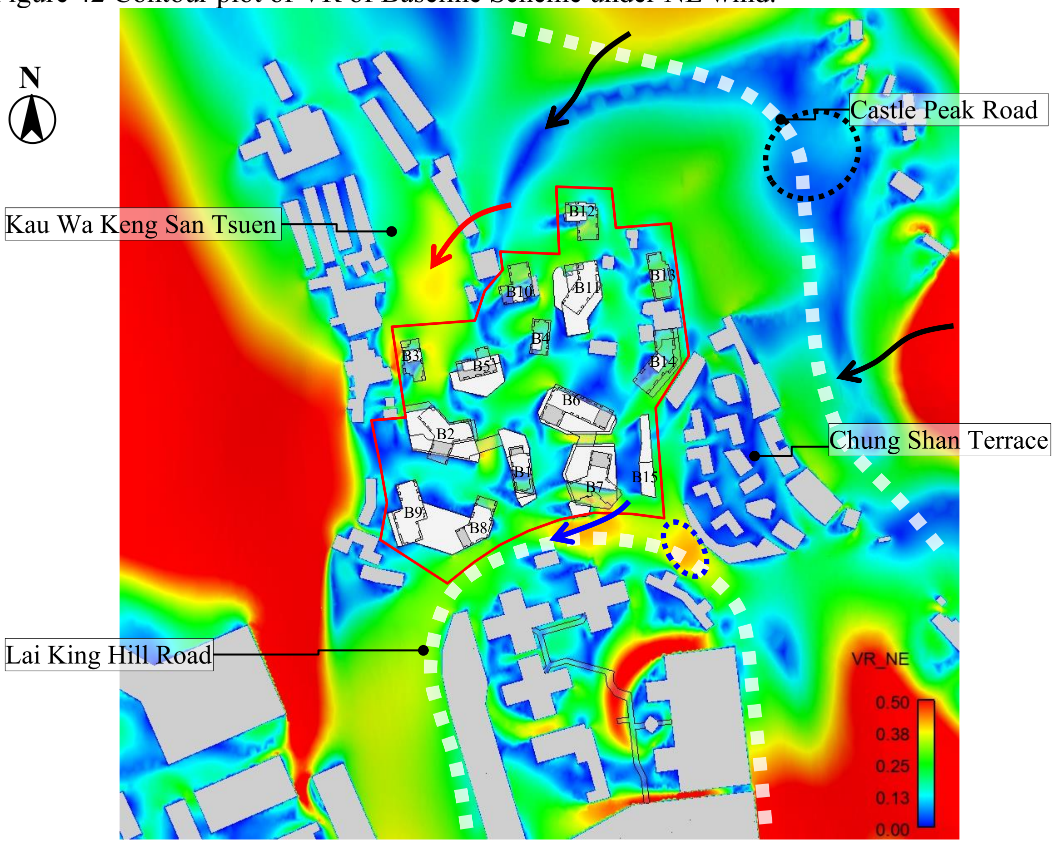


Figure 43 Contour plot of VR of Proposed Scheme under NE wind.

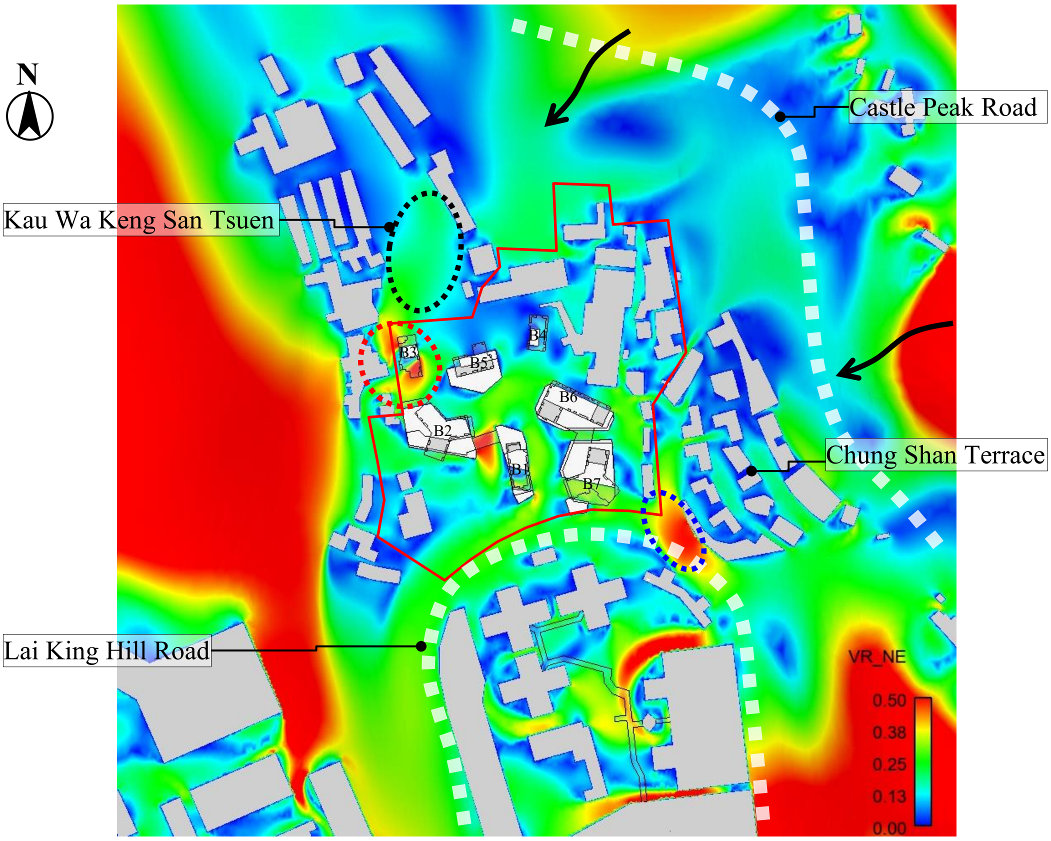


Figure 44 Contour plot of VR of Interim Scheme under NE wind.

4.3.2 ENE Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under ENE winds are presented in Figure 45, Figure 46 and Figure 47, respectively.

The Application Site is situated on a valley and at the leeward side Kam Shan Country Park (>+200mPD). The low-level incoming wind would be shielded by the hills. Under Baseline and Proposed Schemes, mid-level incoming wind would reach the hill on the west of Kau Wa Keng San Tsuen and diverted to ventilate the Application Site from the north. High-level wind would still reach the site from the north through Kau Wa Kei San Tsuen. The incoming wind directions are illustrated by **Black** arrow in Figure 45, Figure 46 and Figure 47, respectively.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme, and the downwashed wind would alleviate the ventilation impact on surrounding environment.

Under Proposed Scheme, due to the larger frontal area B12, B13 and B14, more downwashed wind would be induced to ventilate pedestrian level, slightly higher VR on the Castle Peak Road and central part of Kau Wa Keng San Tsuen would be observed, illustrated by **Blue** arrow in Figure 46.

Similar to NE wind, incoming wind diverted by B11/B12 and B13/B14 would exit from south-eastern side boundary with tendency to lean toward the west, less incoming wind from Chung Shan Terrace would be pushed towards Happy Villa and result in less prominent downwash effect, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 46.

Also, a generally larger building footprint reduced to wind permeability, including smaller building separation between B6/B7, B15 on south-eastern site boundary, continuous podium between B8/B9, with taller building height. As such the incoming wind would be restricted to penetrate the Application Site, resulting in slightly lower VR on Lai King Hill Road and Kai Chung Hospital would be observed, illustrated by **Red** circle in Figure 46.

Under Interim Scheme, due to the absent of high-rise development on north-eastern site boundary, incoming wind would skim over to ventilate central part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 47.

Also, incoming wind would flow around B3, B4 and B5 to reach the southern part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Purple** arrows in Figure 47.

In addition, the higher wind permeability allows incoming wind to skim over the Application Site to reach the Lai King Hill Road where slightly higher VR would be observed, illustrated by **Black** circle in Figure 47.

Similar to NE wind, the openness of north-eastern site boundary allows incoming wind from the north to push incoming wind from Chung Shan Terrace toward Happy Villa and induce more downwash effect where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 47.

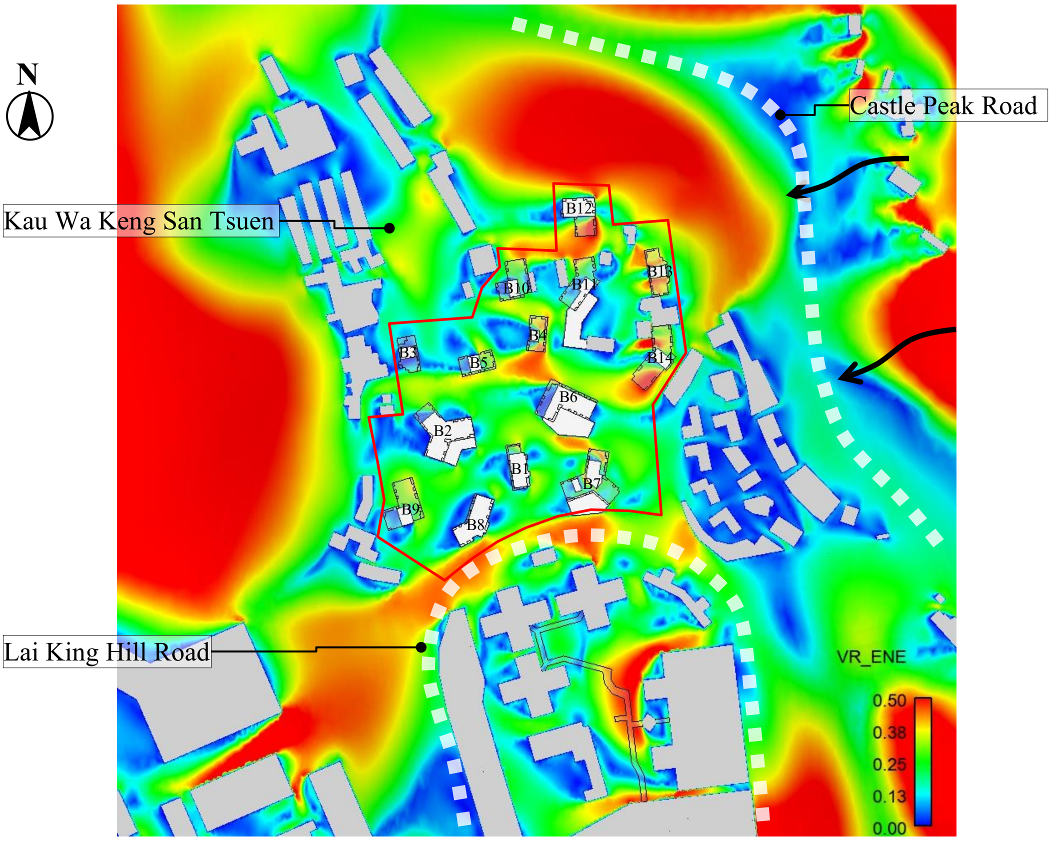


Figure 45 Contour plot of VR of Baseline Scheme under ENE wind.

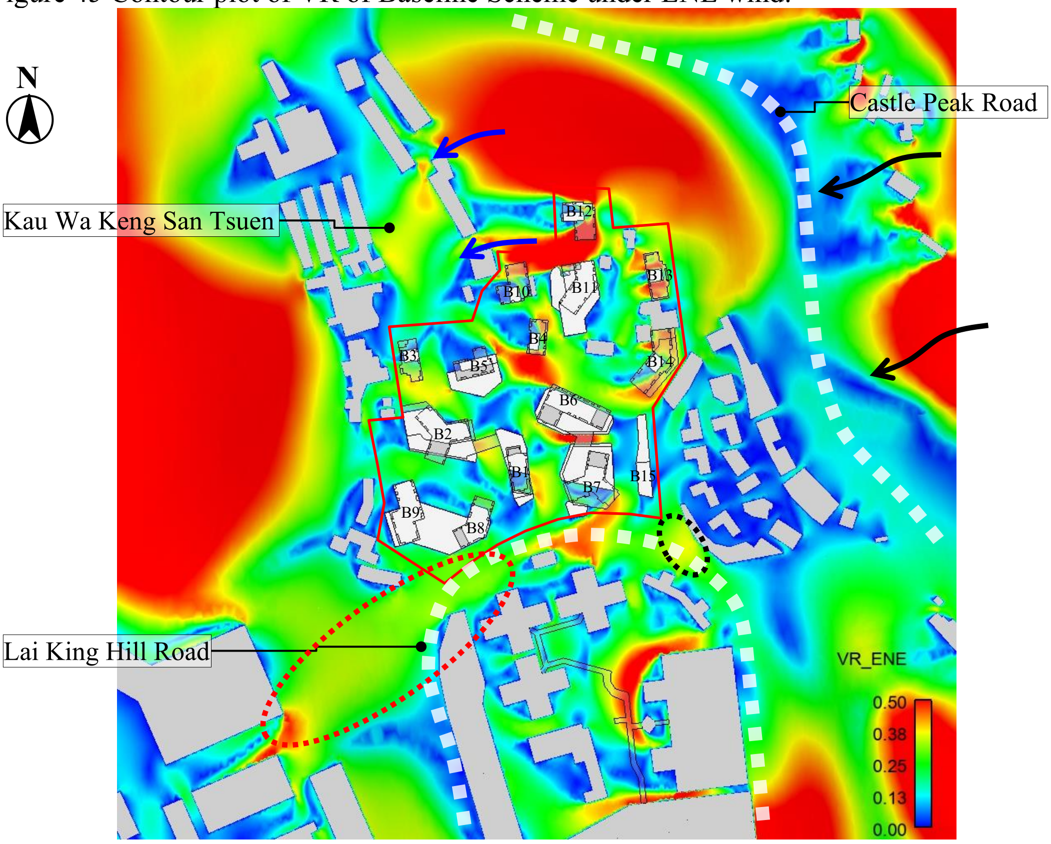


Figure 46 Contour plot of VR of Proposed Scheme under ENE wind.

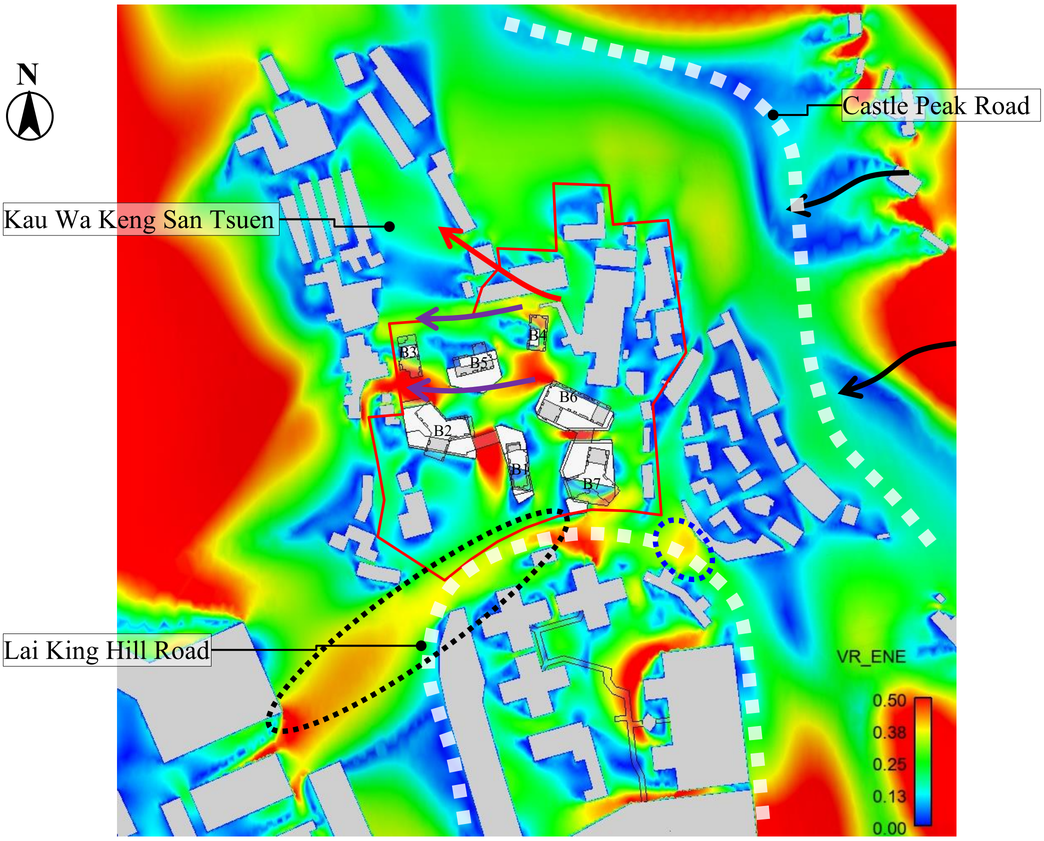


Figure 47 Contour plot of VR of Interim Scheme under ENE wind.

4.3.3 E Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under E winds are presented in Figure 48, Figure 49 and Figure 50 respectively.

The Application Site is in the leeward side of the hills (>+100mPD). Low- and mid-level incoming winds would be diverted to reach the Application Site form the south through Lai King Hill Road and Castle Peak Road. High-level wind would still reach the site from the east. The incoming wind directions are illustrated by **Black** arrow in Figure 48, Figure 49 and Figure 50 respectively.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be slightly better than Baseline Scheme.

The larger frontal area of B6, B7, B12, B13 and B14, more downwashed wind would be induced. Part of the downwashed wind would flow into the Application Site and ventilate the open area within, where slightly higher VR would be observed.

In addition, part of the downwashed wind would travel to ventilate the surrounding from the north, west and south, where slightly higher VR would be observed as discussed below.

Northbound wind would ventilate Castle Peak Road and northern part of Kau Wa Keng San Tsuen from building separation of B10/B11 and hilly terrain near Castle Peak Road, illustrated by **Blue** arrows in Figure 49.

Westbound wind would flow along the diagonal air path and building separation of B4/B5 to ventilate the southern part of Kau Wa Keng San Tsuen, illustrated by **Pink** arrow in Figure 49.

However, the bulky podium of B5 would reduce the podium separation between B4/B5, restricting the air flow from passing the podium separation which would further travel to ventilate Kau Wa Keng San Tsuen. Resulting in slightly lower VR, illustrated by **Red** circle in Figure 49.

Southbound wind would flow along eastern air path to ventilate Lai King Hill Road, and further travel towards Kau Wa Keng Shan Tsuen, illustrated by **White** arrow in Figure 49.

However, downwashed wind traveling to the south would also limit the northbound incoming wind from Lai King Hill Road, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 49.

Under Interim Scheme, due to the smaller building frontal area compared to Proposed Scheme, downwashed wind would be less prominent, slightly lower ventilation performance within the Application Site and Lai King Hill Road would be observed.

However, due to the absent of high-rise development in northern part of Application Site, incoming wind would skim over and reach Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 50.

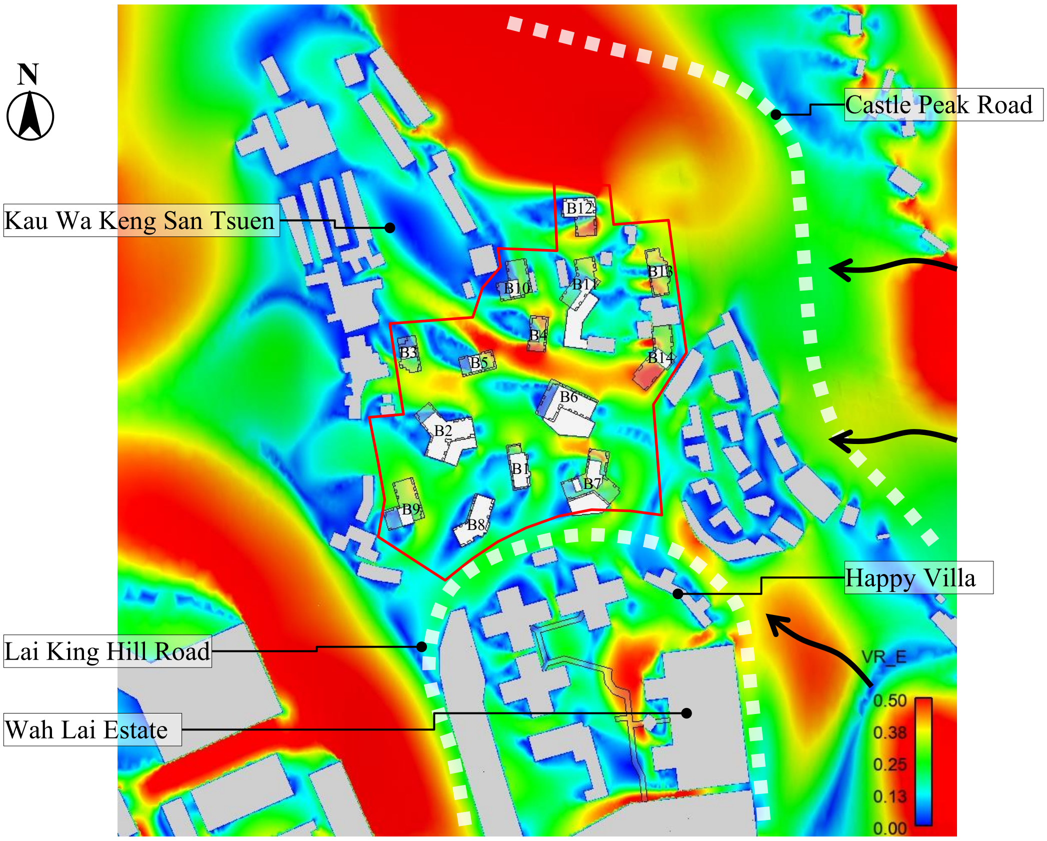


Figure 48 Contour plot of VR of Baseline Scheme under E wind.

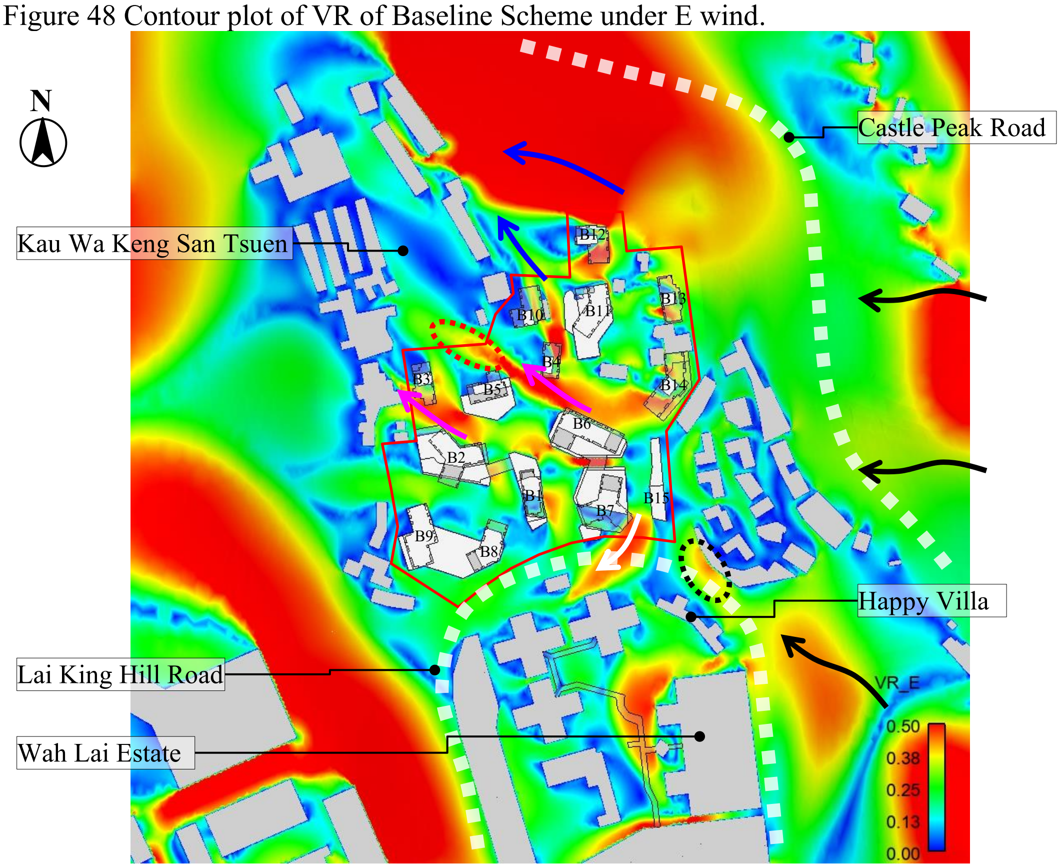


Figure 49 Contour plot of VR of Proposed Scheme under E wind.

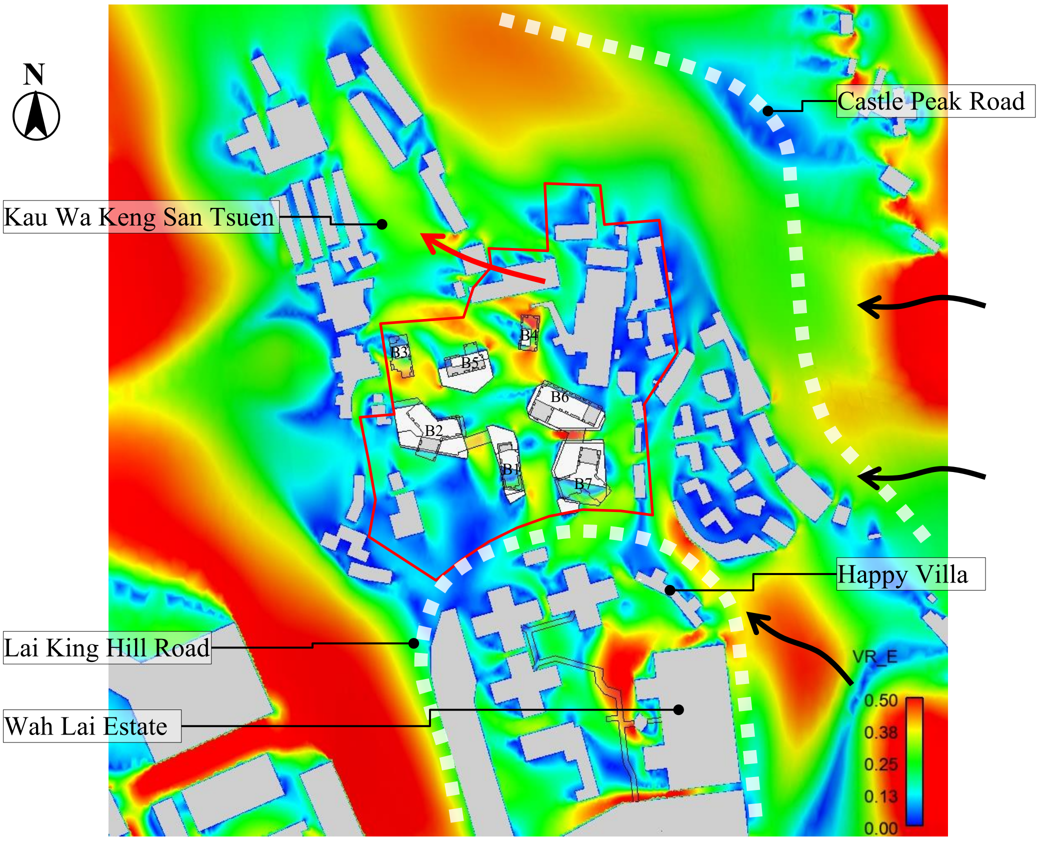


Figure 50 Contour plot of VR of Interim Scheme under E wind.

4.3.4 ESE Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under ESE winds are presented in Figure 51, Figure 52 and Figure 53, respectively.

The Application Site is in the leeward side of hills (>+100mPD), low- and mid-level incoming winds would be diverted and reach the Application Site from the South through Lai King Hill Road. The high-level wind would reach the site from the ESE direction. The incoming wind directions are illustrated by **Black** arrow in in Figure 51, Figure 52 and Figure 53, respectively. The downwashed wind would then travel through the separation between B6/B7, B6/B14 and enter the central part of the Application Site.

Under both Scheme, diverted wind by Happy Villa and Wah Lai Estate would be influenced by the incoming wind diverted by B6, B7 and B14 which is traveling to the south. Under Proposed Scheme, due to the larger frontal area of these buildings, more prominent southbound wind would push diverted wind by Happy Villa and Wah Lai Estate towards the building separation in between, instead of reach pedestrian level, where slightly lower VR would be observed, illustrated by **Blue** circle in Figure 52.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

The continuous podium structure under B8 and B9, incoming wind from building separation of B1/B8 and B1/B2 would be diverted towards southern part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 52.

Under Proposed Scheme, larger frontal area of B6 and B14 induces more prominent downwash effect, together with the diagonal air path, the downwashed wind would pass through the Application Site to ventilate Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 52.

However, the downwashed wind from B14 would be blocked by podium structures under B14 and B15 at south-eastern site boundary, the downwashed wind would not reach the pedestrian level nearby, result in slightly lower VR nearby, illustrated by **Black** circle in Figure 52.

Also, the B15 on south-eastern site boundary would limit the incoming wind from Lai King Hill road from entering the Application Site, it also restrict the downwashed wind from B7 from leaving the Applicating Site, which reduced the ventilation performance near the B15 and Chung Sha Terrace, where slightly lower VR would be observed, illustrated by **Pink** circles in Figure 52.

Under Interim Scheme, due to less prominent downwashed wind from eastern side, less downwashed wind would reach Chung Shan Terrace, where slightly lower VR would be observed illustrated by **Black** circle in Figure 53.

However, due to the absent of high-rise development on north-eastern site boundary, incoming wind would skim over to ventilate the Application Site and the

Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 53.

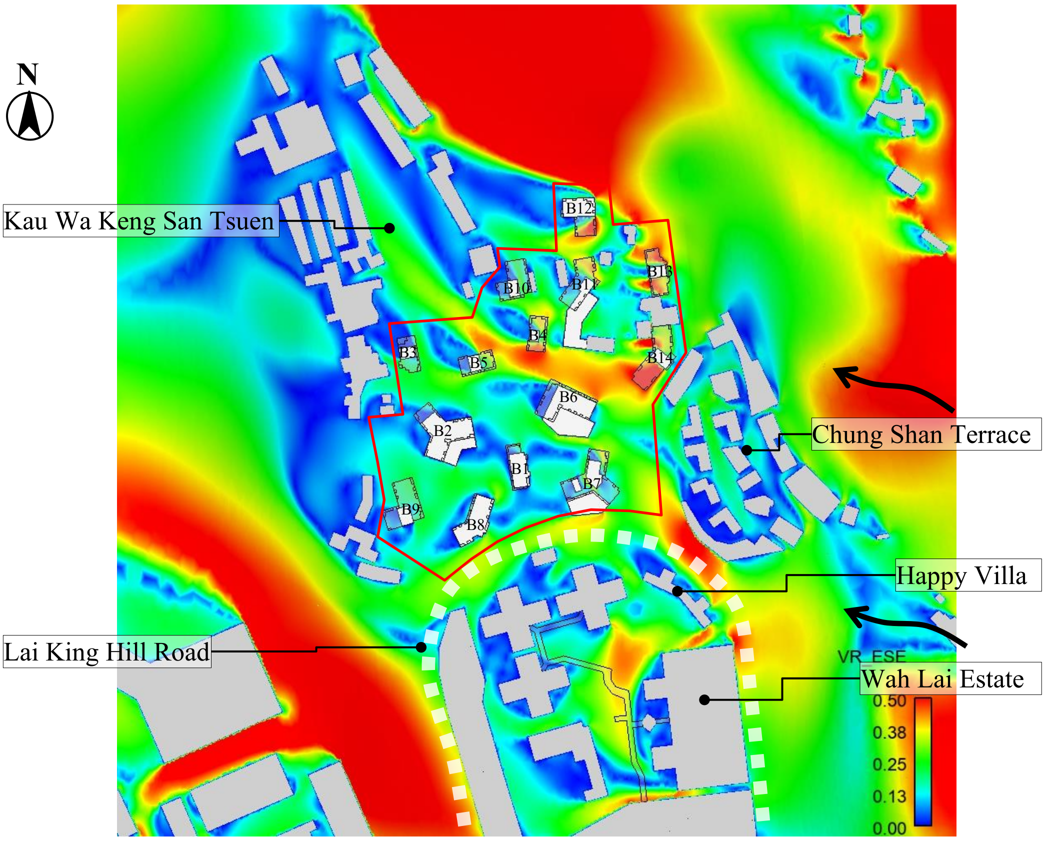


Figure 51 Contour Plot of VR of Baseline Scheme under ESE wind.

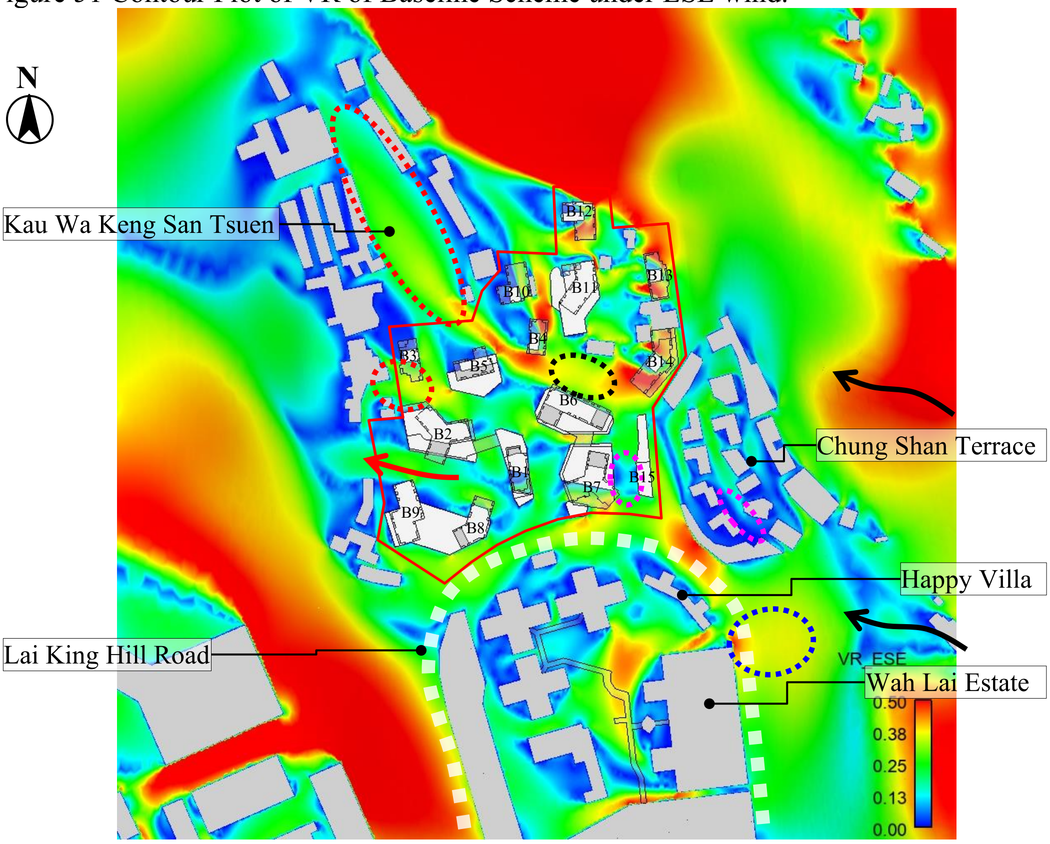


Figure 52 Contour Plot of VR of Proposed Scheme under ESE wind.

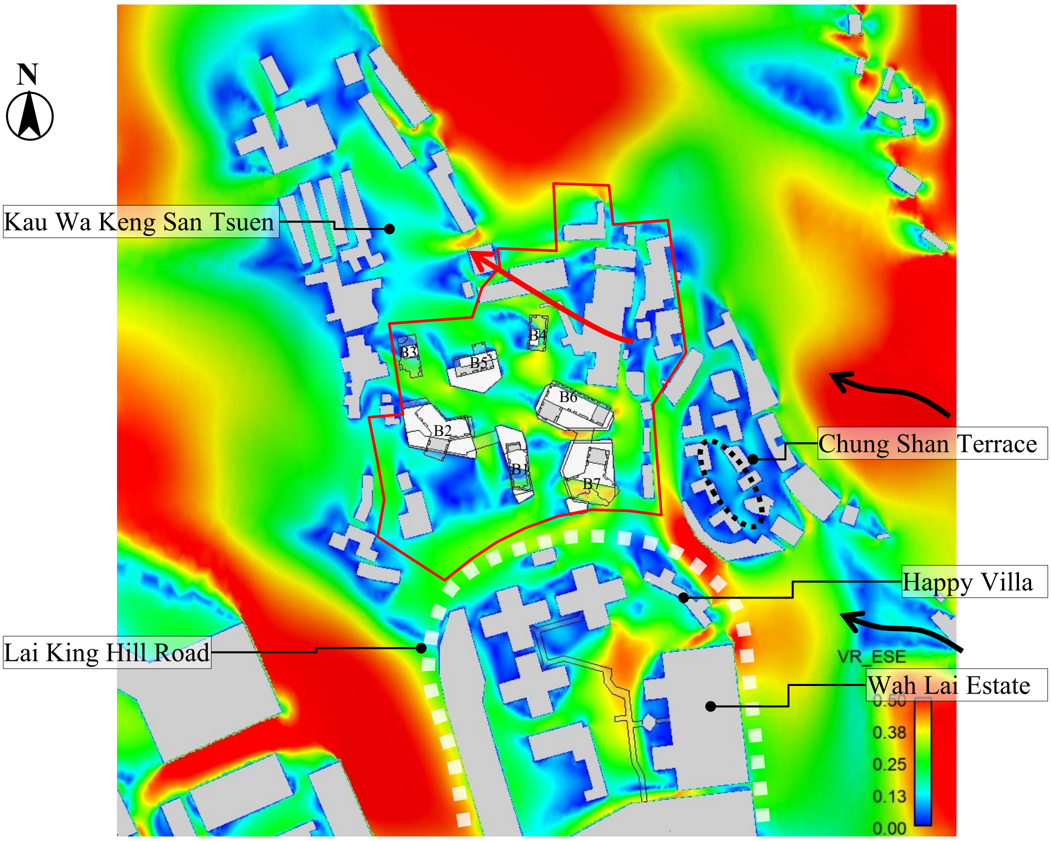


Figure 53 Contour Plot of VR of Interim Scheme under ESE wind.

4.3.5 SE Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under SE winds are presented in Figure 54, Figure 55 and Figure 56, respectively.

The Application Site is in the leeward side of the hills (>+100mPD). Low- and mid-level incoming winds would be diverted and reach the Application Site from the south through Lai King Hill Road. High-level incoming wind would skim over the hills to reach the site from SE direction. The incoming wind direction are illustrated by **Black** arrows in Figure 54, Figure 55 and Figure 56, respectively.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be slightly better than Baseline Scheme.

Under Proposed Scheme, the larger frontal area of B6, B7, B8 and B14 would induce more prominent downwash effect. Downwashed wind from B6 and B14 would pass through the building separation of B4/B5 to ventilate the central and northern parts of Kau Wa Keng San Tsuen (**Blue** arrow in Figure 55). Downwashed wind from B6 and B7 would pass through the diagonal air path to ventilate the southern of Kau Wa Keng San Tsuen (**Red** arrow in Figure 55). Downwashed wind from B8 would ventilate the Lai King Hill Road as well as passing building separation of B2/B9 to ventilate the southern part of Kau Wa Keng San Tsuen (**Purple** arrow in Figure 55).

However, the taller building height of the Application Site would shade the northern part of Kau Wa Keng San Tsuen, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 55.

In addition, downwashed wind from B7 would push some of the downwashed wind into the open space of Wah Lai Estate, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 55.

The bulky podium under B11 would limit the wind permeability, less downwashed wind would be able to penetrate the narrower building separations of B4/B11 and B10/B11 to exit from the northern site boundary, where slightly lower VR would be observed, illustrated by **Pink** circle in Figure 55. While the narrower building separations of B4/B11 and B10/B11 would accelerate air stream and result in slightly higher VR in vicinity, illustrated by **Blue** circle in Figure 55.

Under Interim Scheme, due to the absent of high-rise building on north-eastern site boundary, incoming wind would skim over to ventilate northern park of Kau Wa Keng San Tsuen where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 56.

In addition, due to the absent of high-rise building on south-western site boundary, incoming wind would skim over to ventilate northern park of hilly terrain to the west of Kau Wa Keng San Tsuen where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 56.

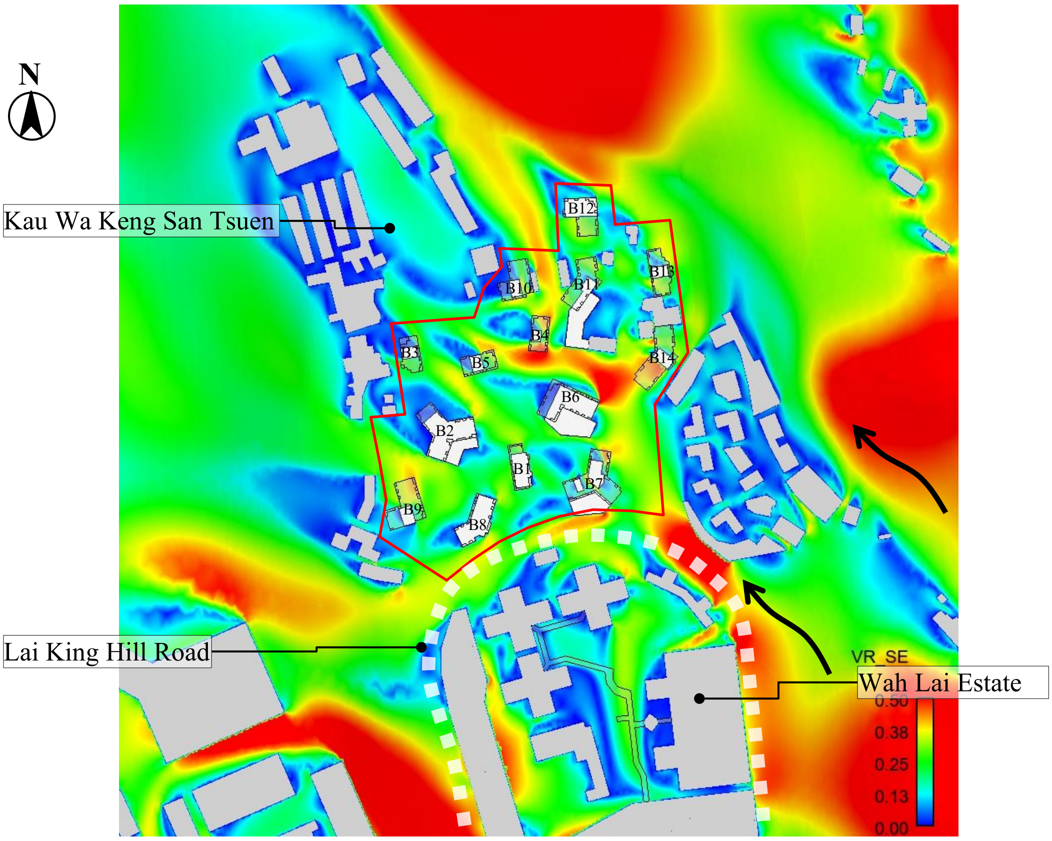


Figure 54 Contour plot of VR of Baseline Scheme under SE wind.

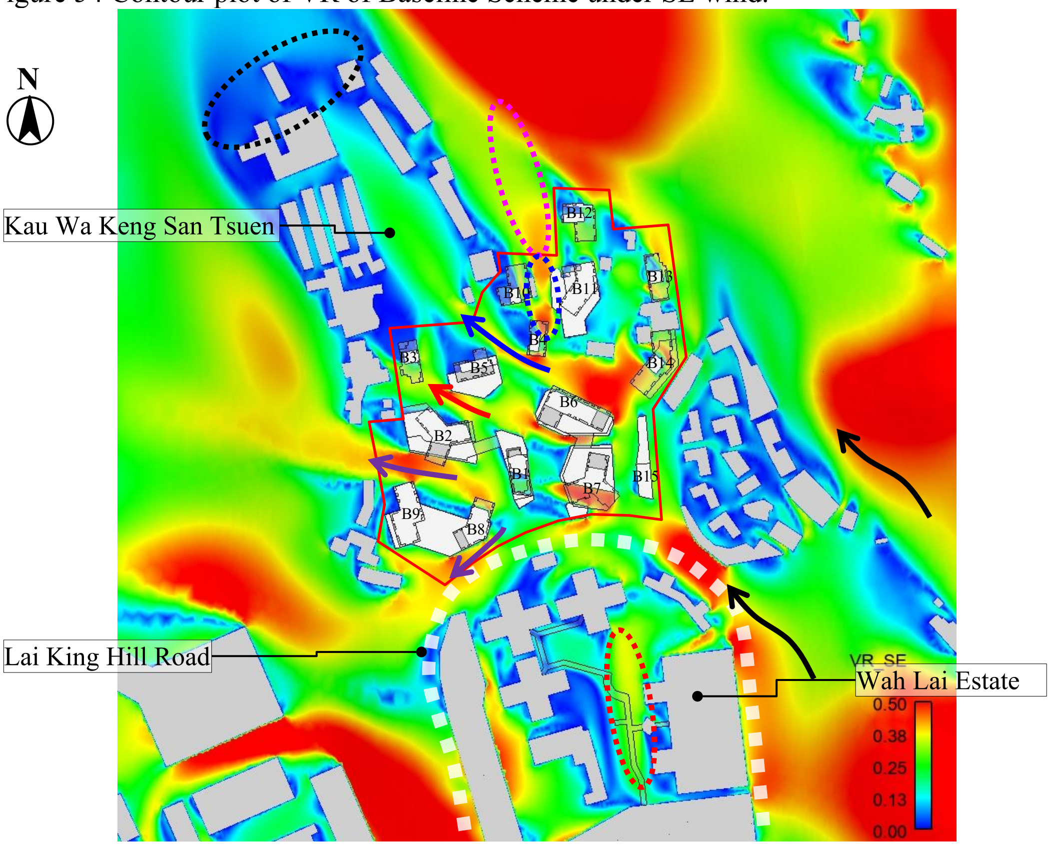


Figure 55 Contour plot of VR of Proposed Scheme under SE wind.

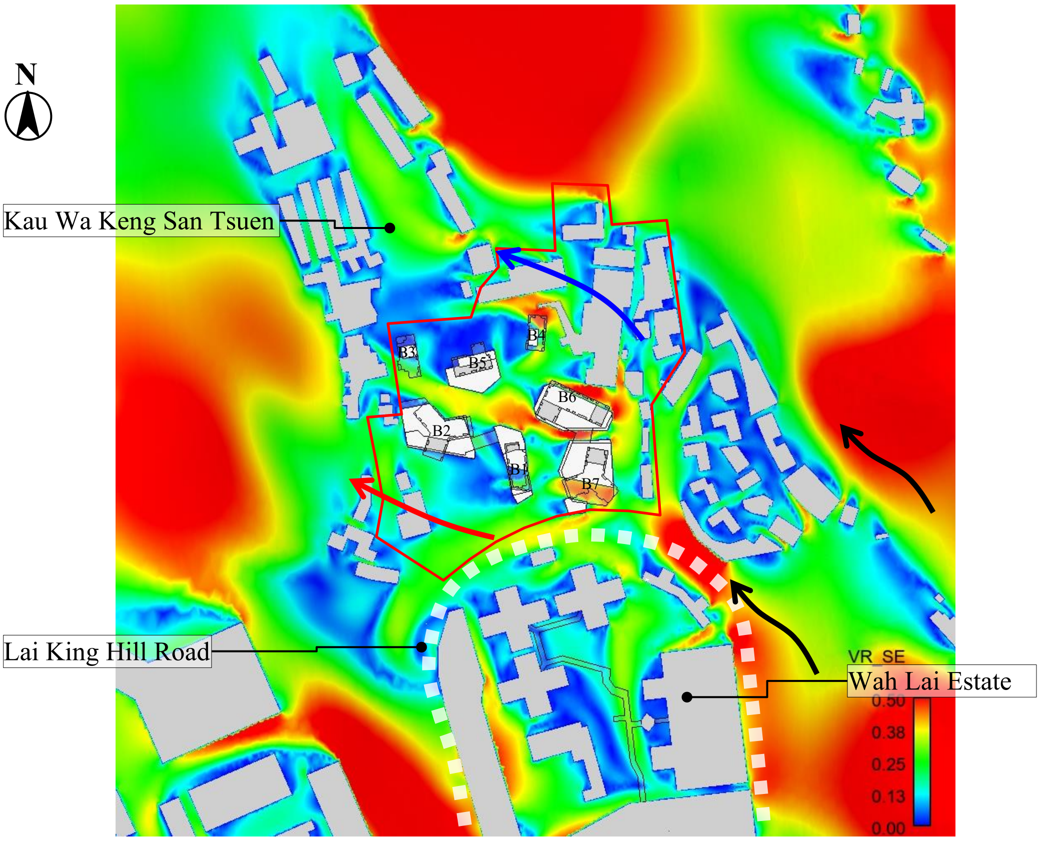


Figure 56 Contour plot of VR of Interim Scheme under SE wind.

4.3.6 SSE Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under SSE winds are presented in Figure 57, Figure 58 and Figure 59, respectively.

The Application Site is in the leeward side of high-rise residential development, Lai Yan court (+120mPD). The incoming wind would reach the Application Site from the south along the Lai King Hill Road. The Kau Wa Keng San Tsuen would be shielded by both high-rise existing residential development and the Application Site. Thus the wind environment would be relatively calm, compare to other wind directions. The direction of incoming wind is illustrated by **Black** arrow in Figure 57, Figure 58 and Figure 59, respectively.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be slightly better than Baseline Scheme.

Under Proposed Scheme, the larger frontal area of B6, B7, B8 and B14 would induce more prominent downwash effect. Downwashed wind from B6 and B14 would pass through the building separation of B4/B5 to ventilate the central parts of Kau Wa Keng San Tsue (**Blue** arrow in Figure 58). Downwashed wind from B6 and B7 would pass through the diagonal air path to ventilate the southern of Kau Wa Keng San Tsuen (**Red** arrow in Figure 58). Downwashed wind from B8 would ventilate the Lai King Hill Road as well as passing building separation of B2/B9 to ventilate the southern part of Kau Wa Keng San Tsuen (**Purple** arrow in Figure 58).

However, since more downwashed wind from B8 is traveling to the north on western side of Kau Wa Keng San Tsuen, it would restrict the incoming wind on the eastern side of Kau Wa Keng San Tsuen to recirculate into the north part of Kau Wa Keng San Tsuen, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 58.

Under Interim Scheme, due to the absent of high-rise building on north-eastern site boundary, incoming wind would skim over to ventilate the central and northern parts of Kau Wa Keng San Tseun, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 59.

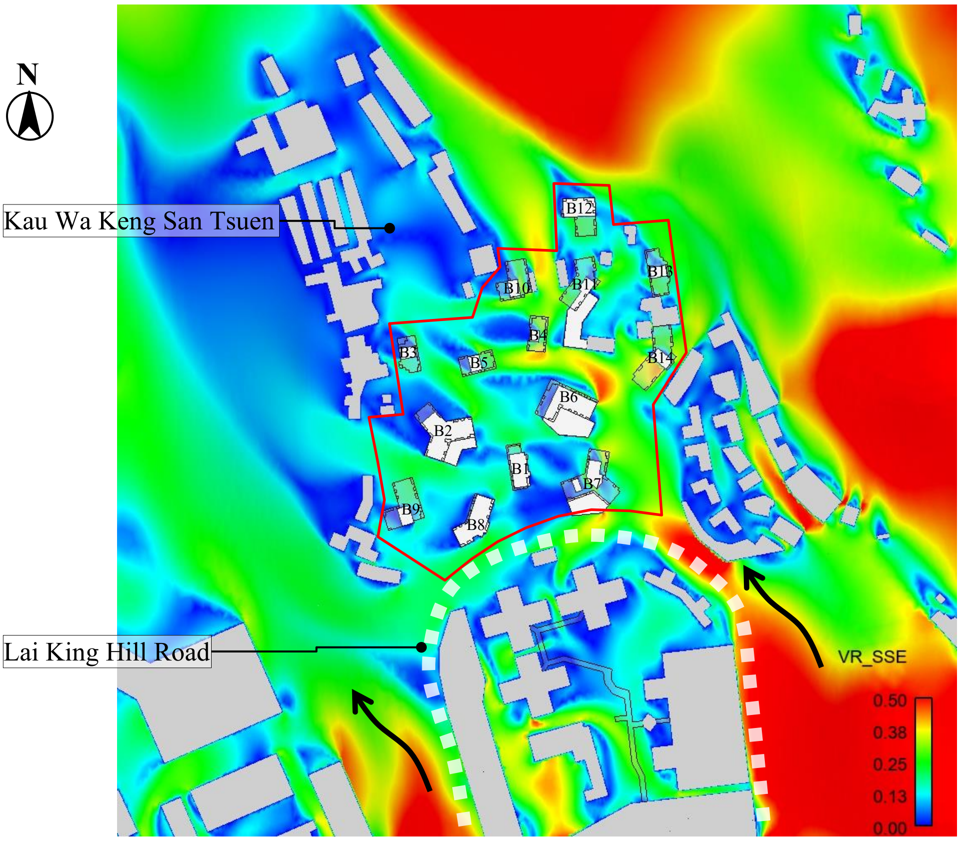


Figure 57 Contour plot of VR of Baseline Scheme under SSE wind.

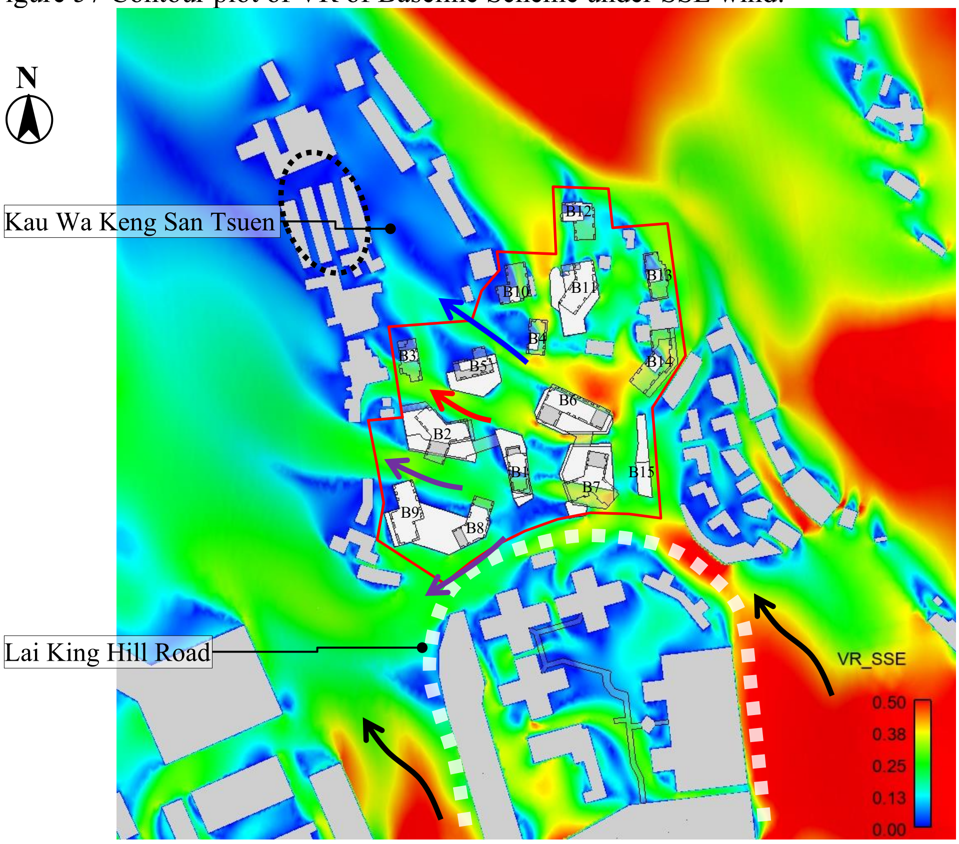


Figure 58 Contour plot of VR of Proposed Scheme under SSE wind.

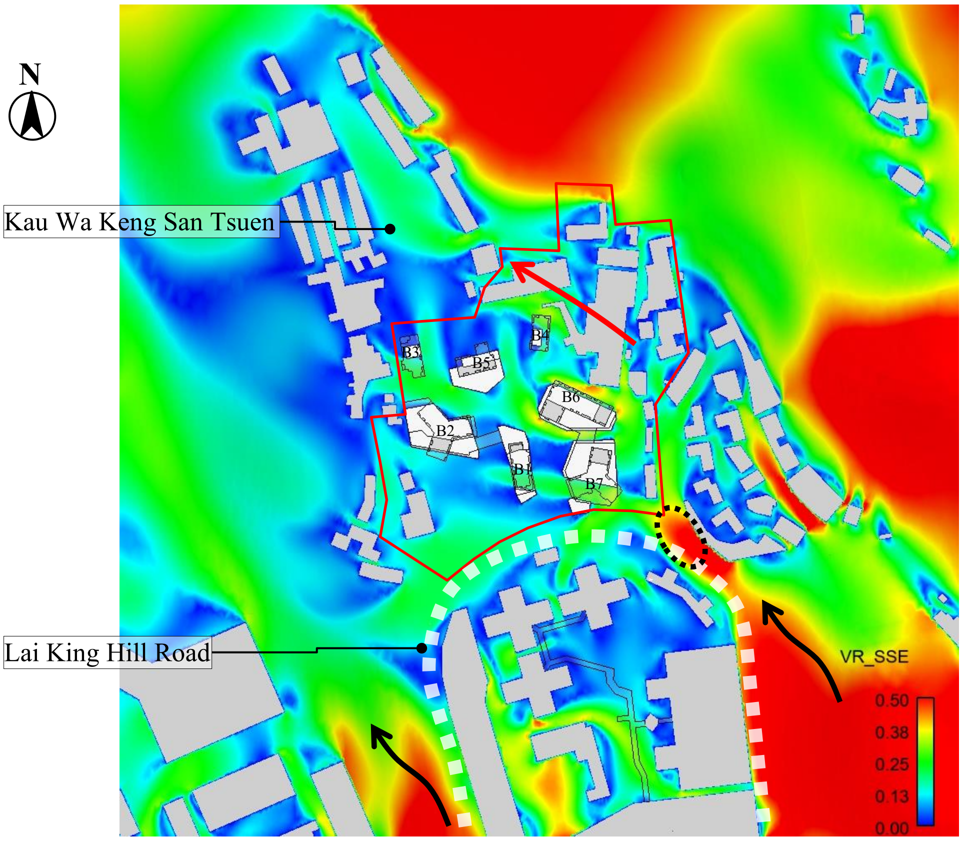


Figure 59 Contour plot of VR of Interim Scheme under SSE wind.

4.3.7 S Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under S wind are presented in Figure 60, Figure 61 and Figure 62, respectively.

The Application Site is in the leeward side of high-rise residential development, Lai Yin Tsuen (+120mPD) and hill (+80mPD) with Princess Margaret Hospital (+147mPD) and Planned Kwai Cheung Hospital (+120mPD). The wind environment within the Application Site is relatively calm, as compared with other wind directions. The incoming wind would arrive the Application Site from the south along Lai King Hill Road and Chung Shan Terrace. Two air streams traveling along the hill to the west of Kau Wa Keng San Tsuen would skim over the low-rise buildings and divert some wind towards the Application Site from the north. With the openness in the south-eastern corner. The incoming wind directions are illustrated by **Black** arrow in Figure 60 , Figure 61 and Figure 62, respectively.

Under Proposed Scheme, the taller building height of the Development restricted some high-level wind to skim over and reach the hilly terrain on the northern side of Kau Wa Keng San Tsuen, which would recirculate to ventilate the Kau Wa Keng San Tsuen from the north, where slightly lower VR would be observed, illustrated by **Pink** circle in Figure 61.

Under both schemes, downwash effect would be observed at the southern façade of blocks, such as B7, B8 and B14, to ventilate the pedestrian level nearby. Under Proposed Scheme, taller building height would induce more downwash effect. Downwashed wind from B7 would reach the pedestrian level of Lai King Hill Road, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 61. And the downwashed wind from B14 would reach the open space between B6 and B11, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 61. However, with the additional podium between B9 and B8, the wind environment in the southwestern part of the Site would be relatively calm.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

Under Interim Scheme, due to the absent of high-rise development on the south-western site boundary, more incoming wind would reach the hilly terrain on the northern side of Kau Wa Keng San Tsuen, which would recirculate to ventilate the Kau Wa Keng San Tsuen from the north, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 62. With less downwash effect induced from high-rise block, the wind environment within the southern part of Application Site would be relatively calm as compared with other schemes.

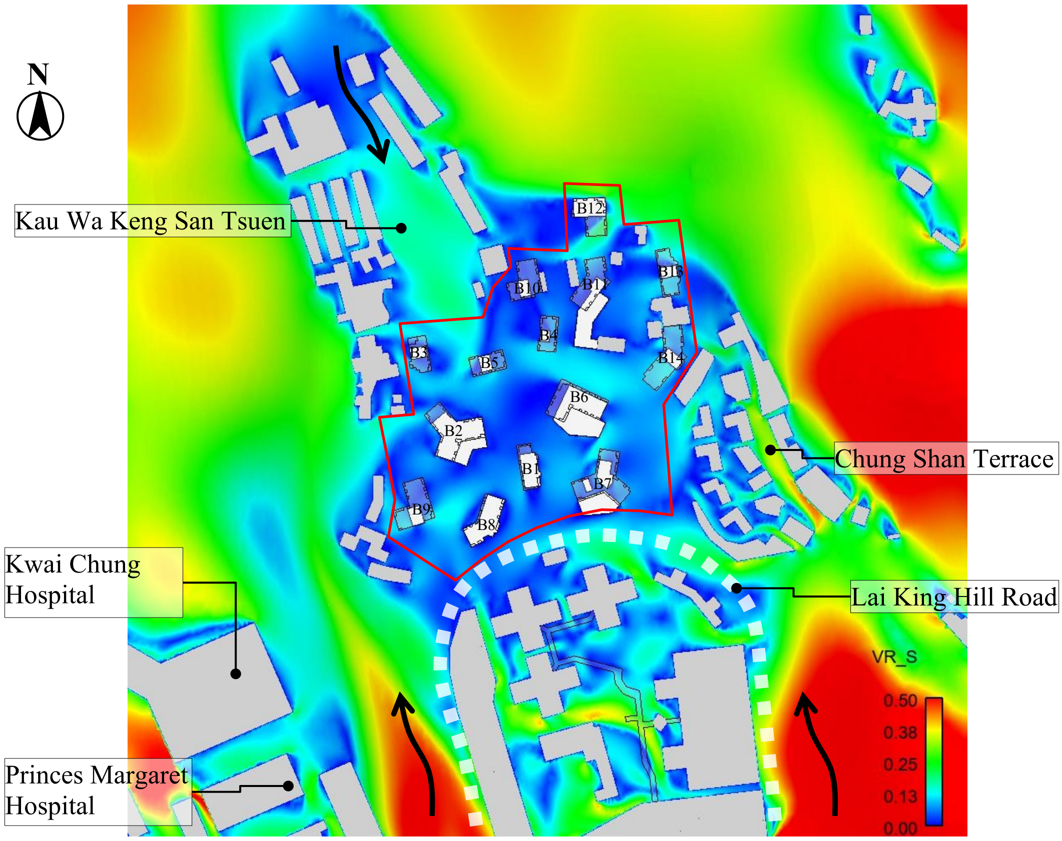


Figure 60 Contour plot of VR of Baseline Scheme under S wind.

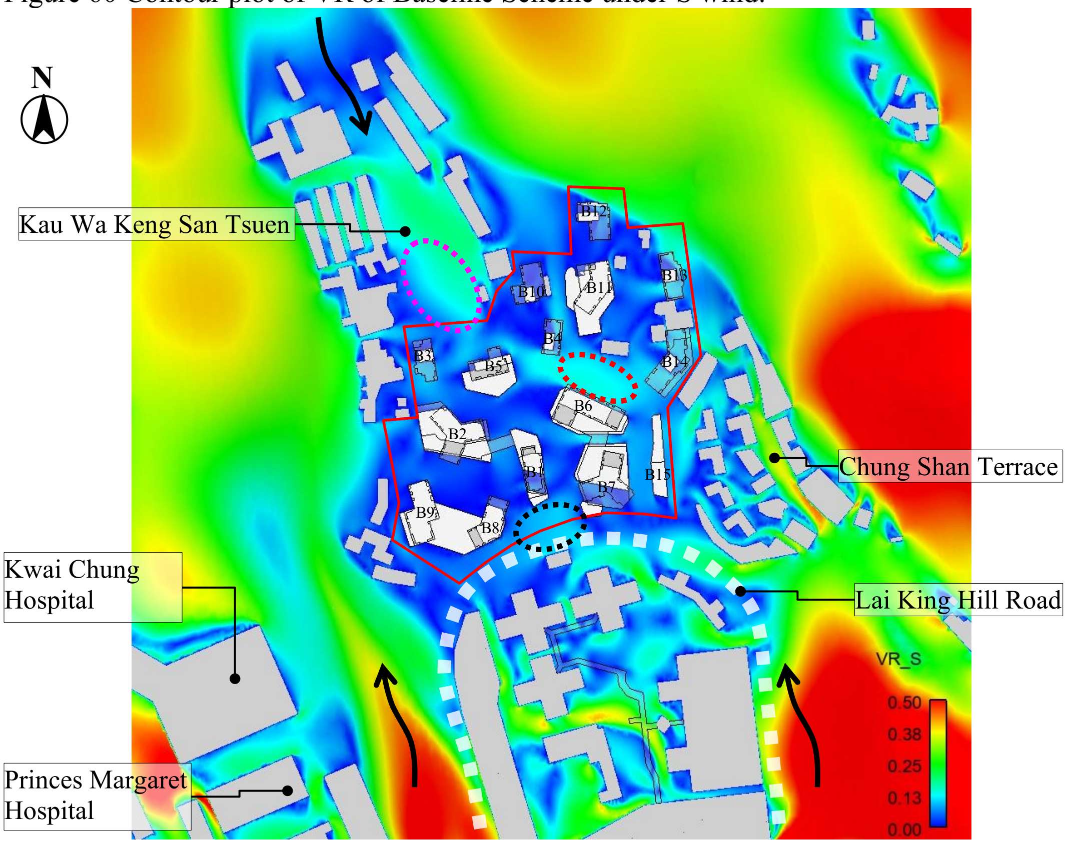


Figure 61 Contour plot of VR of Proposed Scheme under S wind.

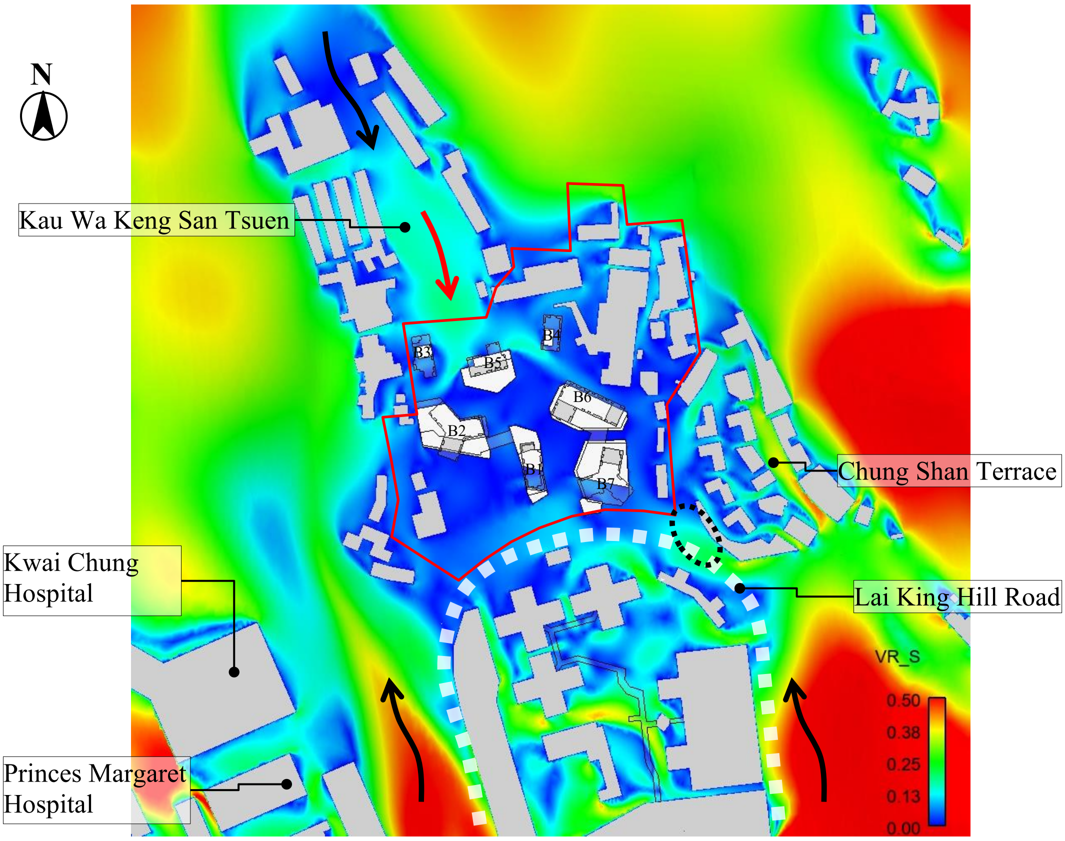


Figure 62 Contour plot of VR of Interim Scheme under S wind.

4.3.8 SSW Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under SSW winds are presented in Figure 63, Figure 64 and Figure 65, respectively.

The Application Site is in the leeward side of high-rise residential development, Lai Yin Estate (+120mPD) and hilly terrain (+80mPD) with Princess Margaret Hospital (+147mPD) and Planned Kwai Cheung Hospital (+120mPD), the incoming wind would arrive the Application Site from the south through Lai King Hill Road. The high-level wind would skim over the Lai Chi Kok Bay Garden (+91mPD) to reach the site from SSW direction. Some high-level wind would skim over the Application Site to reach the hills on Castle Peak Road – Kwai Chung and be diverted to ventilate the Application Site down the hill from the north. The incoming wind directions are illustrated by **Black** arrow in Figure 63, Figure 64 and Figure 65, respectively. Downwashed effect would be

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

The downwashed wind from B8 and B9 would be diverted by the podium structure under B8/B9 towards Lai King Hill Road, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 64. Yet it limited to wind from entering into the Application Site, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 64

Also, the downwashed wind from B2 would be diverted by the podium structure under B2 towards western site boundary to ventilate southern and central part of Kau Wa Keng San Tsuen , where slightly higher VR would be observed, illustrated by **Orange** arrow in Figure 64.

The bulky podium under B6/B7 would restrict the wind penetration, together with the B15 on south-eastern site boundary, less wind would be able to reach the south-eastern site boundary which would eventually ventilate Chung Sha Terrace, together with the B15 where slightly lower VR would be observed, illustrated by **Red** circle in Figure 64.

Under Interim Scheme, downwashed wind from B1 and B2 would be diverted by the podium under B2 to ventilate open area in front and further travel towards southern part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 65.

Also, due to overall higher wind permeability, the better ventilation performance on the northern part of Application Site would be observed.

In addition, due to the absent of high-rise building on the southern part of Application Site, incoming wind from Lai King Hill Road would skim over and ventilate the Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 65.

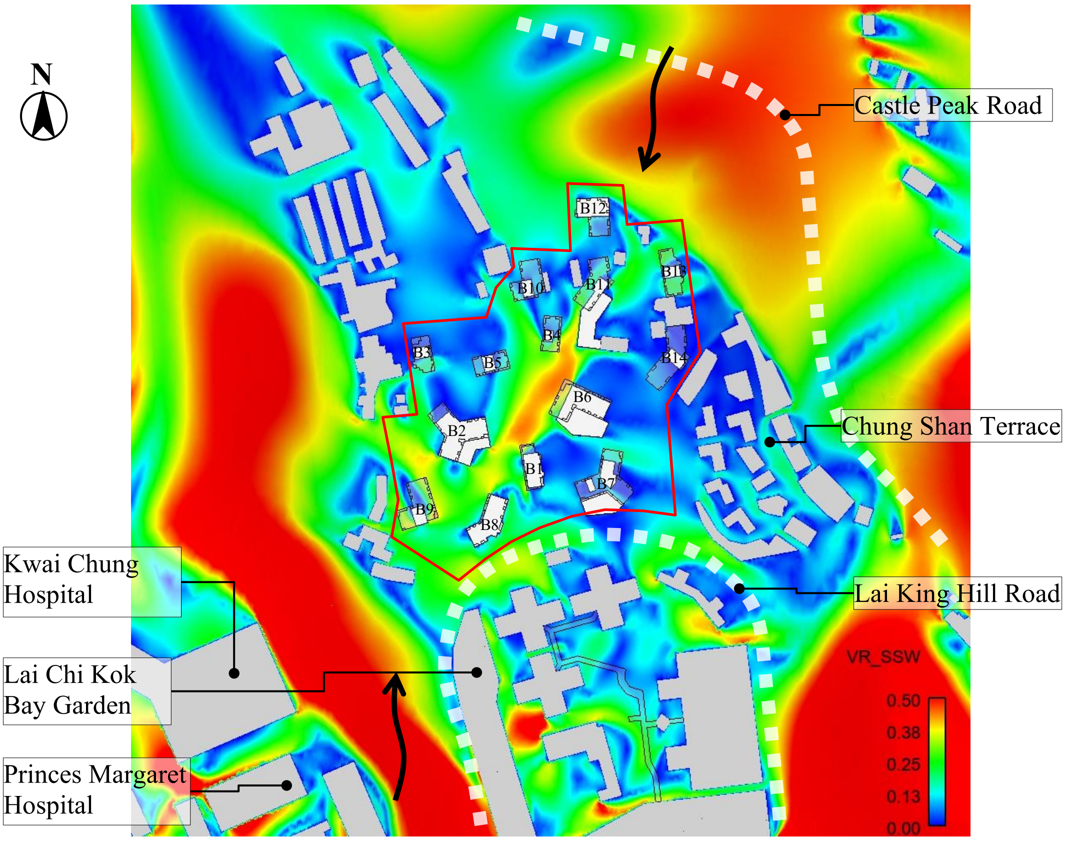


Figure 63 Contour plot of VR of Baseline Scheme under SSW wind.

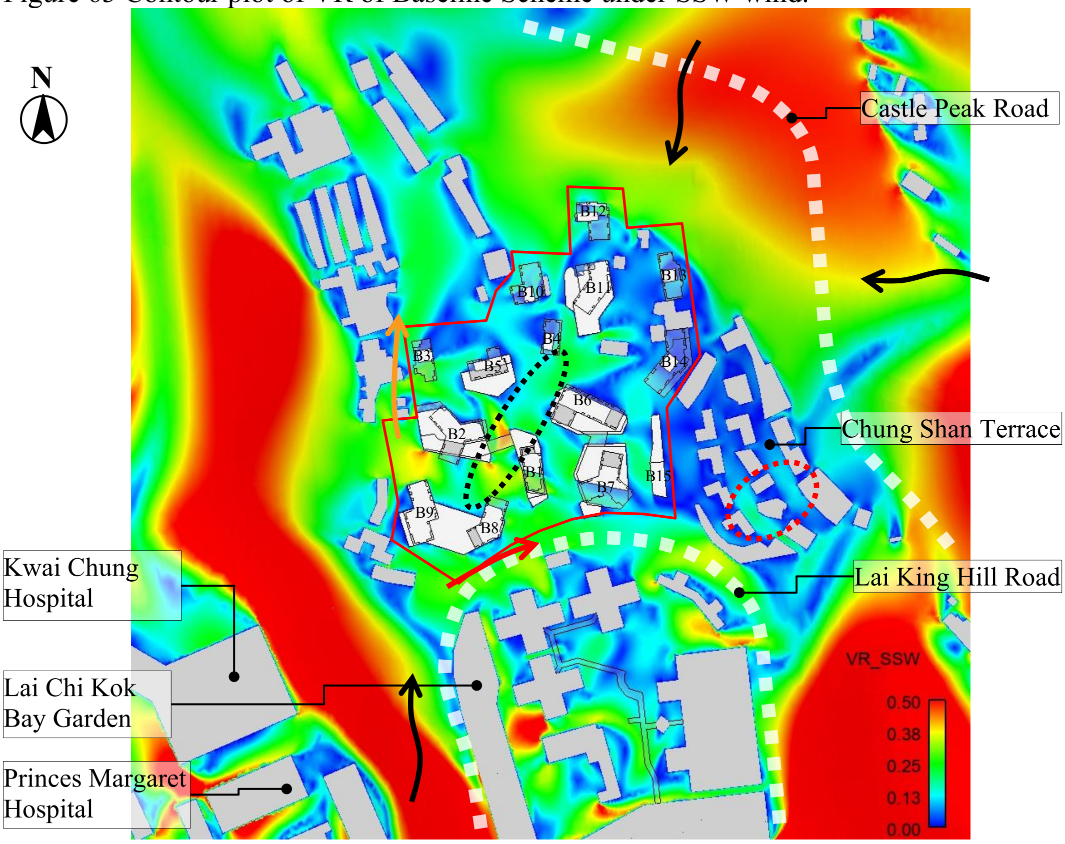


Figure 64 Contour plot of VR of Proposed Scheme under SSW wind.

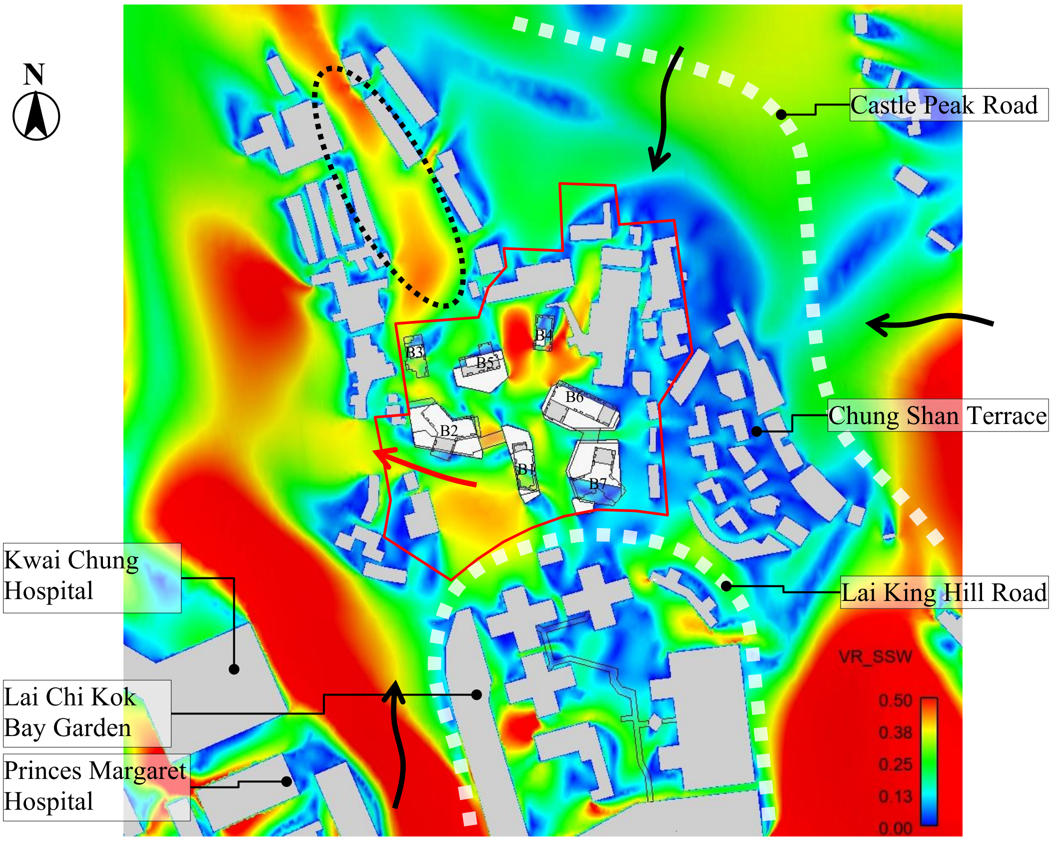


Figure 65 Contour plot of VR of Interim Scheme under SSW wind.

4.3.9 SW Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under SW winds are presented in Figure 66, Figure 67 and Figure 68, respectively.

The Application Site is in the leeward side of high-rise development (+120mPD) and hilly terrain (+80mPD) with Princess Margaret Hospital (+147mPD) and Planned Kwai Cheung Hospital (+120mPD). High-level wind would reach the hills on Kam Shan Country Park and diverted back to reach the Application Site from the north. On low-level, some incoming wind would pass through the Wah Lai Path and Lai King Hill Road to reaching the Application Site from the south. The incoming wind directions are illustrated by **Black** arrow in Figure 66, Figure 67 and Figure 68, respectively.

Under Proposed Scheme, due to bulky podium of B5, incoming wind from Kau Wa Keng San Tsuen would be restricted to enter the he Application Site, where slightly lower VR would be observed, illustrated by **Red** circle in Figure 67.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

Due to larger frontal area, downwash effect would be more prominent. Downwashed wind from B2 and B9 would be diverted by the podium under B2 to ventilate the southern part of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrate by **Red** arrow in Figure 67. Also, downwashed wind from B7 and B8 would ventilate the Lai King Hill Road and further travel towards the Chung Shan Terrace, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 67.

Under Interim Scheme due to the absent of high-rise building on the south-western site boundary, more incoming wind would reach the B7 to induce more prominent downwash effect and ventilate the Lai King Hill Road, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 67.

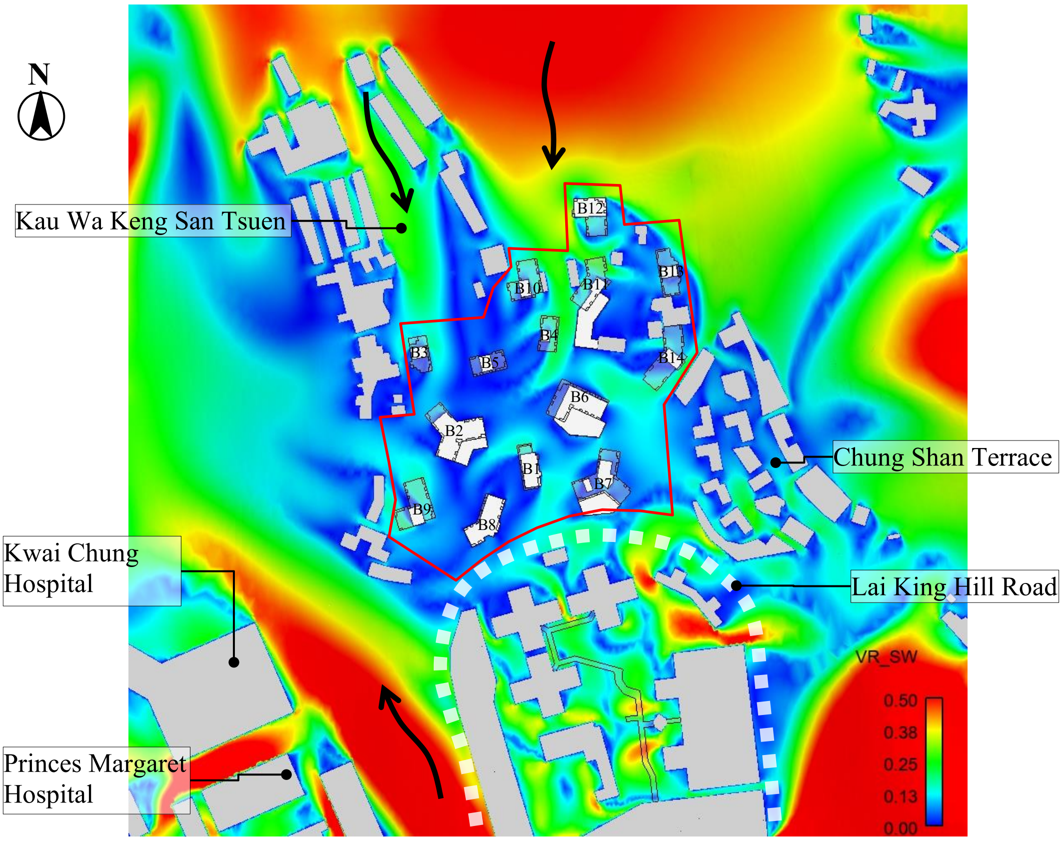


Figure 66 Contour plot of VR of Baseline Scheme under SW wind.

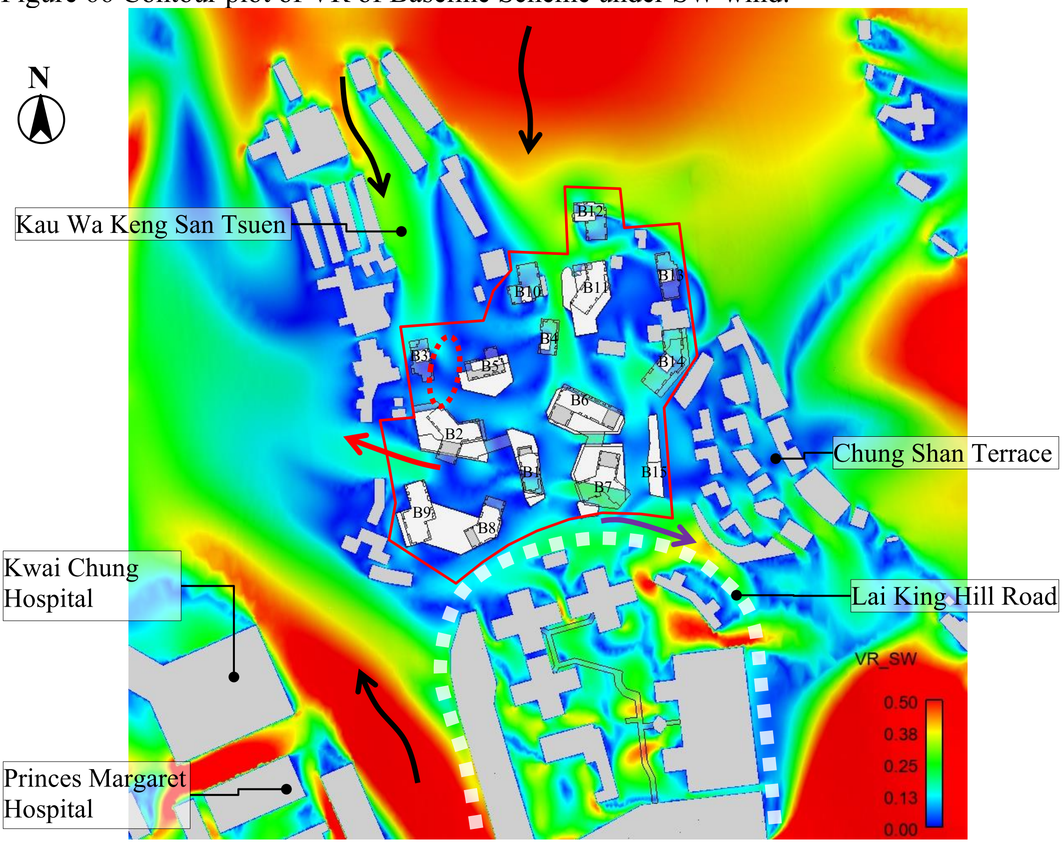


Figure 67 Contour plot of VR of Proposed Scheme under SW wind.

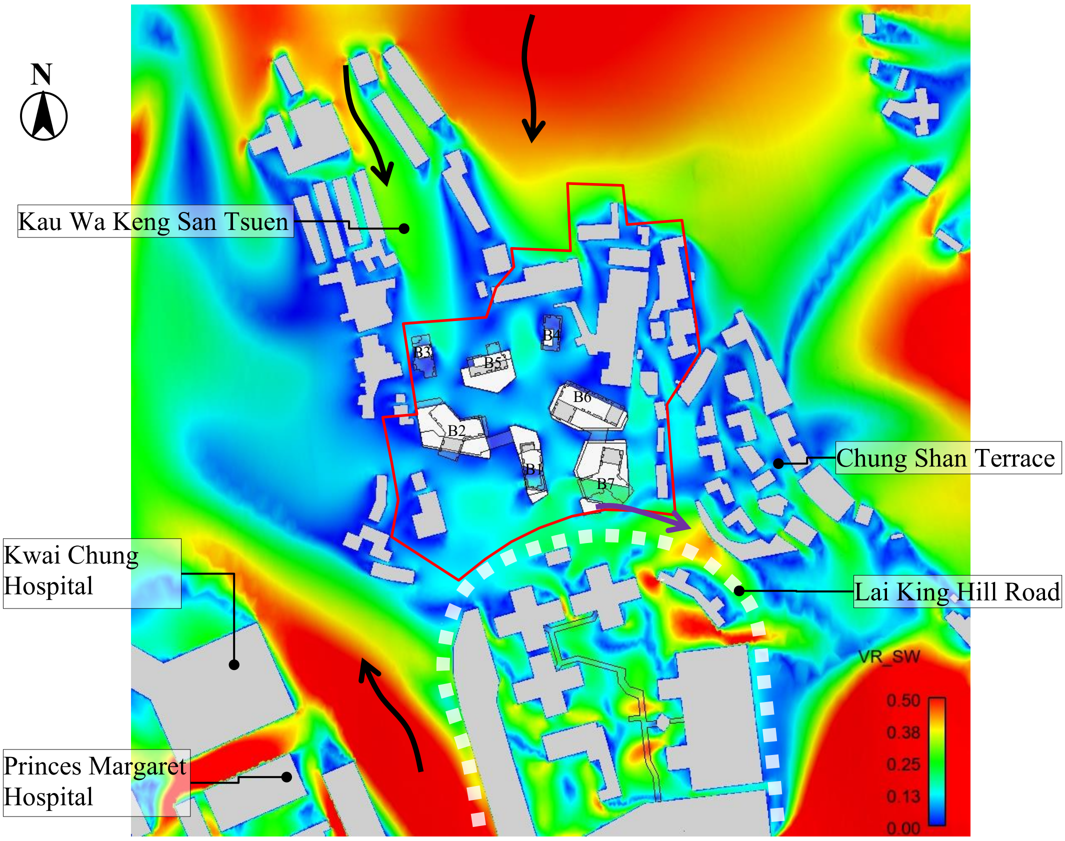


Figure 68 Contour plot of VR of Proposed Scheme under SW wind.

4.3.10 WSW Wind

The overall wind performance of Baseline, Proposed and Interim Schemes under WSW winds are presented in Figure 69, Figure 70 and Figure 71, respectively.

The Application Site is in the leeward side of hilly terrain (+80mPD) with Princess Margaret Hospital (+147mPD) and Planned Kwai Cheung Hospital (+120mPD). High-level wind would reach the hills on Kam Shan Country Park and diverted back to reach the Application Site from the north. The incoming wind direction is illustrated by **Black** arrow in Figure 69, Figure 70 and Figure 71, respectively.

Under Proposed Scheme, generally larger podium footprint reduced wind permeability slightly, incoming wind from the northern side would be restricted to enter and penetrate the Application Site, including the building separation of B3/B5, B2/B3 and B1/B2, where slightly lower VR would be observed, illustrated by **Pink** circle in Figure 70.

Also, the B15 on south-eastern site boundary would limit some incoming wind from penetrating the Application Site through south-eastern site boundary, resulting in lower ventilation performance on Lai King Hill Road, where slightly lower VR would be observed, illustrated by **Blue** arrow in Figure 70.

Also, the open space on the south-eastern site boundary allows more incoming wind from Kam Shan Country Park to enter Lai King Hill Road and Chung Shan Terrace through building separation of B6/B14, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 69.

Under Proposed Scheme, due to the larger frontal area induced more prominent downwash effect, the ventilation performance within the Application Site would be similar to Baseline Scheme.

Incoming wind from Kau Wa Keng San Tsuen would be diverted by the podium under B2 towards building separation of B1/B7 to ventilate the Lai King Hill Road, together with the more prominent downwashed effect from B7, slightly higher VR on Lai King Hill Road would be observed, illustrated by **Red** circle in Figure 70.

Also, the taller building height would divert more wind towards the hilly terrain on western side of Kau Wa Keng San Tsuen, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 70.

Under Interim Scheme, due to the absent of high-rise development on south-western site boundary, more incoming wind would reach the hilly terrain on the northern side of Kau Wa Keng San Tsuen and recirculate to ventilate the Application Site from the north, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 71.

Also, due to the absent of high-rise development on the north-eastern site boundary, incoming wind from hilly terrain would skim over to ventilate the Lai King Hill Road, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 71.

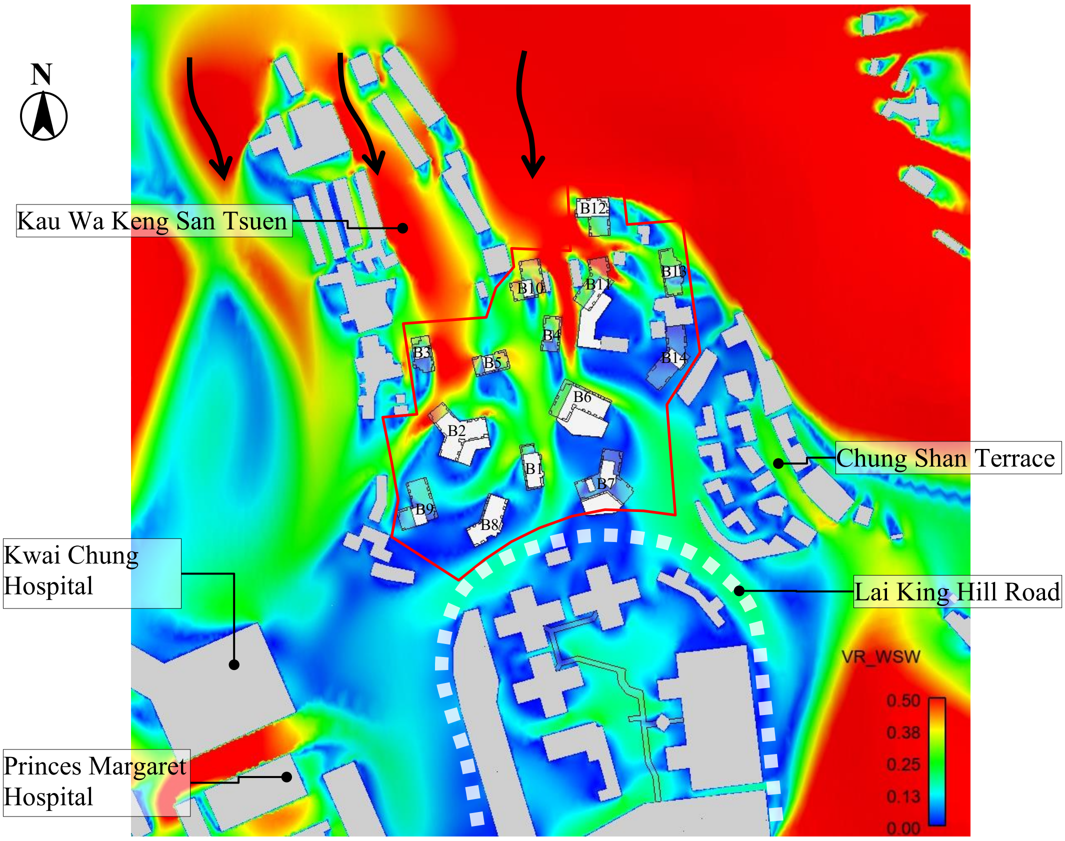


Figure 69 Contour plot of VR of Baseline Scheme under WSW wind

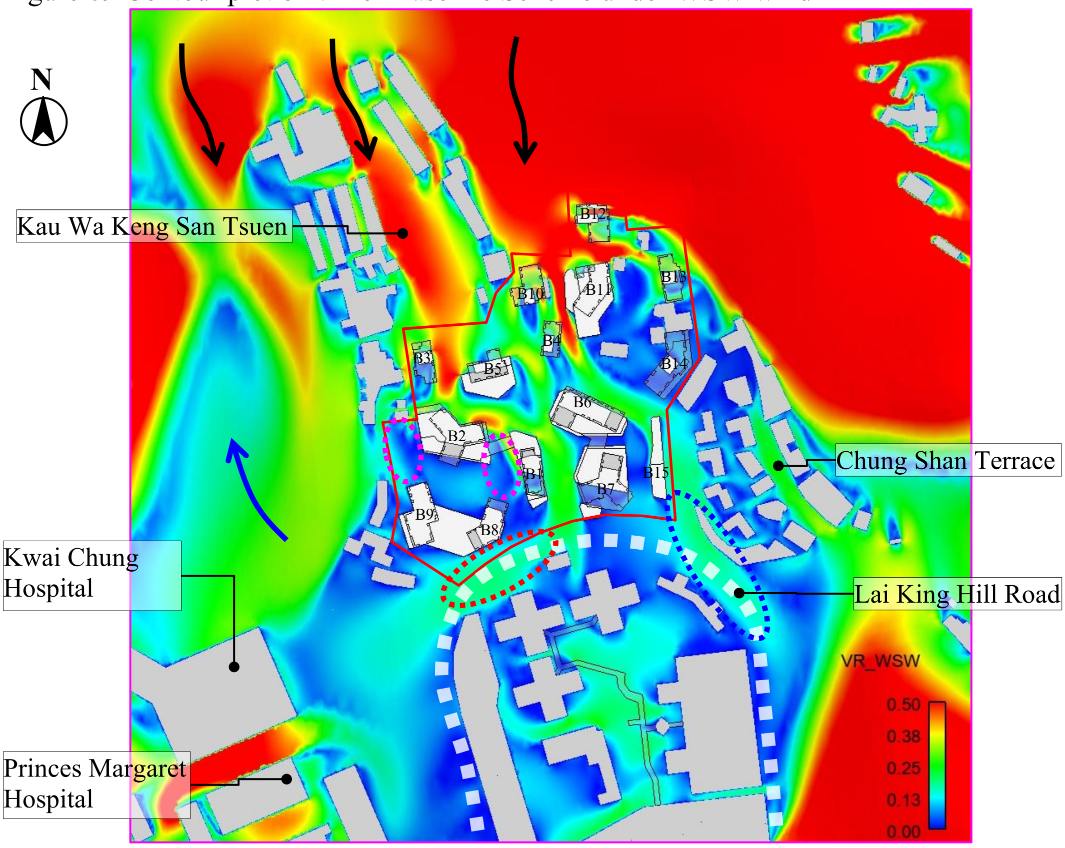


Figure 70 Contour plot of VR of Proposed Scheme under WSW wind

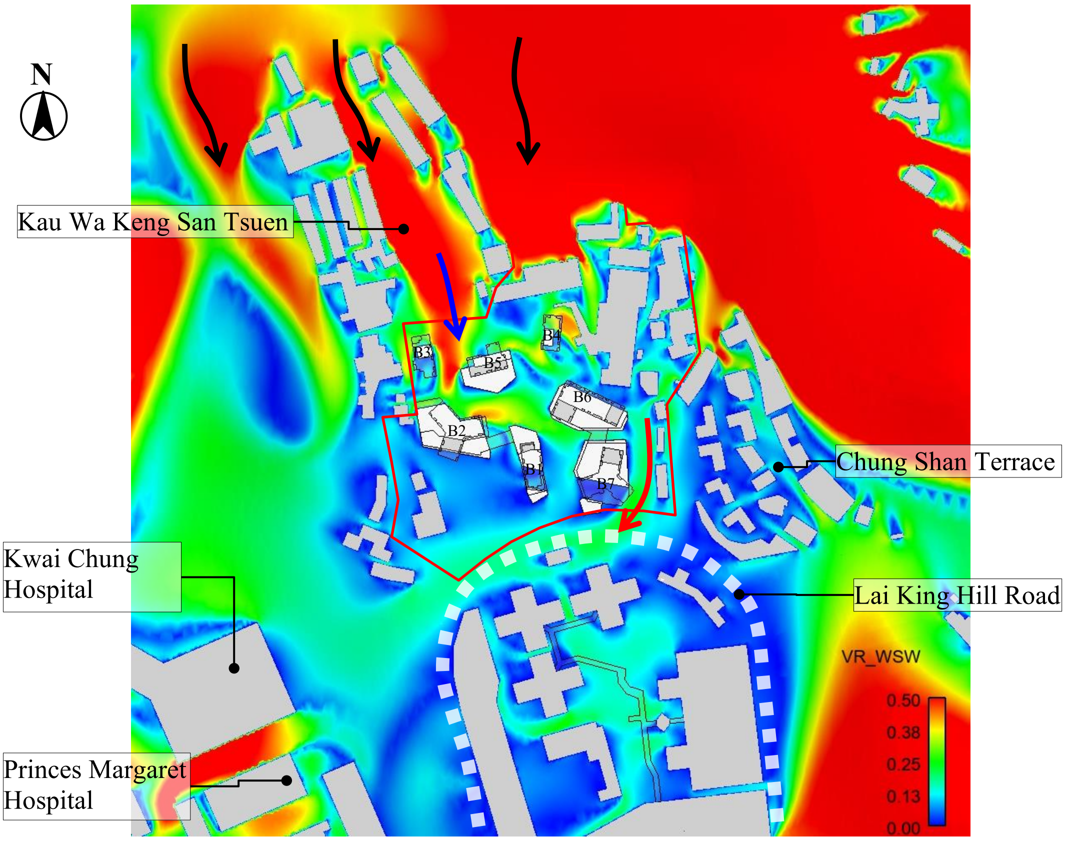


Figure 71 Contour plot of VR of Interim Scheme under WSW wind

4.4 Focus Areas

The average Velocity Ratios of all test points are determined and extracted. The results of all test points are presented in Appendix E.

The proposed Assessment Area and Application Site are presented in Figure 23. A total of 13 focus areas in the Assessment Area are proposed. The associated test points and averaged VR for focus areas are tabulated in Table 10 and Table 11 respectively. The location of each focus area is shown in Figure 72 and Figure 73. Higher VR has been highlighted in bold for reference.

Table 10 Focus Areas and Corresponding Test Points

	Focus Areas	Test Points
1	Castle Peak Road – Kwai Chung	O62-O77
2	Kau Wa Keng San Tsuen	O78-O106
3	Kwai Chung Hospital	O1-O8
4	Lai King Hill Road	O9-O24
5	Wah Lai Path	O25-O29
6	Lai Yan Court	O30-O43
7	Chung Shan Terrace	O44-O61
8	High-rise Block/Building Setback Area (Proposed and Baseline Only)	S9-S11, P36-P41
9	Western Air Path (Proposed and Baseline Only)	S1, S2, S36, S37, P1, P9-P12
10	Middle Air Path	S3-S8, P17, P44
11	Eastern Air Path (Proposed and Baseline Only)	S9-S16, P24-P26, P41
12	Diagonal Air Path	S1, S5, S6, S15, S22-25, S36, P2, P28 (Baseline) S5, S17-21, P10, P37 (Proposed/Interim)
13	Open Area within the Application Site	S1-S38

Table 11 Focus Areas and Corresponding VR

	Focus Areas	Annual Average VR			Summer Average VR		
		Baseline	Proposed	Interim	Baseline	Proposed	Interim
1	Castle Peak Road – Kwai Chung	0.32	**0.33**	0.29	0.40	**0.41**	0.37
2	Kau Wa Keng San Tsuen	0.14	0.16	**0.17**	0.14	0.16	**0.19**
3	Kwai Chung Hospital	0.39	0.39	0.39	0.33	0.33	0.33
4	Lai King Hill Road	**0.26**	**0.26**	0.25	0.22	**0.23**	0.22
5	Wah Lai Path	0.18	0.18	0.18	0.20	0.20	0.20
6	Lai Yan Court	0.23	0.23	0.23	0.18	0.18	0.18
7	Chung Shan Terrace	**0.18**	0.17	0.17	0.17	0.17	0.17
8	High-rise Block/Building Setback Area	**0.21**	0.18	-	**0.17**	0.16	-
9	Western Air Path	0.18	**0.19**	-	0.15	**0.17**	-
10	Middle Air Path	0.17	0.20	**0.21**	0.15	0.16	**0.18**
11	Eastern Air Path	0.23	0.23	-	0.20	0.20	-
12	Diagonal Air Path	**0.23**	**0.23**	0.19	**0.21**	0.19	0.17
13	Open Area within the Application Site	0.20	**0.22**	0.18	0.17	**0.18**	0.16

Annual Condition

Under Annual Condition, prevailing winds are mostly from E quadrant. However, due to the surrounding development and topography, low and mid-levels winds mainly reach the Application Site from N and S directions.

Under Proposed Scheme, the larger frontal area of B12, B13 and B14 would induce more downwashed wind to ventilate the hilly terrain of ***Castle Peak Road***, as discussed in Sections 4.3.2 and 4.3.3.

Also the more promiennt downwashed wind would ventilation the ***Open Area within the Application Site*** and ***Diagonal Air Path***, as discussed in Section 4.3.3.

Under Interim Scheme, the absent of high-rise development on the north-eastern site boundary allows incoming wind to skim over and ventilate the ***Kau Wa Keng San Tsuen***, as discussed in Sections 4.3.2 to 4.3.5.

Under Baseline Scheme, the ***Building Setback Area*** provide higher wind permeability, as discussed in Sections 4.3.4 and 4.3.5.

Under Baseline Sheme, the ***Diagonal Air Path*** enhanced wind permeability and more prominent downwashed wind from Happy Villa enhanced the ventilation perfomrnace in ***Lai King Hill Road***.

Under Proposed Scheme, the larger frontal area of B7 and B8 induced more downwashed wind to ventilate the ***Lai King Hill Road***. As discussed in Section 4.3.1.

The wider building separation of B6/B7 for Baseline Schme divert more wind towards the ***Chung Shan Terrace***, as discussed in Section 4.3.4.

Under Proposed Scheme , due to the larger frontal area of B12, B13, B14, B6 and B7, the more prominent downwashed effect would ventilate the Application Site which better VR on ***Western Air Path*** and ***Open Area within the Application Site*** would be observed, as discussed in Sections 4.3.3.

Summer Condition

Under Summer Condition, prevailing wind area mostly from SW quadrant. However, due to surrounding development and topography, low and mid-levels winds mainly reach the Application Site from N and S directions.

Under Proposed Scheme, the larger frontal area of B12, B13 and B14 would induce more downwashed wind to ventilate the hilly terrain of ***Castle Peak Road***, as discussed in Sections 4.3.3.

Also the more promiennt downwashed wind would ventilation the ***Open Area within the Application Site***, as discussed in Section 4.3.3.

Under Interim Scheme, the absent of high-rise development on the north-eastern and south-western site boundary allows incoming wind to skim over and ventilate the ***Kau Wa Keng San Tsuen***, ***Middle Air Path*** and ***Open Area within Application Site***, as discussed in Sections 4.3.3 and 4.3.8.

Under Proposed Scheme, larger frotnal area of B7 and B8 induced more downwashed wind to ventilate the ***Lai King Hill Road*** and ***Western Air Path*** as discussed in Sections 4.3.8 and 4.3.9.

Under Baseline Scheme, the ***Building Setback Area*** provide higher wind permeability, as discussed in Sections 4.3.4 and 4.3.5.

Under Baseline Scheme, the downwashed wind from B2, B8 and B9 would be diverted to ventilate the ***Diagonal Air Path***, as disccused in Section 4.3.8.

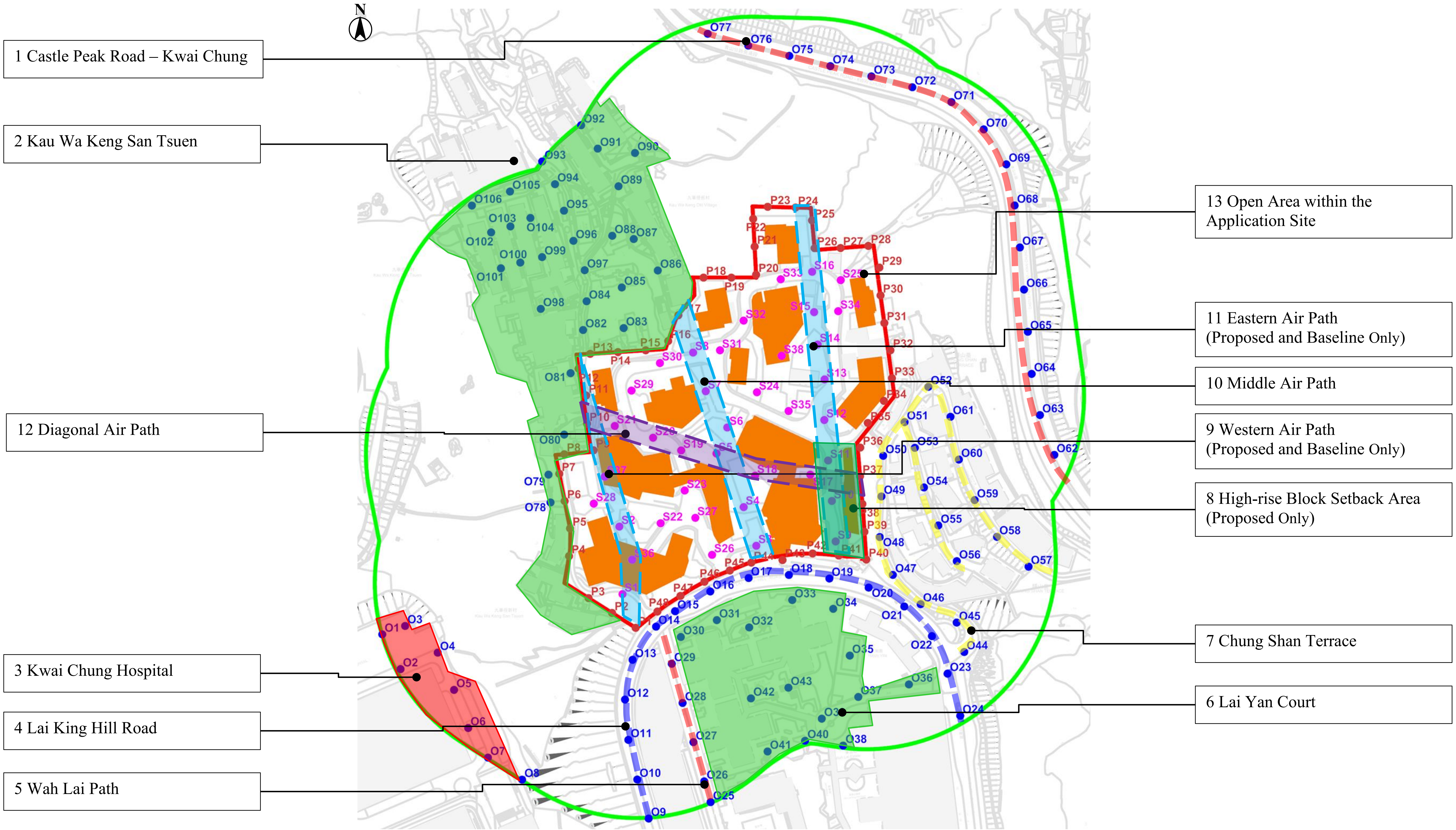


Figure 72 Location of Focus Areas Presented in Proposed Scheme

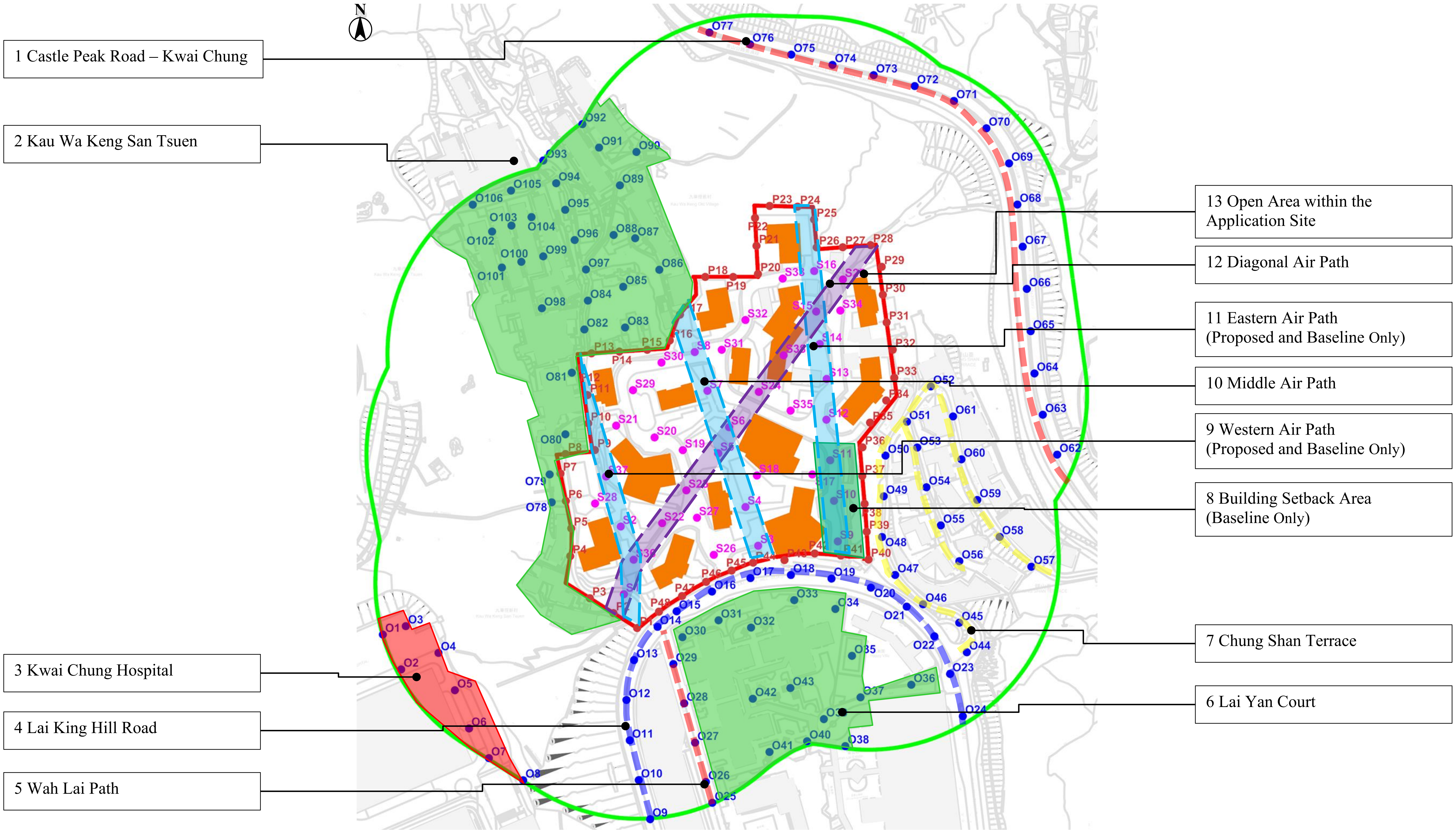


Figure 73 Location of Focus Areas Presented in Baseline Scheme

5 Conclusion

5.1 Overview

An Air Ventilation Assessment (AVA) – Initial Study was conducted to assess the ventilation performance of Baseline Scheme and Proposed Scheme in accordance to *the AVA Technical Circular*[1].

Two schemes were assessed using Computational Fluid Dynamics (CFD) techniques. A series CFD simulations using Realizable k-ε turbulence model were performed under annual and summer wind conditions with reference to *the AVA Technical Circular*[1]. For annual wind condition, NE, ENE, E, ESE, SE, S, SSW and SW were selected which gives total wind frequency of 77.9% over a year while E, ESE, SE, SSE, S, SSW, SW and WSW were selected for summer condition, which gives total wind frequency of 81.2%.

The Velocity Ratio (VR) as proposed by *the AVA Technical Circular*[1] was employed to assess the ventilation performance under different schemes and its impact to the surroundings. With reference to *the AVA Technical Circular*[1], 48 perimeter test points, 103 overall test points and 38 special test points were allocated to assess the overall ventilation performance in the Assessment Area.

5.2 Results

The results showed that:

- Under Annual Condition, Proposed Scheme achieved slightly better SVR (0.22 vs 0.21) and LVR (0.23 vs 0.22) than Baseline Scheme mainly due to the larger frontal area which induce more downwashed wind.
- Similarly, under Summer Condition, Proposed Scheme achieved slightly better SVR (0.19 vs 0.18) and LVR (0.22 vs 0.21) than Baseline Scheme mainly due to the more prominent downwash effect front the development.
- The surrounding area is dominated by hilly terrain and high-rise existing residential cluster in the south. The ventilation performance would be similar for all schemes.
- Under Proposed Scheme, the larger frontal area is beneficial for the localized surrounding as downwashed wind would provide better ventilation performance to the Application Site and nearby surrounding area including Kau Wa Keng San Tsuen.
- For Interim Scheme, under Annual Condition, it achieved lower SVR (0.19 vs 0.21/0.22) than Baseline/Proposed Schemes. Also, it achieved similar LVR (0.22 vs 0.22) than Baseline Scheme, and slightly lower LVR (0.22 vs 0.23) than Proposed Scheme.
- Under Summer Condition, Interim Schem achieved similar SVR (0.18 vs 0.18) and LVR (0.21 vs 0.21) than Baseline Scheme, Also, it achieved slightly slightly lower SVR (0.18 vs 0.19) and LVR (0.21 vs 0.22) than Proposed Scheme.

- Under Interim Scheme, although the absent of high-rise development on north-eastern site boundary (RPB) and south-western site boundary (PRA) enhanced the wind permeability for the Application Site and surrounding. The less prominent of downwash effect limit the wind availability of for the Application Site and surrounding.

6 Reference

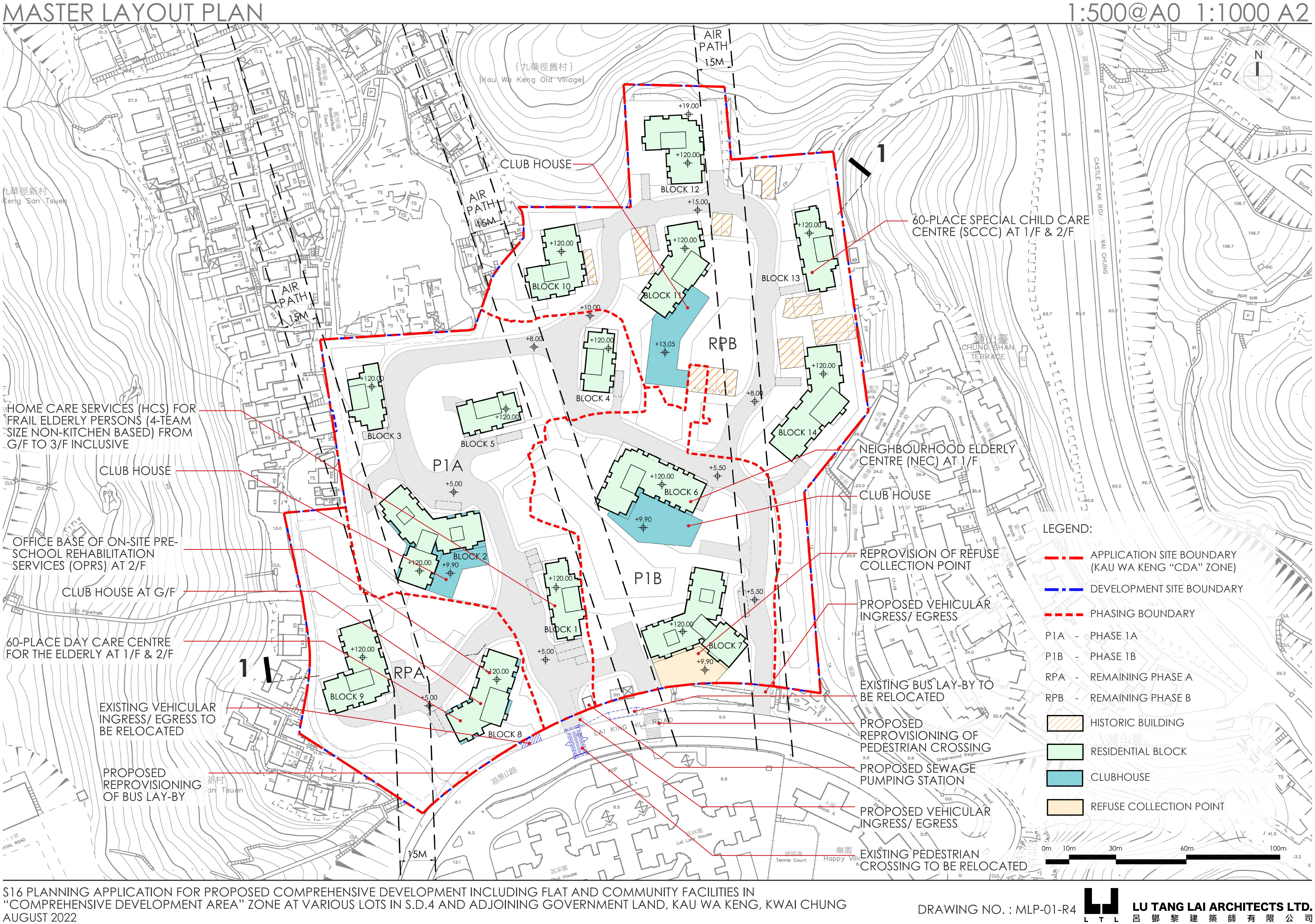
[1] Annex A of Technical Circular No. 1/06 issued by the Housing, Planning and Lands Bureau pertaining specifically to Air Ventilation Assessments, 19th July, 2006 (https://www.devb.gov.hk/filemanager/en/content_679/hplb-etwb-tc-01-06.pdf)

[2] Planning Department RAMS Data (http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/

Appendix A

Layout Plans of Baseline, Proposed and Interim Schemes

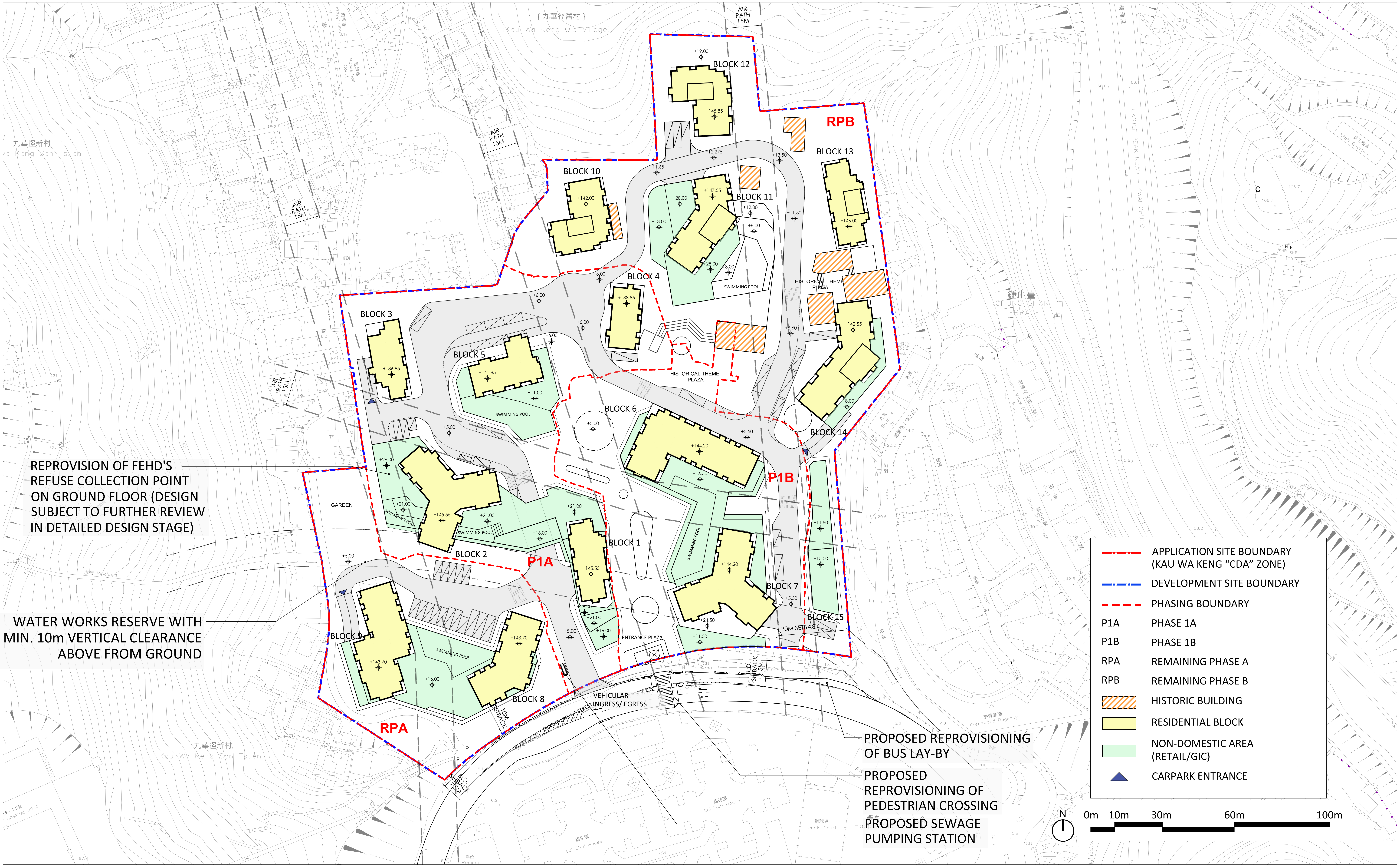
A1 Layout Plan of Baseline Scheme


MASTER LAYOUT PLAN
1:500@A0 1:1000 A2
AIR PATH 15M
CLUB HOUSE
60-PLACE SPECIAL CHILD CARE CENTRE (SCCC) AT 1/F & 2/F
HOME CARE SERVICES (HCS) FOR FRAIL ELDERLY PERSONS (4-TEAM SIZE NON-KITCHEN BASED) FROM G/F TO 3/F INCLUSIVE
NEIGHBOURHOOD ELDERLY CENTRE (NEC) AT 1/F
OFFICE BASE OF ON-SITE PRE-SCHOOL REHABILITATION SERVICES (OPRS) AT 2/F
REPROVISION OF REFUSE COLLECTION POINT
CLUB HOUSE AT G/F
PROPOSED VEHICULAR INGRESS/ EGRESS
60-PLACE DAY CARE CENTRE FOR THE ELDERLY AT 1/F & 2/F
EXISTING BUS LAY-BY TO BE RELOCATED
EXISTING VEHICULAR INGRESS/ EGRESS TO BE RELOCATED
PROPOSED REPROVISIONING OF PEDESTRIAN CROSSING
PROPOSED SEWAGE PUMPING STATION
PROPOSED REPROVISIONING OF BUS LAY-BY
EXISTING PEDESTRIAN CROSSING TO BE RELOCATED
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BLOCK 6
BLOCK 7
BLOCK 8
BLOCK 9
BLOCK 10
BLOCK 11
BLOCK 12
BLOCK 13
BLOCK 14
P1A
P1B
RPA
RPB
LAI KING HILL ROAD
CASTLE PEAK ROAD - KWAI CHUNG
{九華徑舊村}
{Kau Wa Keng Old Village}
LEGEND:
APPLICATION SITE BOUNDARY (KAU WA KENG "CDA" ZONE)
DEVELOPMENT SITE BOUNDARY
PHASING BOUNDARY
P1A - PHASE 1A
P1B - PHASE 1B
RPA - REMAINING PHASE A
RPB - REMAINING PHASE B
HISTORIC BUILDING
RESIDENTIAL BLOCK
CLUBHOUSE
REFUSE COLLECTION POINT
0m 10m 30m 60m 100m
S16 PLANNING APPLICATION FOR PROPOSED COMPREHENSIVE DEVELOPMENT INCLUDING FLAT AND COMMUNITY FACILITIES IN "COMPREHENSIVE DEVELOPMENT AREA" ZONE AT VARIOUS LOTS IN S.D.4 AND ADJOINING GOVERNMENT LAND, KAU WA KENG, KWAI CHUNG
AUGUST 2022
DRAWING NO. : MLP-01-R4
LU TANG LAI ARCHITECTS LTD.
呂鄧黎建築師有限公司

A2 Layout Plan of Proposed Scheme

MASTER LAYOUT PLAN (DOMESTIC PR:6 NON-DOMESTIC PR:0.5)

1:500@A0 1:1000@A2



PROPOSED COMPREHENSIVE DEVELOPMENT INCLUDING FLATS, RETAIL AND COMMUNITY FACILITIES AND MINOR RELAXATION OF PLOT RATIO AND BUILDING HEIGHT RESTRICTION IN "COMPREHENSIVE DEVELOPMENT AREA" ZONE
AT VARIOUS LOTS IN S.D.4 AND ADJOINING GOVERNMENT LAND, KAU WA KENG, KWAI CHUNG
18 NOVEMBER 2025

DRAWING NO.: MLP-SK01-R13

LU TANG LAI ARCHITECTS LTD.
呂 鄧 黎 建 築 師 有 限 公 司

A3 Layout Plan of Interim Scheme

MASTER LAYOUT PLAN - INTERIM

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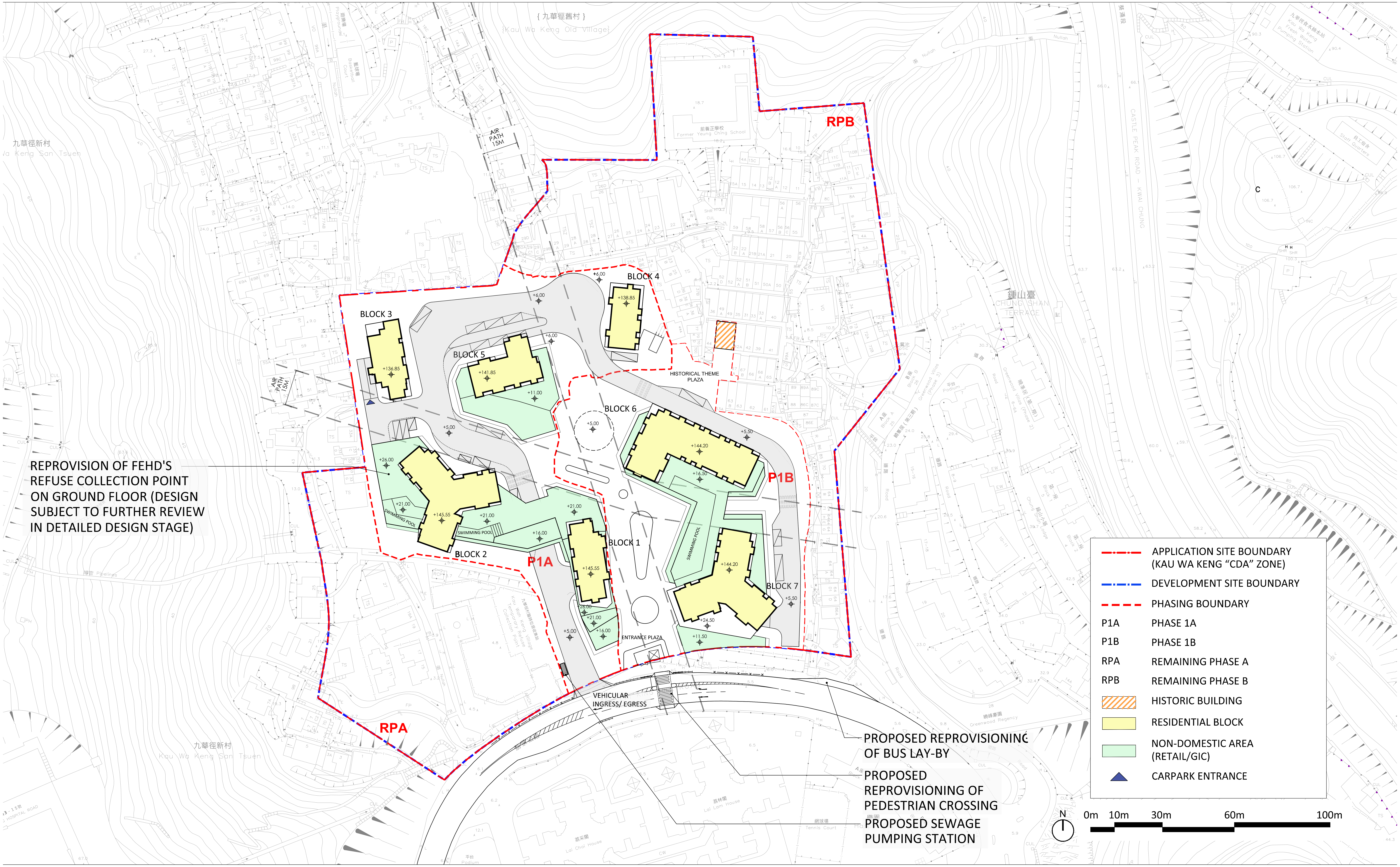


PROPOSED COMPREHENSIVE DEVELOPMENT INCLUDING FLATS, RETAIL AND COMMUNITY FACILITIES AND MINOR RELAXATION OF PLOT RATIO AND BUILDING HEIGHT RESTRICTION IN "COMPREHENSIVE DEVELOPMENT AREA" ZONE
AT VARIOUS LOTS IN S.D.4 AND ADJOINING GOVERNMENT LAND, KAU WA KENG, KWAI CHUNG
18 NOVEMBER 2025

DRAWING NO.: MLP-SK05-R8

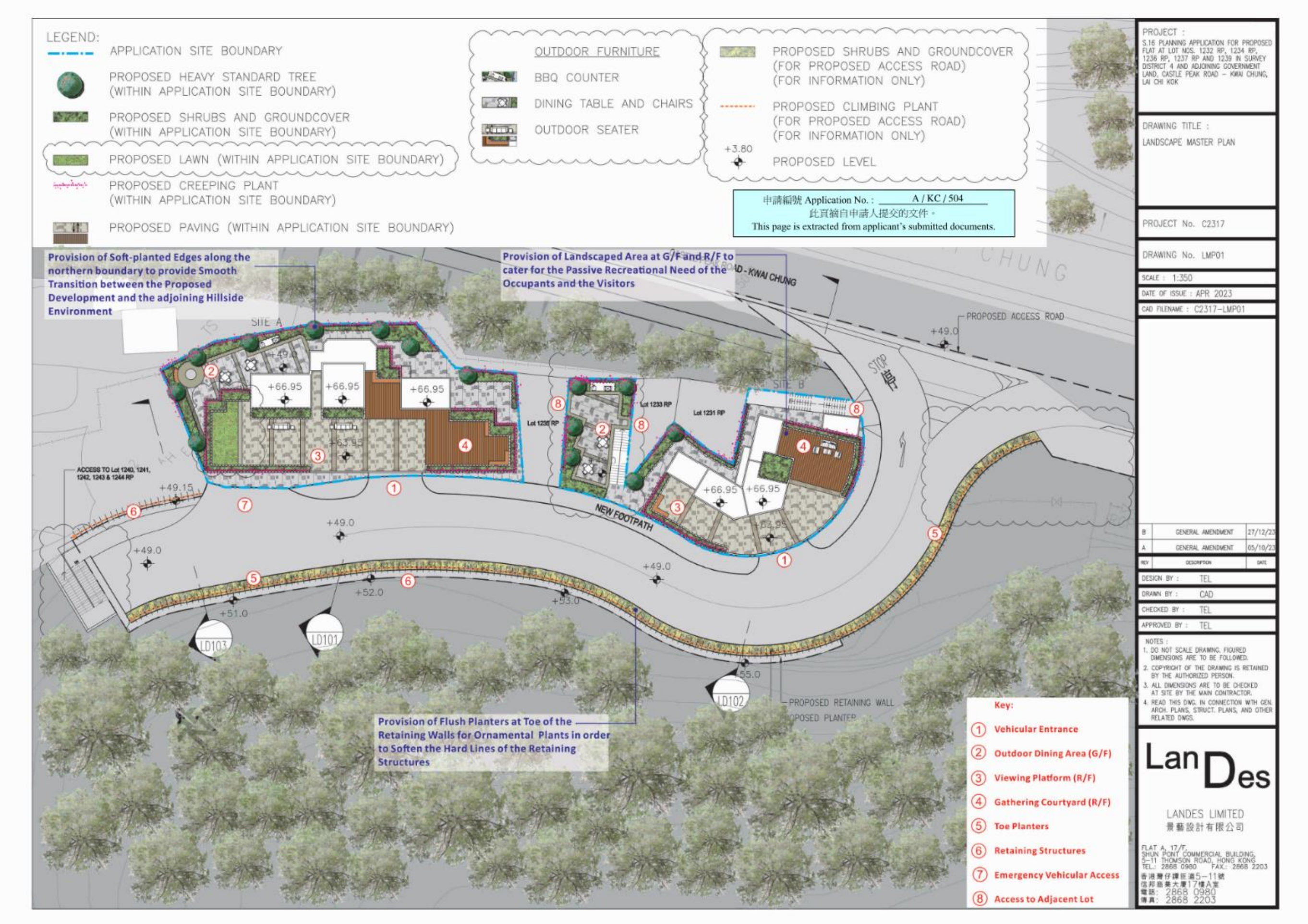
LU TANG LAI ARCHITECTS LTD.
呂 鄧 黎 建 築 師 有 限 公 司

Appendix B

Layout Plan of Planned Development within Surrounding Area

B1 Kwai Chung Hospital Planning Application A/KC/504

B2 Proposed Residential Development Planning Application No. A/KC/504



Appendix C

Contour Plots of Velocity Ratio (VR)

Contents

C1 Baseline Scheme

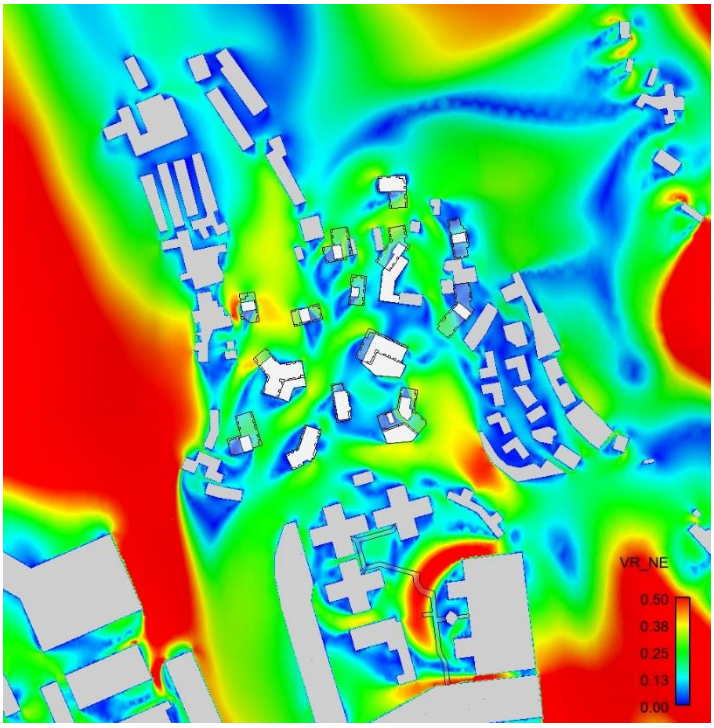


Figure C 1 Contour Plot of VR under NE Wind

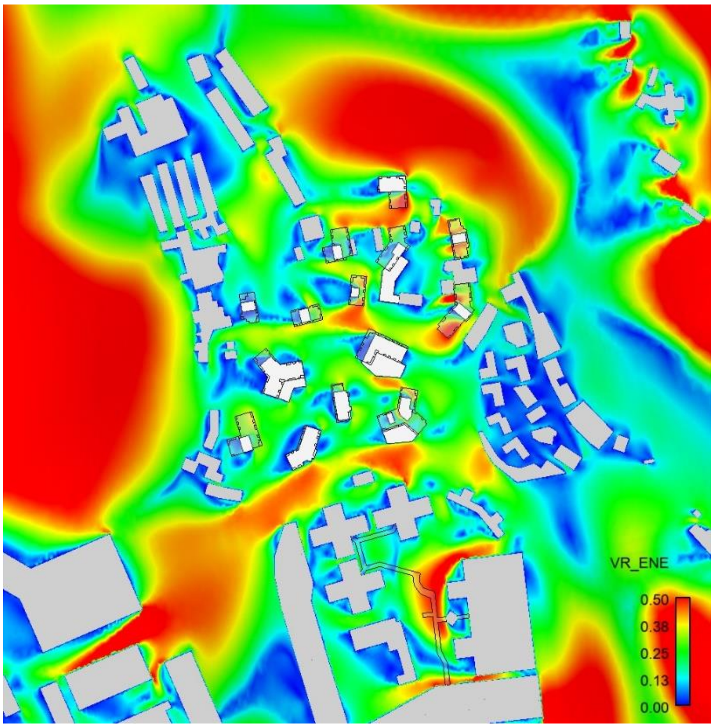


Figure C 2 Contour Plot of VR under ENE Wind

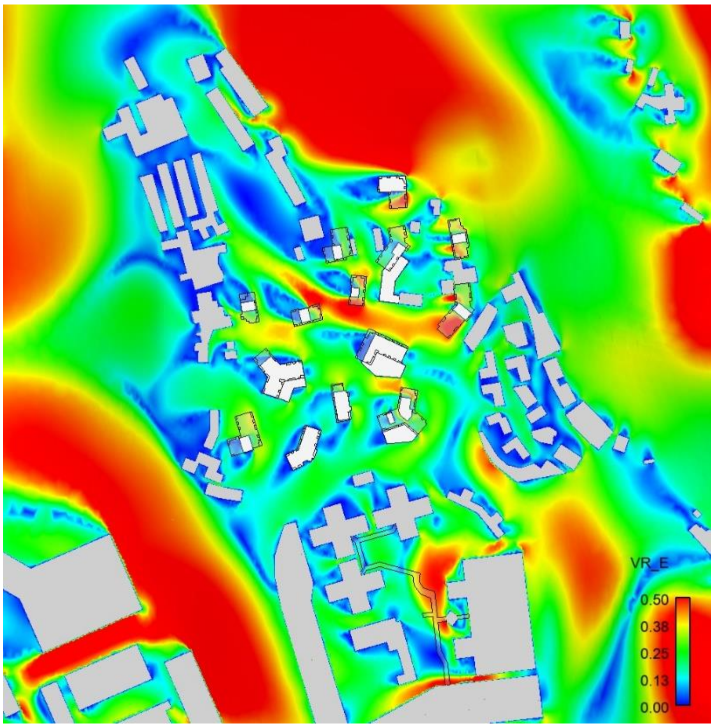


Figure C 3 Contour Plot of VR under E Wind

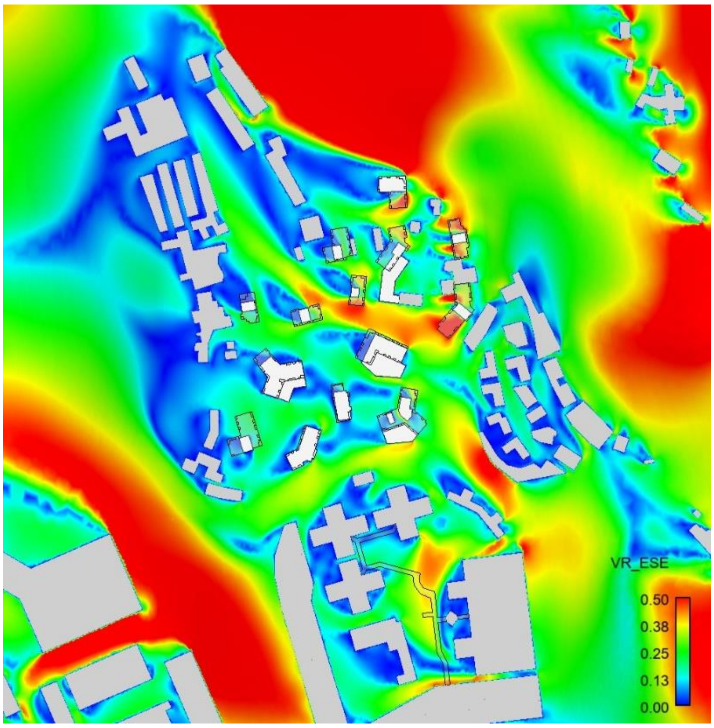


Figure C 4 Contour Plot of VR under ESE Wind

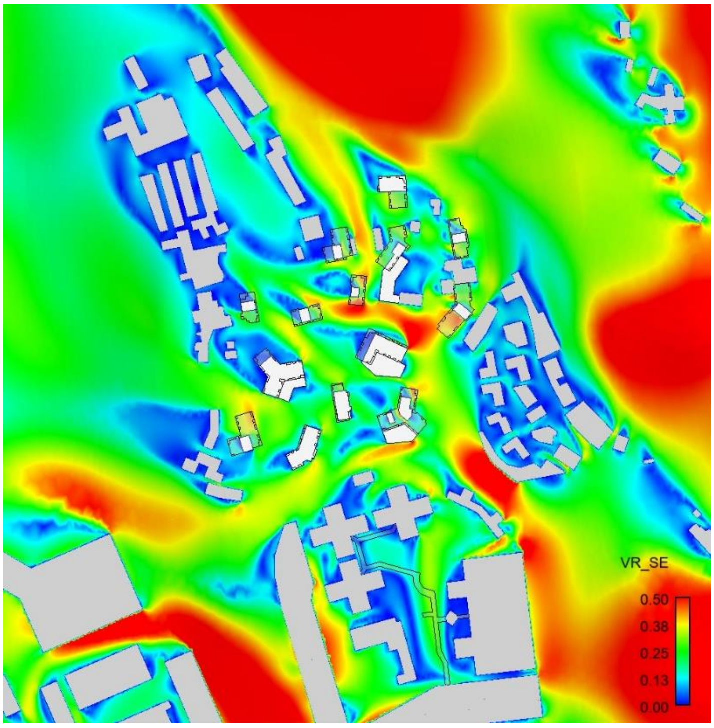


Figure C 5 Contour Plot of VR under SE Wind

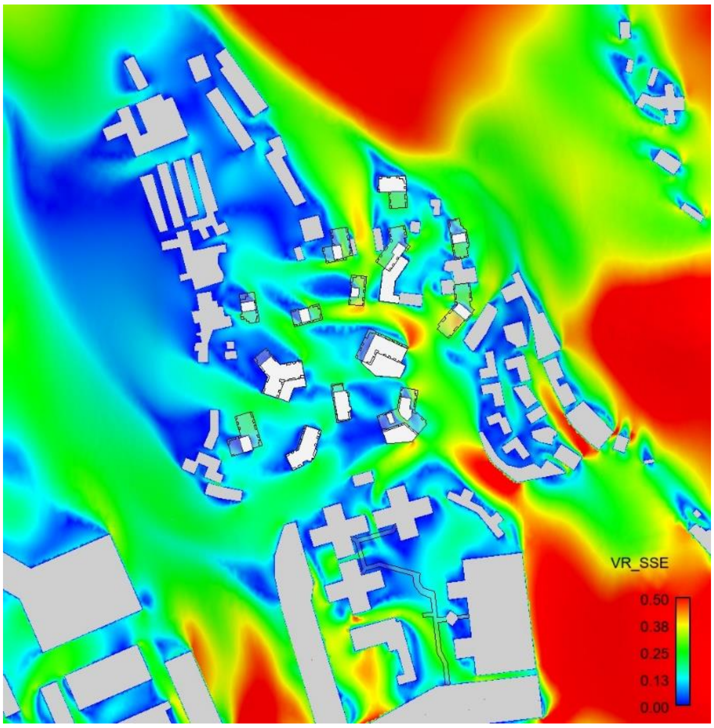


Figure C 6 Contour Plot of VR under SSE Wind

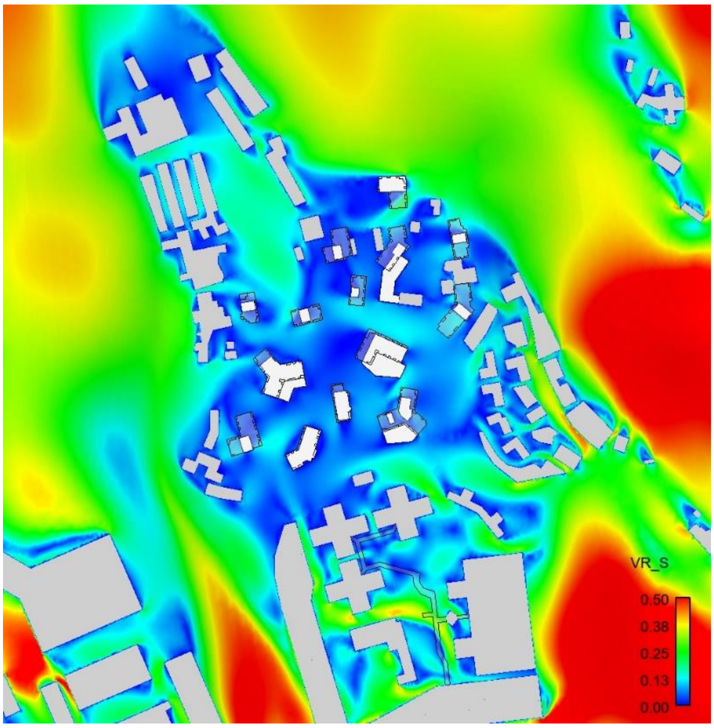


Figure C 7 Contour Plot of VR under S Wind

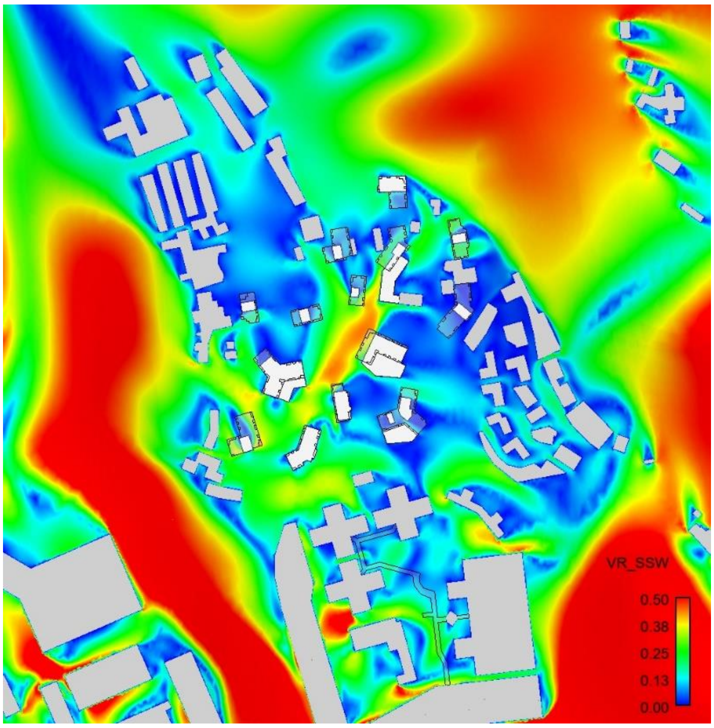


Figure C 8 Contour Plot of VR under SSW Wind

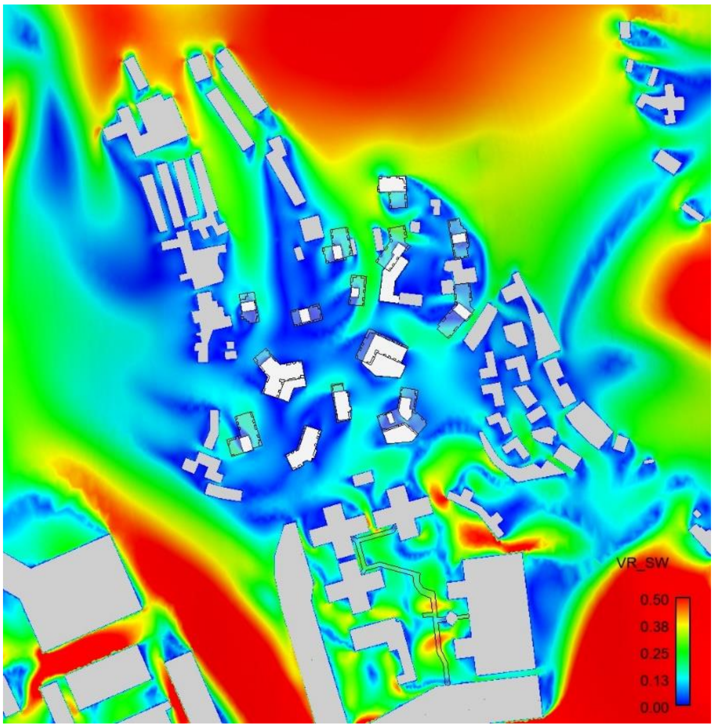


Figure C 9 Contour Plot of VR under SW Wind

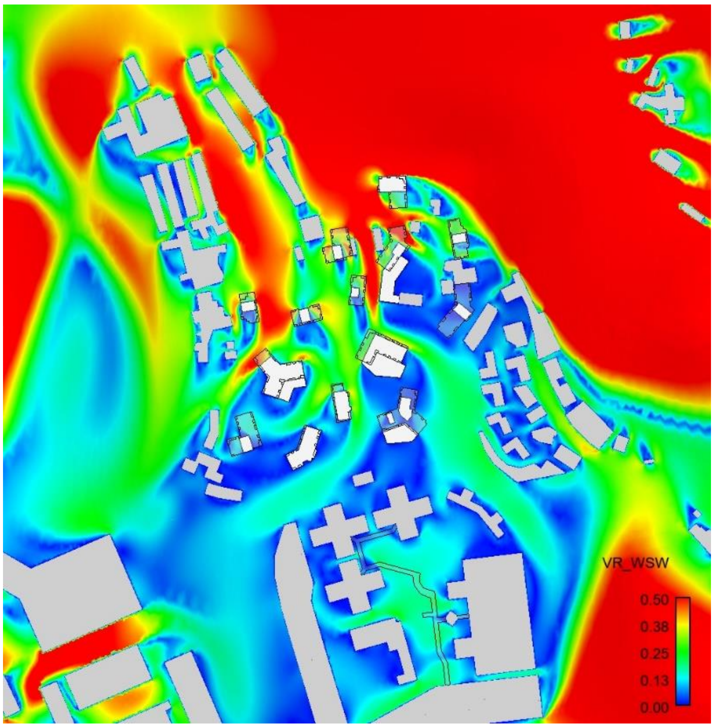


Figure C 10 Contour Plot of VR under WSW Wind

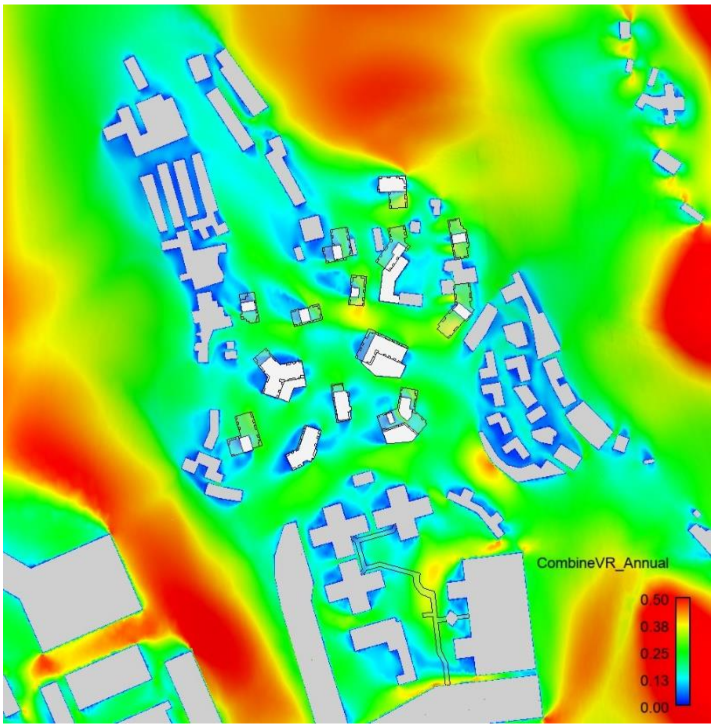


Figure C 11 Annual Weighted Average Contour Plot of VR

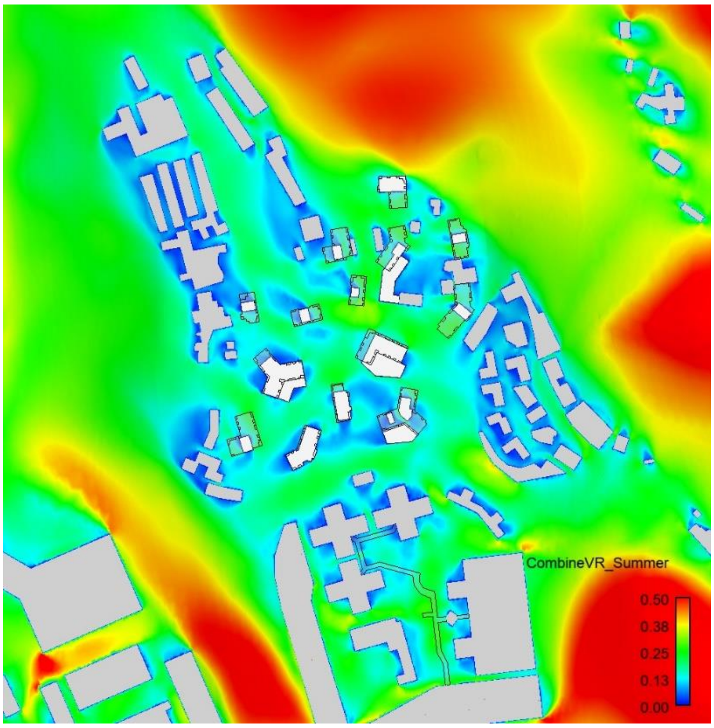


Figure C 12 Summer Weighted Average Contour Plot of VR

C2 Proposed Scheme

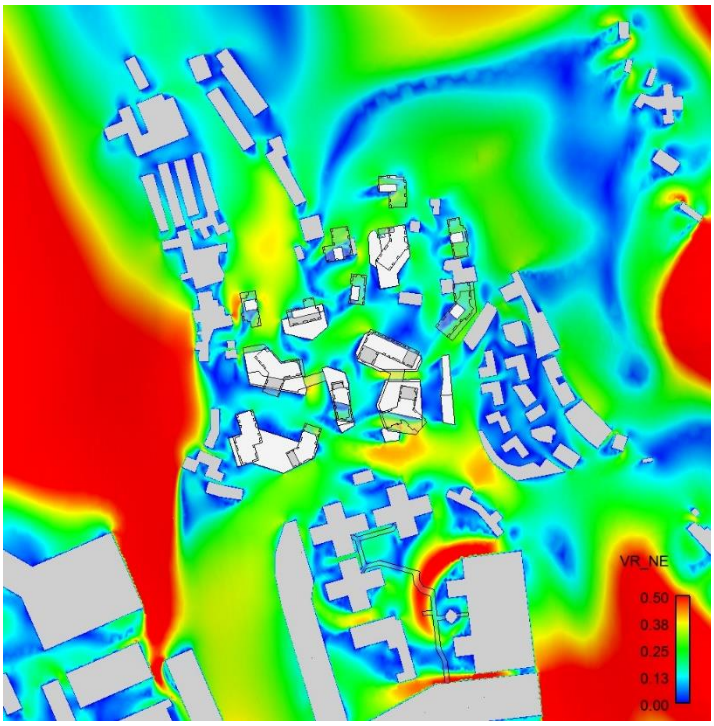


Figure C 13 Contour Plot of VR under NE Wind

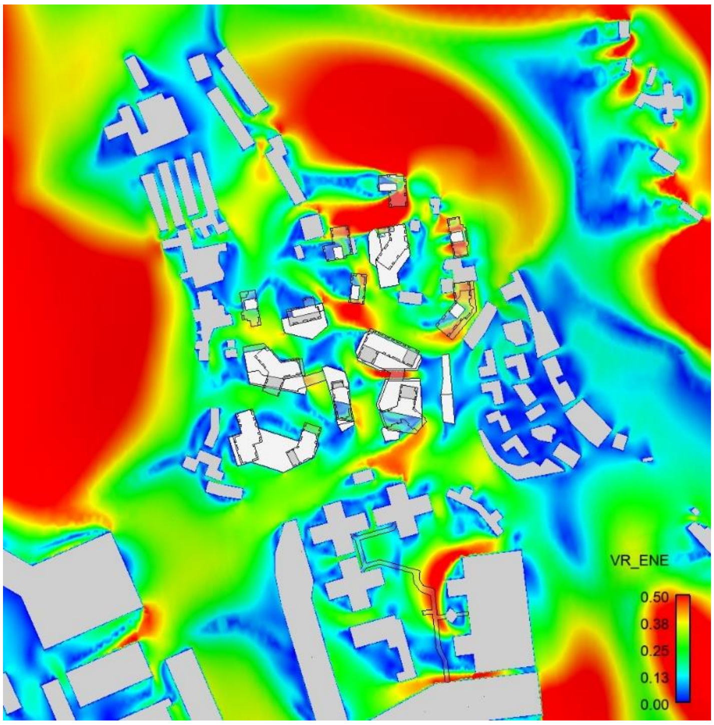


Figure C 14 Contour Plot of VR under ENE Wind

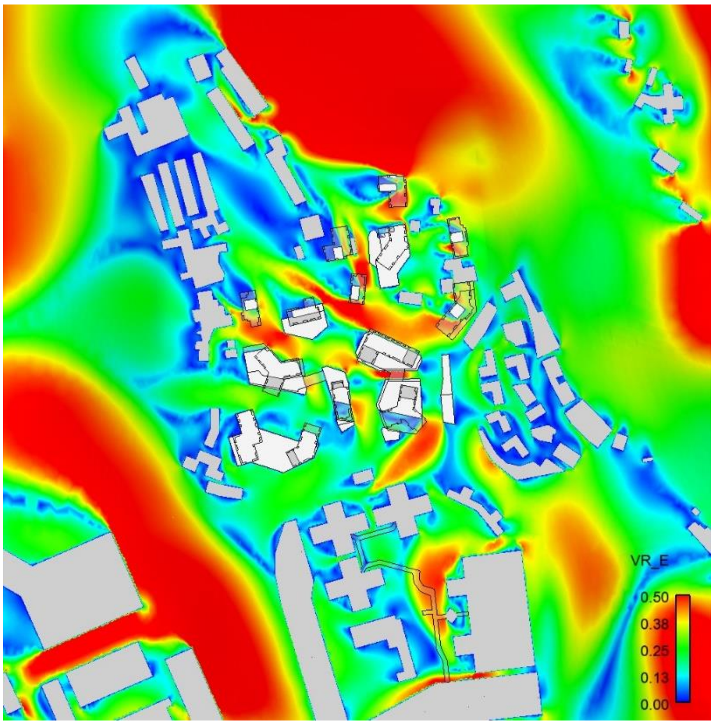


Figure C 15 Contour Plot of VR under E Wind

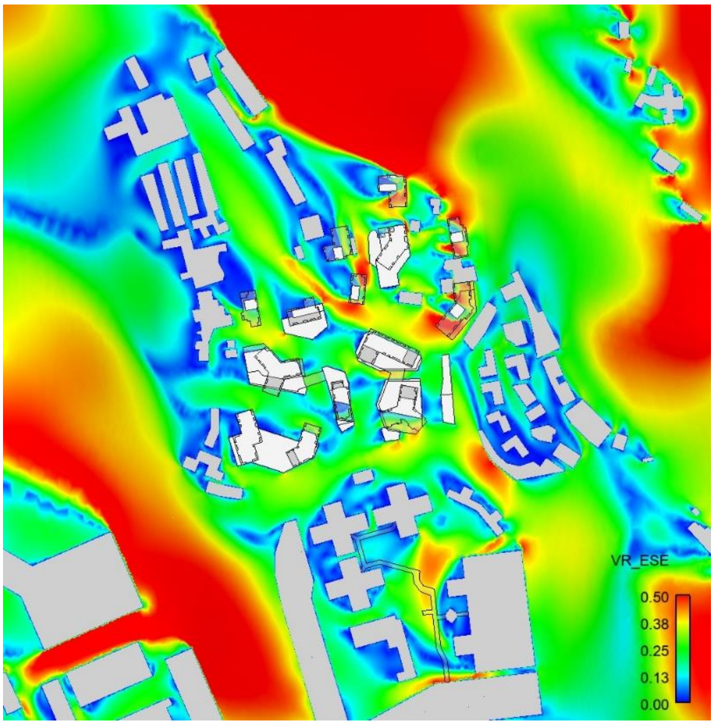


Figure C 16 Contour Plot of VR under ESE Wind

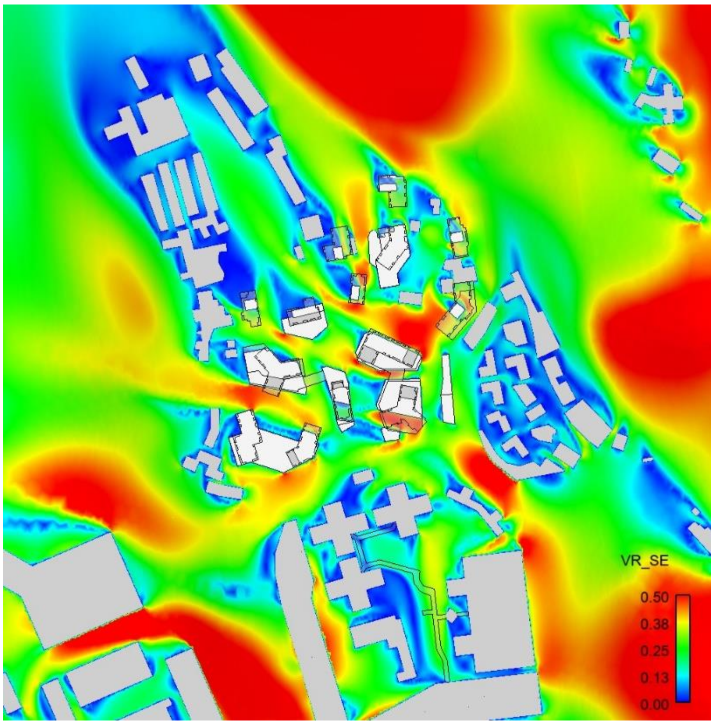


Figure C 17 Contour Plot of VR under SE Wind

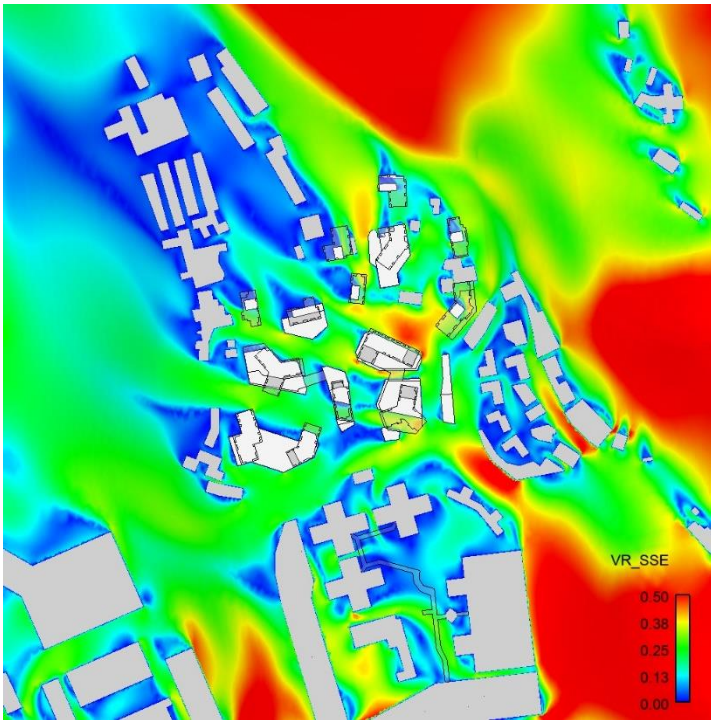


Figure C 18 Contour Plot of VR under SSE Wind

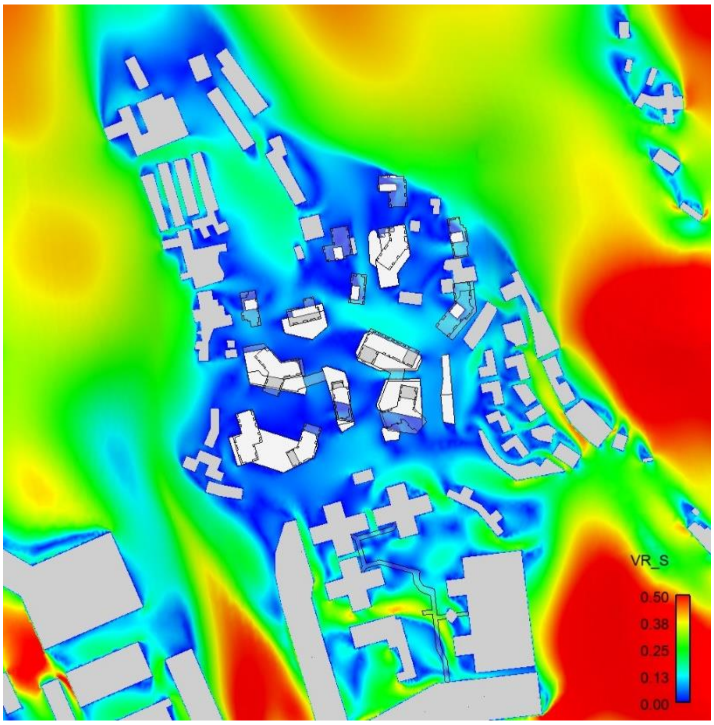


Figure C 19 Contour Plot of VR under S Wind

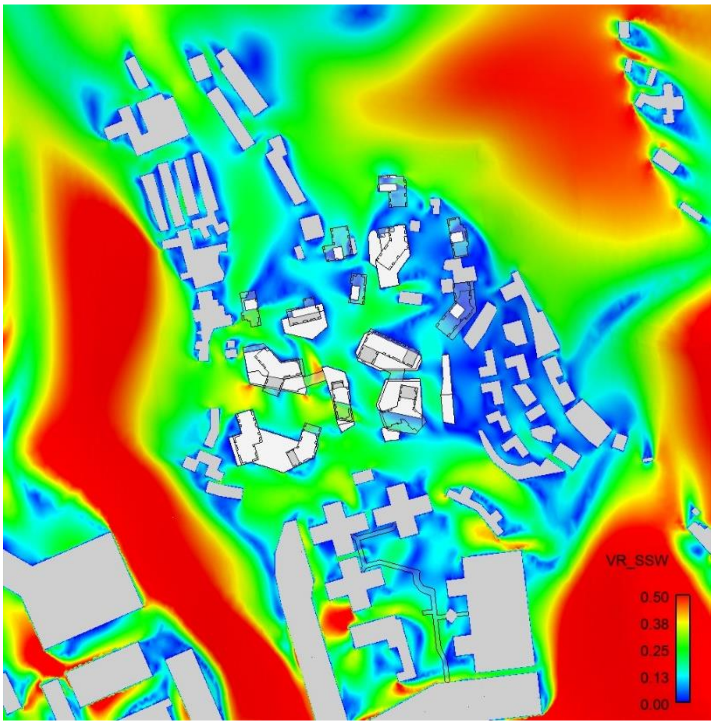


Figure C 20 Contour Plot of VR under SSW Wind

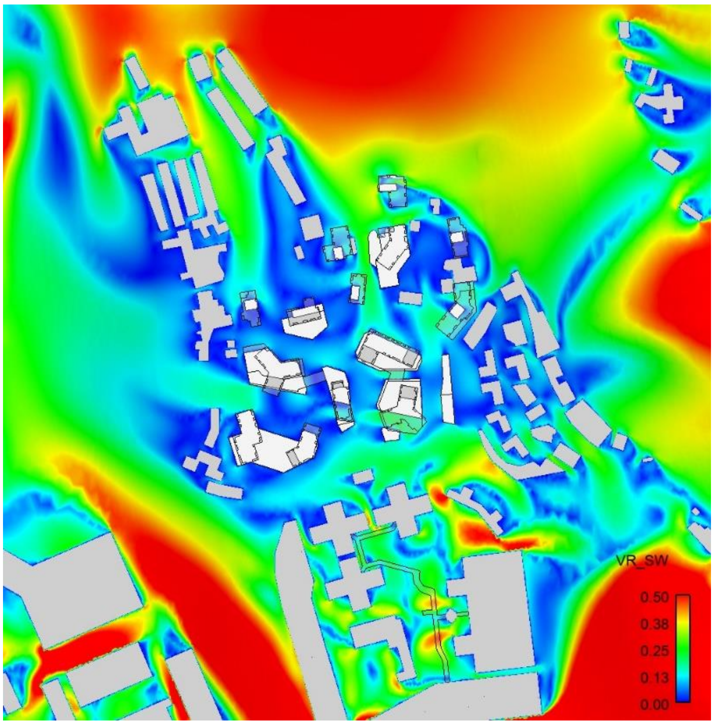


Figure C 21 Contour Plot of VR under SW Wind

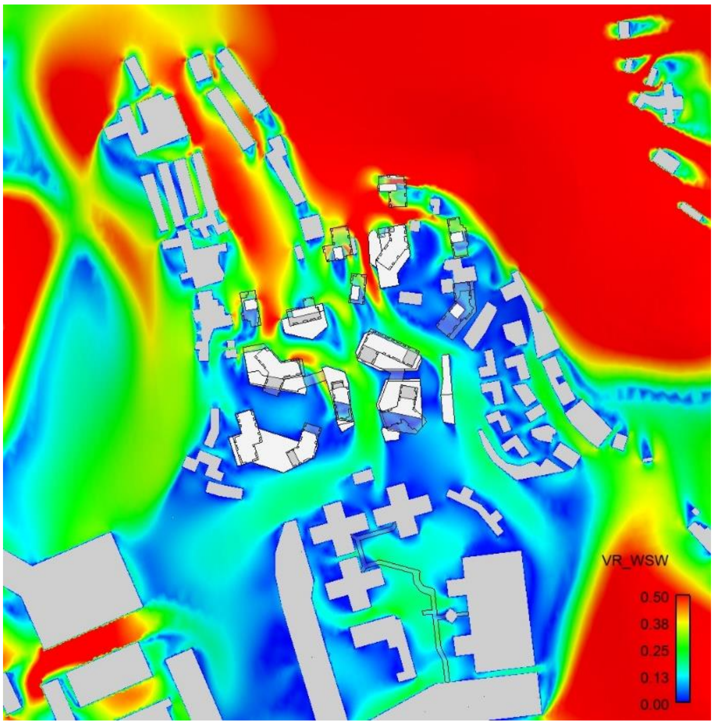


Figure C 22 Contour Plot of VR under WSW Wind

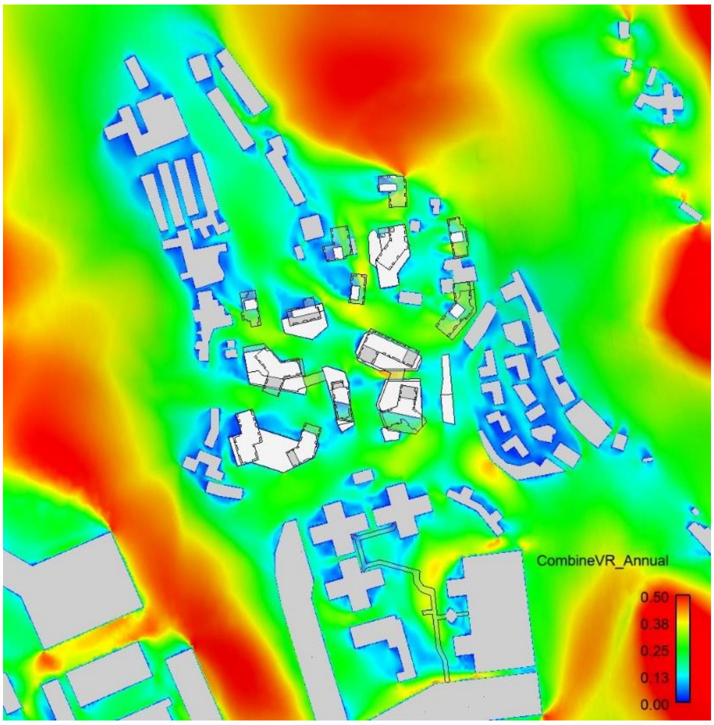


Figure C 23 Annual Weighted Average Contour Plot of VR

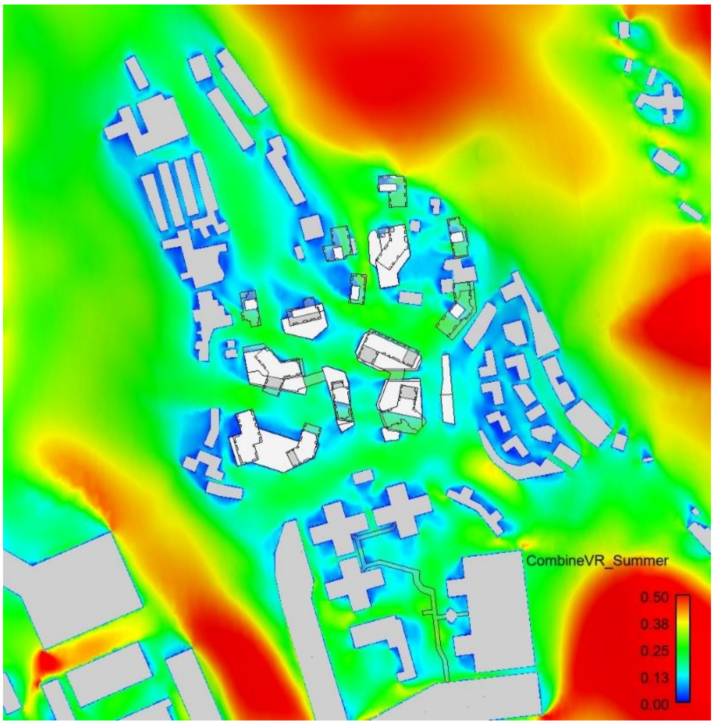


Figure C 24 Summer Weighted Average Contour Plot of VR

C3 Interim Scheme

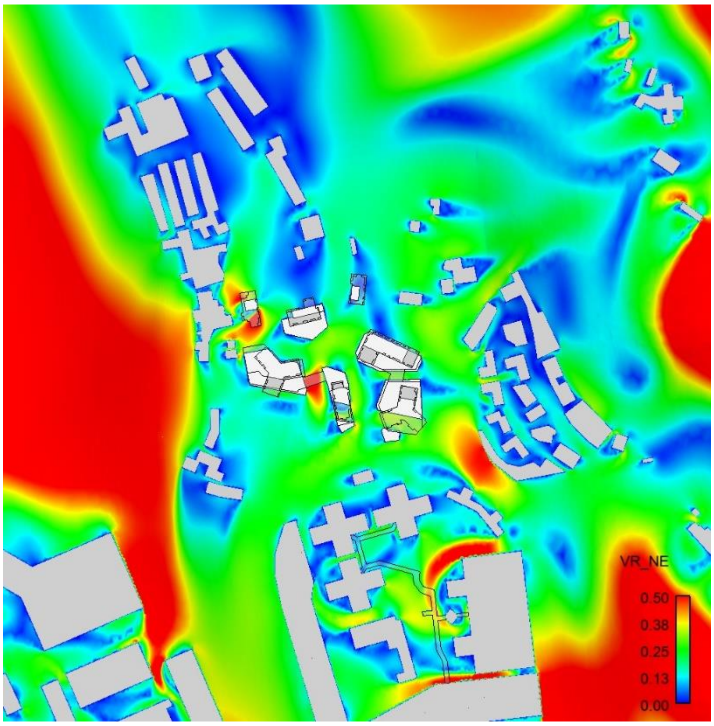


Figure C 25 Contour Plot of VR under NE Wind

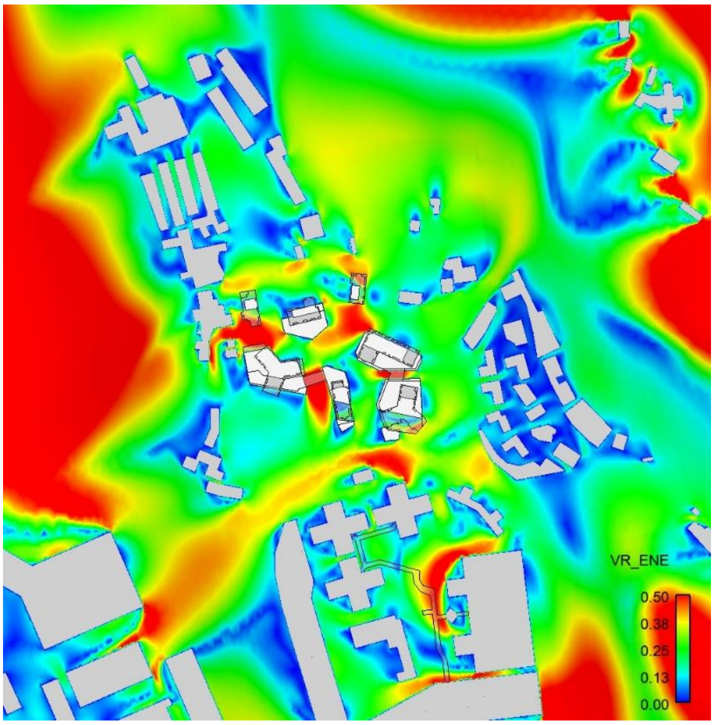


Figure C 26 Contour Plot of VR under ENE Wind

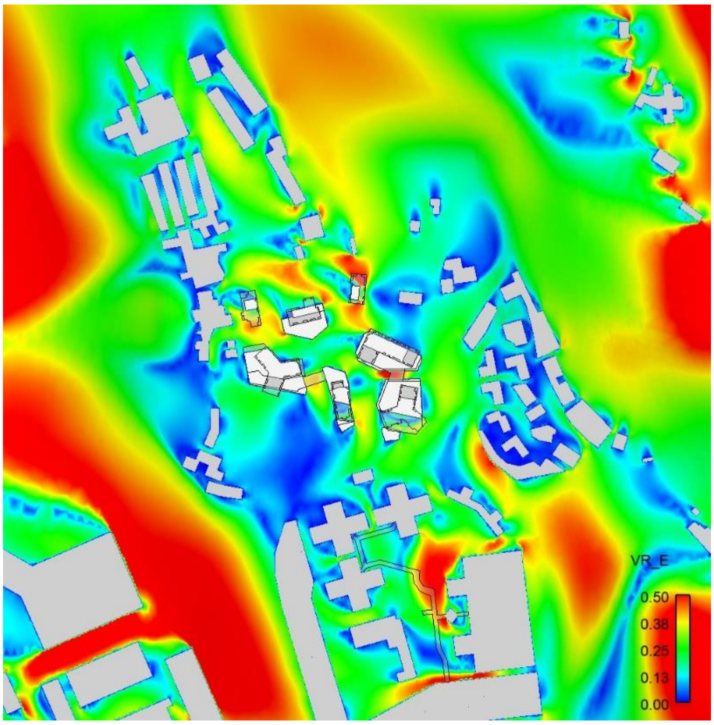


Figure C 27 Contour Plot of VR under E Wind

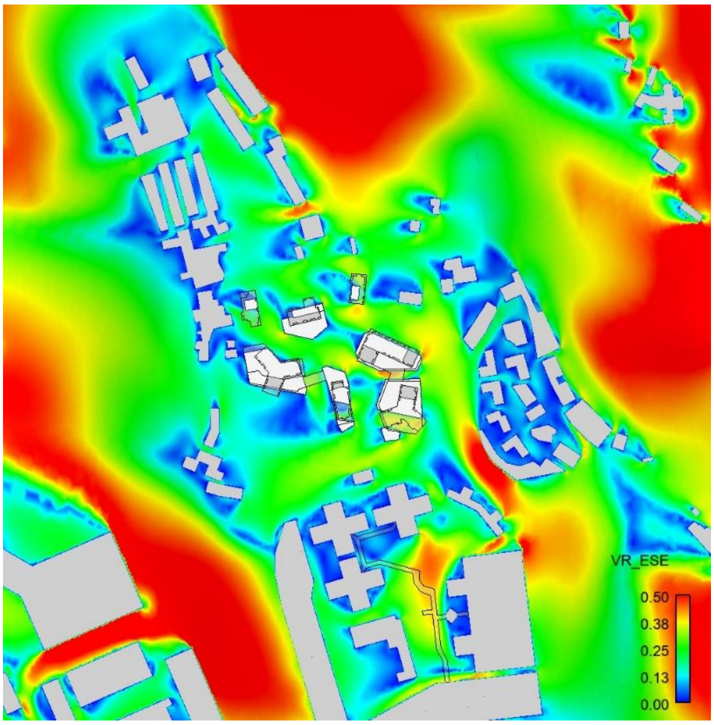


Figure C 28 Contour Plot of VR under ESE Wind

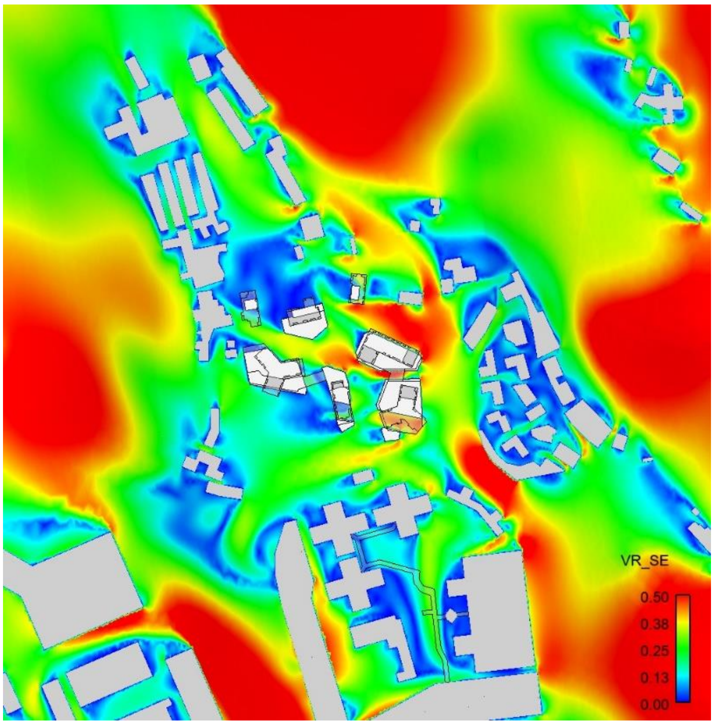


Figure C 29 Contour Plot of VR under SE Wind

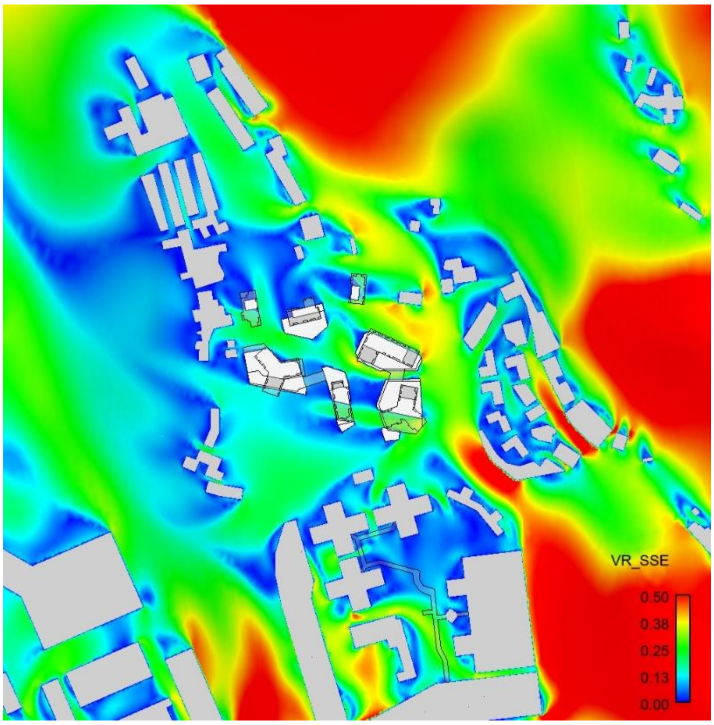


Figure C 30 Contour Plot of VR under SSE Wind

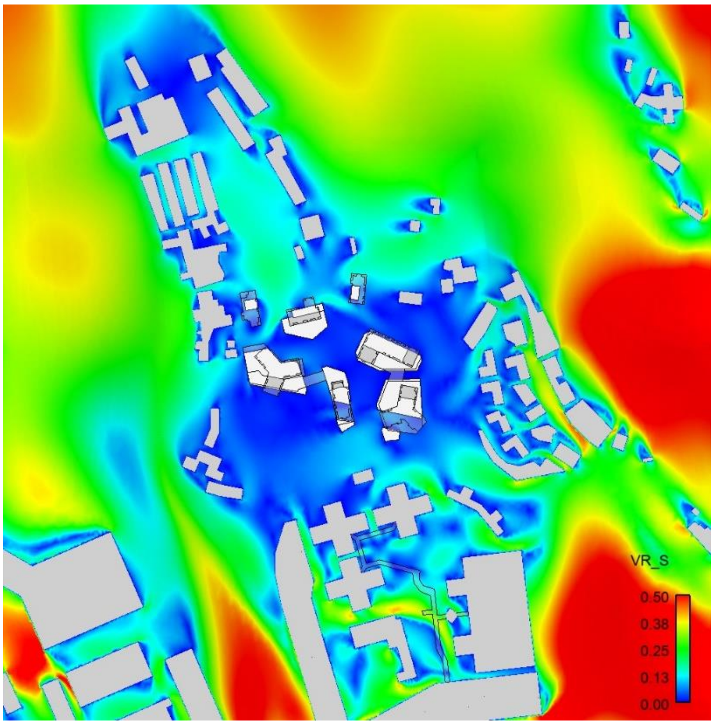


Figure C 31 Contour Plot of VR under S Wind

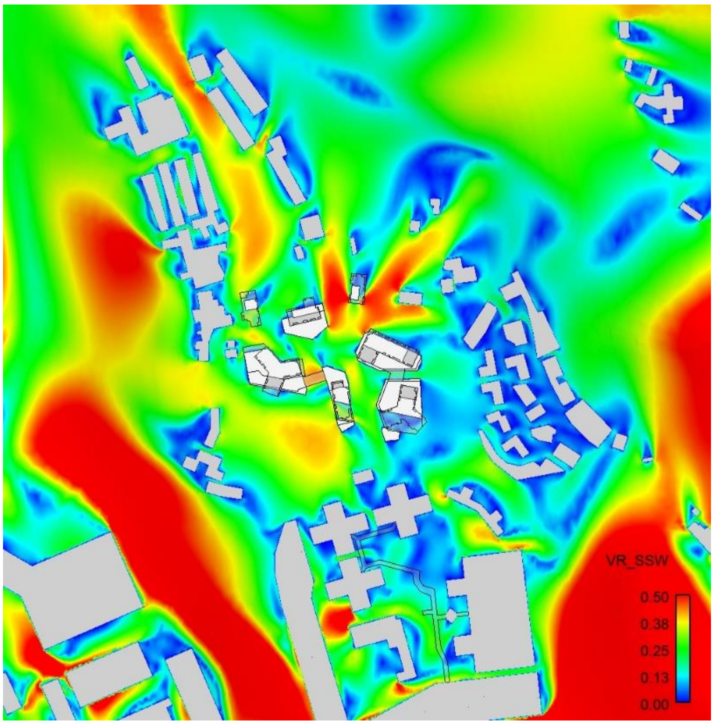


Figure C 32 Contour Plot of VR under SSW Wind

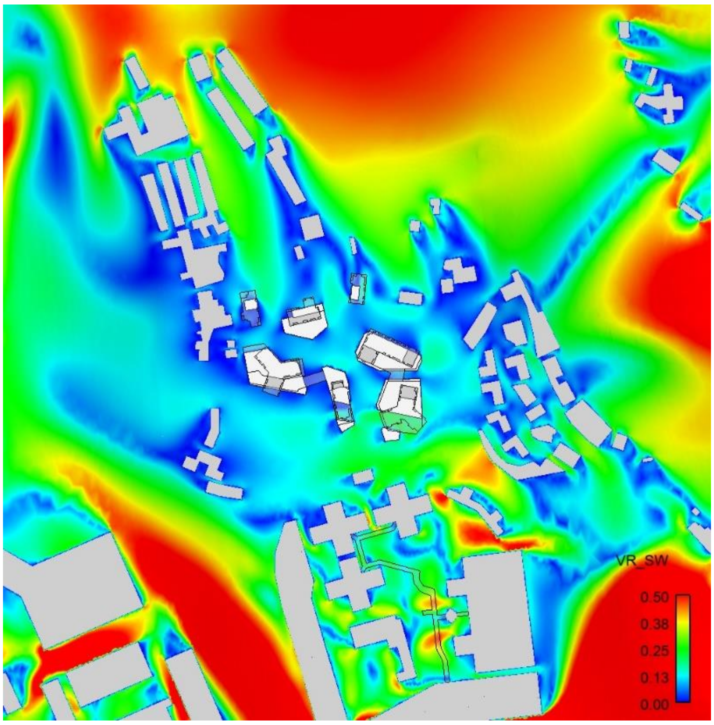


Figure C 33 Contour Plot of VR under SW Wind

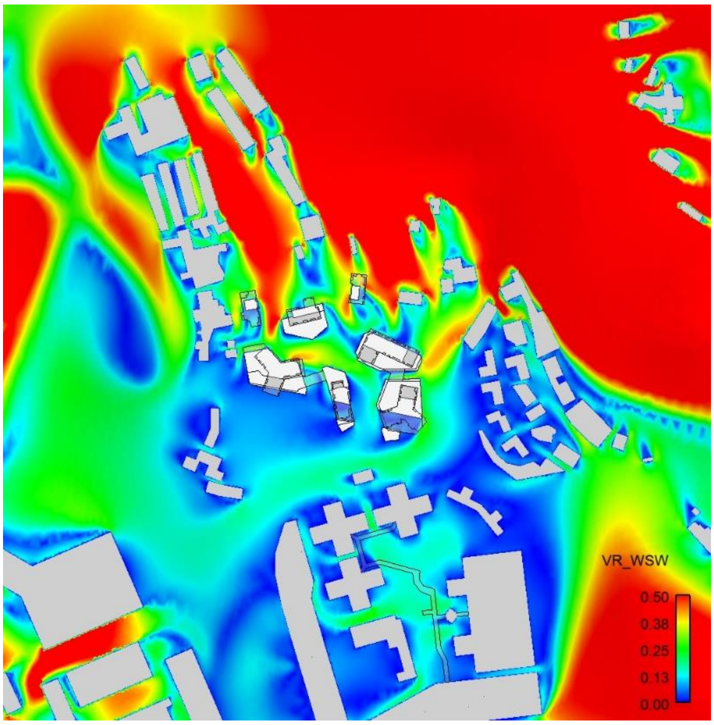


Figure C 34 Contour Plot of VR under WSW Wind

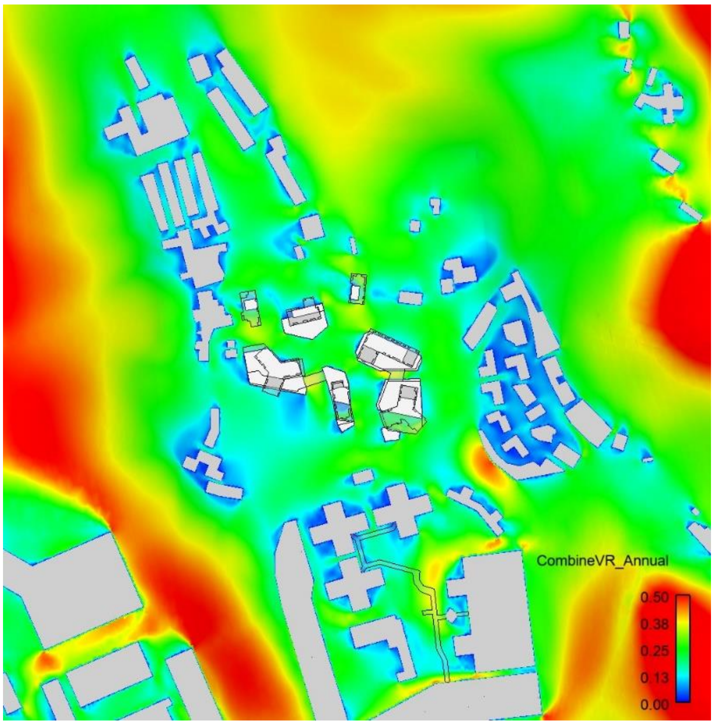


Figure C 35 Annual Weighted Average Contour Plot of VR

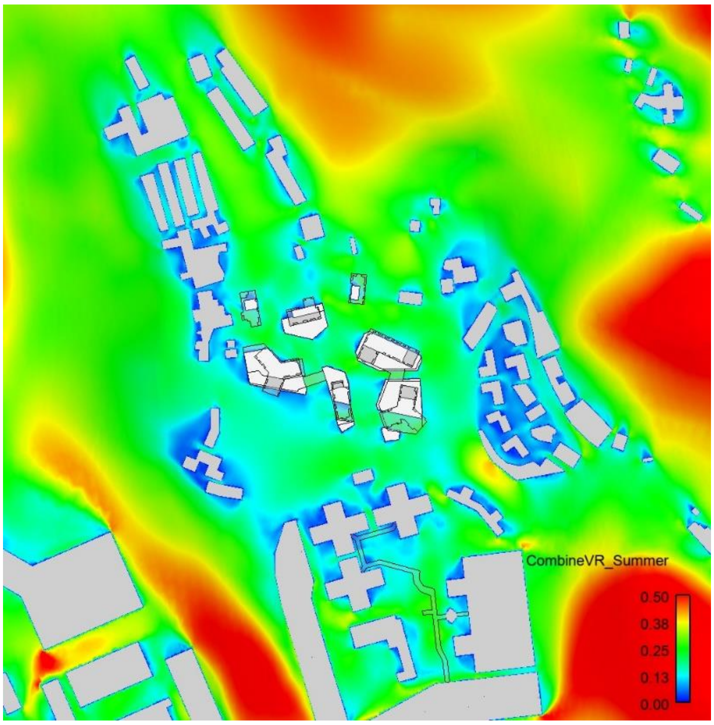


Figure C 36 Summer Weighted Average Contour Plot of VR

C4 Baseline Scheme

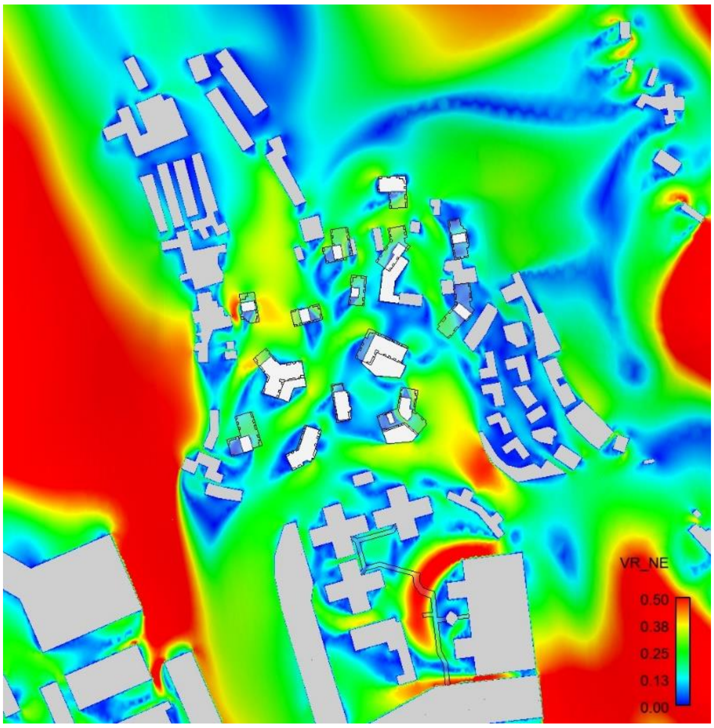


Figure C 37 Contour Plot of VR under NE Wind

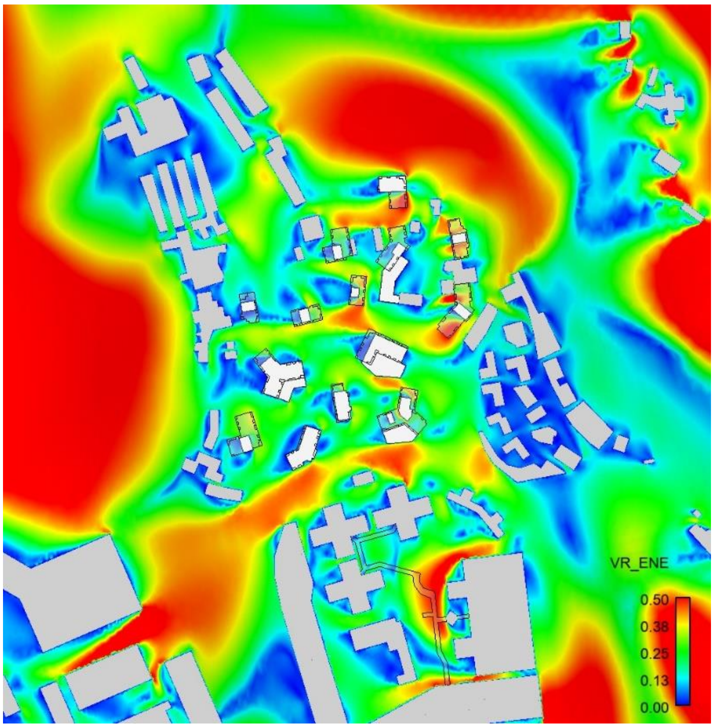


Figure C 38 Contour Plot of VR under ENE Wind

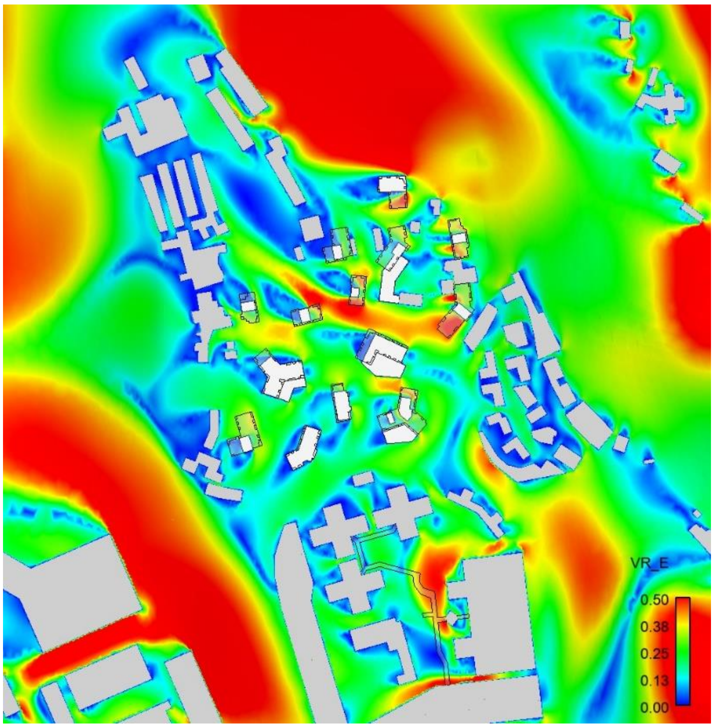


Figure C 39 Contour Plot of VR under E Wind

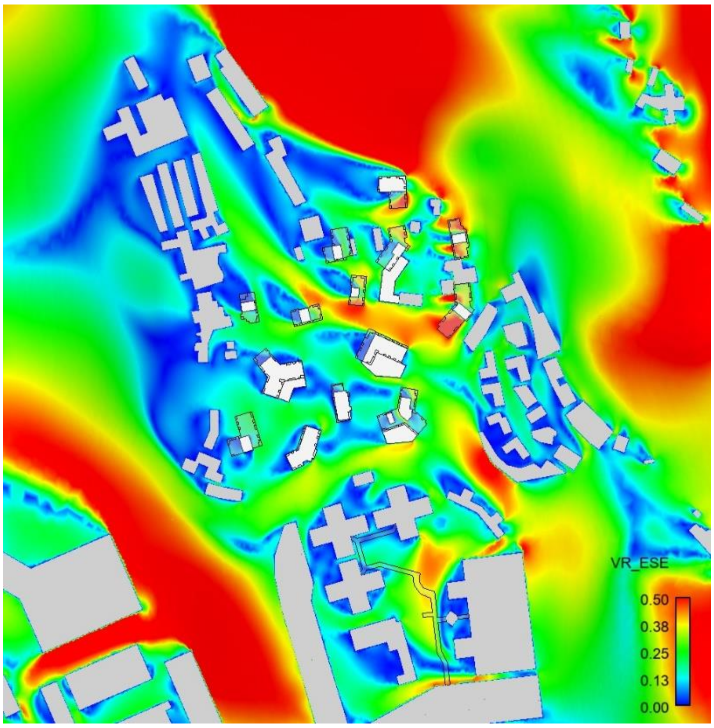


Figure C 40 Contour Plot of VR under ESE Wind

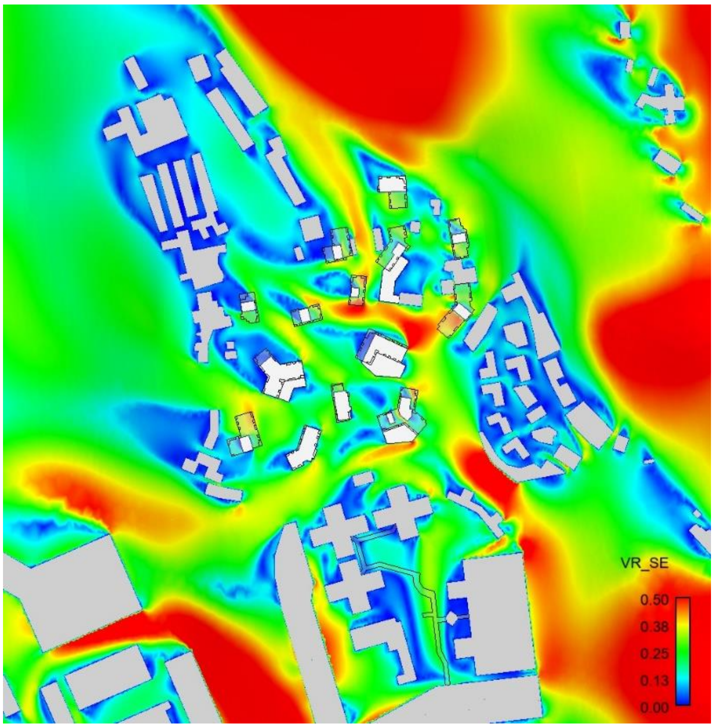


Figure C 41 Contour Plot of VR under SE Wind

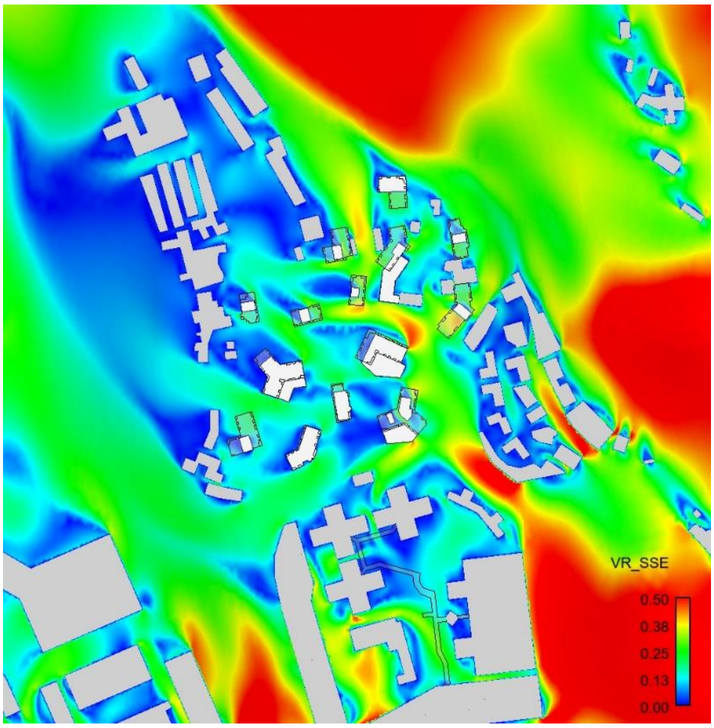


Figure C 42 Contour Plot of VR under SSE Wind

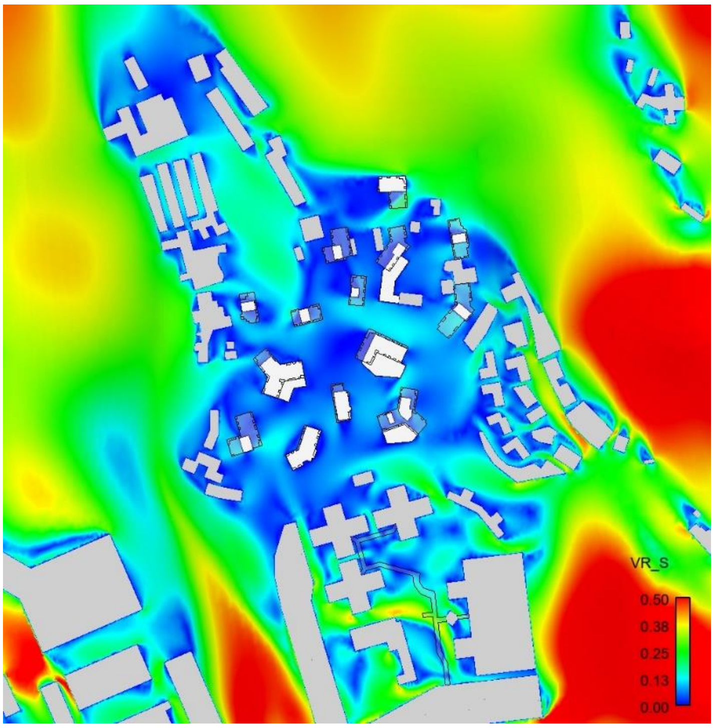


Figure C 43 Contour Plot of VR under S Wind

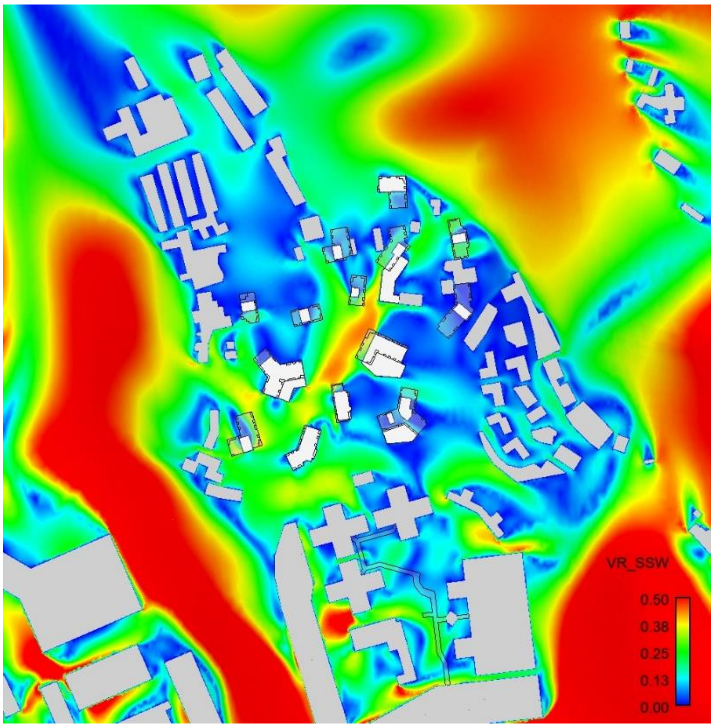


Figure C 44 Contour Plot of VR under SSW Wind

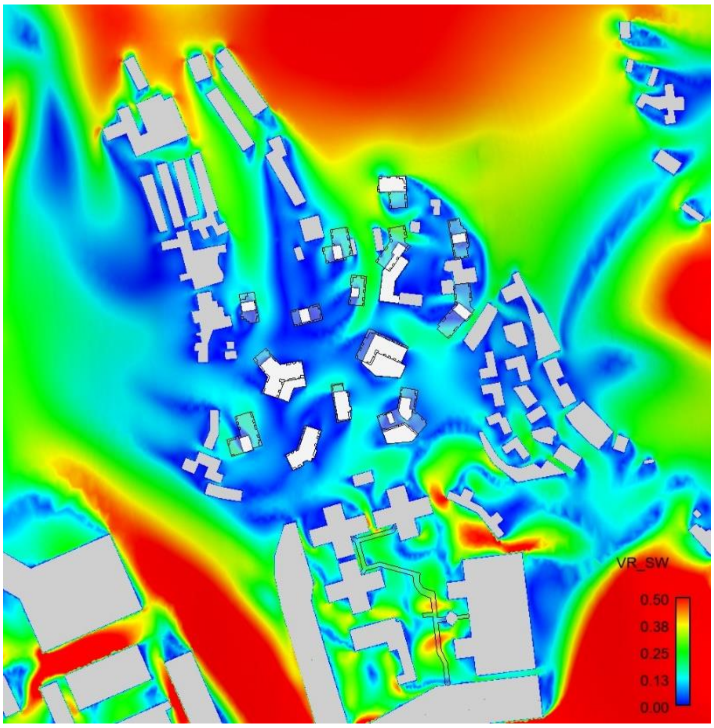


Figure C 45 Contour Plot of VR under SW Wind

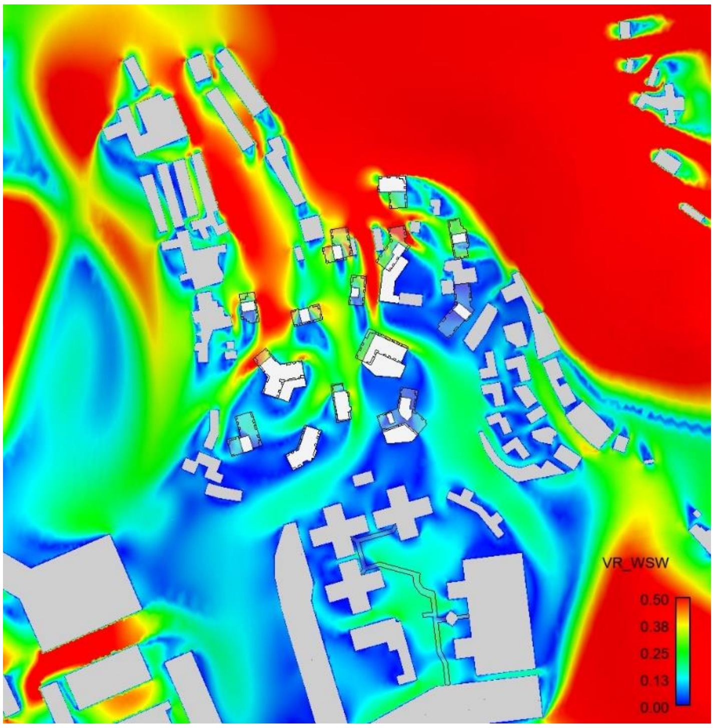


Figure C 46 Contour Plot of VR under WSW Wind

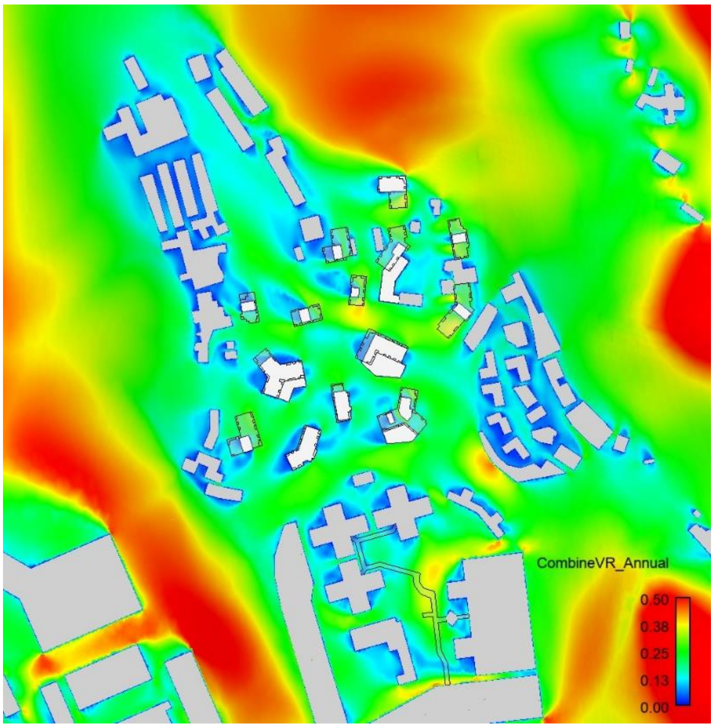


Figure C 47 Annual Weighted Average Contour Plot of VR

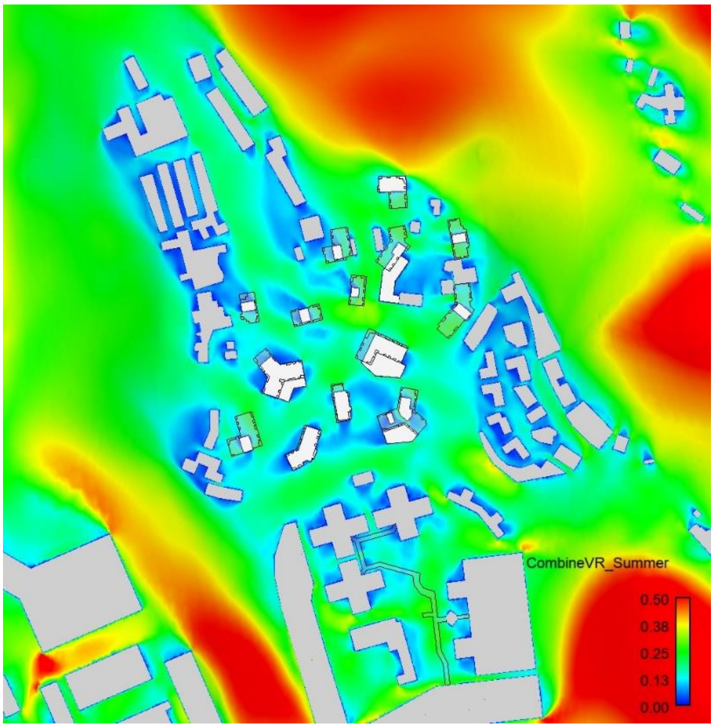


Figure C 48 Summer Weighted Average Contour Plot of VR

C5 Proposed Scheme

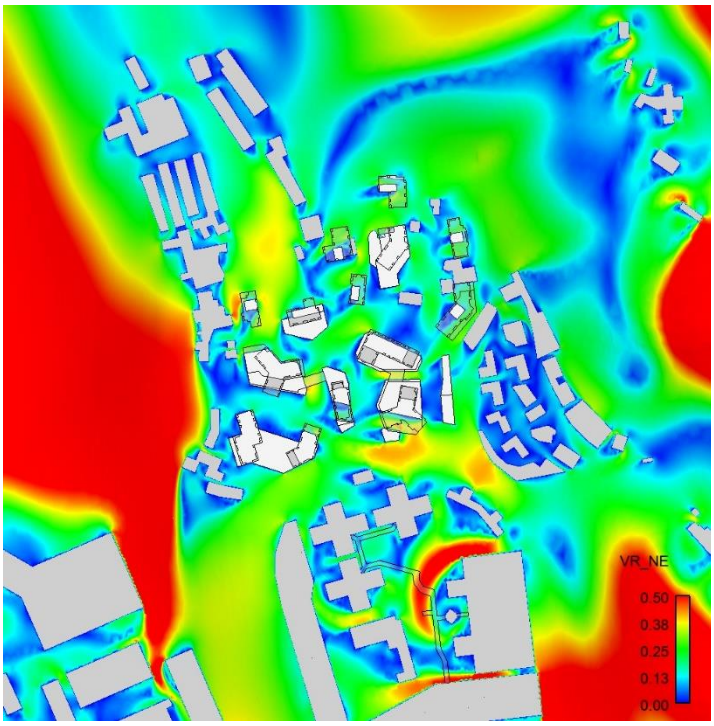


Figure C 49 Contour Plot of VR under NE Wind

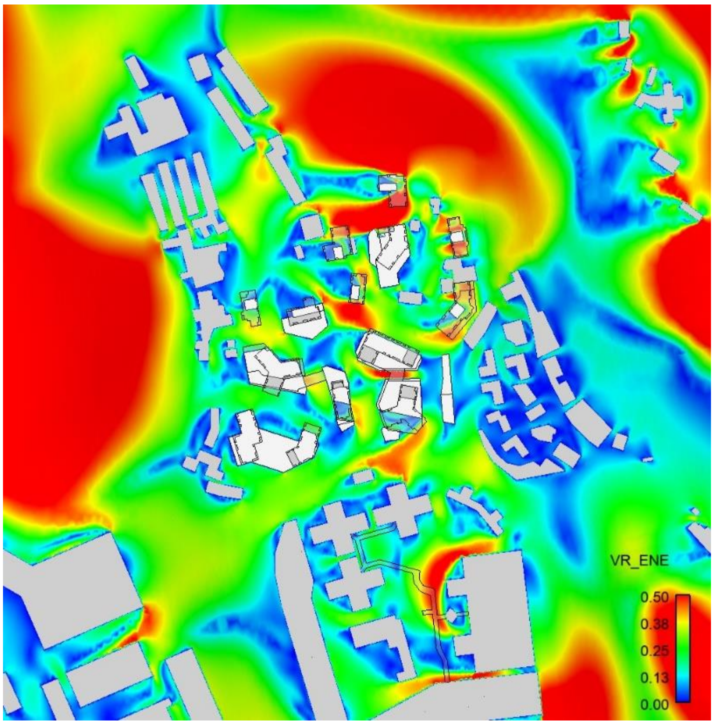


Figure C 50 Contour Plot of VR under ENE Wind

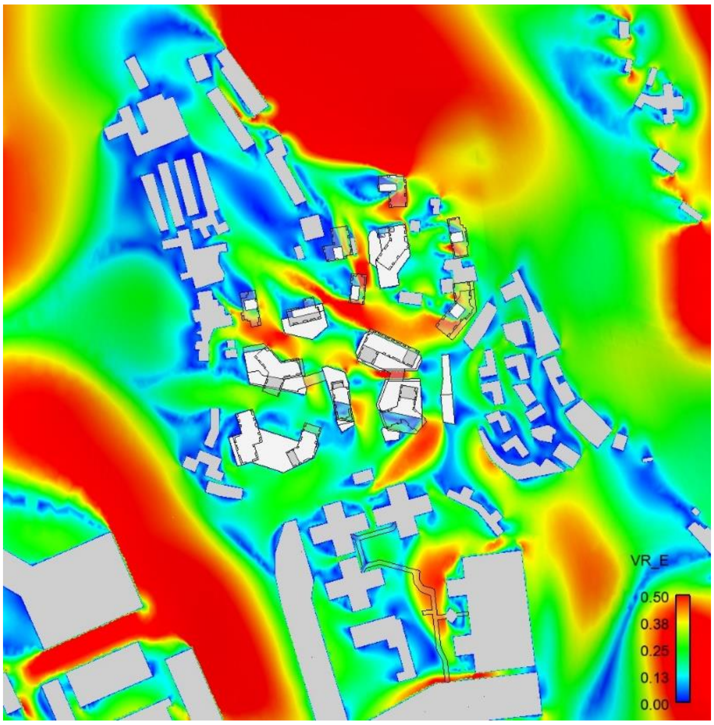


Figure C 51 Contour Plot of VR under E Wind

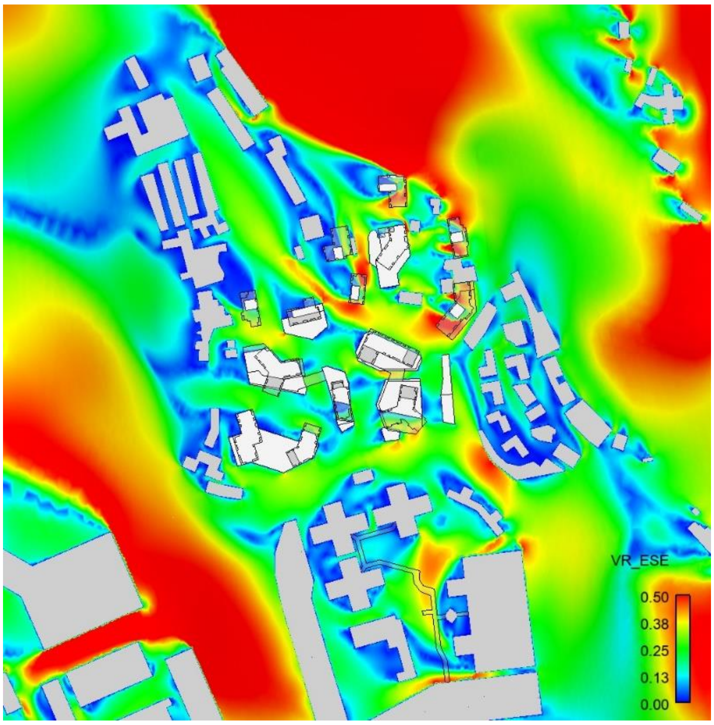


Figure C 52 Contour Plot of VR under ESE Wind

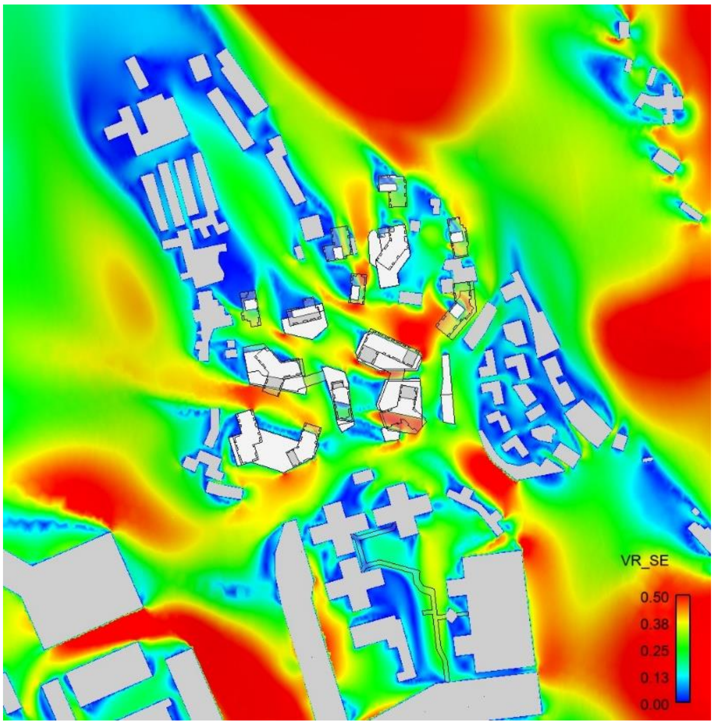


Figure C 53 Contour Plot of VR under SE Wind

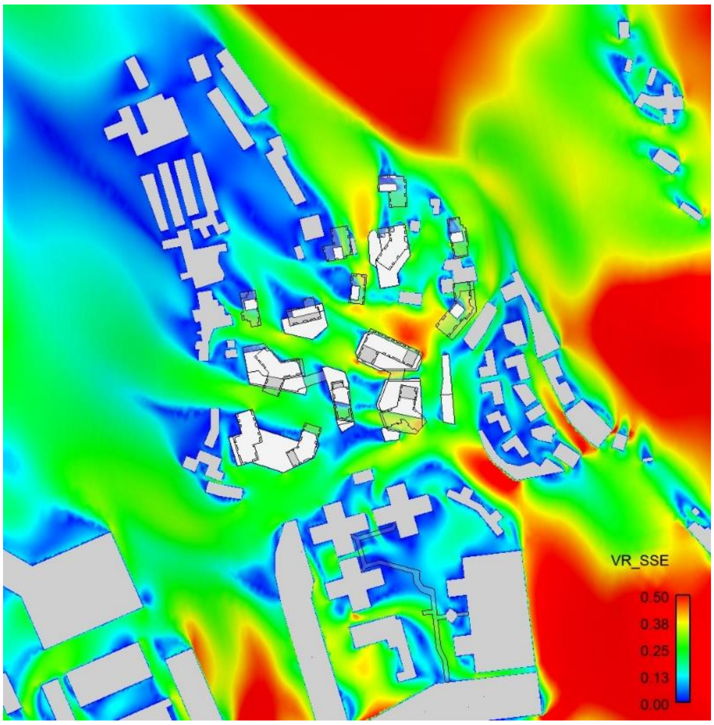


Figure C 54 Contour Plot of VR under SSE Wind

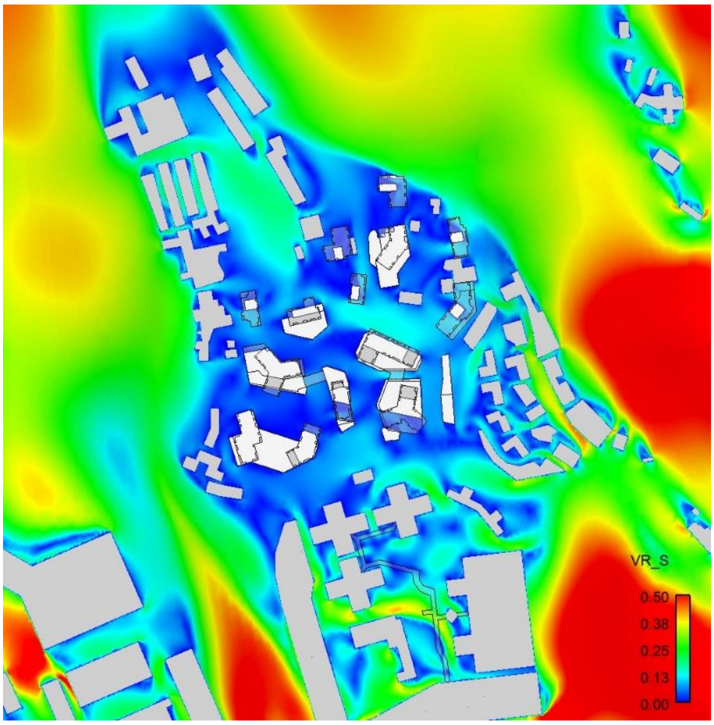


Figure C 55 Contour Plot of VR under S Wind

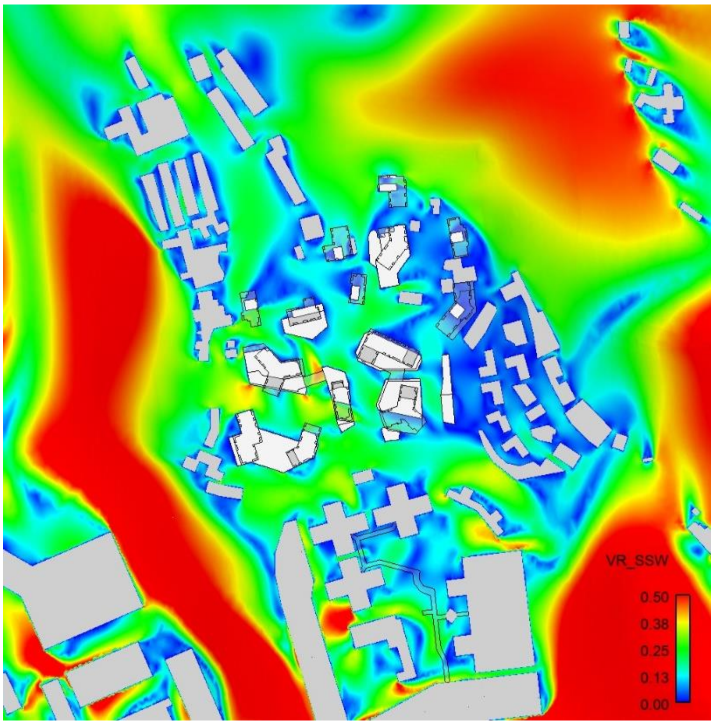


Figure C 56 Contour Plot of VR under SSW Wind

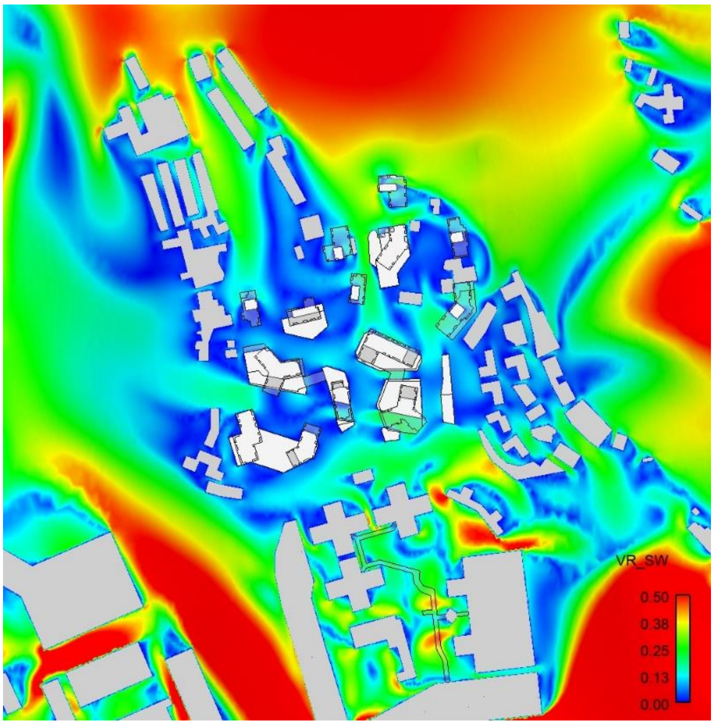


Figure C 57 Contour Plot of VR under SW Wind

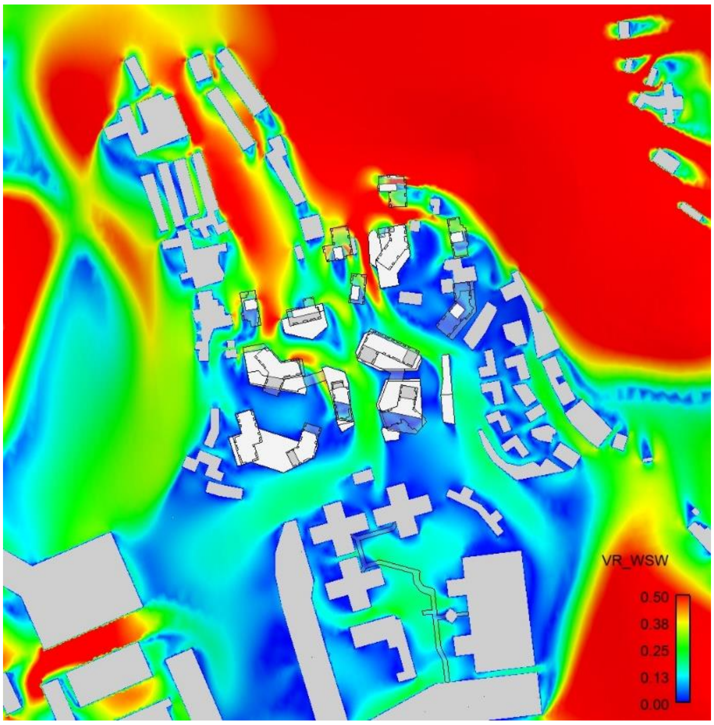


Figure C 58 Contour Plot of VR under WSW Wind

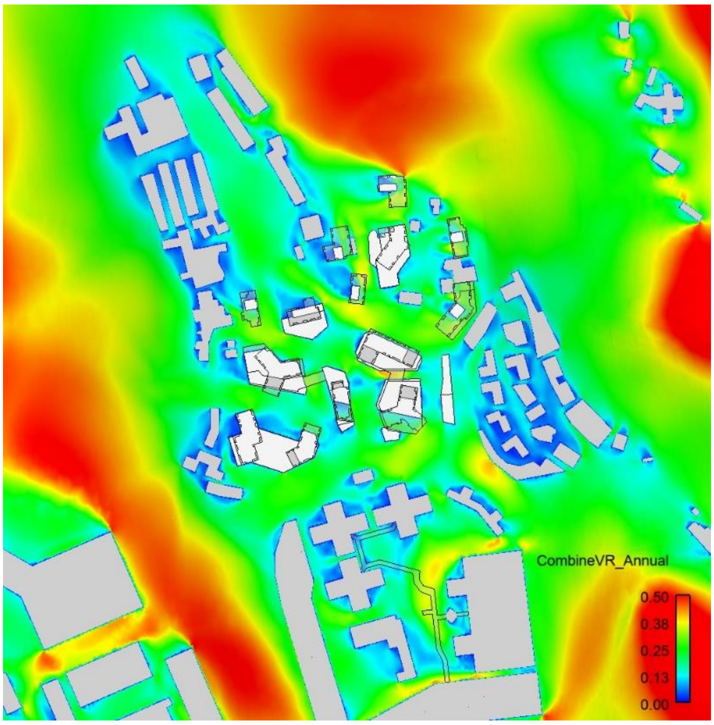


Figure C 59 Annual Weighted Average Contour Plot of VR

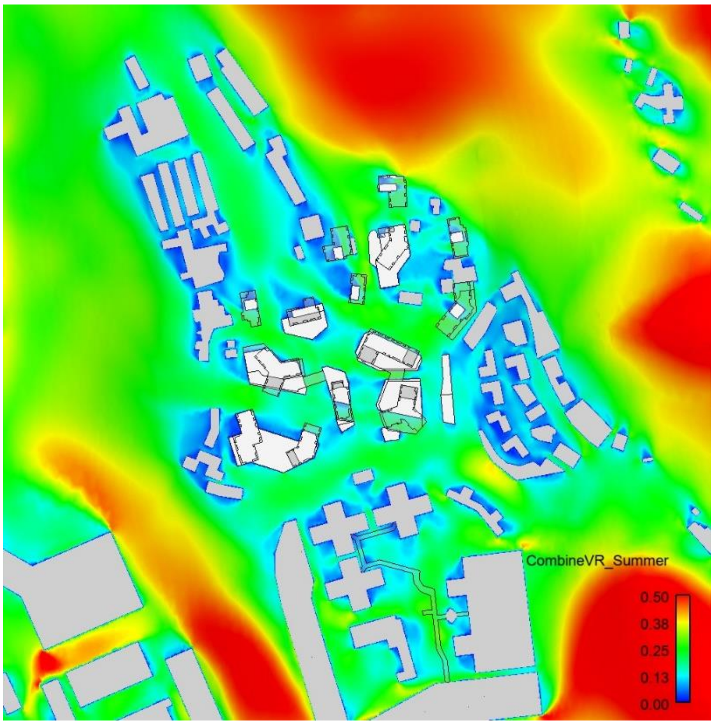


Figure C 60 Summer Weighted Average Contour Plot of VR

C6 Interim Scheme

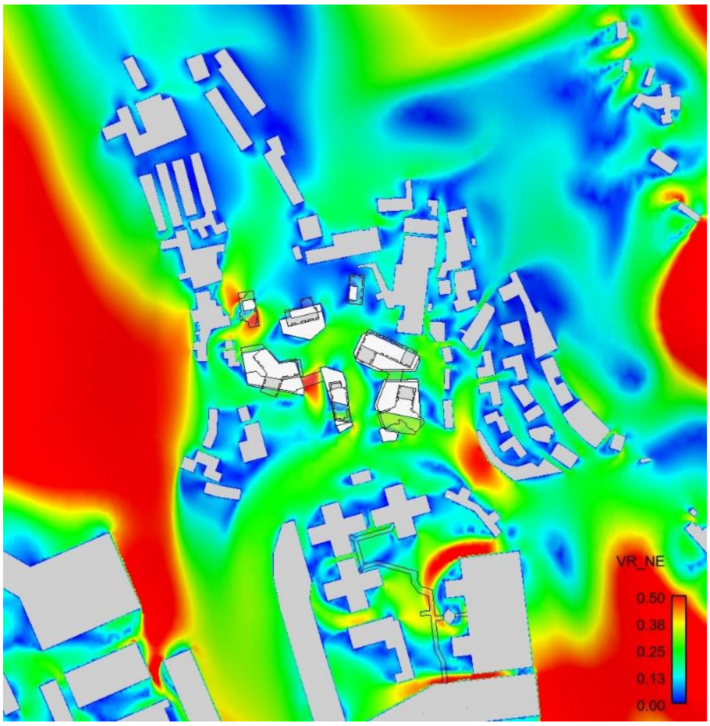


Figure C 61 Contour Plot of VR under NE Wind

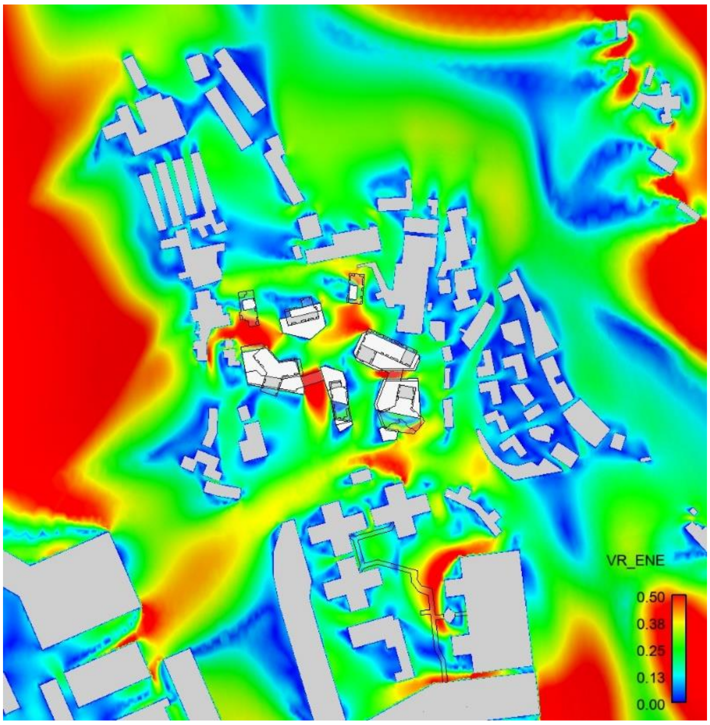


Figure C 62 Contour Plot of VR under ENE Wind

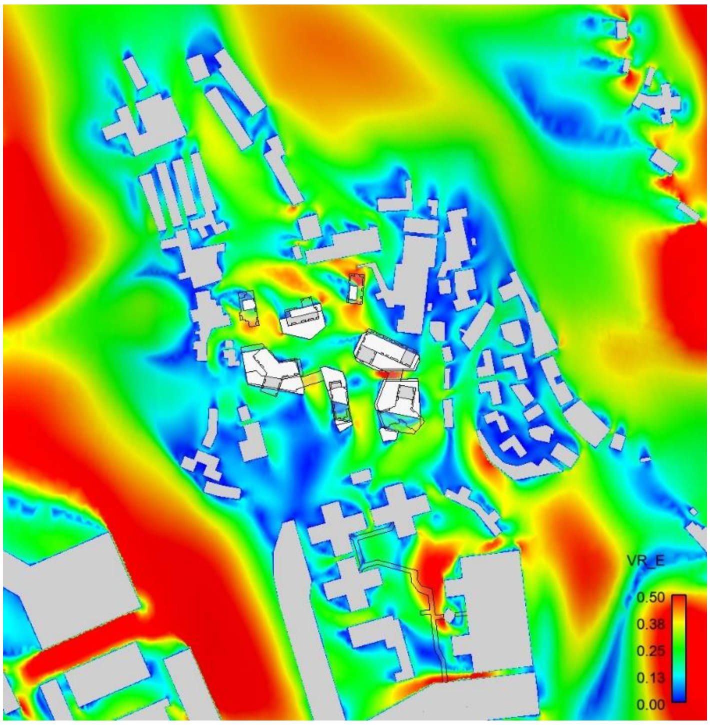


Figure C 63 Contour Plot of VR under E Wind

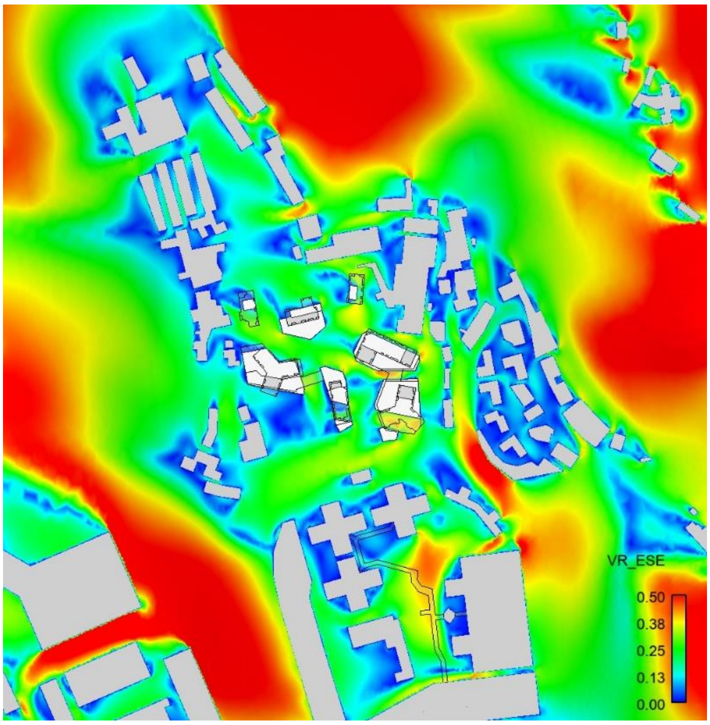


Figure C 64 Contour Plot of VR under ESE Wind

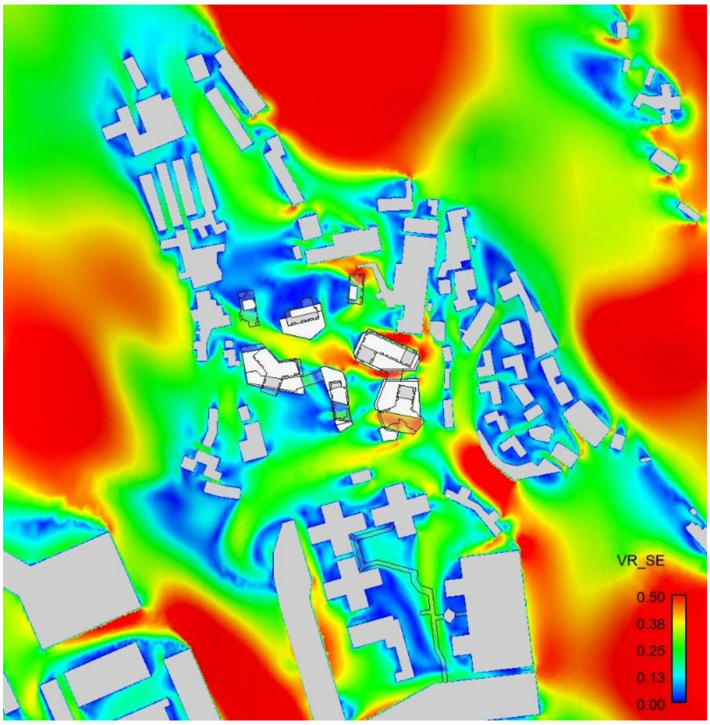


Figure C 65 Contour Plot of VR under SE Wind

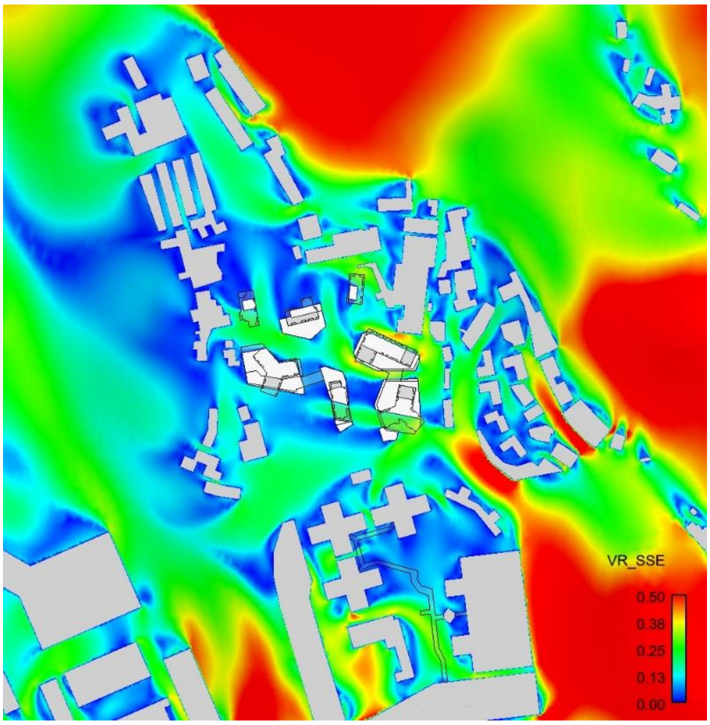


Figure C 66 Contour Plot of VR under SSE Wind

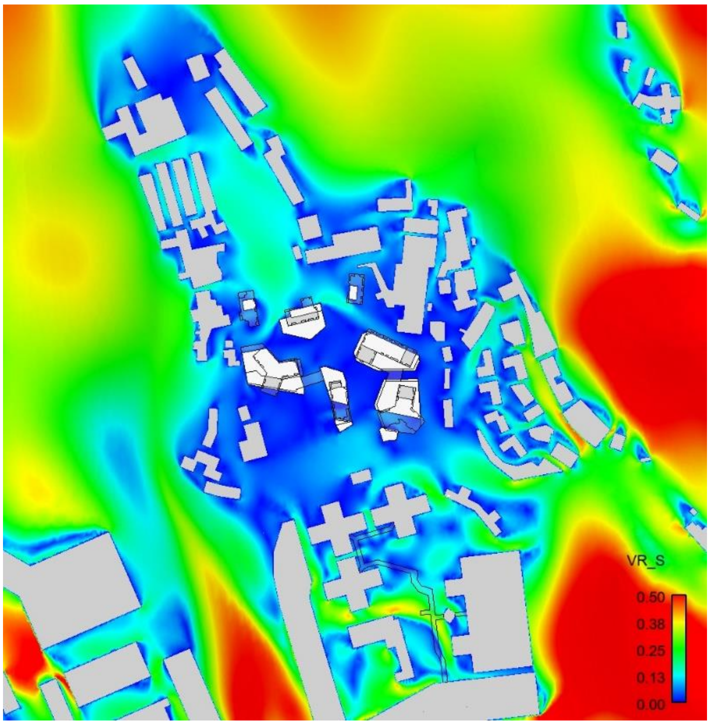


Figure C 67 Contour Plot of VR under S Wind

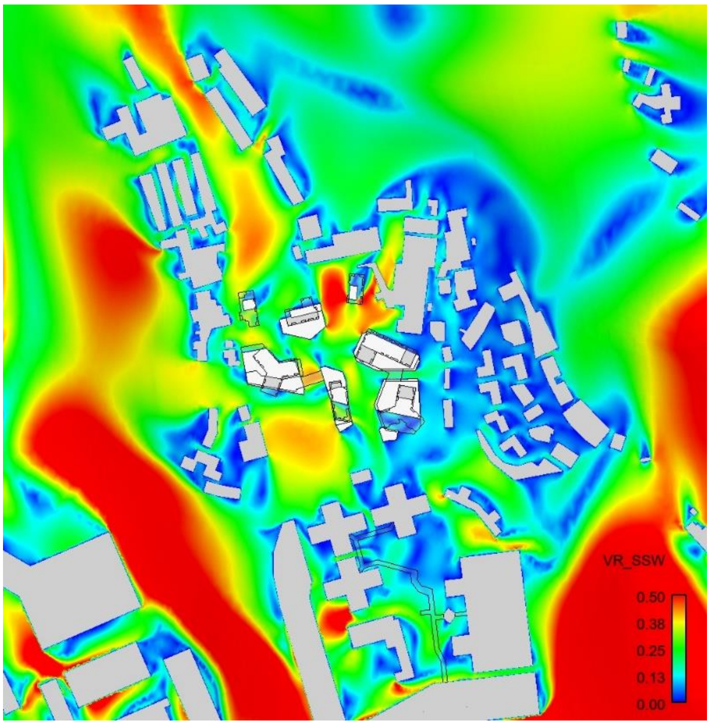


Figure C 68 Contour Plot of VR under SSW Wind

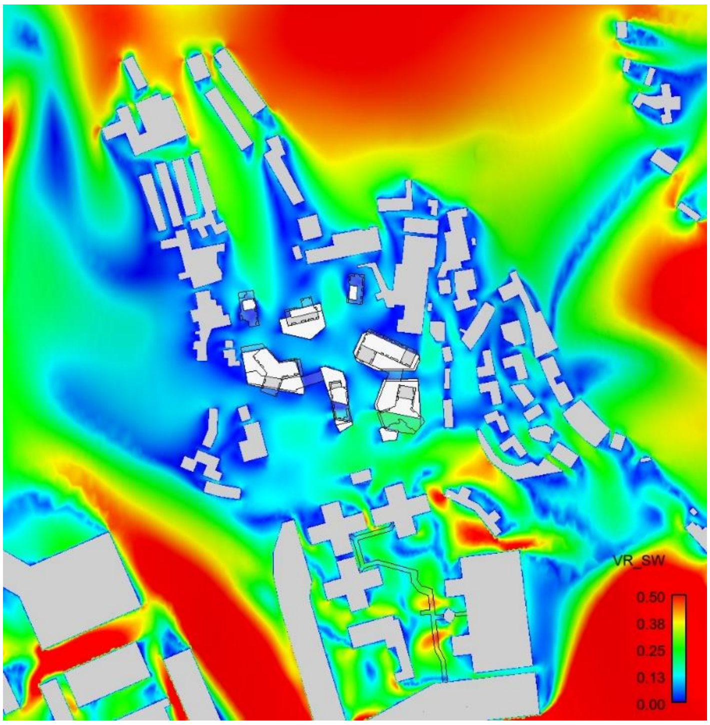


Figure C 69 Contour Plot of VR under SW Wind

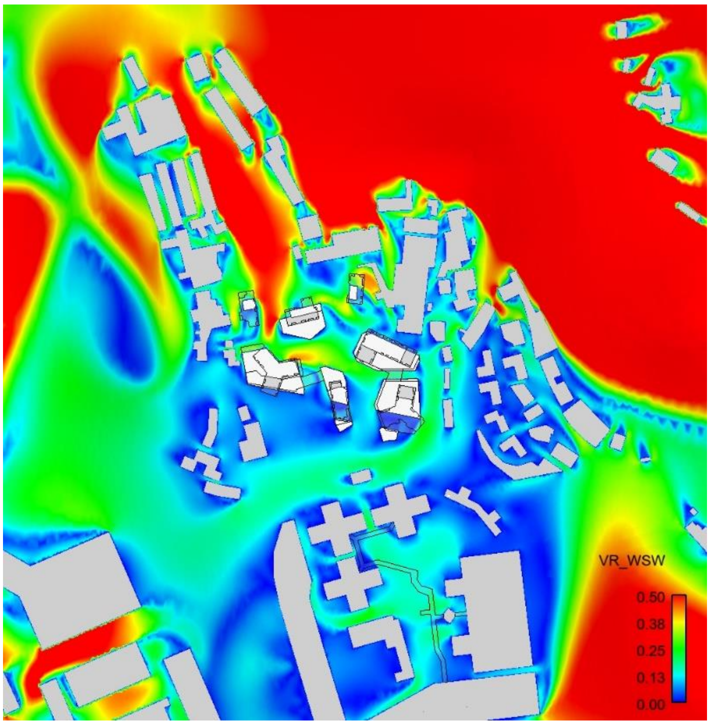


Figure C 70 Contour Plot of VR under WSW Wind

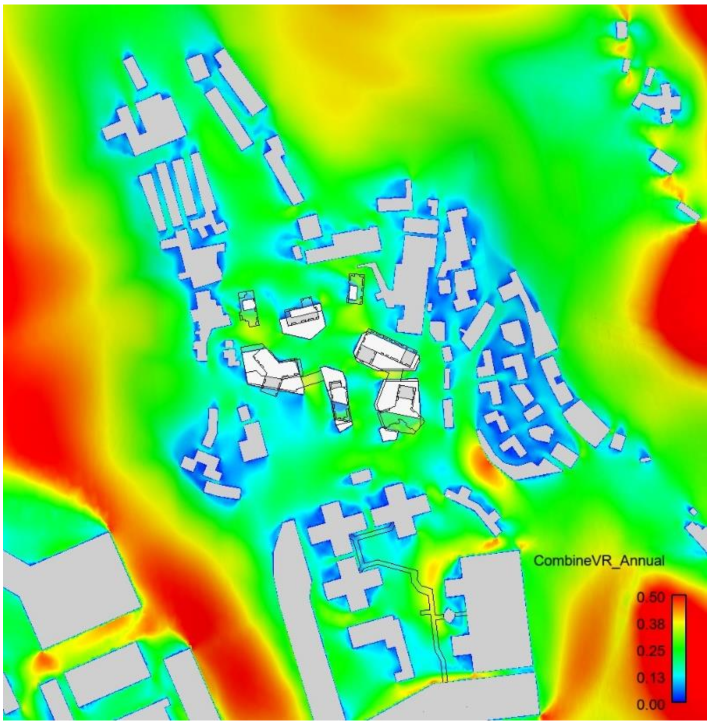


Figure C 71 Annual Weighted Average Contour Plot of VR

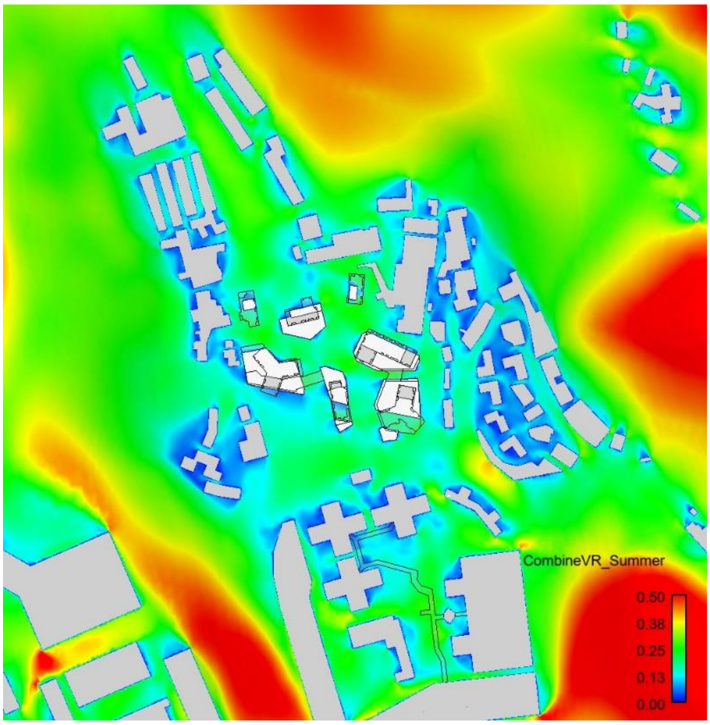


Figure C 72 Summer Weighted Average Contour Plot of VR

C7 Domain Plot of Baseline Scheme

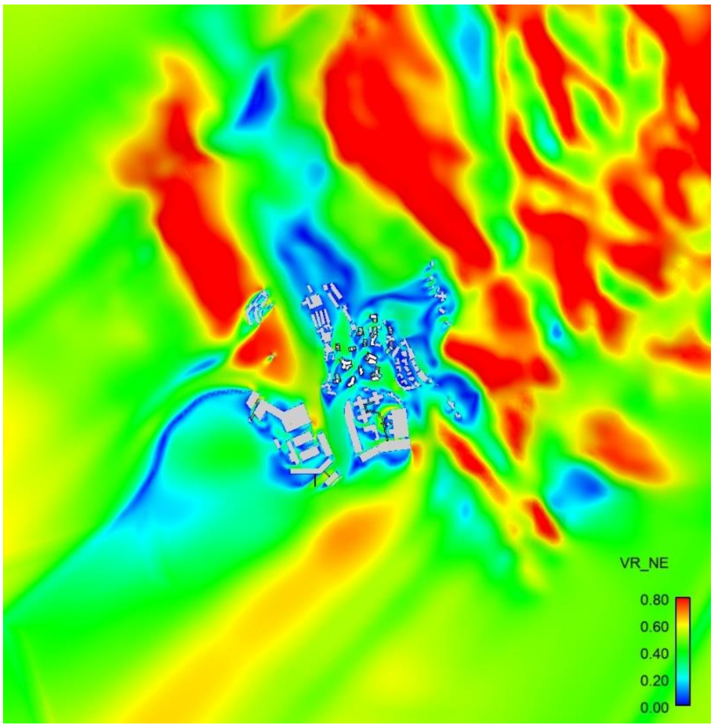


Figure C 73 Domain Contour Plot of VR under NE Wind

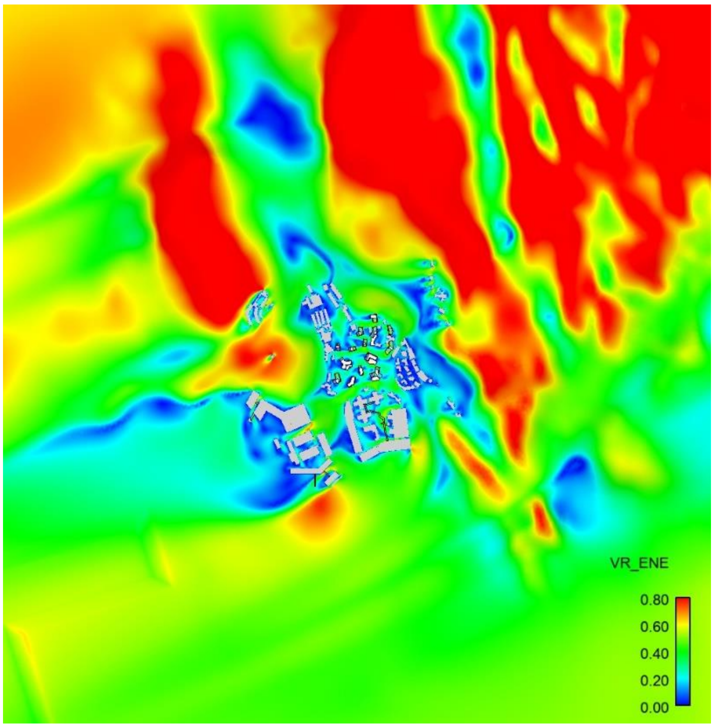


Figure C 74 Domain Contour Plot of VR under ENE Wind

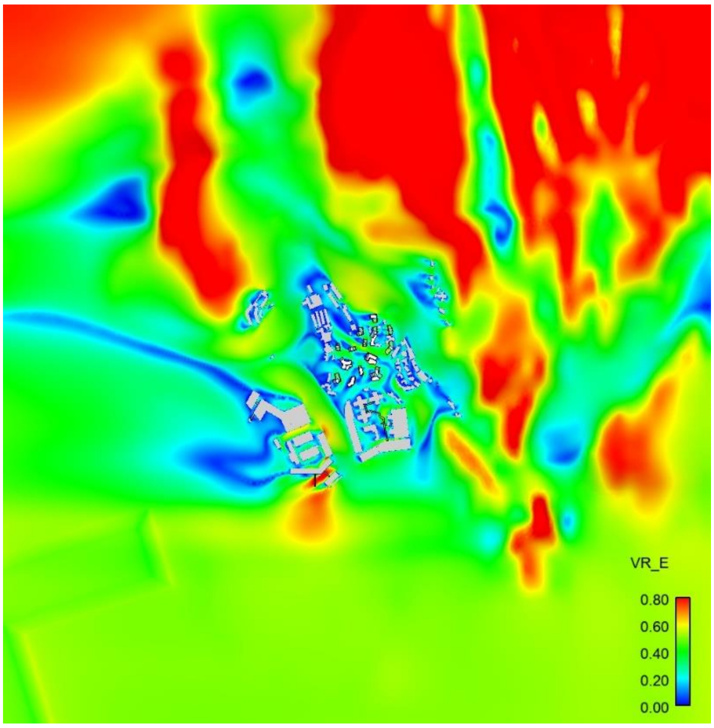


Figure C 75 Domain Contour Plot of VR under E Wind

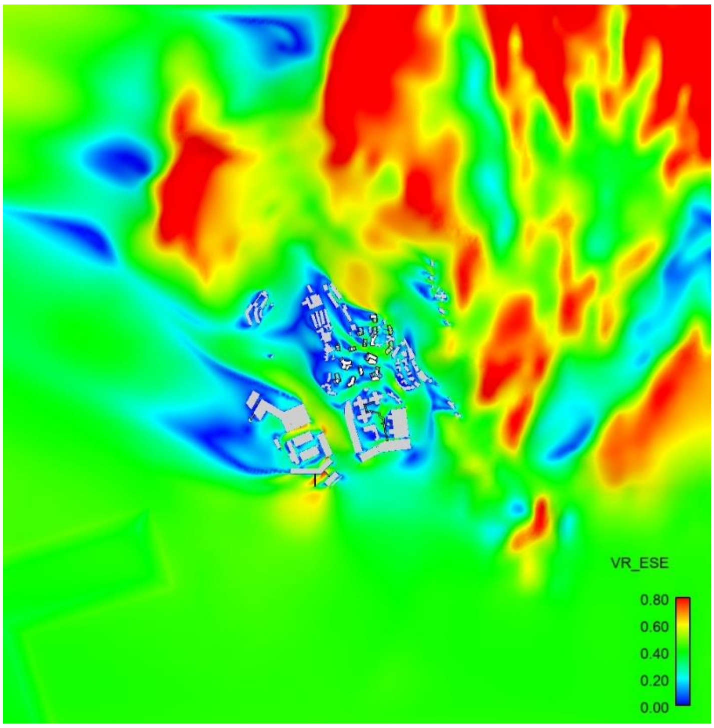


Figure C 76 Domain Contour Plot of VR under ESE Wind

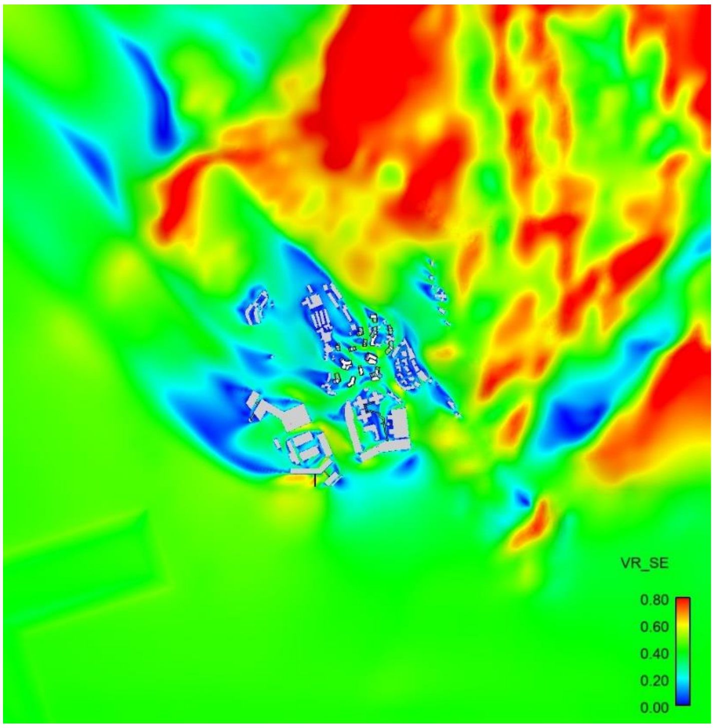


Figure C 77 Domain Contour Plot of VR under SE Wind

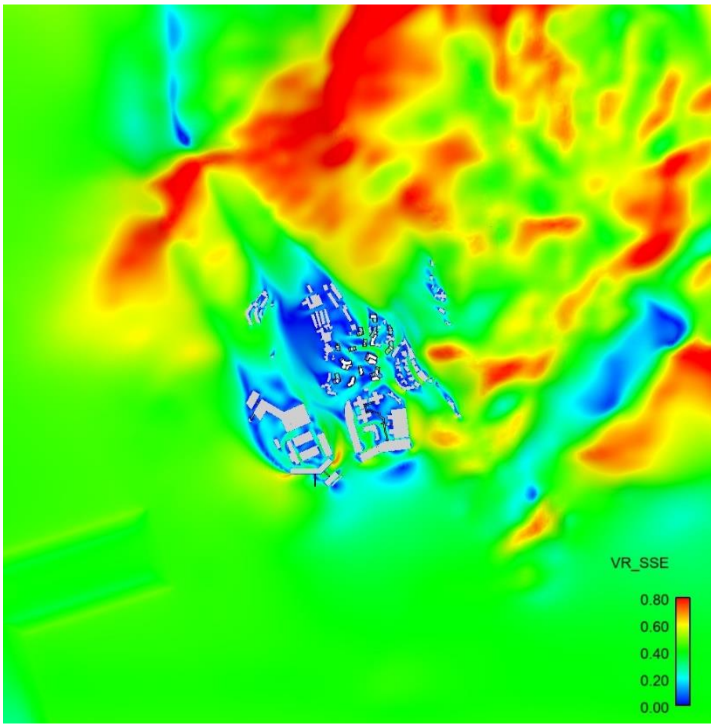


Figure C 78 Domain Contour Plot of VR under SSE Wind

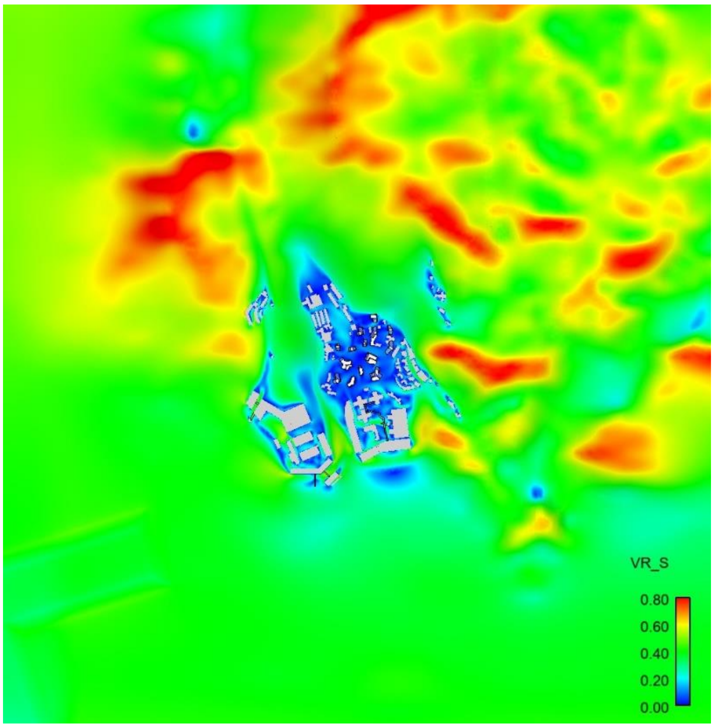


Figure C 79 Domain Contour Plot of VR under S Wind

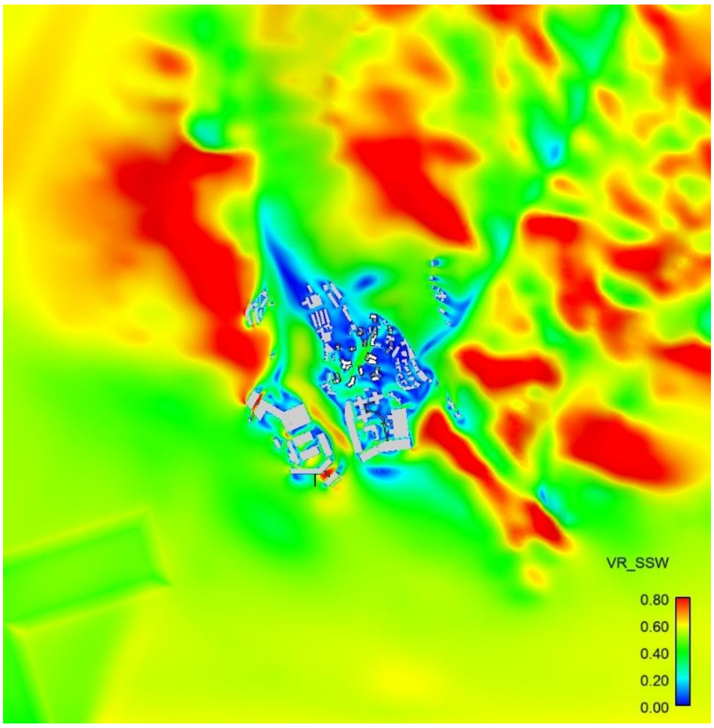


Figure C 80 Domain Contour Plot of VR under SSW Wind

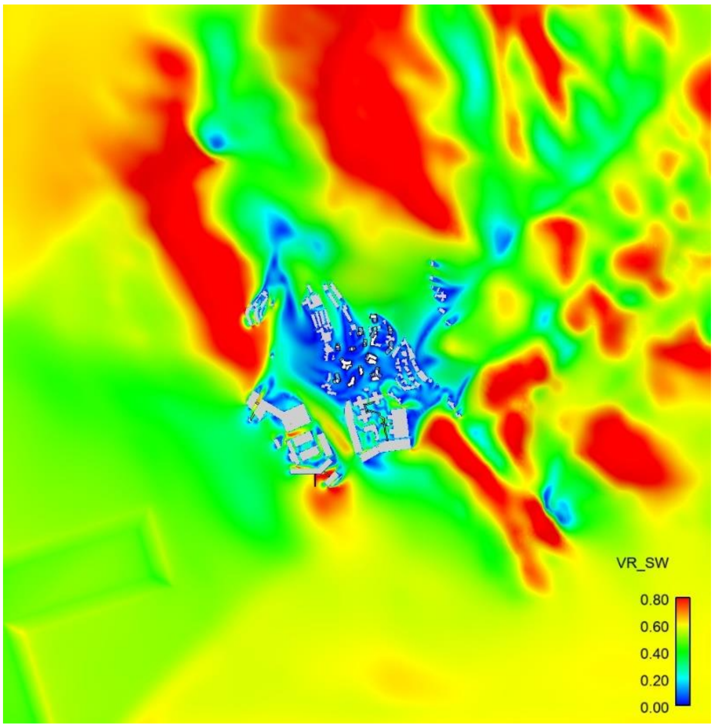


Figure C 81 Domain Contour Plot of VR under SW Wind

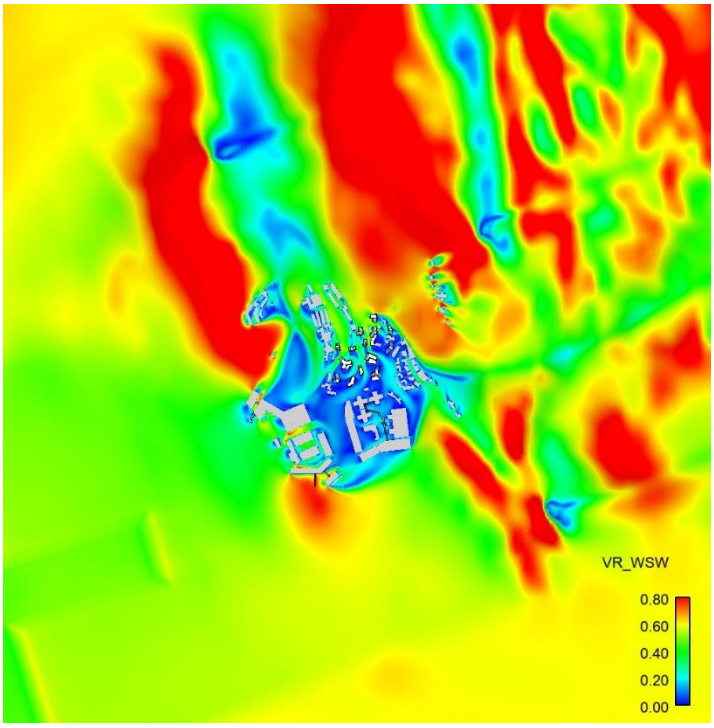


Figure C 82 Domain Contour Plot of VR under WSW Wind

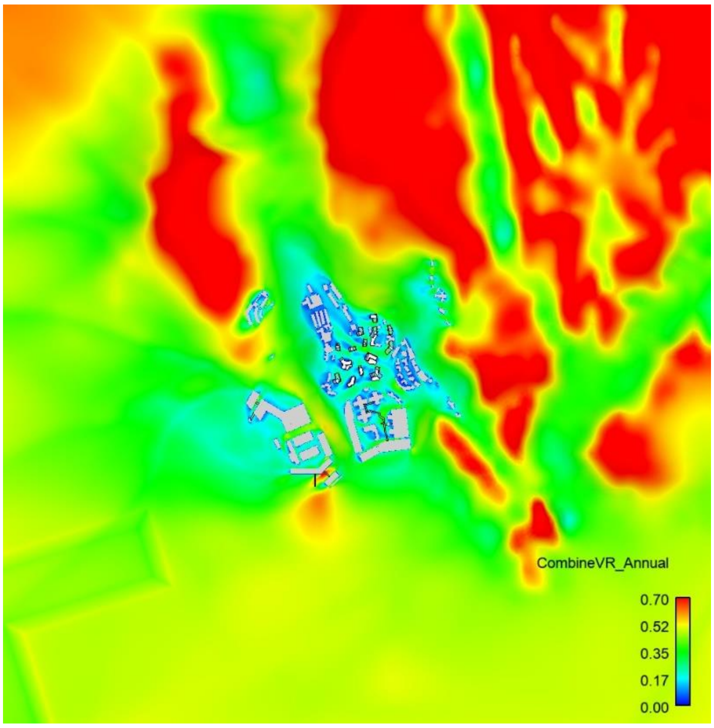


Figure C 83 Annual Weighted Average Domain Contour Plot of VR

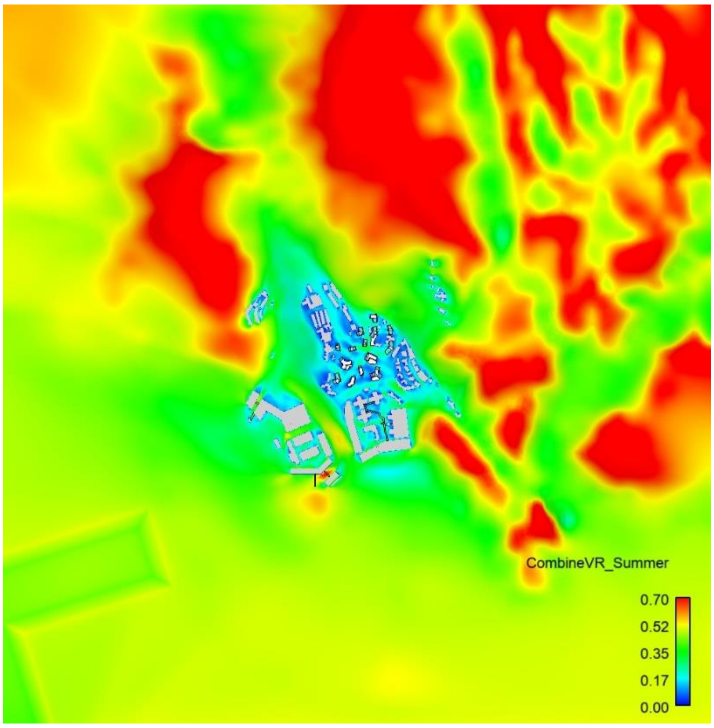


Figure C 84 Summer Weighted Average Domain Contour Plot of VR

C8 Domain Plot of Proposed Scheme

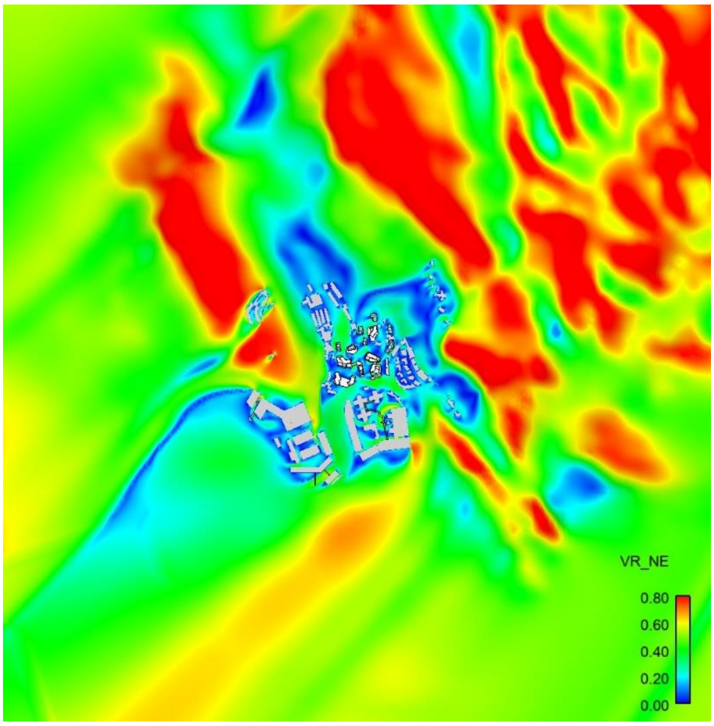


Figure C 85 Domain Contour Plot of VR under NE Wind

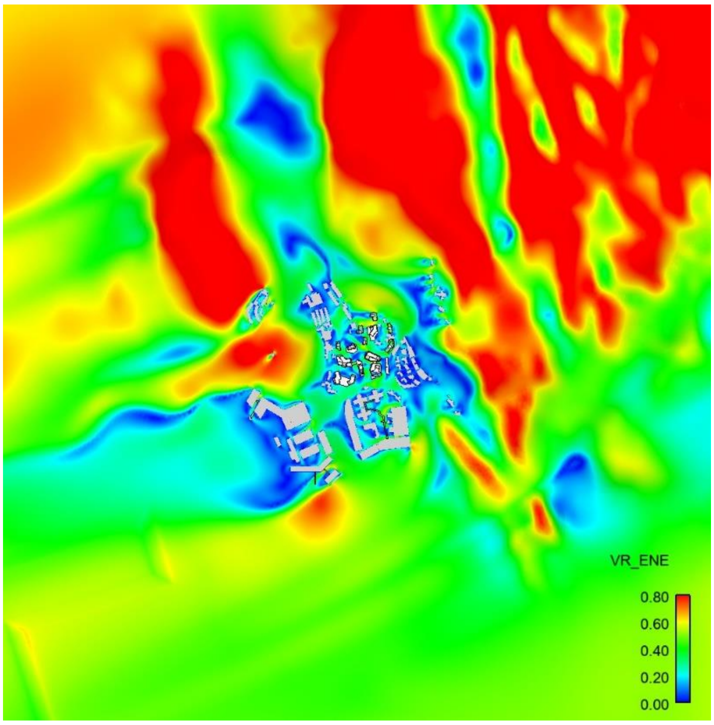


Figure C 86 Domain Contour Plot of VR under ENE Wind

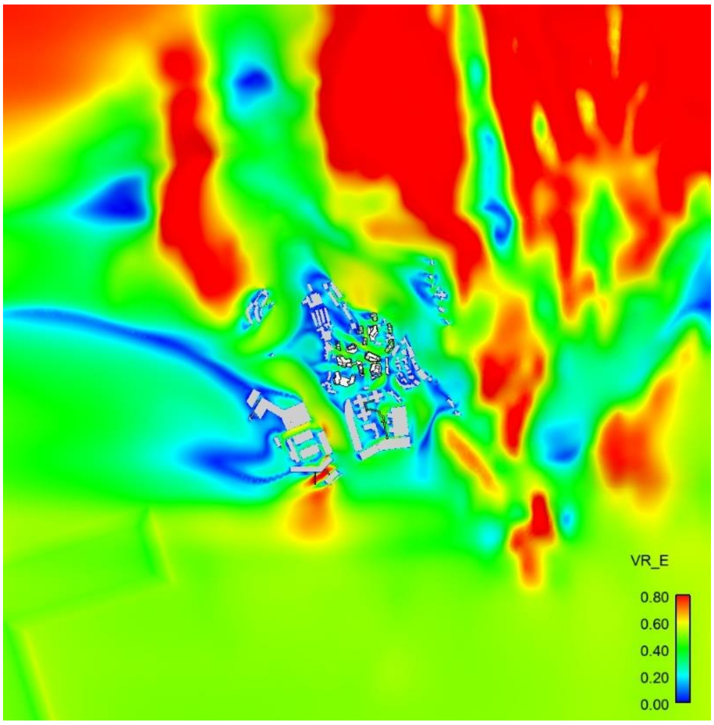


Figure C 87 Domain Contour Plot of VR under E Wind

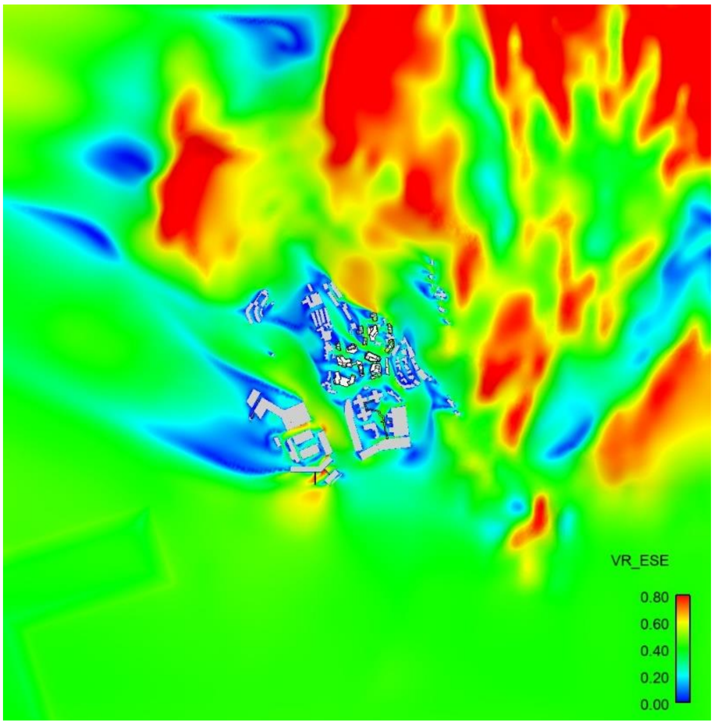


Figure C 88 Domain Contour Plot of VR under ESE Wind

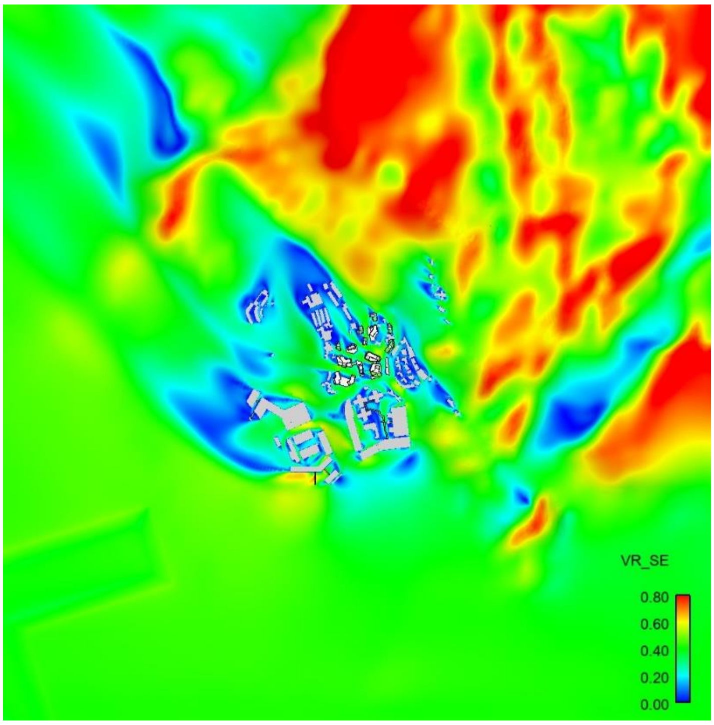


Figure C 89 Domain Contour Plot of VR under SE Wind

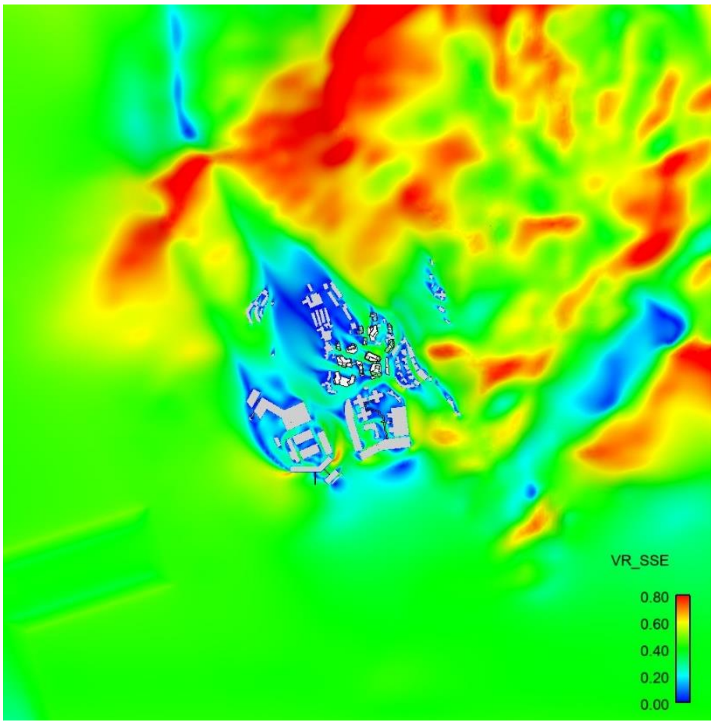


Figure C 90 Domain Contour Plot of VR under SSE Wind

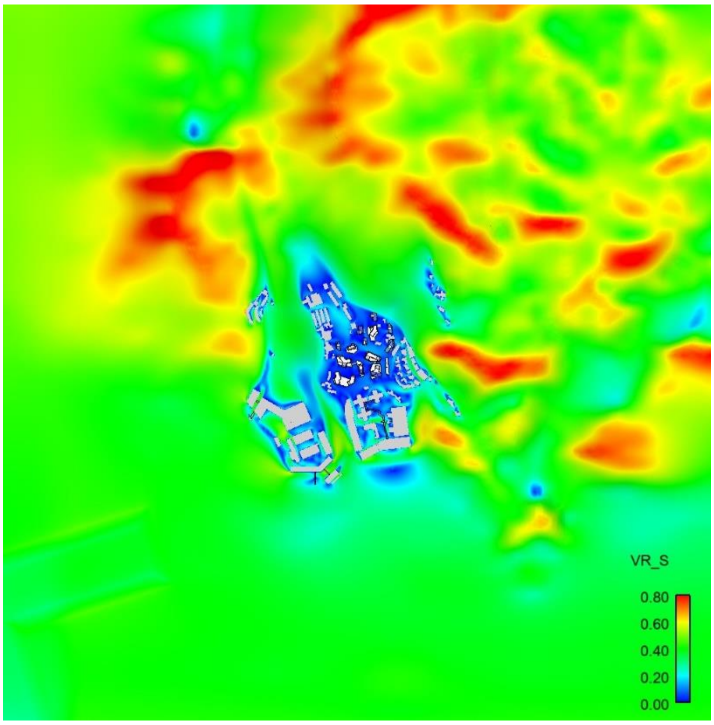


Figure C 91 Domain Contour Plot of VR under S Wind

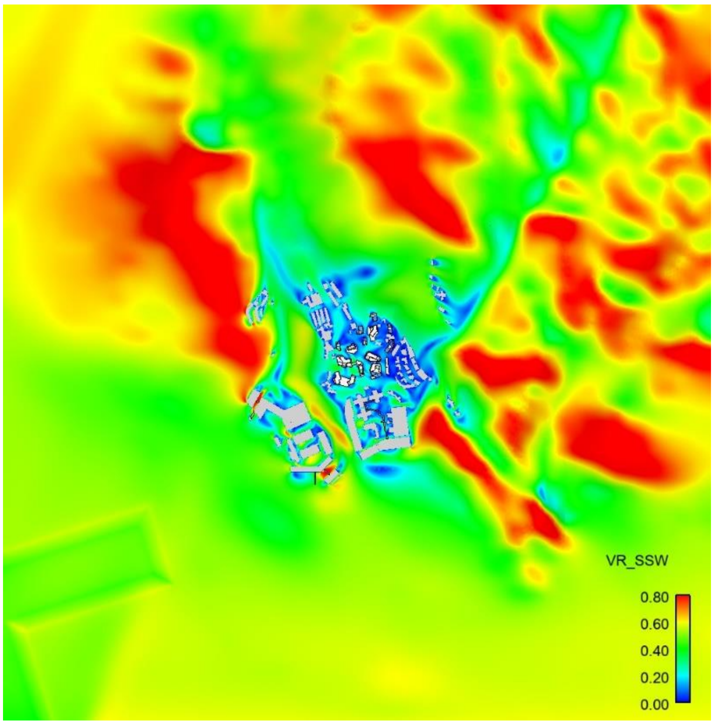


Figure C 92 Domain Contour Plot of VR under SSW Wind

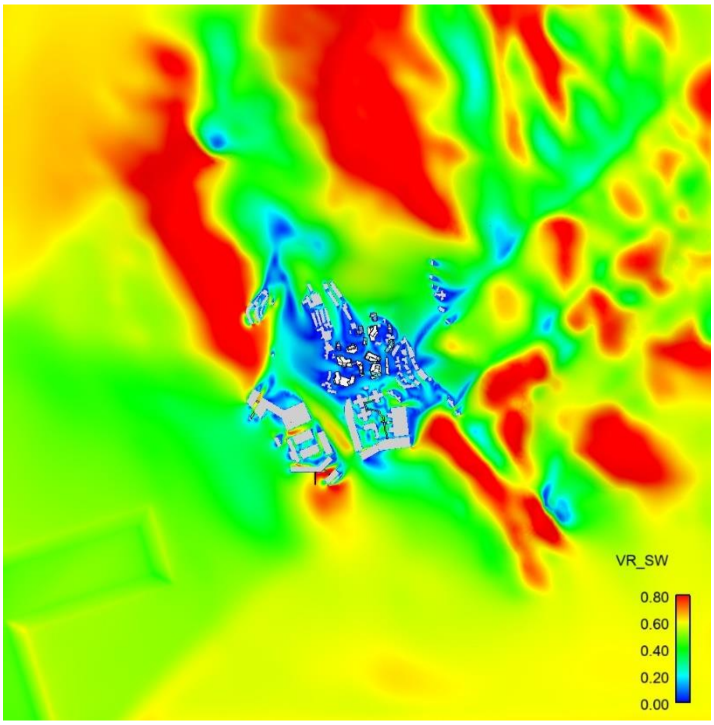


Figure C 93 Domain Contour Plot of VR under SW Wind

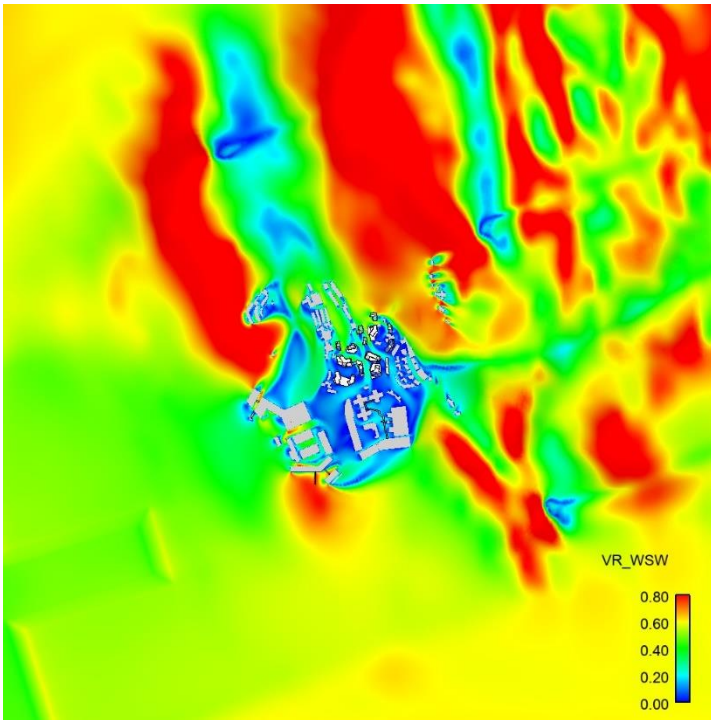


Figure C 94 Domain Contour Plot of VR under WSW Wind

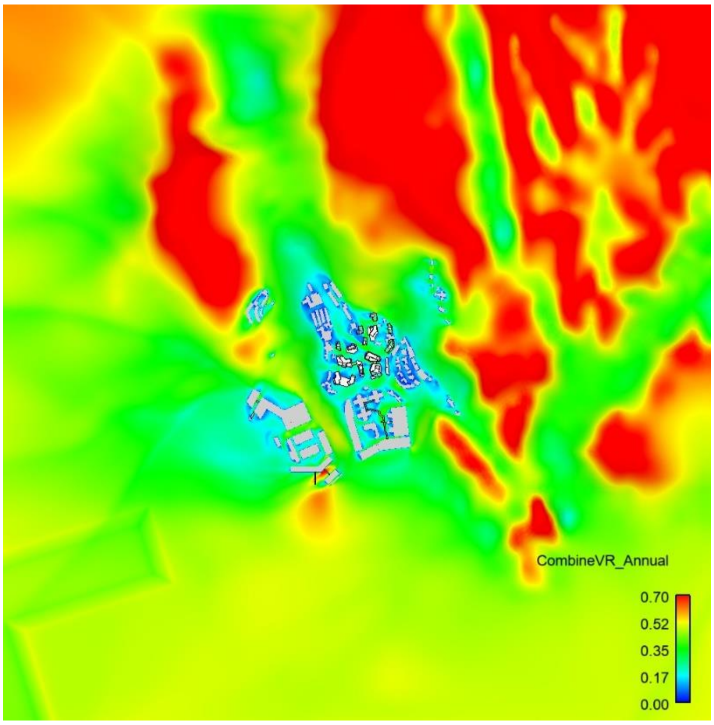


Figure C 95 Annual Weighted Average Domain Contour Plot of VR

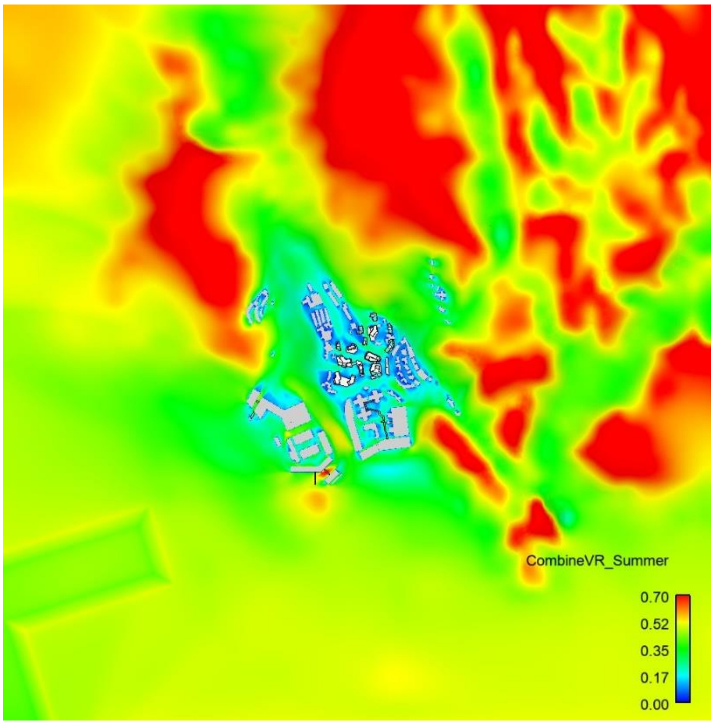


Figure C 96 Summer Weighted Average Domain Contour Plot of VR

C9 Domain Plot of Interim Scheme

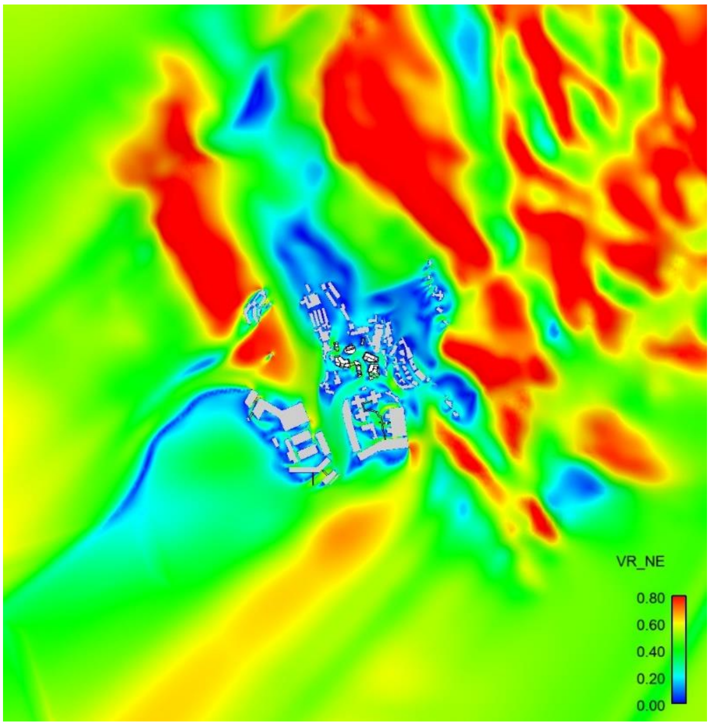


Figure C 97 Domain Contour Plot of VR under NE Wind

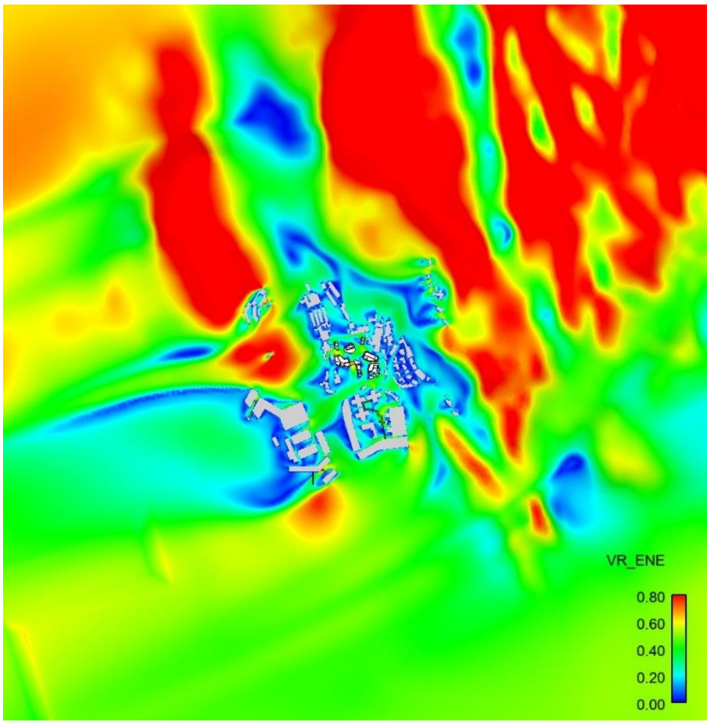


Figure C 98 Domain Contour Plot of VR under ENE Wind

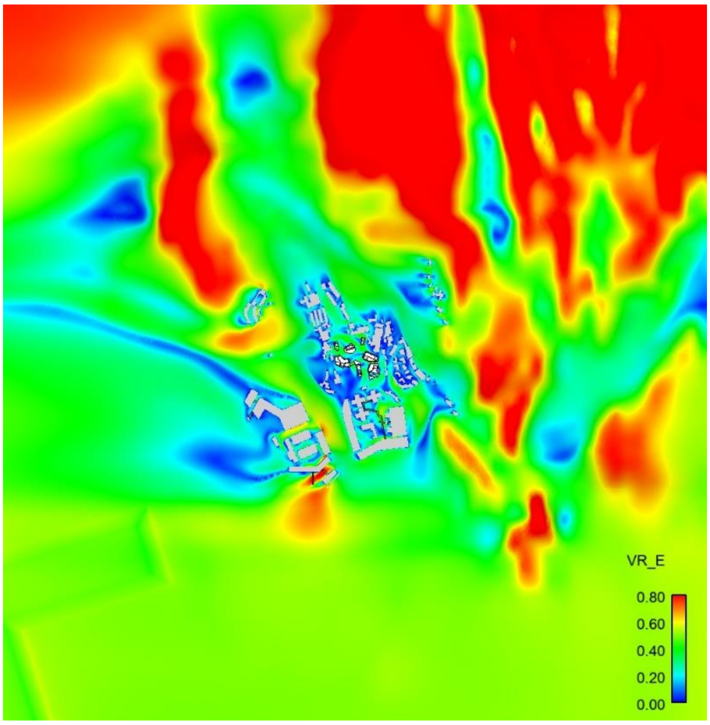


Figure C 99 Domain Contour Plot of VR under E Wind

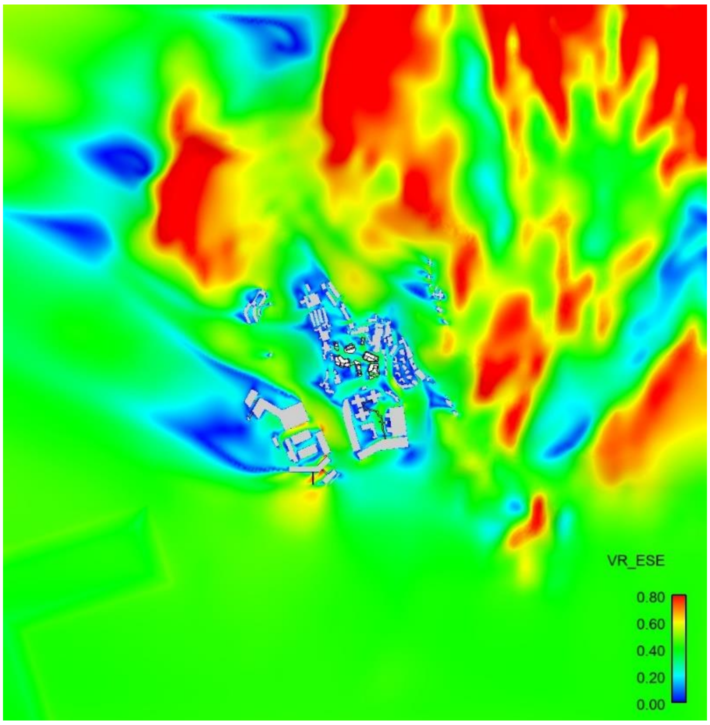


Figure C 100 Domain Contour Plot of VR under ESE Wind

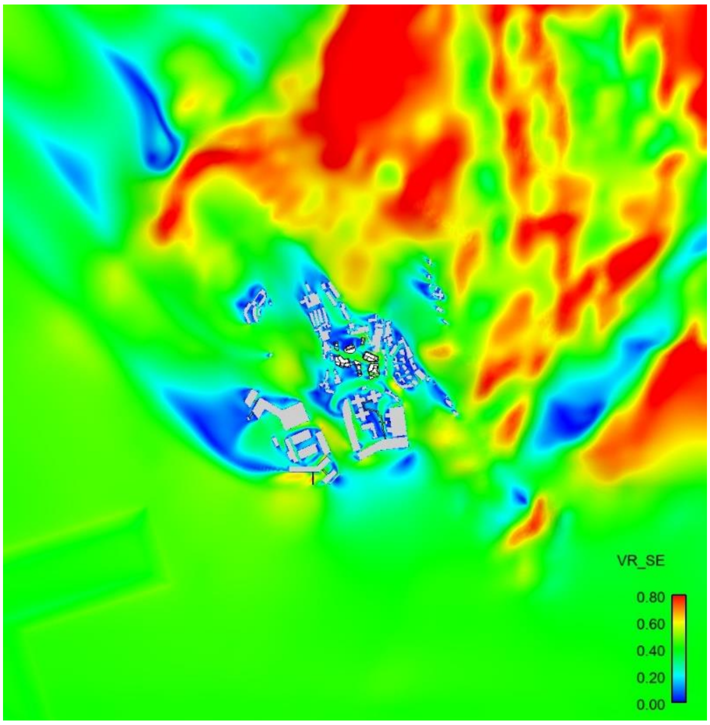


Figure C 101 Domain Contour Plot of VR under SE Wind

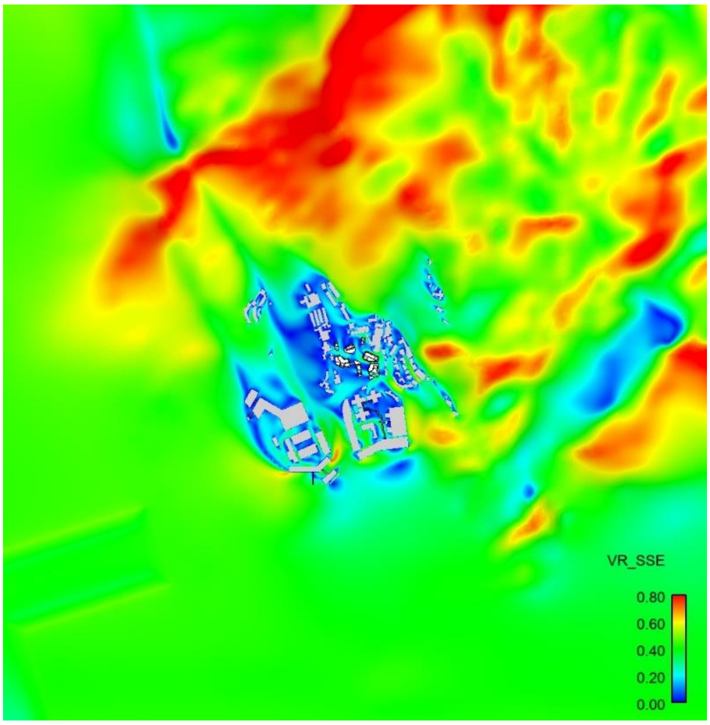


Figure C 102 Domain Contour Plot of VR under SSE Wind

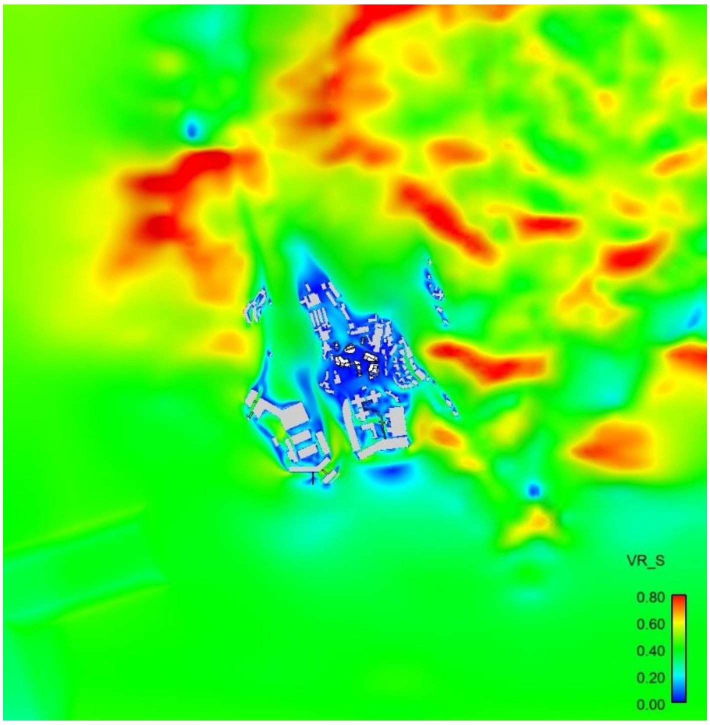


Figure C 103 Domain Contour Plot of VR under S Wind

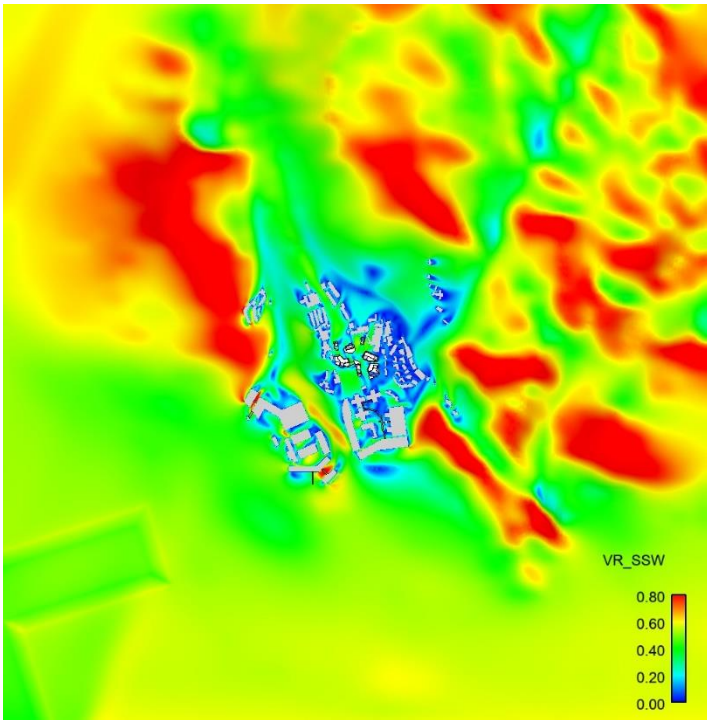


Figure C 104 Domain Contour Plot of VR under SSW Wind

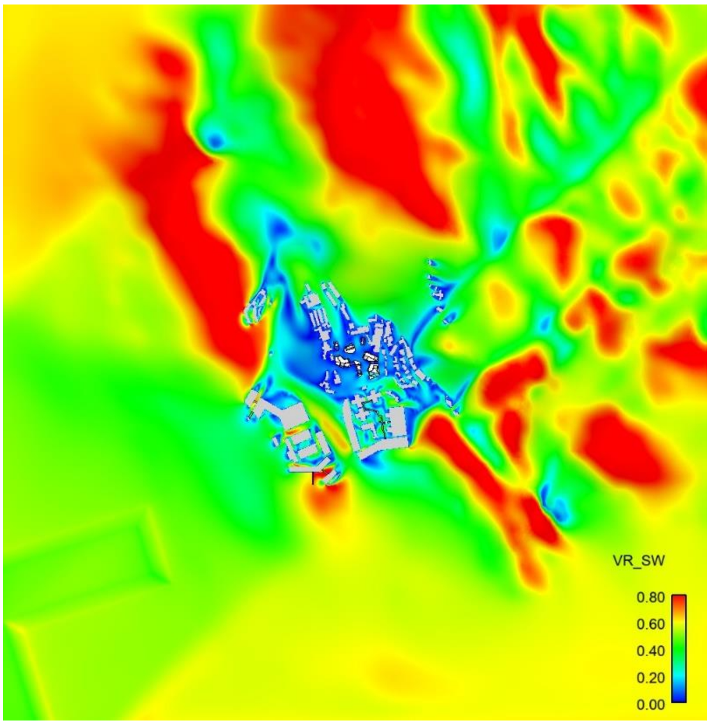


Figure C 105 Domain Contour Plot of VR under SW Wind

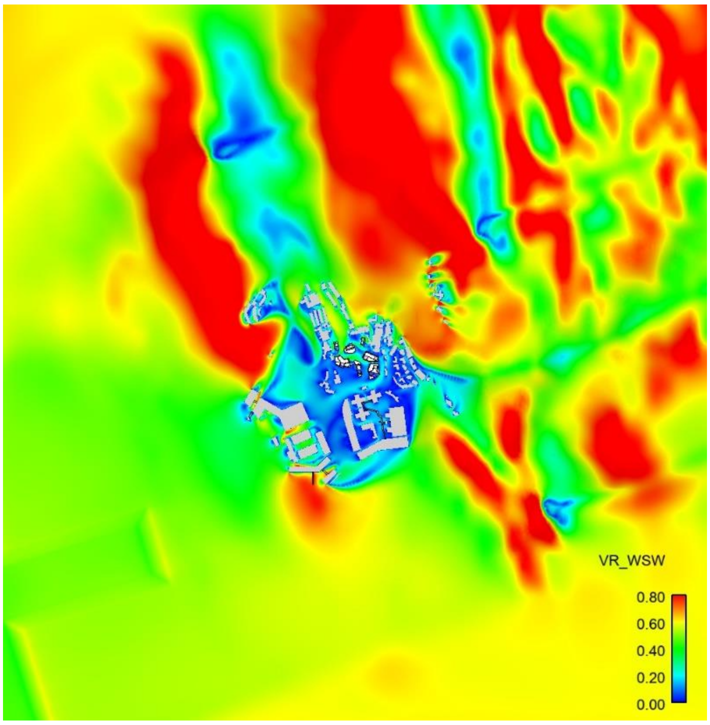


Figure C 106 Domain Contour Plot of VR under WSW Wind

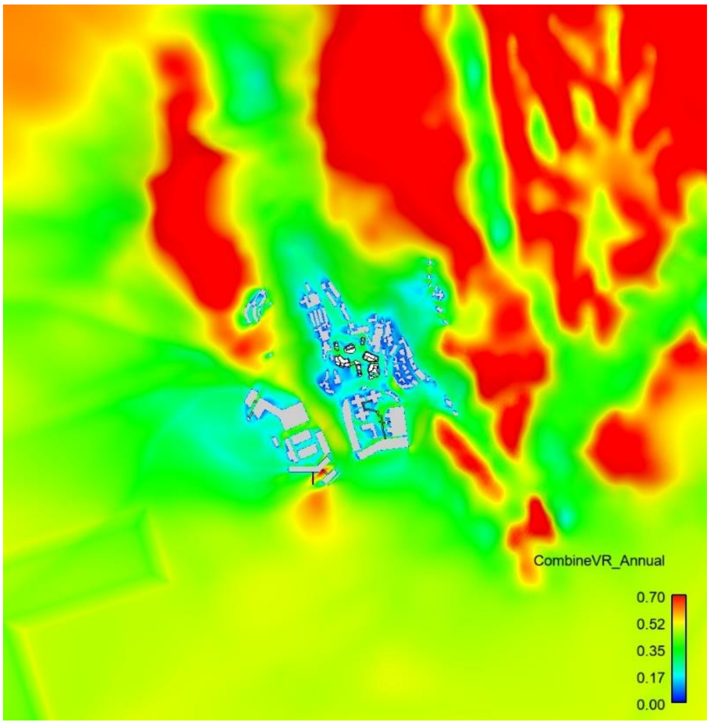


Figure C 107 Annual Weighted Average Domain Contour Plot of VR

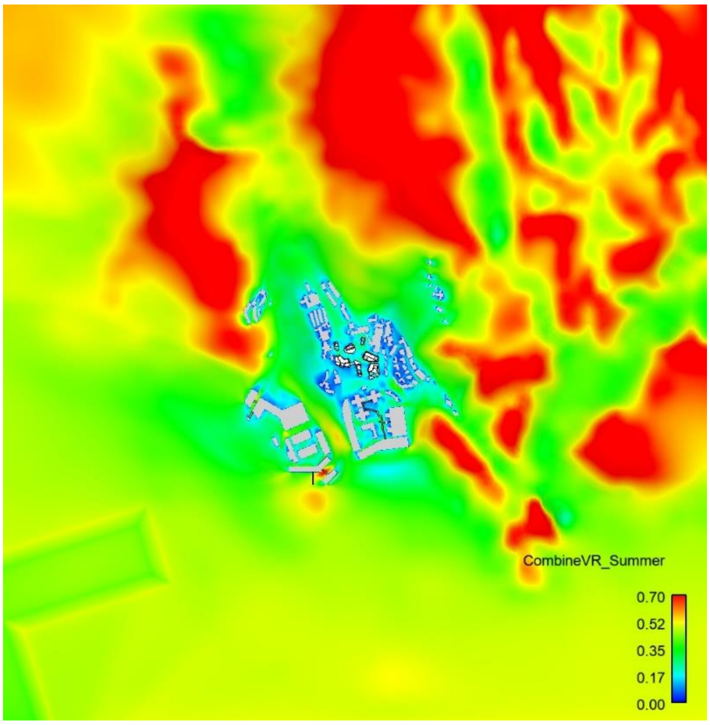


Figure C 108 Summer Weighted Average Domain Contour Plot of VR

Appendix D

Vector Plots of Velocity Ratio (VR)

Contents

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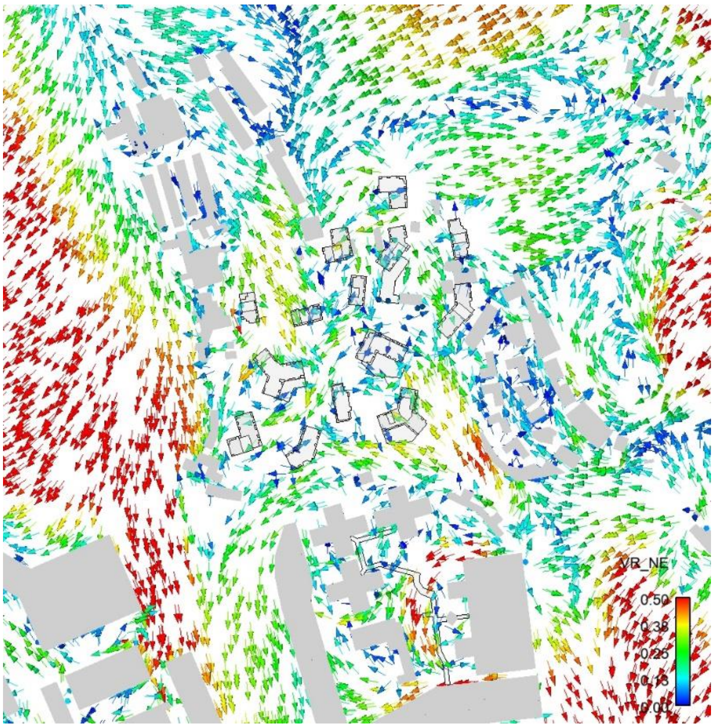


Figure D 1 Vector Plot of VR under NE Wind

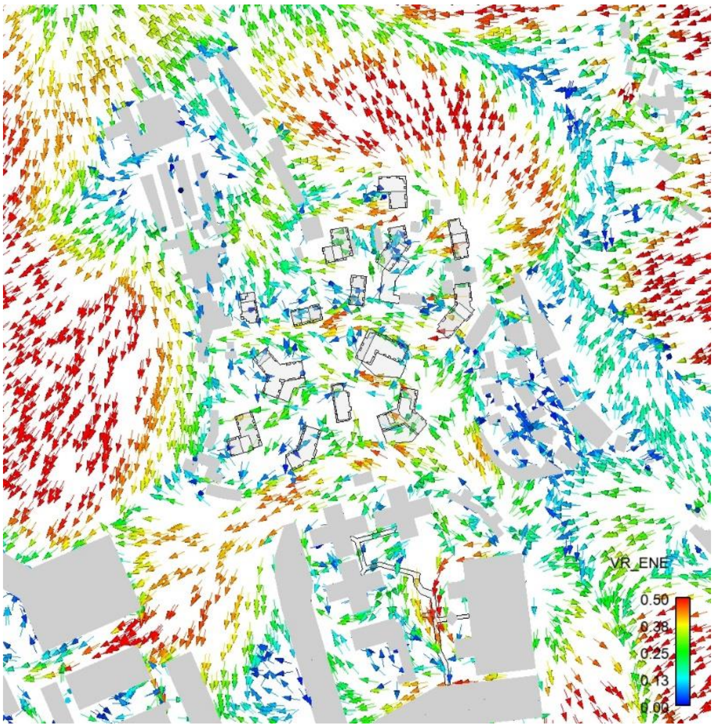


Figure D 2 Vector Plot of VR under ENE Wind

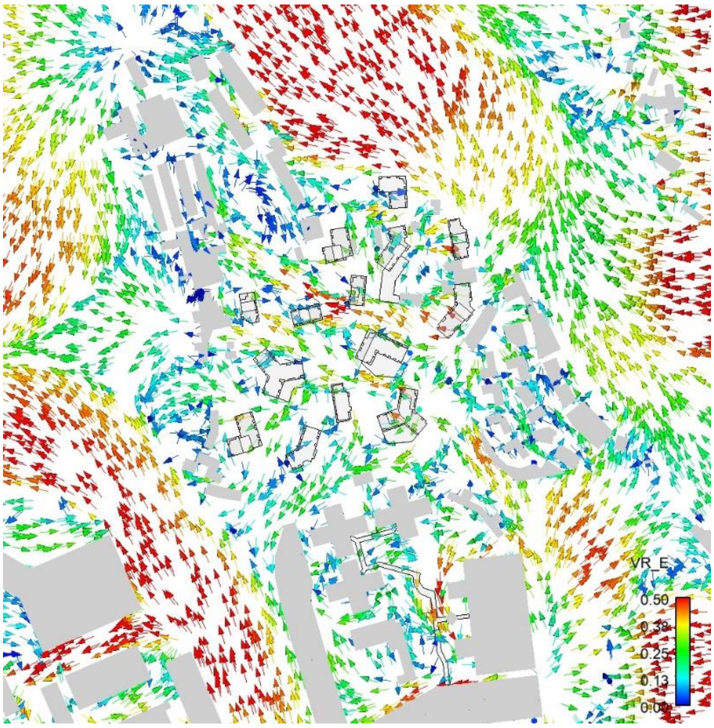


Figure D 3 Vector Plot of VR under E Wind

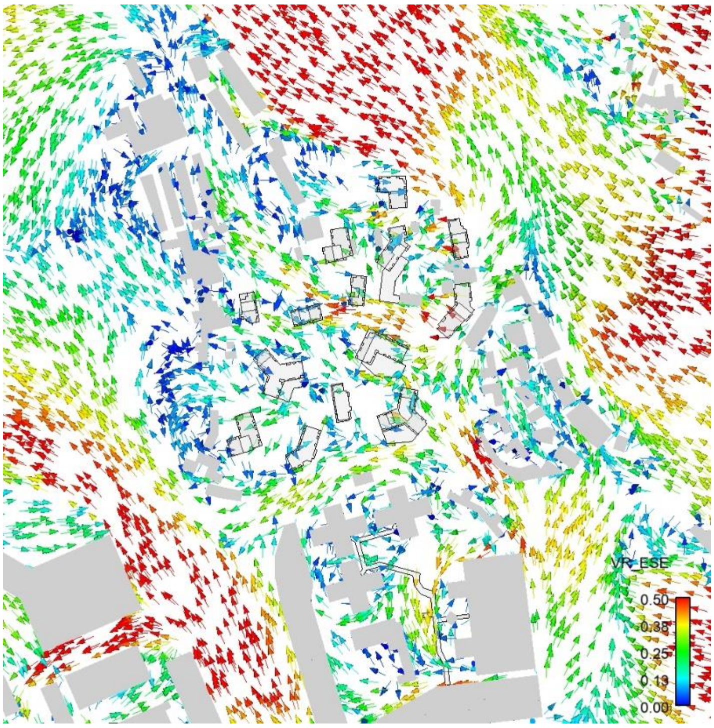


Figure D 4 Vector Plot of VR under ESE Wind

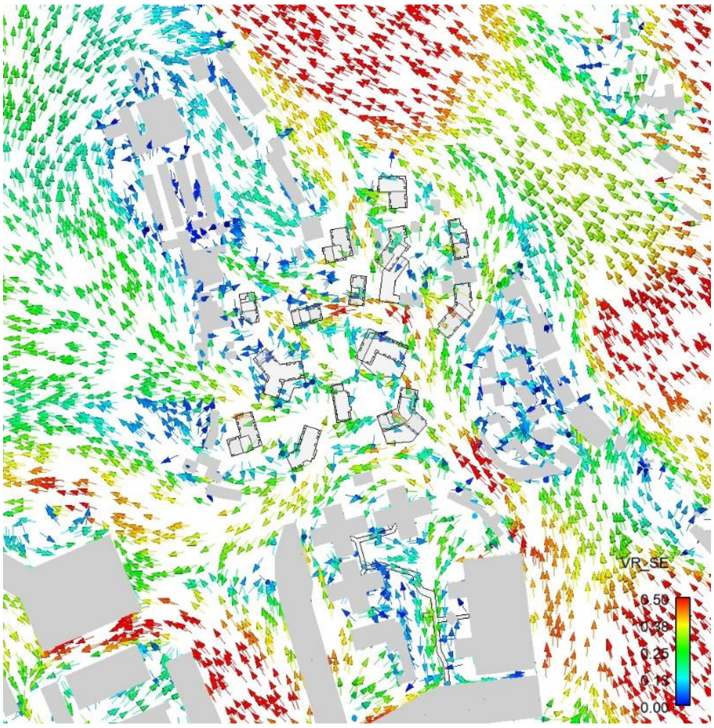


Figure D 5 Vector Plot of VR under SE Wind

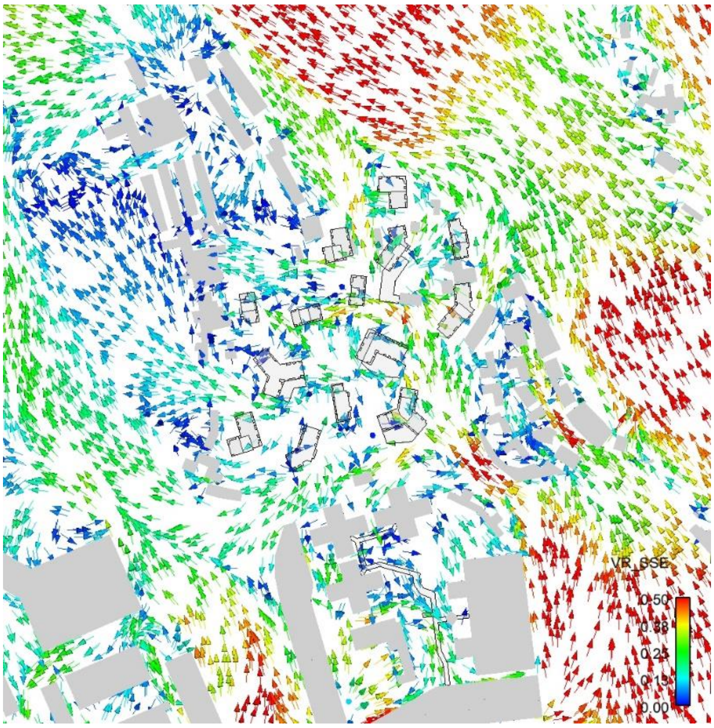


Figure D 6 Vector Plot of VR under SSE Wind\

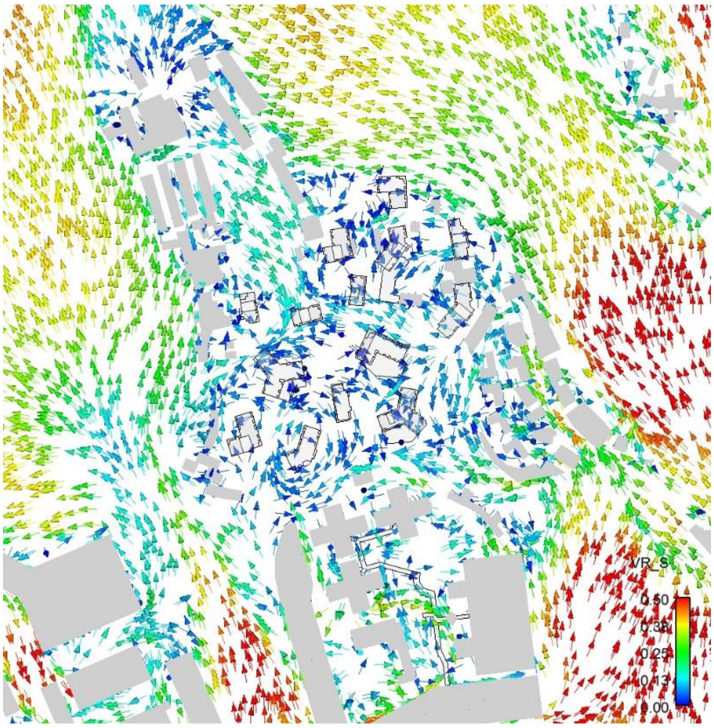


Figure D 7 Vector Plot of VR under S Wind

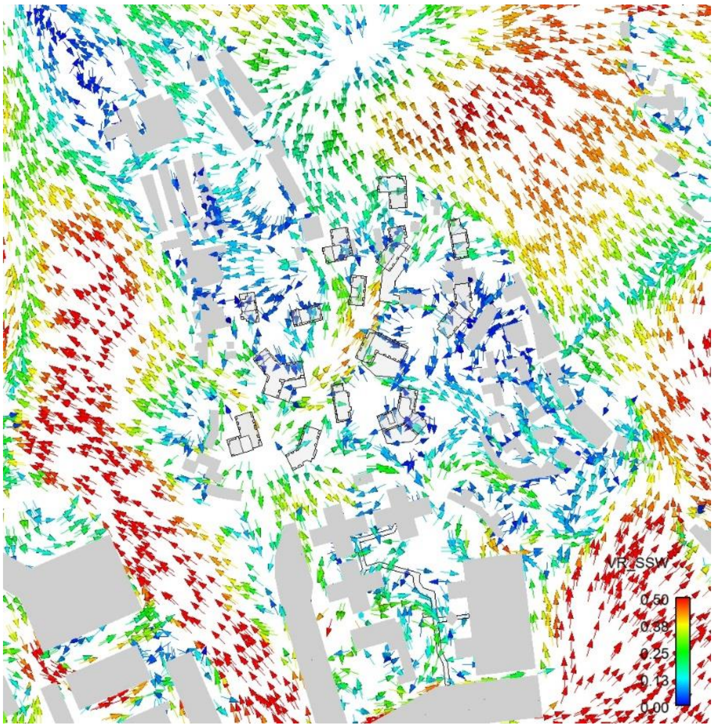


Figure D 8 Vector Plot of VR under SSW Wind

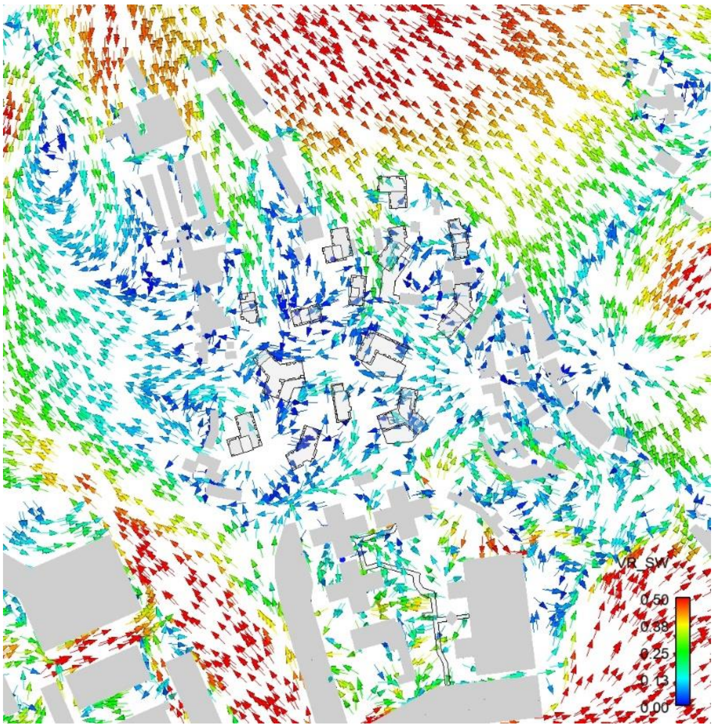


Figure D 9 Vector Plot of VR under SW Wind

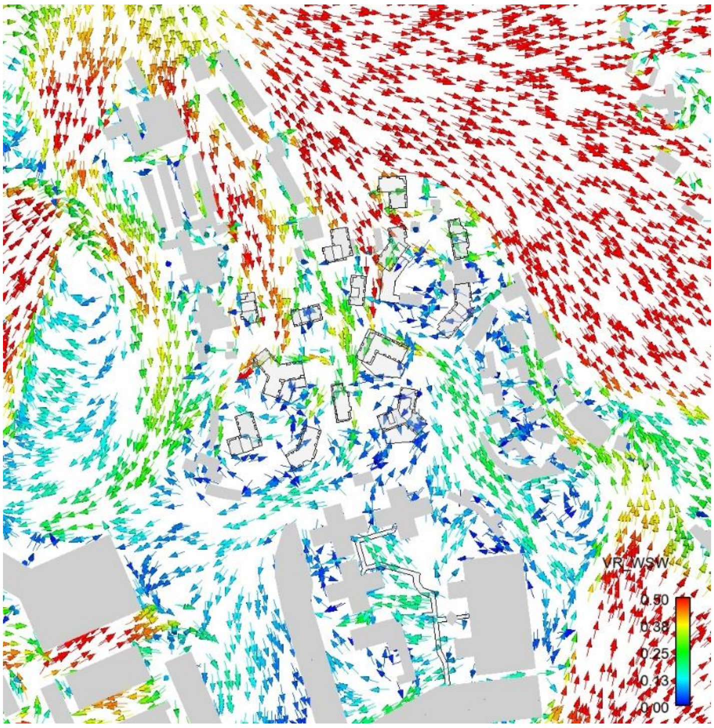


Figure D 10 Vector Plot of VR under WSW Wind

D2 Proposed Scheme

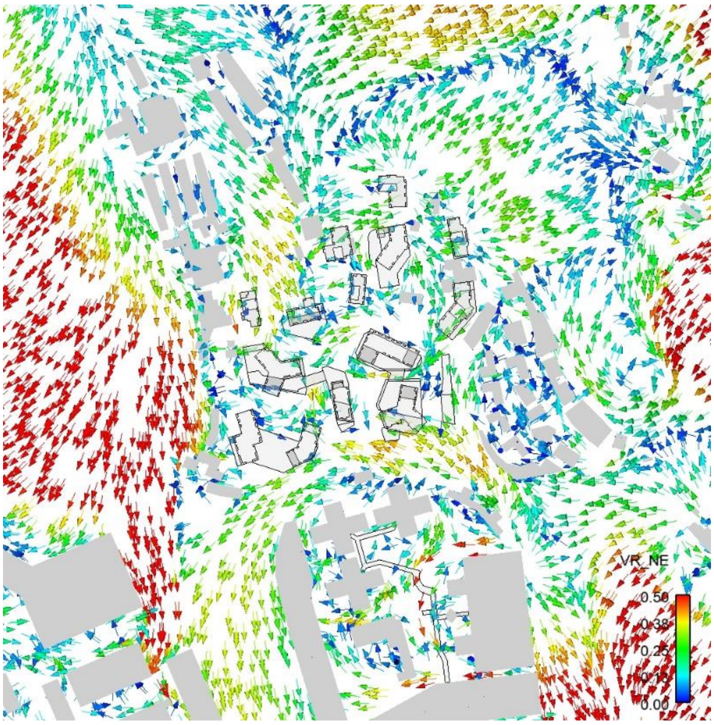


Figure D 11 Vector Plot of VR under NE Wind

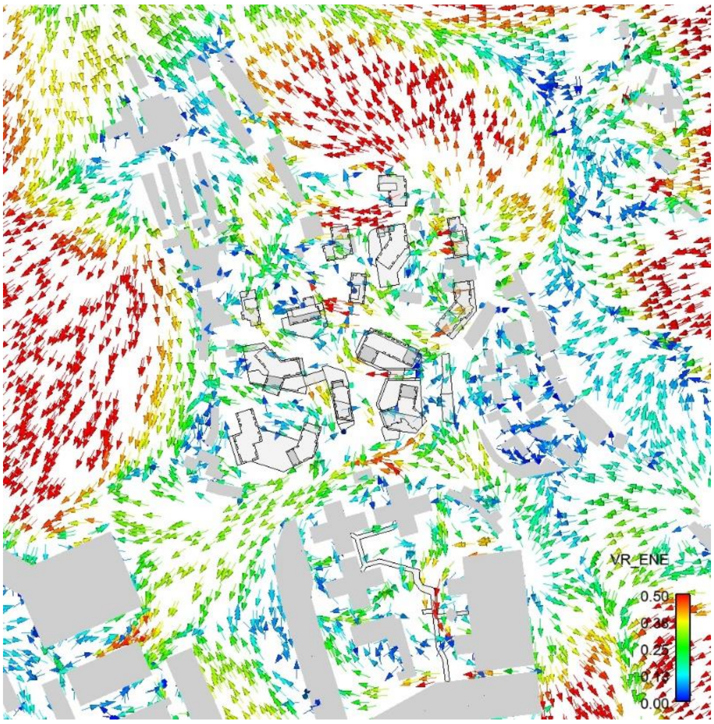


Figure D 12 Vector Plot of VR under ENE Wind

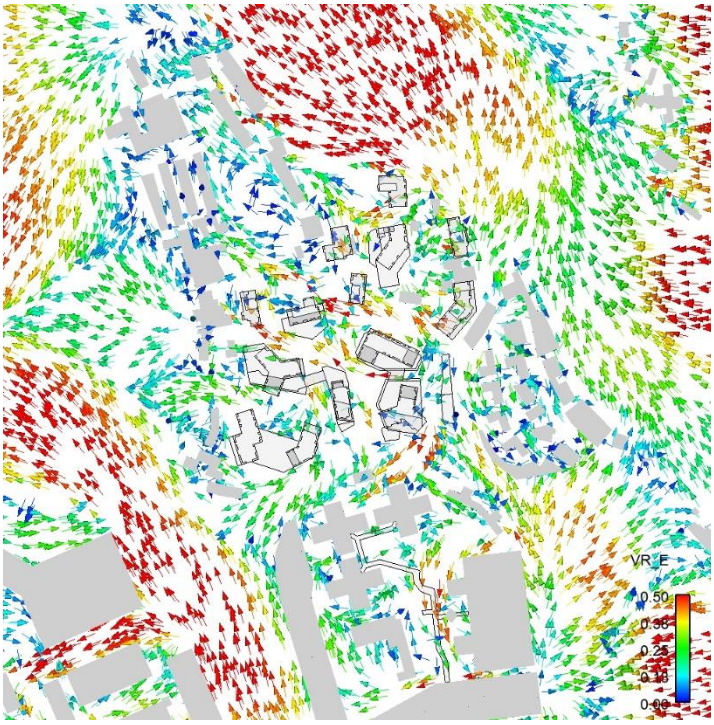


Figure D 13 Vector Plot of VR under E Wind

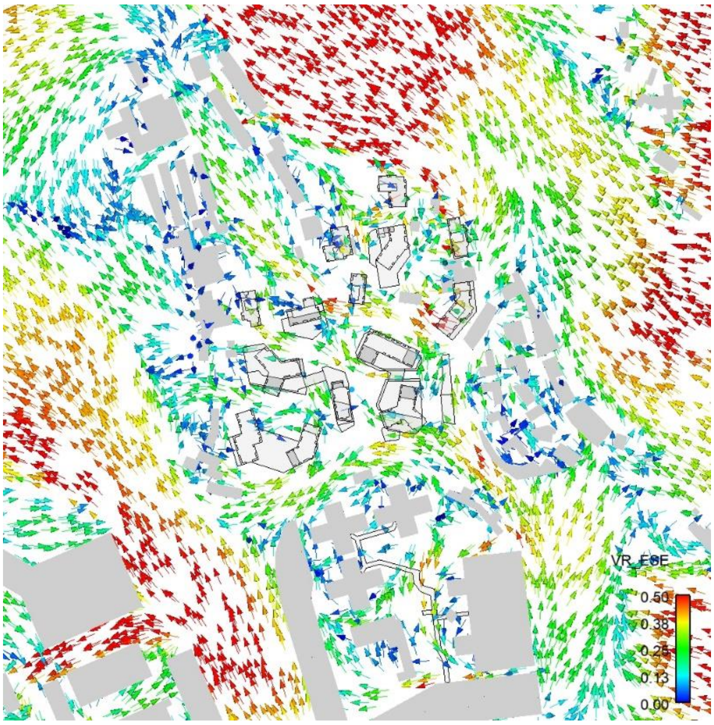


Figure D 14 Vector Plot of VR under ESE Wind

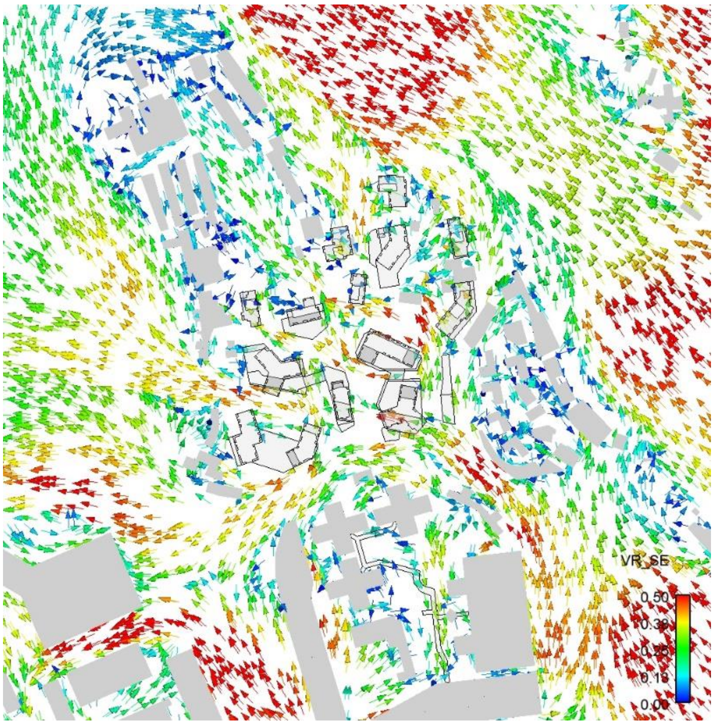


Figure D 15 Vector Plot of VR under SE Wind

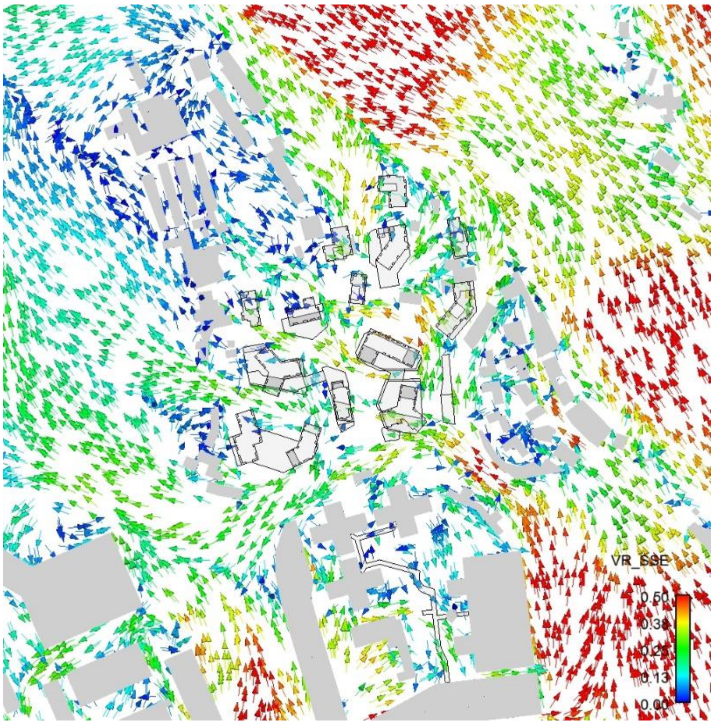
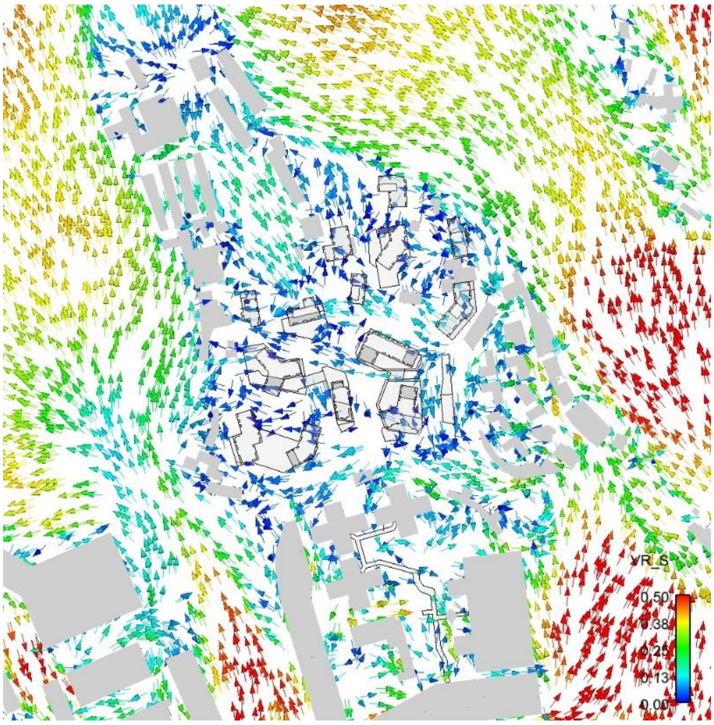


Figure D 16 Vector Plot of VR under SSE Wind



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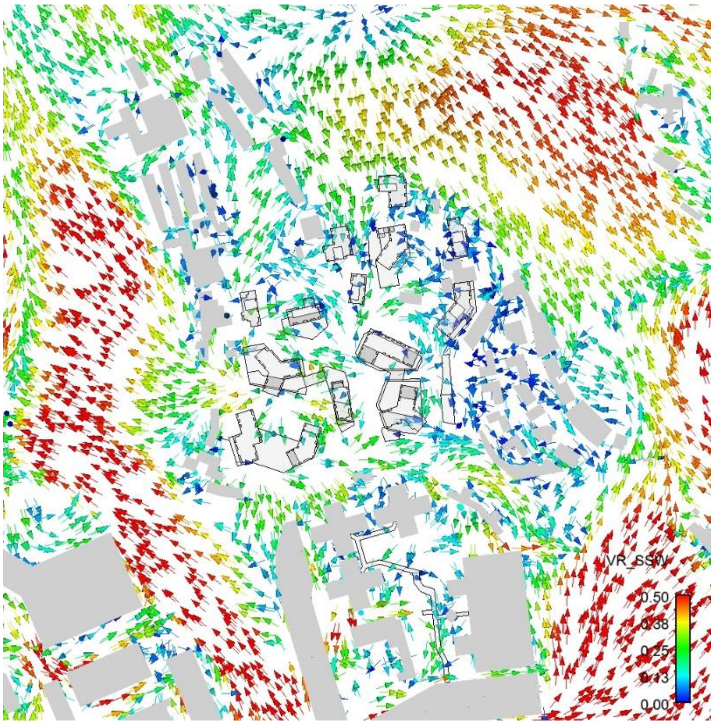

Figure D 18 Vector Plot of VR under SSW Wind

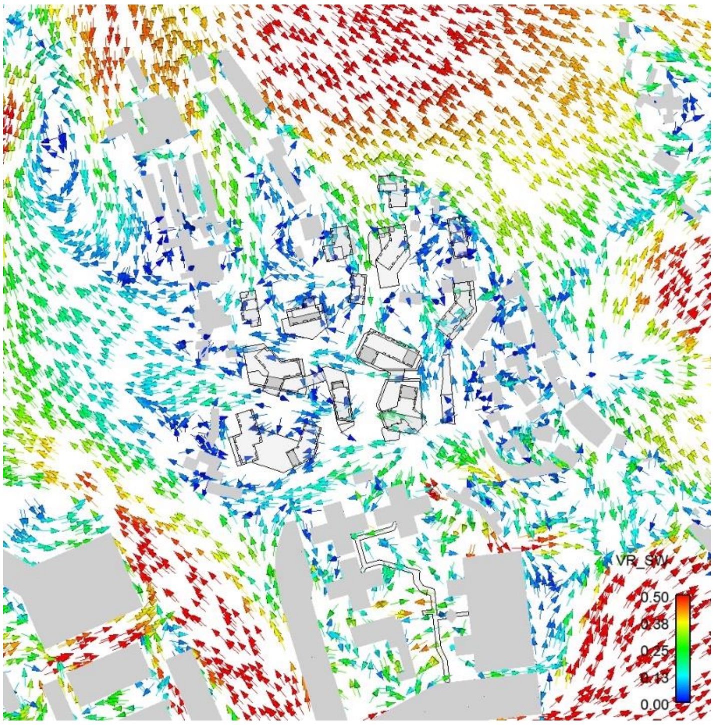

Figure D 19 Vector Plot of VR under SW Wind

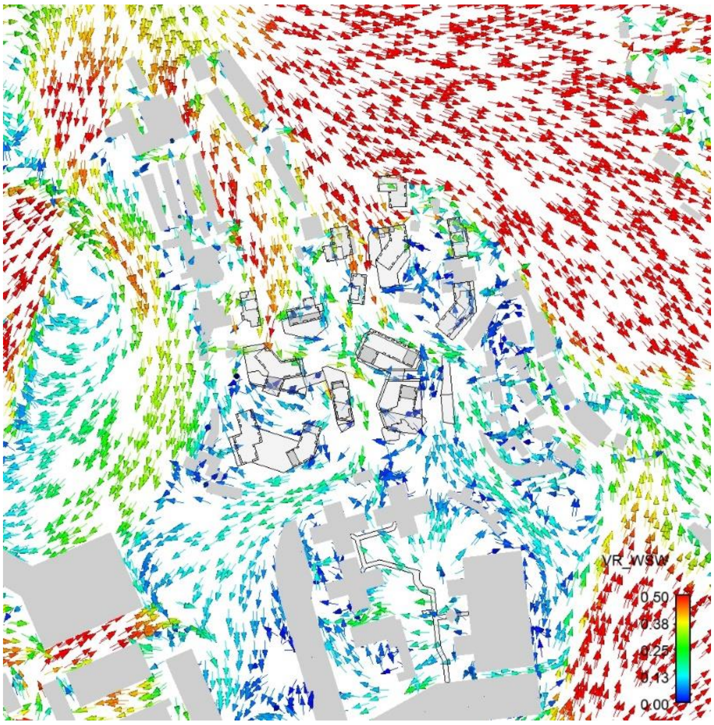

Figure D 20 Vector Plot of VR under WSW Wind

D3 Interim Scheme

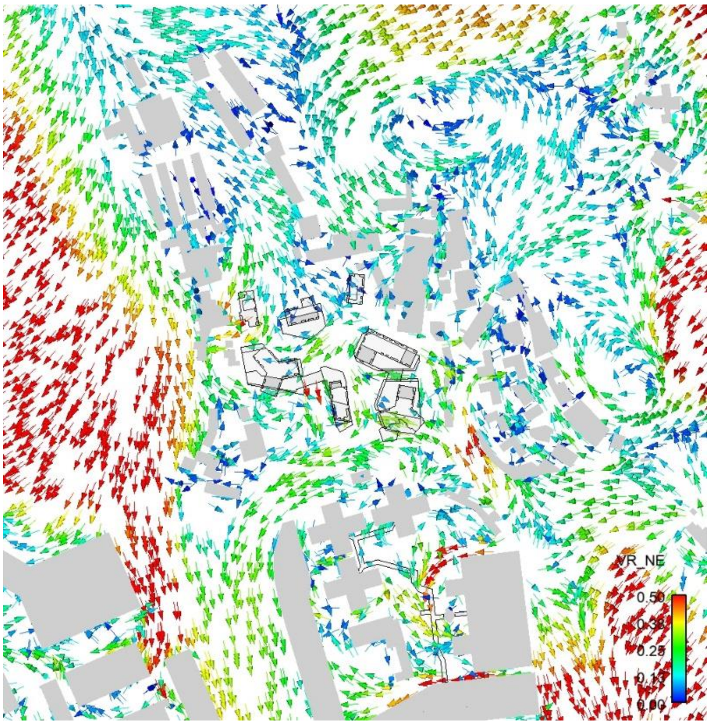

Figure D 21 Vector Plot of VR under NE Wind

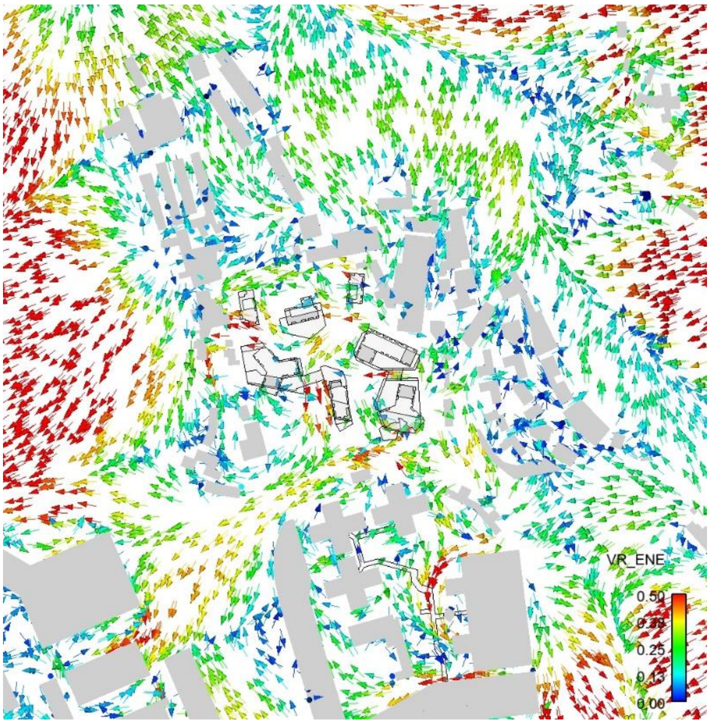

Figure D 22 Vector Plot of VR under ENE Wind

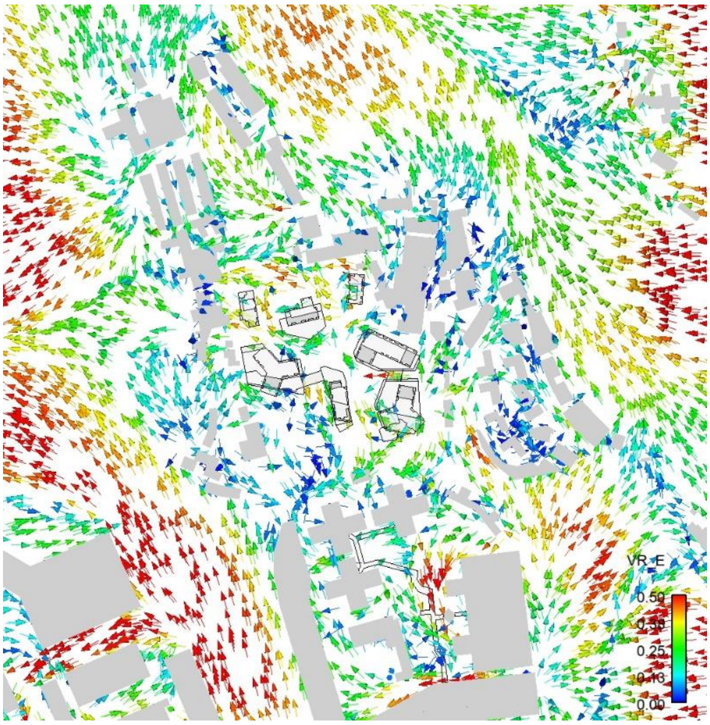

Figure D 23 Vector Plot of VR under E Wind

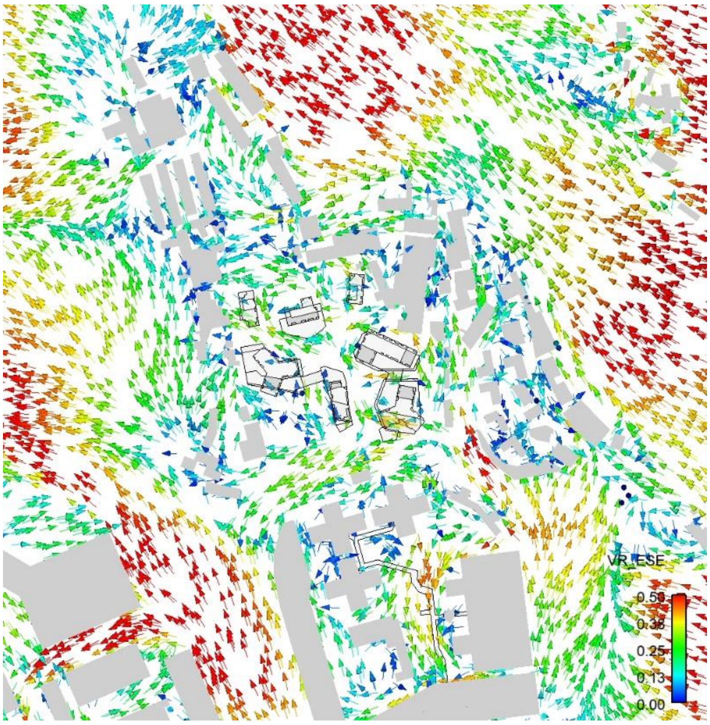

Figure D 24 Vector Plot of VR under ESE Wind

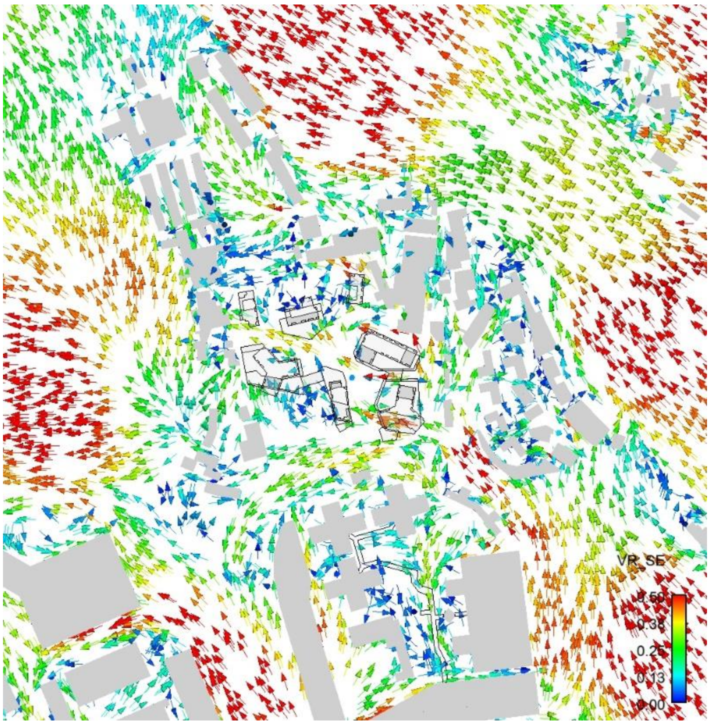

Figure D 25 Vector Plot of VR under SE Wind

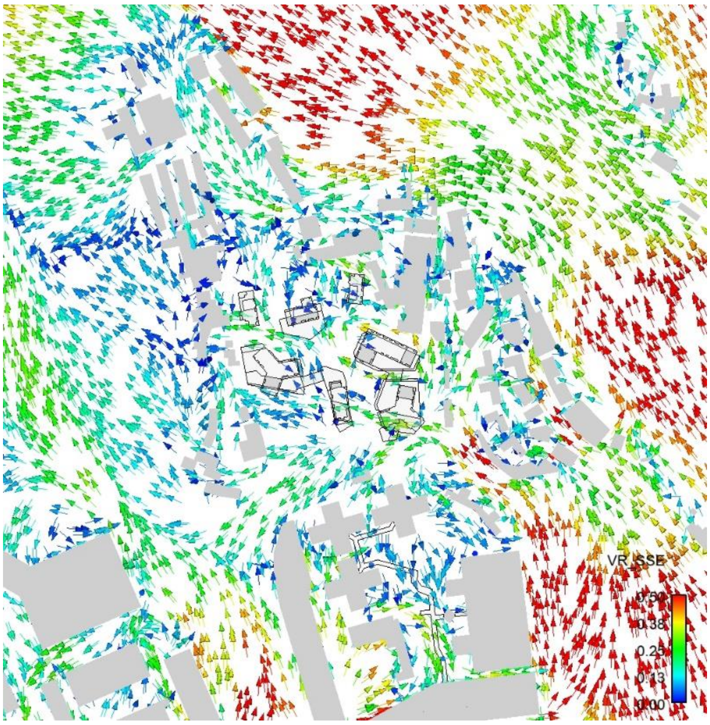

Figure D 26 Vec tor Plot of VR under SSE Wind

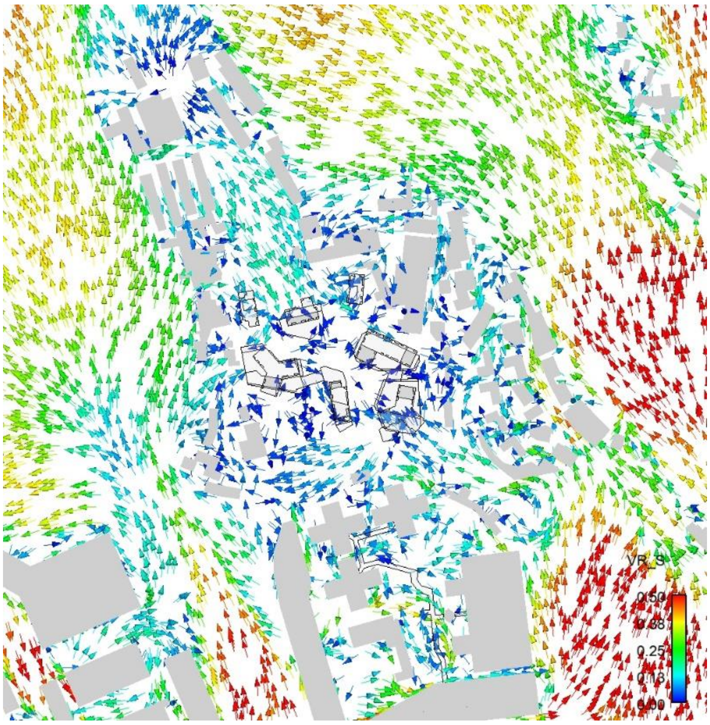

Figure D 27 Vector Plot of VR under S Wind

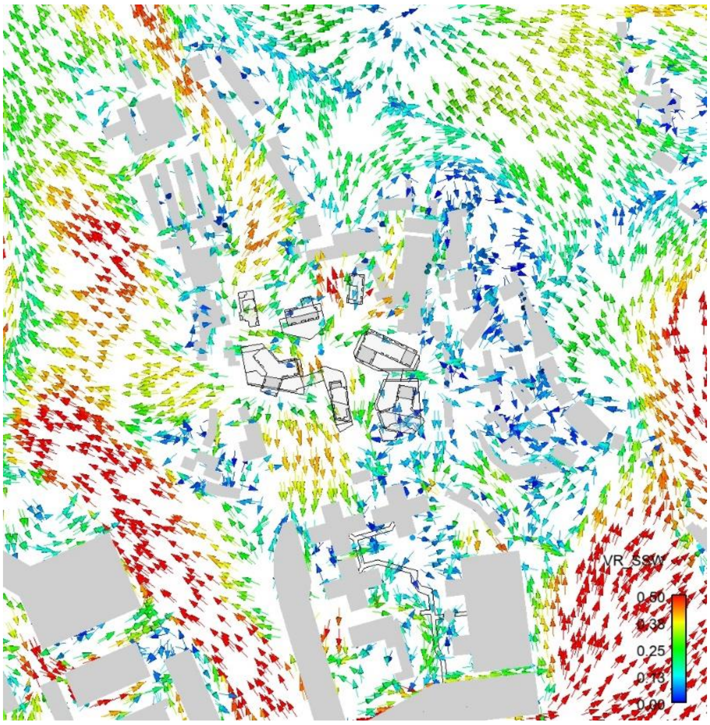

Figure D 28 Vector Plot of VR under SSW Wind

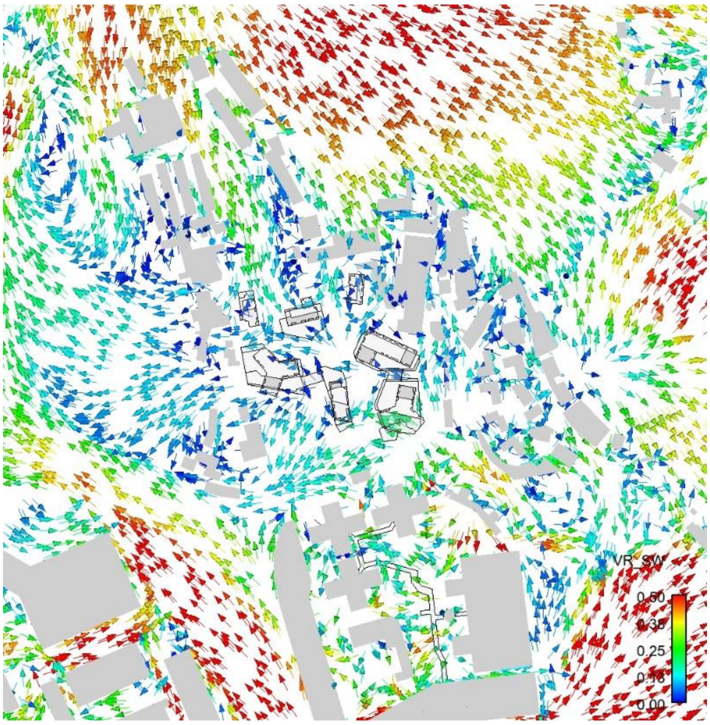

Figure D 29 Vector Plot of VR under SW Wind

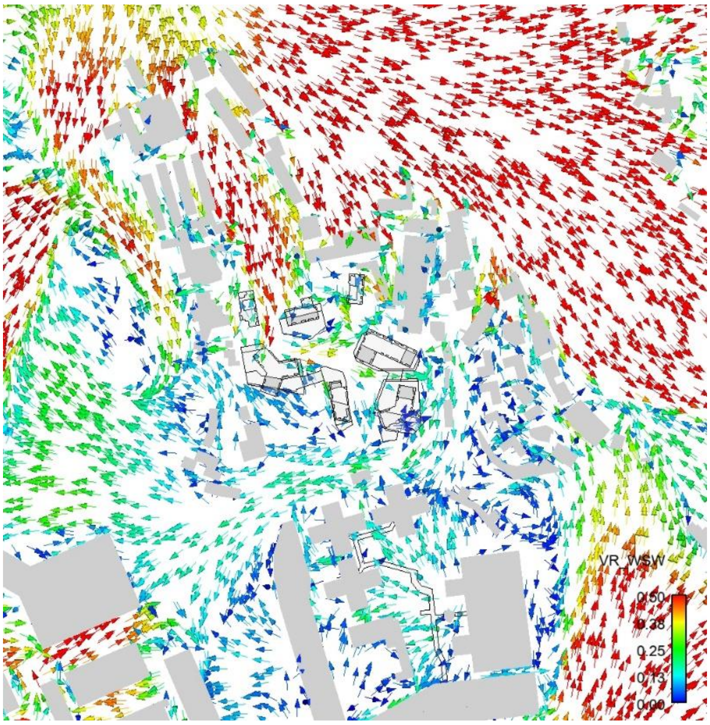

Figure D 30 Vector Plot of VR under WSW Wind

Appendix E

Velocity Ratio (VR) at Test Points

Contents

E1 Baseline Scheme

Table E1 Velocity Ratio of Perimeter Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P1	0.24	0.44	0.16	0.31	0.35	0.20	0.03	0.30	0.09	0.15
P2	0.16	0.27	0.16	0.20	0.29	0.17	0.09	0.26	0.03	0.06
P3	0.08	0.20	0.18	0.17	0.13	0.15	0.05	0.26	0.08	0.03
P4	0.19	0.09	0.10	0.04	0.08	0.10	0.10	0.21	0.14	0.15
P5	0.21	0.14	0.16	0.09	0.16	0.08	0.09	0.24	0.13	0.27
P6	0.13	0.12	0.22	0.14	0.29	0.16	0.06	0.16	0.12	0.28
P7	0.05	0.17	0.18	0.10	0.28	0.15	0.14	0.32	0.10	0.14
P8	0.07	0.15	0.10	0.06	0.19	0.06	0.15	0.32	0.03	0.11
P9	0.31	0.22	0.16	0.09	0.12	0.07	0.09	0.26	0.07	0.27
P10	0.16	0.30	0.31	0.18	0.09	0.08	0.03	0.12	0.02	0.22
P11	0.48	0.09	0.31	0.21	0.22	0.16	0.12	0.03	0.09	0.41
P12	0.35	0.16	0.09	0.03	0.04	0.05	0.10	0.04	0.12	0.31
P13	0.31	0.16	0.11	0.04	0.14	0.15	0.10	0.08	0.13	0.29
P14	0.33	0.20	0.17	0.14	0.21	0.14	0.13	0.09	0.15	0.44
P15	0.33	0.14	0.38	0.31	0.24	0.16	0.17	0.08	0.03	0.40
P16	0.20	0.19	0.24	0.27	0.19	0.19	0.08	0.10	0.03	0.13
P17	0.12	0.08	0.04	0.12	0.04	0.06	0.05	0.16	0.04	0.13
P18	0.19	0.33	0.08	0.17	0.11	0.13	0.02	0.16	0.13	0.39
P19	0.15	0.42	0.18	0.22	0.39	0.37	0.05	0.11	0.26	0.51
P20	0.24	0.41	0.28	0.34	0.16	0.19	0.07	0.15	0.30	0.48
P21	0.18	0.08	0.09	0.08	0.26	0.23	0.02	0.19	0.35	0.51
P22	0.30	0.34	0.29	0.10	0.09	0.21	0.19	0.21	0.28	0.43
P23	0.22	0.45	0.53	0.40	0.13	0.09	0.30	0.25	0.26	0.55
P24	0.16	0.47	0.54	0.59	0.41	0.32	0.30	0.31	0.33	0.66
P25	0.20	0.36	0.43	0.45	0.33	0.26	0.24	0.31	0.34	0.63
P26	0.22	0.20	0.31	0.27	0.08	0.09	0.15	0.15	0.11	0.10
P27	0.26	0.36	0.42	0.50	0.29	0.23	0.23	0.21	0.17	0.10
P28	0.24	0.40	0.39	0.38	0.33	0.25	0.23	0.34	0.33	0.51
P29	0.14	0.33	0.35	0.36	0.32	0.26	0.19	0.30	0.29	0.40
P30	0.08	0.18	0.28	0.29	0.29	0.24	0.07	0.05	0.10	0.19
P31	0.16	0.15	0.18	0.17	0.20	0.18	0.04	0.13	0.05	0.24
P32	0.16	0.21	0.19	0.20	0.30	0.30	0.08	0.04	0.05	0.05
P33	0.08	0.18	0.17	0.20	0.29	0.31	0.09	0.02	0.13	0.08
P34	0.08	0.33	0.07	0.07	0.20	0.21	0.05	0.04	0.23	0.08
P35	0.10	0.35	0.26	0.28	0.15	0.16	0.06	0.02	0.16	0.08
P36	0.14	0.14	0.23	0.28	0.15	0.09	0.09	0.04	0.10	0.11
P37	0.26	0.21	0.14	0.16	0.24	0.22	0.09	0.09	0.10	0.20
P38	0.34	0.23	0.17	0.26	0.29	0.27	0.10	0.12	0.11	0.21
P39	0.37	0.22	0.13	0.37	0.34	0.30	0.06	0.06	0.06	0.20
P40	0.39	0.31	0.19	0.38	0.41	0.38	0.08	0.14	0.24	0.19
P41	0.36	0.26	0.22	0.28	0.29	0.29	0.06	0.10	0.16	0.16
P42	0.25	0.32	0.31	0.30	0.36	0.34	0.07	0.03	0.09	0.03
P43	0.36	0.41	0.23	0.38	0.42	0.24	0.05	0.02	0.12	0.03
P44	0.32	0.35	0.13	0.27	0.30	0.09	0.05	0.16	0.12	0.07
P45	0.28	0.36	0.19	0.27	0.25	0.07	0.07	0.20	0.13	0.17

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P46	0.21	0.35	0.19	0.25	0.24	0.19	0.07	0.25	0.09	0.14
P47	0.29	0.45	0.24	0.34	0.37	0.23	0.06	0.30	0.07	0.15
P48	0.26	0.45	0.19	0.33	0.35	0.21	0.07	0.34	0.08	0.15

Table E2 Velocity Ratio of Overall Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O1	0.38	0.47	0.17	0.14	0.36	0.10	0.35	0.14	0.11	0.22
O2	0.23	0.35	0.20	0.17	0.15	0.08	0.15	0.18	0.17	0.16
O3	0.45	0.48	0.49	0.48	0.48	0.27	0.29	0.49	0.41	0.21
O4	0.42	0.28	0.53	0.53	0.44	0.29	0.22	0.55	0.46	0.18
O5	0.52	0.25	0.50	0.50	0.27	0.24	0.15	0.56	0.45	0.04
O6	0.59	0.22	0.49	0.48	0.24	0.16	0.11	0.52	0.39	0.09
O7	0.64	0.48	0.48	0.47	0.37	0.16	0.14	0.41	0.36	0.17
O8	0.52	0.46	0.62	0.61	0.54	0.36	0.06	0.47	0.50	0.20
O9	0.22	0.04	0.32	0.40	0.37	0.29	0.25	0.24	0.39	0.05
O10	0.26	0.17	0.28	0.37	0.25	0.20	0.13	0.21	0.30	0.08
O11	0.27	0.24	0.17	0.30	0.12	0.04	0.13	0.14	0.19	0.08
O12	0.27	0.27	0.16	0.17	0.06	0.15	0.12	0.07	0.23	0.08
O13	0.26	0.44	0.19	0.24	0.33	0.22	0.03	0.19	0.07	0.15
O14	0.23	0.43	0.21	0.32	0.34	0.20	0.09	0.33	0.09	0.16
O15	0.24	0.44	0.24	0.34	0.35	0.21	0.06	0.32	0.10	0.16
O16	0.18	0.36	0.22	0.29	0.27	0.16	0.09	0.31	0.11	0.15
O17	0.30	0.44	0.23	0.35	0.39	0.20	0.12	0.23	0.16	0.04
O18	0.34	0.47	0.30	0.34	0.33	0.35	0.15	0.08	0.19	0.06
O19	0.31	0.33	0.17	0.20	0.19	0.13	0.12	0.11	0.24	0.10
O20	0.41	0.36	0.17	0.31	0.45	0.38	0.16	0.27	0.17	0.17
O21	0.43	0.35	0.37	0.46	0.56	0.50	0.21	0.19	0.12	0.19
O22	0.30	0.25	0.36	0.39	0.44	0.39	0.07	0.05	0.02	0.19
O23	0.16	0.18	0.35	0.40	0.47	0.43	0.17	0.26	0.38	0.17
O24	0.18	0.13	0.36	0.38	0.45	0.48	0.17	0.11	0.05	0.07
O25	0.08	0.14	0.21	0.11	0.42	0.36	0.09	0.36	0.14	0.05
O26	0.25	0.20	0.22	0.18	0.40	0.28	0.24	0.49	0.20	0.11
O27	0.08	0.07	0.11	0.11	0.36	0.26	0.23	0.25	0.23	0.06
O28	0.11	0.07	0.14	0.07	0.31	0.16	0.20	0.25	0.14	0.04
O29	0.22	0.26	0.07	0.19	0.11	0.05	0.17	0.22	0.06	0.09
O30	0.21	0.36	0.19	0.28	0.30	0.17	0.04	0.25	0.05	0.14
O31	0.20	0.23	0.09	0.12	0.08	0.08	0.04	0.31	0.14	0.10
O32	0.12	0.20	0.22	0.11	0.17	0.09	0.06	0.07	0.17	0.08
O33	0.22	0.41	0.22	0.26	0.32	0.15	0.18	0.10	0.12	0.03
O34	0.12	0.15	0.24	0.23	0.35	0.14	0.21	0.26	0.41	0.10
O35	0.14	0.24	0.22	0.17	0.27	0.14	0.09	0.12	0.26	0.09
O36	0.42	0.38	0.46	0.45	0.42	0.09	0.24	0.34	0.43	0.01
O37	0.64	0.53	0.45	0.37	0.19	0.16	0.13	0.10	0.28	0.13
O38	0.04	0.39	0.43	0.08	0.17	0.15	0.19	0.12	0.18	0.09
O39	0.53	0.43	0.46	0.42	0.32	0.13	0.09	0.08	0.24	0.15
O40	0.46	0.35	0.25	0.33	0.11	0.08	0.18	0.13	0.14	0.17
O41	0.21	0.19	0.18	0.19	0.04	0.08	0.23	0.18	0.23	0.13
O42	0.16	0.19	0.15	0.19	0.10	0.05	0.07	0.13	0.09	0.10
O43	0.08	0.12	0.15	0.13	0.15	0.03	0.14	0.20	0.07	0.14

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O44	0.17	0.18	0.38	0.36	0.37	0.42	0.11	0.11	0.20	0.14
O45	0.22	0.16	0.30	0.29	0.27	0.31	0.15	0.16	0.11	0.10
O46	0.38	0.30	0.38	0.46	0.56	0.54	0.24	0.26	0.12	0.18
O47	0.47	0.41	0.43	0.50	0.54	0.48	0.14	0.23	0.31	0.22
O48	0.36	0.27	0.27	0.36	0.32	0.28	0.03	0.06	0.07	0.19
O49	0.15	0.19	0.17	0.15	0.15	0.16	0.10	0.10	0.09	0.20
O50	0.16	0.14	0.29	0.26	0.11	0.13	0.16	0.06	0.07	0.11
O51	0.05	0.15	0.13	0.13	0.11	0.06	0.12	0.03	0.07	0.06
O52	0.18	0.22	0.20	0.17	0.08	0.04	0.21	0.04	0.07	0.04
O53	0.03	0.09	0.26	0.26	0.09	0.08	0.11	0.02	0.06	0.13
O54	0.07	0.02	0.21	0.23	0.10	0.18	0.08	0.05	0.06	0.09
O55	0.10	0.05	0.22	0.18	0.07	0.12	0.07	0.15	0.19	0.02
O56	0.10	0.04	0.18	0.16	0.06	0.08	0.04	0.11	0.24	0.05
O57	0.24	0.13	0.25	0.27	0.28	0.46	0.33	0.06	0.18	0.38
O58	0.15	0.03	0.15	0.07	0.09	0.46	0.36	0.14	0.16	0.33
O59	0.08	0.04	0.04	0.11	0.05	0.42	0.36	0.18	0.10	0.29
O60	0.11	0.03	0.12	0.11	0.10	0.32	0.33	0.14	0.08	0.25
O61	0.06	0.04	0.03	0.03	0.07	0.05	0.22	0.03	0.03	0.04
O62	0.14	0.16	0.35	0.45	0.50	0.55	0.55	0.31	0.06	0.54
O63	0.15	0.13	0.31	0.42	0.49	0.56	0.56	0.18	0.19	0.65
O64	0.09	0.17	0.24	0.32	0.38	0.43	0.49	0.22	0.17	0.67
O65	0.08	0.20	0.23	0.29	0.32	0.34	0.42	0.33	0.09	0.68
O66	0.13	0.09	0.23	0.29	0.32	0.32	0.38	0.38	0.16	0.69
O67	0.14	0.08	0.27	0.35	0.35	0.36	0.37	0.41	0.25	0.71
O68	0.21	0.12	0.25	0.37	0.35	0.35	0.37	0.43	0.31	0.70
O69	0.12	0.07	0.19	0.34	0.33	0.32	0.35	0.44	0.35	0.67
O70	0.10	0.04	0.17	0.31	0.31	0.30	0.34	0.46	0.39	0.64
O71	0.15	0.08	0.25	0.34	0.33	0.33	0.33	0.48	0.42	0.64
O72	0.24	0.15	0.36	0.41	0.40	0.40	0.33	0.46	0.45	0.67
O73	0.36	0.21	0.43	0.47	0.47	0.46	0.34	0.40	0.47	0.68
O74	0.37	0.27	0.48	0.53	0.54	0.50	0.34	0.29	0.50	0.69
O75	0.32	0.28	0.53	0.59	0.58	0.54	0.36	0.15	0.51	0.68
O76	0.26	0.27	0.55	0.62	0.62	0.56	0.39	0.10	0.53	0.66
O77	0.18	0.23	0.56	0.64	0.64	0.58	0.40	0.23	0.53	0.62
O78	0.24	0.17	0.21	0.12	0.26	0.14	0.13	0.07	0.10	0.24
O79	0.14	0.17	0.18	0.10	0.27	0.15	0.15	0.29	0.11	0.11
O80	0.11	0.21	0.14	0.08	0.06	0.05	0.06	0.23	0.02	0.14
O81	0.24	0.11	0.12	0.04	0.06	0.05	0.04	0.03	0.08	0.23
O82	0.25	0.16	0.21	0.14	0.21	0.12	0.08	0.09	0.11	0.21
O83	0.35	0.25	0.34	0.30	0.11	0.15	0.19	0.11	0.13	0.46
O84	0.23	0.27	0.28	0.25	0.11	0.11	0.10	0.09	0.23	0.41
O85	0.33	0.29	0.04	0.18	0.15	0.06	0.17	0.06	0.15	0.46
O86	0.21	0.15	0.11	0.10	0.14	0.05	0.15	0.04	0.07	0.26
O87	0.33	0.34	0.11	0.07	0.13	0.06	0.18	0.06	0.04	0.30
O88	0.25	0.32	0.05	0.03	0.17	0.07	0.18	0.10	0.17	0.40
O89	0.18	0.34	0.21	0.15	0.17	0.14	0.21	0.13	0.21	0.43
O90	0.06	0.35	0.43	0.34	0.30	0.22	0.25	0.17	0.17	0.25
O91	0.04	0.13	0.25	0.28	0.06	0.09	0.10	0.06	0.30	0.44
O92	0.04	0.12	0.22	0.24	0.08	0.07	0.11	0.10	0.28	0.33

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O93	0.10	0.07	0.19	0.13	0.14	0.05	0.07	0.15	0.36	0.47
O94	0.12	0.06	0.16	0.14	0.15	0.07	0.14	0.15	0.32	0.47
O95	0.11	0.07	0.10	0.18	0.16	0.06	0.12	0.14	0.31	0.50
O96	0.12	0.15	0.11	0.22	0.14	0.10	0.15	0.12	0.30	0.51
O97	0.18	0.31	0.16	0.26	0.10	0.04	0.17	0.09	0.27	0.51
O98	0.08	0.15	0.05	0.04	0.03	0.02	0.02	0.06	0.04	0.19
O99	0.05	0.13	0.04	0.03	0.04	0.11	0.15	0.02	0.15	0.33
O100	0.09	0.11	0.03	0.08	0.01	0.01	0.12	0.02	0.01	0.06
O101	0.14	0.15	0.13	0.07	0.05	0.01	0.12	0.03	0.06	0.24
O102	0.05	0.07	0.02	0.04	0.07	0.02	0.12	0.01	0.09	0.06
O103	0.04	0.05	0.02	0.03	0.03	0.05	0.09	0.02	0.08	0.03
O104	0.01	0.08	0.05	0.07	0.05	0.10	0.07	0.03	0.16	0.31
O105	0.08	0.04	0.07	0.09	0.04	0.10	0.15	0.15	0.17	0.26
O106	0.07	0.11	0.05	0.08	0.03	0.14	0.16	0.15	0.08	0.12

Table E3 Velocity Ratio of Special Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S1	0.15	0.18	0.21	0.13	0.18	0.11	0.07	0.24	0.08	0.02
S2	0.15	0.25	0.24	0.17	0.29	0.14	0.04	0.31	0.10	0.12
S3	0.07	0.13	0.10	0.07	0.08	0.03	0.07	0.10	0.09	0.10
S4	0.13	0.25	0.24	0.17	0.21	0.12	0.09	0.05	0.11	0.20
S5	0.17	0.28	0.27	0.20	0.23	0.13	0.02	0.43	0.07	0.27
S6	0.26	0.15	0.14	0.11	0.14	0.11	0.01	0.42	0.08	0.28
S7	0.15	0.30	0.43	0.39	0.39	0.31	0.09	0.23	0.04	0.37
S8	0.07	0.10	0.09	0.14	0.08	0.07	0.06	0.17	0.05	0.25
S9	0.33	0.11	0.30	0.27	0.24	0.22	0.06	0.09	0.05	0.16
S10	0.33	0.30	0.28	0.27	0.34	0.29	0.05	0.16	0.10	0.12
S11	0.17	0.19	0.16	0.25	0.34	0.28	0.08	0.04	0.12	0.19
S12	0.11	0.38	0.40	0.41	0.46	0.35	0.11	0.05	0.17	0.06
S13	0.11	0.10	0.21	0.23	0.33	0.27	0.04	0.03	0.08	0.06
S14	0.26	0.12	0.13	0.16	0.10	0.11	0.06	0.08	0.04	0.05
S15	0.23	0.16	0.22	0.25	0.19	0.24	0.04	0.26	0.10	0.39
S16	0.21	0.29	0.16	0.18	0.16	0.13	0.02	0.07	0.15	0.40
S17	0.28	0.26	0.19	0.28	0.32	0.30	0.09	0.09	0.10	0.05
S18	0.09	0.37	0.34	0.27	0.26	0.17	0.06	0.07	0.04	0.04
S19	0.20	0.21	0.25	0.16	0.32	0.21	0.06	0.16	0.05	0.33
S20	0.24	0.23	0.33	0.20	0.19	0.13	0.07	0.09	0.04	0.26
S21	0.30	0.34	0.36	0.21	0.05	0.06	0.10	0.06	0.10	0.35
S22	0.32	0.25	0.21	0.23	0.26	0.16	0.08	0.31	0.06	0.19
S23	0.34	0.24	0.21	0.07	0.11	0.07	0.04	0.35	0.13	0.26
S24	0.14	0.28	0.40	0.40	0.41	0.34	0.11	0.41	0.13	0.43
S25	0.06	0.43	0.40	0.45	0.14	0.13	0.13	0.19	0.07	0.27
S26	0.19	0.18	0.09	0.09	0.21	0.10	0.07	0.13	0.06	0.07
S27	0.13	0.21	0.14	0.24	0.27	0.18	0.08	0.27	0.04	0.10
S28	0.09	0.23	0.27	0.19	0.37	0.21	0.06	0.35	0.14	0.07
S29	0.39	0.14	0.13	0.13	0.26	0.18	0.06	0.07	0.11	0.51
S30	0.30	0.18	0.41	0.34	0.29	0.15	0.13	0.04	0.05	0.28
S31	0.22	0.26	0.08	0.08	0.09	0.10	0.02	0.11	0.12	0.11
S32	0.29	0.15	0.30	0.24	0.35	0.31	0.05	0.07	0.21	0.43

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S33	0.32	0.45	0.30	0.34	0.23	0.13	0.14	0.07	0.23	0.49
S34	0.24	0.22	0.28	0.32	0.21	0.16	0.07	0.15	0.09	0.12
S35	0.06	0.30	0.41	0.42	0.42	0.35	0.12	0.05	0.15	0.06
S36	0.22	0.24	0.26	0.20	0.25	0.12	0.13	0.27	0.07	0.03
S37	0.15	0.08	0.09	0.09	0.10	0.06	0.05	0.24	0.04	0.18
S38	0.26	0.36	0.33	0.35	0.09	0.13	0.06	0.36	0.10	0.05

E2 Proposed Scheme

Table E4 Velocity Ratio of Perimeter Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P1	0.30	0.30	0.25	0.29	0.39	0.24	0.06	0.30	0.12	0.17
P2	0.22	0.26	0.20	0.28	0.37	0.23	0.05	0.26	0.06	0.13
P3	0.12	0.26	0.25	0.31	0.38	0.26	0.07	0.25	0.10	0.07
P4	0.06	0.07	0.10	0.11	0.11	0.09	0.04	0.09	0.08	0.05
P5	0.14	0.19	0.15	0.09	0.20	0.07	0.03	0.26	0.10	0.04
P6	0.07	0.19	0.27	0.22	0.40	0.24	0.03	0.32	0.17	0.15
P7	0.04	0.17	0.14	0.11	0.35	0.22	0.09	0.29	0.13	0.14
P8	0.04	0.24	0.14	0.12	0.13	0.08	0.09	0.32	0.02	0.16
P9	0.21	0.12	0.11	0.06	0.08	0.10	0.05	0.32	0.06	0.17
P10	0.15	0.28	0.36	0.28	0.23	0.23	0.06	0.23	0.07	0.14
P11	0.45	0.23	0.41	0.30	0.31	0.26	0.09	0.12	0.10	0.40
P12	0.34	0.09	0.12	0.03	0.03	0.05	0.07	0.16	0.12	0.29
P13	0.31	0.13	0.07	0.02	0.02	0.03	0.07	0.24	0.14	0.26
P14	0.34	0.20	0.25	0.20	0.18	0.16	0.06	0.07	0.12	0.41
P15	0.33	0.17	0.37	0.27	0.16	0.18	0.11	0.07	0.05	0.37
P16	0.14	0.23	0.27	0.36	0.32	0.18	0.04	0.14	0.08	0.12
P17	0.12	0.10	0.10	0.14	0.21	0.08	0.06	0.08	0.04	0.12
P18	0.18	0.41	0.06	0.09	0.05	0.05	0.06	0.16	0.09	0.38
P19	0.21	0.52	0.35	0.32	0.40	0.35	0.06	0.20	0.24	0.50
P20	0.24	0.53	0.34	0.25	0.35	0.37	0.02	0.14	0.29	0.47
P21	0.07	0.13	0.13	0.09	0.35	0.36	0.04	0.26	0.35	0.51
P22	0.22	0.33	0.17	0.11	0.31	0.33	0.04	0.26	0.28	0.46
P23	0.20	0.55	0.58	0.60	0.15	0.12	0.23	0.24	0.26	0.55
P24	0.19	0.51	0.55	0.62	0.45	0.29	0.26	0.28	0.31	0.66
P25	0.22	0.36	0.42	0.48	0.36	0.25	0.23	0.32	0.34	0.67
P26	0.20	0.18	0.27	0.18	0.05	0.12	0.03	0.16	0.07	0.13
P27	0.23	0.37	0.42	0.50	0.33	0.24	0.17	0.22	0.24	0.25
P28	0.23	0.40	0.40	0.42	0.36	0.32	0.22	0.31	0.33	0.54
P29	0.22	0.33	0.36	0.40	0.35	0.32	0.16	0.29	0.29	0.42
P30	0.10	0.18	0.29	0.31	0.32	0.30	0.11	0.06	0.09	0.23
P31	0.12	0.16	0.22	0.22	0.24	0.21	0.08	0.03	0.08	0.07
P32	0.15	0.20	0.20	0.18	0.28	0.30	0.11	0.06	0.09	0.10
P33	0.12	0.19	0.18	0.19	0.30	0.33	0.11	0.04	0.12	0.05
P34	0.28	0.33	0.21	0.23	0.31	0.31	0.08	0.02	0.10	0.06
P35	0.30	0.40	0.29	0.32	0.21	0.21	0.08	0.04	0.06	0.04
P36	0.20	0.16	0.08	0.14	0.18	0.09	0.07	0.07	0.09	0.18
P37	0.15	0.10	0.15	0.25	0.26	0.23	0.10	0.05	0.08	0.14
P38	0.24	0.07	0.08	0.32	0.30	0.29	0.08	0.03	0.05	0.18
P39	0.25	0.15	0.06	0.31	0.29	0.25	0.10	0.02	0.04	0.16
P40	0.33	0.25	0.19	0.35	0.38	0.37	0.04	0.15	0.24	0.13
P41	0.34	0.19	0.41	0.28	0.30	0.30	0.04	0.12	0.20	0.10
P42	0.40	0.43	0.45	0.37	0.38	0.34	0.04	0.12	0.11	0.08
P43	0.39	0.32	0.11	0.38	0.42	0.31	0.03	0.18	0.16	0.03
P44	0.37	0.22	0.27	0.21	0.30	0.19	0.10	0.22	0.16	0.23
P45	0.31	0.20	0.16	0.25	0.27	0.16	0.10	0.25	0.16	0.15

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P46	0.23	0.18	0.20	0.22	0.26	0.15	0.08	0.24	0.13	0.12
P47	0.30	0.28	0.27	0.31	0.40	0.23	0.07	0.15	0.10	0.16
P48	0.31	0.30	0.27	0.32	0.42	0.25	0.06	0.27	0.11	0.17

Table E5 Velocity Ratio of Overall Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O1	0.37	0.44	0.14	0.16	0.46	0.13	0.35	0.14	0.11	0.25
O2	0.22	0.18	0.19	0.17	0.17	0.09	0.15	0.18	0.17	0.28
O3	0.46	0.38	0.47	0.49	0.52	0.29	0.29	0.50	0.41	0.26
O4	0.43	0.33	0.53	0.52	0.46	0.27	0.22	0.54	0.46	0.25
O5	0.52	0.16	0.51	0.49	0.27	0.23	0.15	0.55	0.45	0.10
O6	0.57	0.20	0.50	0.48	0.15	0.17	0.11	0.52	0.39	0.12
O7	0.60	0.37	0.48	0.47	0.34	0.17	0.14	0.42	0.36	0.16
O8	0.35	0.26	0.61	0.60	0.52	0.36	0.06	0.47	0.49	0.19
O9	0.21	0.05	0.32	0.39	0.37	0.29	0.24	0.23	0.39	0.02
O10	0.25	0.06	0.30	0.37	0.25	0.21	0.12	0.20	0.30	0.03
O11	0.30	0.10	0.23	0.31	0.14	0.04	0.12	0.13	0.19	0.06
O12	0.31	0.17	0.15	0.21	0.04	0.14	0.09	0.08	0.23	0.07
O13	0.32	0.32	0.23	0.20	0.36	0.26	0.06	0.22	0.07	0.17
O14	0.29	0.31	0.26	0.30	0.39	0.23	0.08	0.29	0.12	0.18
O15	0.29	0.30	0.27	0.32	0.39	0.23	0.06	0.24	0.13	0.19
O16	0.20	0.25	0.19	0.27	0.28	0.19	0.09	0.30	0.17	0.17
O17	0.35	0.37	0.22	0.32	0.33	0.30	0.11	0.24	0.20	0.19
O18	0.41	0.44	0.40	0.34	0.31	0.32	0.06	0.20	0.20	0.04
O19	0.34	0.29	0.36	0.23	0.19	0.14	0.09	0.16	0.18	0.08
O20	0.37	0.32	0.16	0.30	0.42	0.37	0.15	0.29	0.35	0.12
O21	0.38	0.32	0.34	0.42	0.54	0.49	0.20	0.34	0.27	0.17
O22	0.28	0.23	0.34	0.36	0.42	0.38	0.07	0.25	0.18	0.16
O23	0.16	0.17	0.34	0.37	0.46	0.42	0.16	0.23	0.35	0.12
O24	0.19	0.12	0.36	0.36	0.44	0.48	0.16	0.12	0.10	0.04
O25	0.07	0.14	0.24	0.16	0.41	0.33	0.09	0.34	0.13	0.07
O26	0.25	0.21	0.23	0.18	0.39	0.26	0.23	0.47	0.20	0.12
O27	0.11	0.10	0.17	0.12	0.35	0.24	0.22	0.24	0.22	0.08
O28	0.11	0.12	0.15	0.06	0.30	0.17	0.19	0.25	0.13	0.08
O29	0.25	0.09	0.09	0.15	0.09	0.05	0.16	0.26	0.06	0.05
O30	0.25	0.28	0.22	0.25	0.31	0.22	0.05	0.24	0.09	0.16
O31	0.21	0.20	0.19	0.10	0.08	0.08	0.03	0.29	0.18	0.12
O32	0.11	0.09	0.14	0.07	0.20	0.11	0.06	0.08	0.14	0.04
O33	0.31	0.45	0.41	0.25	0.34	0.13	0.16	0.14	0.18	0.05
O34	0.14	0.18	0.18	0.19	0.31	0.15	0.19	0.24	0.36	0.06
O35	0.20	0.24	0.23	0.16	0.25	0.13	0.09	0.12	0.26	0.11
O36	0.42	0.38	0.44	0.44	0.42	0.08	0.24	0.34	0.43	0.02
O37	0.64	0.54	0.44	0.37	0.21	0.15	0.13	0.10	0.28	0.14
O38	0.05	0.30	0.41	0.07	0.33	0.11	0.19	0.13	0.18	0.09
O39	0.51	0.41	0.45	0.42	0.32	0.11	0.08	0.08	0.24	0.15
O40	0.38	0.31	0.32	0.32	0.06	0.07	0.18	0.13	0.14	0.18
O41	0.23	0.19	0.15	0.19	0.02	0.07	0.24	0.18	0.23	0.14
O42	0.17	0.18	0.15	0.13	0.11	0.05	0.06	0.12	0.10	0.12
O43	0.05	0.11	0.15	0.08	0.18	0.09	0.14	0.20	0.06	0.14

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O44	0.16	0.16	0.36	0.33	0.36	0.41	0.11	0.16	0.13	0.14
O45	0.21	0.16	0.29	0.26	0.26	0.30	0.15	0.14	0.08	0.09
O46	0.35	0.26	0.36	0.41	0.53	0.53	0.23	0.34	0.34	0.16
O47	0.39	0.36	0.40	0.46	0.50	0.46	0.09	0.24	0.36	0.19
O48	0.30	0.22	0.23	0.32	0.29	0.25	0.04	0.02	0.11	0.18
O49	0.20	0.08	0.24	0.10	0.17	0.19	0.11	0.08	0.09	0.18
O50	0.20	0.19	0.30	0.23	0.16	0.16	0.17	0.02	0.05	0.11
O51	0.09	0.10	0.12	0.13	0.18	0.18	0.11	0.05	0.04	0.03
O52	0.24	0.21	0.20	0.20	0.13	0.07	0.21	0.05	0.03	0.03
O53	0.06	0.16	0.26	0.26	0.08	0.07	0.11	0.05	0.04	0.06
O54	0.05	0.07	0.24	0.23	0.09	0.18	0.08	0.07	0.09	0.12
O55	0.10	0.02	0.19	0.15	0.09	0.10	0.07	0.12	0.11	0.04
O56	0.07	0.03	0.12	0.05	0.05	0.09	0.04	0.16	0.20	0.06
O57	0.19	0.10	0.24	0.24	0.26	0.44	0.32	0.06	0.30	0.33
O58	0.12	0.04	0.12	0.07	0.09	0.44	0.36	0.11	0.22	0.27
O59	0.07	0.05	0.03	0.09	0.02	0.40	0.36	0.11	0.04	0.25
O60	0.03	0.05	0.14	0.11	0.09	0.31	0.33	0.04	0.13	0.22
O61	0.04	0.06	0.03	0.03	0.06	0.13	0.23	0.06	0.11	0.02
O62	0.15	0.15	0.32	0.43	0.47	0.53	0.54	0.19	0.12	0.42
O63	0.17	0.12	0.28	0.40	0.46	0.55	0.56	0.10	0.27	0.56
O64	0.12	0.15	0.22	0.31	0.36	0.43	0.49	0.23	0.25	0.61
O65	0.09	0.20	0.22	0.28	0.31	0.34	0.42	0.33	0.11	0.65
O66	0.14	0.09	0.23	0.28	0.31	0.32	0.38	0.39	0.18	0.68
O67	0.09	0.06	0.28	0.34	0.35	0.36	0.37	0.43	0.29	0.71
O68	0.05	0.09	0.28	0.37	0.35	0.36	0.37	0.47	0.34	0.71
O69	0.08	0.06	0.26	0.35	0.33	0.33	0.36	0.48	0.38	0.68
O70	0.09	0.04	0.26	0.34	0.32	0.32	0.34	0.49	0.41	0.65
O71	0.08	0.09	0.33	0.36	0.34	0.34	0.33	0.49	0.42	0.65
O72	0.11	0.17	0.41	0.43	0.41	0.41	0.34	0.49	0.45	0.68
O73	0.25	0.25	0.47	0.50	0.49	0.47	0.35	0.45	0.47	0.70
O74	0.35	0.31	0.52	0.56	0.55	0.51	0.37	0.38	0.50	0.70
O75	0.35	0.34	0.57	0.61	0.60	0.55	0.39	0.25	0.52	0.69
O76	0.30	0.34	0.59	0.64	0.63	0.59	0.41	0.13	0.53	0.66
O77	0.22	0.30	0.59	0.66	0.64	0.61	0.41	0.12	0.54	0.62
O78	0.25	0.19	0.27	0.21	0.39	0.22	0.08	0.29	0.16	0.16
O79	0.16	0.15	0.17	0.13	0.37	0.24	0.12	0.27	0.14	0.12
O80	0.11	0.22	0.20	0.15	0.09	0.10	0.02	0.27	0.02	0.20
O81	0.23	0.05	0.11	0.08	0.09	0.09	0.04	0.07	0.09	0.21
O82	0.24	0.06	0.22	0.03	0.01	0.12	0.04	0.14	0.12	0.18
O83	0.37	0.20	0.29	0.28	0.18	0.16	0.12	0.11	0.09	0.45
O84	0.25	0.25	0.21	0.24	0.09	0.14	0.09	0.20	0.24	0.38
O85	0.36	0.24	0.06	0.32	0.28	0.02	0.16	0.21	0.11	0.45
O86	0.25	0.32	0.12	0.07	0.10	0.08	0.17	0.12	0.08	0.24
O87	0.35	0.34	0.12	0.11	0.14	0.08	0.18	0.12	0.07	0.29
O88	0.28	0.36	0.07	0.21	0.21	0.07	0.19	0.21	0.13	0.40
O89	0.19	0.41	0.23	0.13	0.07	0.12	0.19	0.21	0.20	0.43
O90	0.08	0.41	0.48	0.37	0.25	0.26	0.15	0.21	0.17	0.25
O91	0.09	0.19	0.30	0.27	0.04	0.09	0.12	0.15	0.30	0.44
O92	0.08	0.17	0.27	0.24	0.04	0.09	0.12	0.12	0.28	0.34

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O93	0.13	0.08	0.20	0.22	0.15	0.06	0.09	0.23	0.37	0.47
O94	0.15	0.14	0.16	0.25	0.19	0.06	0.15	0.17	0.33	0.46
O95	0.15	0.15	0.06	0.27	0.22	0.04	0.16	0.13	0.32	0.49
O96	0.17	0.22	0.10	0.29	0.22	0.05	0.15	0.16	0.30	0.50
O97	0.23	0.36	0.13	0.30	0.21	0.08	0.13	0.19	0.27	0.50
O98	0.09	0.16	0.05	0.04	0.04	0.03	0.04	0.04	0.04	0.20
O99	0.09	0.23	0.03	0.03	0.09	0.06	0.17	0.14	0.13	0.31
O100	0.12	0.22	0.03	0.07	0.14	0.04	0.17	0.22	0.01	0.08
O101	0.15	0.25	0.11	0.05	0.11	0.04	0.07	0.11	0.05	0.24
O102	0.06	0.09	0.04	0.03	0.07	0.03	0.16	0.03	0.10	0.06
O103	0.05	0.06	0.05	0.06	0.11	0.02	0.13	0.07	0.09	0.05
O104	0.03	0.05	0.03	0.04	0.07	0.04	0.09	0.07	0.15	0.29
O105	0.10	0.06	0.05	0.14	0.10	0.02	0.20	0.19	0.16	0.25
O106	0.09	0.14	0.06	0.15	0.11	0.02	0.19	0.19	0.06	0.11

Table E6 Velocity Ratio of Special Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S1	0.17	0.23	0.21	0.25	0.33	0.23	0.02	0.19	0.03	0.08
S2	0.08	0.06	0.09	0.09	0.15	0.14	0.02	0.23	0.05	0.07
S3	0.09	0.29	0.29	0.17	0.10	0.03	0.09	0.15	0.07	0.24
S4	0.14	0.34	0.39	0.22	0.19	0.15	0.05	0.17	0.08	0.24
S5	0.12	0.22	0.41	0.27	0.38	0.33	0.06	0.22	0.11	0.21
S6	0.26	0.18	0.24	0.18	0.30	0.26	0.02	0.17	0.08	0.21
S7	0.13	0.39	0.40	0.33	0.29	0.25	0.09	0.11	0.06	0.18
S8	0.13	0.10	0.13	0.19	0.29	0.09	0.02	0.12	0.09	0.25
S9	0.26	0.30	0.45	0.25	0.27	0.26	0.07	0.05	0.11	0.11
S10	0.05	0.10	0.17	0.15	0.26	0.23	0.08	0.19	0.09	0.03
S11	0.14	0.05	0.08	0.22	0.33	0.29	0.07	0.10	0.11	0.05
S12	0.13	0.32	0.43	0.42	0.49	0.41	0.12	0.13	0.16	0.09
S13	0.22	0.12	0.16	0.24	0.40	0.35	0.08	0.05	0.14	0.07
S14	0.20	0.17	0.22	0.19	0.14	0.18	0.05	0.07	0.05	0.05
S15	0.21	0.12	0.30	0.31	0.17	0.26	0.06	0.08	0.05	0.03
S16	0.17	0.29	0.18	0.19	0.11	0.13	0.04	0.10	0.21	0.50
S17	0.30	0.32	0.28	0.16	0.16	0.15	0.08	0.12	0.03	0.02
S18	0.24	0.36	0.33	0.21	0.29	0.25	0.08	0.14	0.09	0.19
S19	0.14	0.04	0.29	0.14	0.28	0.21	0.04	0.36	0.10	0.40
S20	0.07	0.30	0.44	0.31	0.36	0.29	0.04	0.14	0.08	0.26
S21	0.26	0.37	0.45	0.36	0.29	0.28	0.08	0.26	0.10	0.27
S22	0.17	0.18	0.15	0.24	0.39	0.23	0.01	0.24	0.05	0.11
S23	0.36	0.37	0.38	0.26	0.30	0.16	0.07	0.24	0.04	0.04
S24	0.18	0.37	0.42	0.36	0.38	0.34	0.12	0.23	0.19	0.14
S25	0.08	0.44	0.33	0.31	0.18	0.18	0.04	0.08	0.13	0.35
S26	0.26	0.06	0.11	0.11	0.17	0.08	0.08	0.23	0.08	0.03
S27	0.13	0.22	0.25	0.12	0.33	0.19	0.04	0.33	0.10	0.05
S28	0.13	0.27	0.31	0.27	0.45	0.29	0.05	0.37	0.18	0.06
S29	0.36	0.25	0.32	0.26	0.21	0.15	0.08	0.18	0.10	0.46
S30	0.27	0.16	0.38	0.26	0.17	0.18	0.08	0.06	0.06	0.24
S31	0.29	0.05	0.08	0.09	0.08	0.08	0.02	0.04	0.12	0.05
S32	0.33	0.28	0.44	0.43	0.35	0.30	0.10	0.12	0.23	0.46

S33	0.27	0.59	0.41	0.23	0.21	0.18	0.03	0.10	0.24	0.45
S34	0.10	0.23	0.29	0.35	0.27	0.25	0.09	0.05	0.05	0.06
S35	0.06	0.28	0.42	0.36	0.48	0.43	0.13	0.09	0.07	0.23
S36	0.14	0.19	0.29	0.21	0.07	0.11	0.02	0.31	0.16	0.02
S37	0.10	0.17	0.17	0.18	0.32	0.25	0.02	0.29	0.15	0.07
S38	0.32	0.29	0.40	0.38	0.25	0.32	0.06	0.23	0.06	0.04

E3 Interim Scheme

Table E7 Velocity Ratio of Perimeter Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P1	0.25	0.36	0.11	0.26	0.26	0.21	0.05	0.19	0.13	0.17
P2	0.17	0.21	0.11	0.20	0.22	0.19	0.06	0.11	0.11	0.14
P3	0.02	0.16	0.10	0.11	0.08	0.13	0.05	0.05	0.09	0.11
P4	0.07	0.13	0.06	0.13	0.11	0.12	0.05	0.23	0.08	0.07
P5	0.07	0.20	0.13	0.26	0.24	0.18	0.07	0.32	0.10	0.11
P6	0.19	0.15	0.12	0.16	0.19	0.09	0.06	0.35	0.10	0.11
P7	0.19	0.32	0.12	0.17	0.23	0.07	0.13	0.32	0.06	0.12
P8	0.20	0.24	0.17	0.14	0.23	0.08	0.14	0.19	0.01	0.09
P9	0.25	0.23	0.07	0.04	0.10	0.04	0.02	0.18	0.06	0.17
P10	0.37	0.50	0.30	0.14	0.18	0.18	0.07	0.31	0.07	0.16
P11	0.35	0.35	0.37	0.25	0.24	0.18	0.03	0.24	0.10	0.37
P12	0.41	0.33	0.16	0.11	0.05	0.03	0.10	0.27	0.10	0.27
P13	0.34	0.31	0.34	0.18	0.08	0.02	0.10	0.37	0.11	0.22
P14	0.17	0.29	0.35	0.19	0.06	0.15	0.17	0.29	0.17	0.46
P15	0.10	0.30	0.42	0.24	0.12	0.04	0.17	0.21	0.09	0.43
P16	0.08	0.33	0.35	0.24	0.25	0.12	0.09	0.14	0.06	0.13
P17	0.04	0.18	0.25	0.26	0.21	0.14	0.07	0.18	0.08	0.25
P18	0.20	0.19	0.20	0.16	0.18	0.13	0.05	0.13	0.16	0.55
P19	0.20	0.20	0.23	0.25	0.27	0.17	0.05	0.20	0.24	0.54
P20	0.21	0.28	0.29	0.35	0.22	0.19	0.10	0.11	0.28	0.57
P21	0.19	0.12	0.09	0.28	0.14	0.15	0.12	0.22	0.28	0.51
P22	0.19	0.19	0.21	0.36	0.40	0.40	0.26	0.22	0.34	0.59
P23	0.17	0.22	0.22	0.40	0.47	0.45	0.30	0.22	0.35	0.61
P24	0.18	0.17	0.17	0.40	0.46	0.44	0.30	0.20	0.34	0.61
P25	0.21	0.31	0.23	0.36	0.41	0.40	0.28	0.09	0.33	0.66
P26	0.11	0.27	0.19	0.11	0.20	0.20	0.12	0.04	0.09	0.21
P27	0.06	0.19	0.12	0.21	0.32	0.31	0.20	0.06	0.21	0.50
P28	0.07	0.17	0.09	0.18	0.28	0.28	0.23	0.06	0.30	0.56
P29	0.10	0.16	0.06	0.10	0.12	0.13	0.14	0.09	0.13	0.29
P30	0.04	0.10	0.02	0.07	0.14	0.14	0.09	0.07	0.04	0.16
P31	0.09	0.09	0.03	0.20	0.16	0.15	0.12	0.05	0.04	0.13
P32	0.07	0.12	0.05	0.27	0.16	0.15	0.15	0.07	0.05	0.30
P33	0.05	0.04	0.03	0.17	0.07	0.06	0.11	0.04	0.08	0.28
P34	0.12	0.08	0.08	0.13	0.09	0.08	0.04	0.06	0.04	0.21
P35	0.04	0.08	0.10	0.15	0.18	0.15	0.02	0.05	0.08	0.07
P36	0.04	0.03	0.06	0.23	0.17	0.11	0.01	0.07	0.10	0.23
P37	0.05	0.06	0.05	0.28	0.26	0.22	0.03	0.02	0.11	0.17
P38	0.26	0.17	0.14	0.35	0.32	0.30	0.08	0.10	0.11	0.13
P39	0.35	0.23	0.22	0.36	0.34	0.32	0.05	0.07	0.06	0.13
P40	0.39	0.26	0.20	0.35	0.42	0.40	0.10	0.13	0.28	0.12
P41	0.27	0.24	0.30	0.18	0.26	0.25	0.08	0.11	0.24	0.15
P42	0.29	0.39	0.32	0.30	0.34	0.28	0.05	0.12	0.13	0.22
P43	0.27	0.34	0.20	0.34	0.39	0.18	0.02	0.05	0.16	0.07
P44	0.19	0.23	0.30	0.20	0.29	0.10	0.11	0.14	0.17	0.09
P45	0.28	0.33	0.22	0.29	0.34	0.14	0.10	0.29	0.19	0.13

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P46	0.29	0.31	0.10	0.31	0.33	0.17	0.09	0.38	0.16	0.15
P47	0.28	0.33	0.04	0.30	0.30	0.20	0.07	0.37	0.13	0.17
P48	0.26	0.34	0.07	0.29	0.27	0.21	0.06	0.33	0.12	0.18

Table E8 Velocity Ratio of Overall Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O1	0.38	0.52	0.18	0.14	0.34	0.11	0.35	0.14	0.11	0.28
O2	0.23	0.16	0.20	0.18	0.15	0.08	0.14	0.18	0.18	0.11
O3	0.45	0.46	0.49	0.47	0.43	0.28	0.29	0.49	0.41	0.26
O4	0.40	0.39	0.54	0.52	0.37	0.30	0.23	0.54	0.46	0.22
O5	0.49	0.14	0.52	0.51	0.32	0.24	0.15	0.55	0.46	0.10
O6	0.56	0.26	0.52	0.50	0.30	0.15	0.11	0.53	0.40	0.07
O7	0.60	0.44	0.49	0.47	0.39	0.15	0.15	0.42	0.37	0.12
O8	0.44	0.39	0.62	0.61	0.57	0.36	0.06	0.48	0.51	0.15
O9	0.22	0.03	0.34	0.39	0.38	0.30	0.25	0.25	0.39	0.04
O10	0.26	0.03	0.32	0.38	0.28	0.21	0.13	0.18	0.29	0.09
O11	0.27	0.10	0.28	0.32	0.11	0.03	0.12	0.13	0.20	0.02
O12	0.27	0.18	0.19	0.20	0.12	0.08	0.11	0.17	0.24	0.05
O13	0.26	0.36	0.07	0.23	0.07	0.21	0.05	0.19	0.07	0.12
O14	0.25	0.37	0.07	0.27	0.21	0.20	0.07	0.29	0.12	0.17
O15	0.27	0.36	0.05	0.29	0.25	0.20	0.06	0.34	0.13	0.18
O16	0.25	0.35	0.14	0.31	0.33	0.18	0.09	0.36	0.17	0.17
O17	0.24	0.45	0.26	0.33	0.38	0.14	0.11	0.14	0.19	0.18
O18	0.20	0.44	0.31	0.30	0.30	0.26	0.05	0.10	0.19	0.21
O19	0.12	0.31	0.22	0.11	0.16	0.07	0.08	0.09	0.25	0.14
O20	0.36	0.34	0.15	0.21	0.44	0.33	0.16	0.25	0.37	0.06
O21	0.42	0.33	0.38	0.49	0.58	0.49	0.21	0.30	0.37	0.04
O22	0.30	0.24	0.37	0.42	0.46	0.38	0.07	0.23	0.26	0.03
O23	0.17	0.18	0.36	0.43	0.48	0.43	0.17	0.21	0.34	0.03
O24	0.19	0.13	0.37	0.41	0.46	0.49	0.17	0.12	0.10	0.03
O25	0.09	0.18	0.17	0.19	0.43	0.35	0.09	0.39	0.13	0.05
O26	0.27	0.20	0.23	0.21	0.40	0.28	0.24	0.50	0.21	0.14
O27	0.08	0.07	0.12	0.16	0.37	0.26	0.23	0.23	0.23	0.06
O28	0.07	0.14	0.14	0.13	0.30	0.16	0.20	0.20	0.14	0.10
O29	0.19	0.08	0.09	0.06	0.22	0.04	0.16	0.06	0.07	0.11
O30	0.21	0.29	0.08	0.18	0.11	0.13	0.05	0.27	0.10	0.08
O31	0.22	0.26	0.16	0.16	0.16	0.08	0.03	0.27	0.18	0.17
O32	0.11	0.13	0.17	0.08	0.19	0.07	0.06	0.02	0.11	0.09
O33	0.20	0.47	0.25	0.24	0.31	0.14	0.14	0.08	0.20	0.17
O34	0.20	0.17	0.24	0.26	0.36	0.16	0.21	0.29	0.32	0.05
O35	0.15	0.26	0.21	0.18	0.27	0.08	0.09	0.14	0.28	0.10
O36	0.43	0.39	0.47	0.46	0.43	0.06	0.24	0.34	0.43	0.03
O37	0.63	0.55	0.46	0.37	0.20	0.09	0.13	0.10	0.28	0.14
O38	0.05	0.36	0.46	0.24	0.15	0.12	0.19	0.13	0.19	0.09
O39	0.37	0.40	0.49	0.44	0.31	0.09	0.09	0.07	0.25	0.14
O40	0.32	0.31	0.27	0.35	0.13	0.08	0.18	0.14	0.16	0.15
O41	0.24	0.19	0.21	0.21	0.06	0.08	0.23	0.17	0.23	0.12
O42	0.17	0.19	0.16	0.06	0.09	0.05	0.06	0.14	0.11	0.05
O43	0.09	0.12	0.13	0.12	0.14	0.08	0.14	0.16	0.07	0.14

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O44	0.17	0.17	0.38	0.38	0.38	0.42	0.11	0.12	0.14	0.04
O45	0.22	0.15	0.31	0.30	0.28	0.31	0.15	0.09	0.10	0.06
O46	0.38	0.27	0.38	0.48	0.57	0.54	0.24	0.28	0.35	0.05
O47	0.48	0.38	0.44	0.54	0.57	0.50	0.14	0.27	0.38	0.02
O48	0.37	0.25	0.33	0.39	0.34	0.32	0.03	0.09	0.11	0.10
O49	0.25	0.17	0.20	0.23	0.26	0.25	0.09	0.09	0.12	0.07
O50	0.13	0.18	0.18	0.23	0.27	0.23	0.16	0.07	0.13	0.08
O51	0.10	0.16	0.17	0.19	0.25	0.19	0.15	0.07	0.06	0.03
O52	0.04	0.05	0.19	0.18	0.19	0.13	0.22	0.07	0.06	0.24
O53	0.06	0.04	0.09	0.06	0.06	0.09	0.09	0.04	0.05	0.07
O54	0.09	0.02	0.09	0.09	0.07	0.20	0.08	0.04	0.12	0.04
O55	0.16	0.06	0.12	0.09	0.07	0.12	0.07	0.05	0.10	0.02
O56	0.12	0.04	0.02	0.11	0.08	0.09	0.04	0.03	0.21	0.07
O57	0.22	0.13	0.27	0.30	0.31	0.48	0.32	0.10	0.30	0.29
O58	0.20	0.04	0.17	0.06	0.08	0.49	0.36	0.03	0.22	0.13
O59	0.18	0.05	0.14	0.06	0.05	0.46	0.36	0.07	0.04	0.10
O60	0.04	0.08	0.07	0.09	0.08	0.34	0.33	0.07	0.16	0.16
O61	0.01	0.05	0.04	0.03	0.04	0.05	0.23	0.02	0.10	0.13
O62	0.11	0.17	0.39	0.50	0.55	0.58	0.55	0.22	0.13	0.64
O63	0.13	0.13	0.36	0.49	0.55	0.60	0.57	0.26	0.28	0.73
O64	0.13	0.18	0.30	0.40	0.43	0.47	0.49	0.19	0.31	0.72
O65	0.14	0.24	0.28	0.37	0.36	0.38	0.42	0.10	0.20	0.69
O66	0.14	0.10	0.28	0.39	0.35	0.34	0.38	0.15	0.12	0.68
O67	0.07	0.08	0.29	0.43	0.37	0.36	0.37	0.22	0.24	0.69
O68	0.11	0.15	0.16	0.38	0.35	0.33	0.36	0.25	0.31	0.68
O69	0.09	0.13	0.05	0.29	0.32	0.30	0.35	0.29	0.36	0.65
O70	0.06	0.09	0.11	0.18	0.28	0.28	0.34	0.33	0.40	0.63
O71	0.08	0.04	0.09	0.17	0.30	0.30	0.33	0.34	0.42	0.63
O72	0.18	0.12	0.15	0.27	0.37	0.38	0.33	0.33	0.45	0.65
O73	0.33	0.17	0.26	0.38	0.45	0.45	0.34	0.28	0.47	0.66
O74	0.37	0.22	0.33	0.46	0.51	0.50	0.35	0.20	0.49	0.68
O75	0.33	0.22	0.37	0.53	0.57	0.53	0.36	0.12	0.51	0.67
O76	0.27	0.18	0.41	0.58	0.61	0.56	0.39	0.18	0.52	0.65
O77	0.18	0.12	0.43	0.60	0.63	0.59	0.41	0.25	0.52	0.63
O78	0.21	0.11	0.13	0.20	0.22	0.06	0.12	0.37	0.11	0.06
O79	0.18	0.22	0.10	0.18	0.23	0.02	0.14	0.35	0.07	0.11
O80	0.21	0.35	0.25	0.07	0.10	0.05	0.06	0.17	0.02	0.08
O81	0.30	0.25	0.11	0.06	0.07	0.05	0.09	0.18	0.07	0.21
O82	0.26	0.16	0.19	0.13	0.08	0.02	0.09	0.29	0.09	0.17
O83	0.18	0.12	0.26	0.15	0.06	0.11	0.18	0.37	0.17	0.52
O84	0.21	0.09	0.23	0.13	0.12	0.06	0.11	0.35	0.22	0.42
O85	0.19	0.12	0.23	0.18	0.22	0.11	0.15	0.42	0.18	0.53
O86	0.09	0.29	0.40	0.39	0.41	0.28	0.12	0.27	0.05	0.36
O87	0.20	0.16	0.22	0.17	0.20	0.11	0.15	0.22	0.04	0.36
O88	0.16	0.20	0.29	0.18	0.27	0.17	0.15	0.37	0.19	0.46
O89	0.11	0.12	0.20	0.18	0.18	0.17	0.17	0.40	0.22	0.47
O90	0.02	0.13	0.21	0.40	0.45	0.42	0.22	0.22	0.17	0.27
O91	0.05	0.10	0.09	0.32	0.15	0.21	0.08	0.13	0.30	0.47
O92	0.04	0.06	0.06	0.25	0.15	0.20	0.09	0.15	0.28	0.35

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O93	0.08	0.16	0.32	0.18	0.26	0.17	0.06	0.38	0.35	0.50
O94	0.08	0.25	0.35	0.23	0.29	0.19	0.12	0.36	0.31	0.51
O95	0.07	0.26	0.33	0.21	0.27	0.18	0.11	0.34	0.31	0.55
O96	0.07	0.21	0.26	0.11	0.23	0.15	0.15	0.33	0.29	0.57
O97	0.12	0.13	0.22	0.14	0.21	0.13	0.16	0.34	0.27	0.57
O98	0.10	0.11	0.08	0.06	0.10	0.05	0.01	0.04	0.04	0.21
O99	0.03	0.08	0.13	0.11	0.16	0.12	0.14	0.11	0.15	0.33
O100	0.07	0.11	0.16	0.17	0.21	0.14	0.11	0.15	0.01	0.08
O101	0.14	0.09	0.20	0.16	0.22	0.10	0.13	0.08	0.06	0.23
O102	0.06	0.15	0.06	0.11	0.12	0.06	0.12	0.14	0.09	0.09
O103	0.03	0.18	0.08	0.10	0.13	0.09	0.10	0.09	0.08	0.04
O104	0.01	0.20	0.17	0.10	0.07	0.05	0.08	0.20	0.16	0.31
O105	0.06	0.06	0.15	0.12	0.11	0.09	0.15	0.23	0.17	0.21
O106	0.05	0.10	0.21	0.25	0.14	0.19	0.16	0.27	0.08	0.09

Table E9 Velocity Ratio of Special Test Points

Points	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S1	0.14	0.17	0.06	0.23	0.25	0.21	0.05	0.09	0.09	0.14
S2	0.17	0.21	0.12	0.12	0.22	0.13	0.04	0.30	0.08	0.11
S3	0.12	0.17	0.30	0.13	0.09	0.05	0.09	0.28	0.14	0.09
S4	0.29	0.25	0.33	0.24	0.24	0.08	0.03	0.26	0.11	0.09
S5	0.16	0.20	0.28	0.33	0.44	0.22	0.03	0.26	0.11	0.29
S6	0.27	0.39	0.15	0.17	0.23	0.21	0.03	0.29	0.10	0.14
S7	0.15	0.31	0.27	0.21	0.07	0.19	0.04	0.48	0.16	0.13
S8	0.08	0.17	0.22	0.11	0.08	0.09	0.08	0.36	0.10	0.07
S9	0.25	0.37	0.34	0.19	0.25	0.24	0.07	0.12	0.12	0.20
S10	0.12	0.23	0.24	0.23	0.29	0.19	0.03	0.09	0.14	0.19
S11	0.27	0.20	0.23	0.30	0.37	0.28	0.04	0.16	0.15	0.17
S12	0.19	0.12	0.15	0.33	0.43	0.33	0.01	0.02	0.15	0.12
S13	0.05	0.03	0.02	0.05	0.11	0.08	0.08	0.07	0.06	0.08
S14	0.14	0.07	0.04	0.09	0.08	0.09	0.08	0.07	0.06	0.11
S15	0.10	0.22	0.20	0.05	0.15	0.06	0.07	0.36	0.06	0.31
S16	0.07	0.18	0.13	0.17	0.14	0.16	0.11	0.19	0.08	0.32
S17	0.18	0.26	0.21	0.13	0.18	0.14	0.01	0.20	0.05	0.14
S18	0.11	0.32	0.26	0.23	0.33	0.21	0.02	0.18	0.08	0.22
S19	0.26	0.27	0.15	0.22	0.34	0.12	0.04	0.26	0.10	0.40
S20	0.16	0.23	0.25	0.28	0.37	0.21	0.02	0.18	0.08	0.25
S21	0.34	0.58	0.37	0.28	0.32	0.23	0.09	0.37	0.11	0.12
S22	0.18	0.15	0.05	0.05	0.09	0.08	0.03	0.36	0.12	0.08
S23	0.47	0.62	0.38	0.31	0.18	0.05	0.04	0.23	0.04	0.06
S24	0.06	0.25	0.23	0.24	0.22	0.12	0.04	0.44	0.10	0.14
S25	0.14	0.20	0.06	0.06	0.11	0.09	0.02	0.27	0.01	0.13
S26	0.22	0.15	0.09	0.23	0.24	0.10	0.08	0.38	0.12	0.07
S27	0.28	0.46	0.26	0.19	0.08	0.16	0.02	0.32	0.09	0.07
S28	0.23	0.20	0.10	0.10	0.13	0.09	0.02	0.33	0.11	0.04
S29	0.23	0.18	0.33	0.20	0.07	0.14	0.12	0.24	0.13	0.48
S30	0.08	0.25	0.41	0.26	0.03	0.07	0.14	0.27	0.05	0.28
S31	0.05	0.29	0.28	0.14	0.18	0.10	0.07	0.44	0.10	0.12
S32	0.10	0.25	0.27	0.26	0.36	0.24	0.10	0.24	0.09	0.15

S33	0.17	0.17	0.11	0.22	0.09	0.07	0.08	0.22	0.07	0.18
S34	0.15	0.13	0.09	0.10	0.14	0.15	0.09	0.11	0.06	0.10
S35	0.14	0.21	0.11	0.20	0.18	0.15	0.13	0.11	0.02	0.13
S36	0.06	0.06	0.19	0.10	0.09	0.09	0.02	0.39	0.11	0.05
S37	0.12	0.14	0.08	0.19	0.24	0.11	0.03	0.29	0.04	0.01
S38	0.14	0.17	0.11	0.08	0.14	0.06	0.04	0.35	0.11	0.28