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Report Prepared by:
**Allied Environmental Consultants Ltd.**

**COMMERCIAL-IN-CONFIDENCE**

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AEC 沛然環境評估工程顧問有限公司

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## EXECUTIVE SUMMARY

Allied Environmental Consultants Limited (AEC) was commissioned by Hong Kong Housing Authority (HKHA) to conduct the Initial Study on Air Ventilation Assessment (AVA-IS) for the Proposed Development at Hiu Ming Street and Hiu Kwong Street (the Subject Site).

This AVA-IS is aimed to quantitatively review and evaluate the potential air ventilation impact on the pedestrian wind environment within and in the vicinity of the Subject Site using the methodology framework as set out in *Technical Circular No. 1/06 and its Annex A - Technical Guide for Air Ventilation Assessment for Development in Hong Kong* issued jointly by *Housing, Planning and Lands Bureau and Environment, Transport and Work Bureau* (Technical Guide).

The Subject Site is a Public Housing Development at Hiu Ming Street and Hiu Kwong Street. The Subject Site is positioned at an elevation of about 25-67mPD throughout where the site area is surrounded by mid- and high-rise buildings on three sides.

Good design features were incorporated into the proposed scheme, which includes:

- Building Separation - The proposed blocks would be located away from the private residential blocks at the north as far as possible to facilitate air ventilation to pass through the Subject Site to the downwind side under annual ENE, E and NE prevailing wind conditions at the pedestrian level.
- Ground Coverage - Divide the domestic block into two blocks in order to provide a wind corridor for better air ventilation performance
- Site Permeability - A large void is designed inside the residential block at the sky garden level. The large void enhances the permeability of the building, which favour wind penetration to the elevated pedestrian walkway between Block 1 and Block 2.

# 1. INTRODUCTION

1.1.1 Allied Environmental Consultants Limited (AEC) was commissioned by Hong Kong Housing Authority (HKHA) to conduct Air Ventilation Assessment for the proposed development at Hiu Ming Street and Hiu Kwong Street (the Subject Site).

1.1.2 The main objectives of the study are to conduct a qualitative review and evaluate the potential air ventilation impact on the pedestrian wind environment within the Subject Site and its nearby surrounding areas using the methodology framework as set out by relevant environmental standards, guidelines and technical circulars.

1.1.3 The methodology framework for conducting air ventilation assessment is set out in *Technical Circular No. 1/06* and its *Annex A - Technical Guide for Air Ventilation Assessment for Development in Hong Kong*. The Technical Circular is jointly issued by Housing, Planning and Lands Bureau (HPLB) and Environment, Transport and Work Bureau (ETWB) in July 2006 (Technical Guide).

1.1.4 The scope of this study shall cover the following:

- To identify any potentially affected areas due to the proposed building design including building heights, layout and deposition;
- To provide recommendations for alleviating the potential air ventilation impact identified;
- To identify any major wind corridors which should be preserved or reserved; and
- To identify good design features.

# 2. ASSESSMENT METHODOLOGY

## 2.1 WIND AVAILABILITY DATA

2.1.1 The wind availability to the Subject Site is evaluated with reference to the "Consultancy Study on Establishment of Simulated Site Wind Availability Data for Air Ventilation Assessments in Hong Kong" simulated by the meso-scale model of RAMS Version 6.0 at the horizontal resolution of 0.5 km x 0.5 km.

2.1.2 The Subject Site is located within grid (092, 042) and its wind rose diagrams are shown in ***Figure 1***.

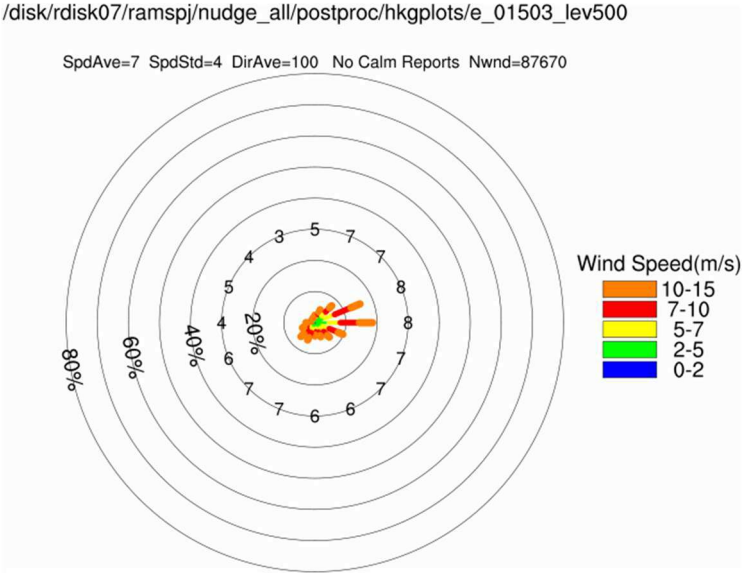
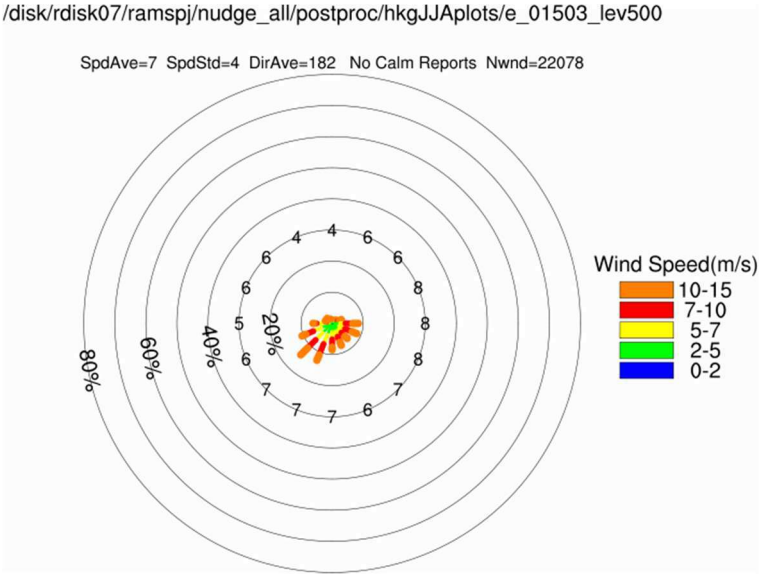
| | Wind Rose Diagrams |
|---|---|
| Annual |  |
| Summer |  |



***Figure 1 Wind Rose at 500m (Grid 092,042)***

2.1.3 As a conservative approach, the wind data at 500m is considered as representative of the wind environment at the urban canopy. According to PlanD's simulated data, wind speed and wind probability data are provided in Table 1.

***Table 1 Summary of Winds***

| Wind Direction | Annual Probability | Summer Probability |
|---|---|---|
| N | 2.1% | 0.6% |
| NNE | 7.2% | 0.9% |
| NE | 9.3% | 1.5% |
| ENE | 18.7% | 4.5% |
| E | **22.6%** | 11.1% |
| ESE | 7.4% | 8.2% |

| | | |
|---|---|---|
| SE | 4.9% | 8.4% |
| SSE | 3.6% | 8.2% |
| S | 3.1% | 7.2% |
| SSW | 4.1% | 9.8% |
| SW | 5.3% | **13.6%** |
| WSW | 4.7% | 12.6% |
| W | 3.3% | 7.7% |
| WNW | 1.9% | 3.6% |
| NW | 1.0% | 1.4% |
| NNW | 0.8% | 0.7% |

2.1.4 The most dominant annual wind direction is E, which accounts for 22.6% of the annual wind occurrence at 500 m above ground. The 8 most frequent wind directions include E, ENE, NE, ESE, NNE, SW, SE and WSW which accounted for approximately 80.1% of winter wind occurrence.

2.1.5 The E and ENE winds are likely to flow from the hillsides of On Tat Estate and Po Tat Estate to reach the Subject Site. Although the set back of proposed development favours incoming winds from the northeast quadrant, the densely development located at upwind locations may cause impediment to the air flow, resulting to a relatively calmer wind environment within Subject Site.

2.1.6 The most dominant summer wind directions is SW, which accounts for 13.6% of the summer wind occurrence at 500 m above ground at the Subject Site. The 8 most frequent wind directions include SW, WSW, E, SSW, SE, ESE, SSE, and W, which accounted for approximately 79.6% of summer wind occurrence.

2.1.7 Compared to the high-rise developments and Tsui Ming (North) Estate located at the immediate northwest of the Subject Site, the lower dense area of HKIVE and the schools located at the immediate southwest favours SW wind to penetrate of the Subject Site, resulting a relatively favourable wind environment within the Subject Site.

# 3 PROJECT DESCRIPTION

## 3.1 SITE LOCATION

3.1.1 The site area of the Proposed Public Housing Development at Hiu Ming Street and Hiu Kwong Street is approximately 1.06 ha. The Subject Site is located at Hiu Ming Street and Hiu Kwong Street in Kwun Tong as shown in ***Figure 2***.


***Figure 2 Aerial Photo of Subject Site***

**Urban Morphology and Land Use**

3.1.2 The Subject Site is a Public Housing Development at Hiu Ming Street and Hiu Kwong Street. The site is positioned at an elevation of about 25-67mPD throughout where the site area is surrounded by mid- and high-rise buildings on three sides as shown in Figure 2**.** The existing building height profile surrounding the site would be referred to ***Figure 3***. The building environments next to the site as shown in Figure 2 are summarised as follows:

- Immediate to its N are Hiu Ming Court (132mPD), Hiu Kwong Court (132mPD), Hiu Wah Building (154mPD) and Fu Wah Court (154mPD).
- To its NW are Tsui Ping (North) Estate Tsui Mei House (77.3mPD), Tsui Yeung House (81.2mPD), Tsui Nam House (92mPD), Tsui Ping Commercial Complex (18.7mPD) and Po Pui Court Po Shan House (115mPD).
- To its W are Tsui Ping (North) Estate Tsui To House (77.8mPD), Tsui Mui House (92mPD), Tsui Yue House (92mPD) and The Church of Christ in China Mong Man Wai College (44.5mPD)
- To its SW are Tsui Ping (North) Estate Tsui Lau House, Tsui Tsz House, Tsui Yung House (112.9mPD), Tsui On House (80mPD) and Tsui Pak House (92 mPD).
- To its SSW are Our Lady of China Catholic Primary School (30 mPD), Tsui Ping (South) Estate Car Park (40 mPD) and Tsui Ping (South) Estate Tsui Ying House (85mPD)

- To its S are The Mission Covenant Church Holm Glad College (38.5mPD), Tsui Ping (South) Estate Tsui Lok House, Tsui Hon House and Tsui Heng House (115mPD)
- To its SSE are Leung Shek Chee College, HKTA Ching Chung Secondary School, HKIVE (Kwun Tong) (106.4mPD), Tsui Ping (South) Estate Tsui Wing House, Tsui Tung House and Tsui Chung House (130mPD)
- To the SE across the Hiu Kwong Street is Sau Mau Ping Estate Sau Ming House (153mPD), Sau Mau Ping (South) Estate Sau Sin House, Sau Tak House, Sau Mei House (217mPD)
- To the E across Hiu Kwong Street are Sau Mau Ping Estate Sau On House, Sau Fu House (164mPD), St. Matthew's Lutheran School (114.1mPD), Sau Mau Ping (South) Estate Sau Wong House (217mPD), Sau Ho House (217mPD), Sau Mau Ping Catholic Primary School (100mPD) and all houses of Po Tat Estate (240mPD).
- To the NE of the Subject Site are Sau Mau Ping Estate Sau Wo House, Sau Yat House, Sau Wah House, Sau Ching House, Sau Wai House, Sau Yue House, Sau King House, Sau Chi House, Sau Yin House, Sau Fai House (210-240mPD), Sau Mau Ping Shopping Centre (110mPD) and Sau Mau Ping Estate Ancillary Facility Block (150mPD)

3.1.3 These locations would be deliberately considered in this study. The land use of the surrounding environment is tabulated in ***Table 2***.

***Table 2 Existing Land Use***

| Name | Land Use | No. of Storeys | Relative Location to the Subject Site | Approx. Distance from the Subject Site boundary(m) |
|---|---|---|---|---|
| The Mission Covenant Church Holm Glad College | G/IC Use | 4 | S | 161.7 |
| Tsui Ping (South) Estate Tsui Lok House | Residential Building | 35 | S | 380 |
| Tsui Ping (South) Estate Tsui Hon House | Residential Building | 35 | S | 380 |
| Tsui Ping (South) Estate Tsui Heng House | Residential Building | 35 | S | 385 |
| Our Lady of China Catholic Primary School | G/IC Use | 7 | SSW | 340 |
| Tsui Ping (South) Estate Car Park | Ancillary Block | 6 | SSW | 330 |
| Tsui Ping (South) Estate Tsui Ying House | Residential Building | 25 | SSW | 372 |
| Tsui Ping (North) Estate Tsui Yung House | Residential Building | 35 | SW | 89.4 |
| Tsui Ping (North) Estate Tsui Lau House | Residential Building | 27 | SW | 185.4 |
| Tsui Ping (North) Estate Tsui On House | Residential Building | 20 | SW | 215 |
| Tsui Ping (North) Estate Tsui Pak House | Residential Building | 27 | SW | 250 |
| Tsui Ping (North) Estate Tsui Tsz House | Residential Building | 27 | SW | 236.9 |

| Name | Land Use | No. of Storeys | Relative Location to the Subject Site | Approx. Distance from the Subject Site boundary(m) |
|---|---|---|---|---|
| Tsui Ping (North) Estate Tsui To House | Residential Building | 21 | W | 105.5 |
| The Church of Christ in China Mong Man Wai College | G/IC Use | 5 | W | 20 |
| Tsui Ping(North) Estate Tsui Mui House | Residential Building | 25 | W | 190 |
| Tsui Ping(North) Estate Tsui Yue House | Residential Building | 27 | W | 172 |
| Tsui Ping (North) Estate Tsui Yeung House | Residential Building | 18 | NW | 16.2 |
| Tsui Ping (North) Estate Tsui Mei House | Residential Building | 20 | NW | 91.4 |
| Tsui Ping Commercial Complex | Commercial Building | 2 | NW | 95.9 |
| Po Pui Court Po Shan House | Residential Building | 35 | NW | 192 |
| Tsui Ping(North) Estate Tsui Nam House | Residential Building | 27 | NW | 161 |
| Hiu Ming Court | Residential Building | 26 | N | 54.4 |
| Hiu Wah Building | Residential Building | 31 | N | 12 |
| Hiu Kwong Court | Residential Building | 26 | N | 53.7 |
| Fu Wah Court | Residential Building | 31 | N | 12 |
| Sau Mau Ping Shopping Centre | Commercial Building | 4 | NE | 210 |
| Sau Mau Ping Estate Sau Wo House | Residential Building | 41 | NE | 85.2 |
| Sau Mau Ping Estate Sau Yat House | Residential Building | 41 | NE | 85.4 |
| Sau Mau Ping Estate Sau Wah House | Residential Building | 41 | NE | 137 |
| Sau Mau Ping Estate Sau Ching House | Residential Building | 41 | NE | 297 |
| Sau Mau Ping Estate Sau Wai House | Residential Building | 41 | NE | 243 |
| Sau Mau Ping Estate Sau Yue House | Residential Building | 41 | NE | 210 |
| Sau Mau Ping Estate Sau King House | Residential Building | 41 | NE | 230 |
| Sau Mau Ping Estate Sau Chi House | Residential Building | 41 | NE | 285 |
| Sau Mau Ping Estate Sau Yin House | Residential Building | 41 | NE | 304 |
| Sau Mau Ping Estate Sau Fai House | Residential Building | 41 | NE | 370 |
| Sau Mau Ping Estate Ancillary Facility Block | Ancillary Block | 10 | NE | 317 |
| St. Matthew's Lutheran School | G/IC Use | 8 | E | 145.3 |
| Sau Mau Ping Estate | Residential | 27 | E | 93.4 |

| Name | Land Use | No. of Storeys | Relative Location to the Subject Site | Approx. Distance from the Subject Site boundary(m) |
|---|---|---|---|---|
| Sau On House | Building | | | |
| Sau Mau Ping Estate Sau Fu House | Residential Building | 27 | E | 45.2 |
| Sau Mau Ping (South) Estate Sau Wong House | Residential Building | 41 | E | 228 |
| Sau Mau Ping (South) Estate Sau Ho House | Residential Building | 41 | E | 268 |
| Po Tat Estate Tat Cheung House | Residential Building | 24 | E | 453 |
| Po Tat Estate Tat Hong House | Residential Building | 41 | E | 500 |
| Po Tat Estate Tat Fu House | Residential Building | 41 | E | 550 |
| Po Tat Estate Tat Shun House | Residential Building | 41 | E | 530 |
| Sau Mau Ping Catholic Primary School | G/IC Use | 8 | E | 540 |
| Po Tat Estate Tat Fung House | Residential Building | 41 | E | 600 |
| Po Tat Estate Tat Kai House | Residential Building | 41 | E | 600 |
| Po Tat Estate Tat Chui House | Residential Building | 41 | E | 680 |
| Po Tat Estate Tat Hin House | Residential Building | 41 | E | 680 |
| Po Tat Estate Tat Yan House | Residential Building | 41 | E | 730 |
| Po Tat Estate Tat Kwai House | Residential Building | 41 | E | 724 |
| Po Tat Estate Tat Yi House | Residential Building | 41 | E | 792 |
| Po Tat Estate Tat On House | Residential Building | 41 | E | 778 |
| Sau Mau Ping (South) Estate Sau Sin House | Residential Building | 41 | SE | 310 |
| Sau Mau Ping (South) Estate Sau Tak House | Residential Building | 41 | SE | 340 |
| Sau Mau Ping (South) Estate Sau Mei House | Residential Building | 41 | SE | 380 |
| Sau Mau Ping Estate Sau Ming House | Residential Building | 22 | SE | 108.9 |
| HKTA Ching Chung Secondary School | G/IC Use | 8 | SSE | 237.9 |
| Leung Shek Chee College | G/IC Use | 8 | SSE | 250 |
| HKIVE (Kwun Tong) | G/IC Use | 8 | SSE | 250 |
| Tsui Ping (South) Estate Tsui Wing House | Residential Building | 37 | SSE | 385 |
| Tsui Ping (South) Estate Tsui Tung House | Residential Building | 35 | SSE | 385 |
| Tsui Ping (South) Estate Tsui Chung House | Residential Building | 35 | SSE | 385 |

3.1.4 The characteristics of the surrounding area are summarized as below:

1. The Subject Site is located at elevation of about 25-67mPD
2. High ground coverage especially at NE of the Subject Site
3. A slope with height of about 60mPD immediate to the NE of the Subject Site
4. High-rise buildings in the vicinity of the Subject Site except to the SE
5. Proposed building heights lower than the high-rise residential buildings to the NE
6. Residential developments are distributed around the Subject Site except to the immediate SE and S
7. The Church Of Christ In China Mong Man Wai College, St. Matthew's Lutheran School, Leung Shek Chee College, HKIVE (Kwun Tong), Our Lady of China Catholic Primary School, HKTA Ching Chung Secondary School and Sau Mau Ping Catholic Primary School are the major G/IC use near the Subject Site

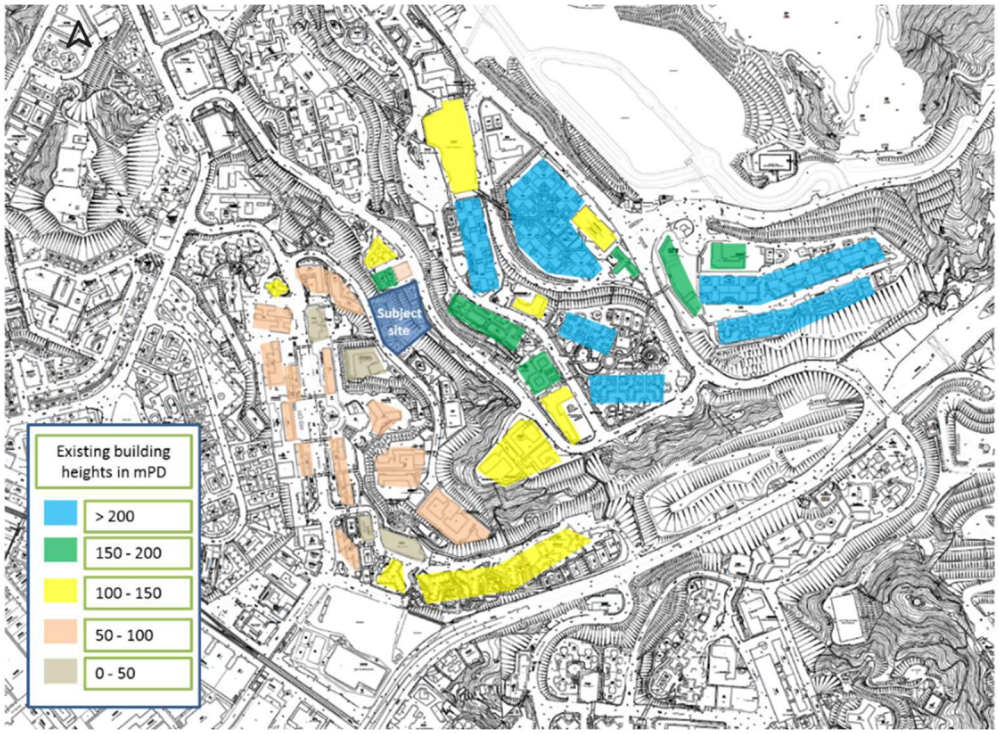



***Figure 3 Surrounding Building Heights***

**Road/ Street Pattern**

3.1.5 Under annual wind condition, incoming E and ENE winds are expected to travel along the major breezeway along air path of Hiu Ming Street, Hiu Kwong Street North and Tsui Ping Road. Meanwhile, summer winds flowing from SW and SSW directions shall pass through the Subject Site along major breezeway of Tsui Ping Road and Hiu Kwong Street East as shown in ***Figure 4***.

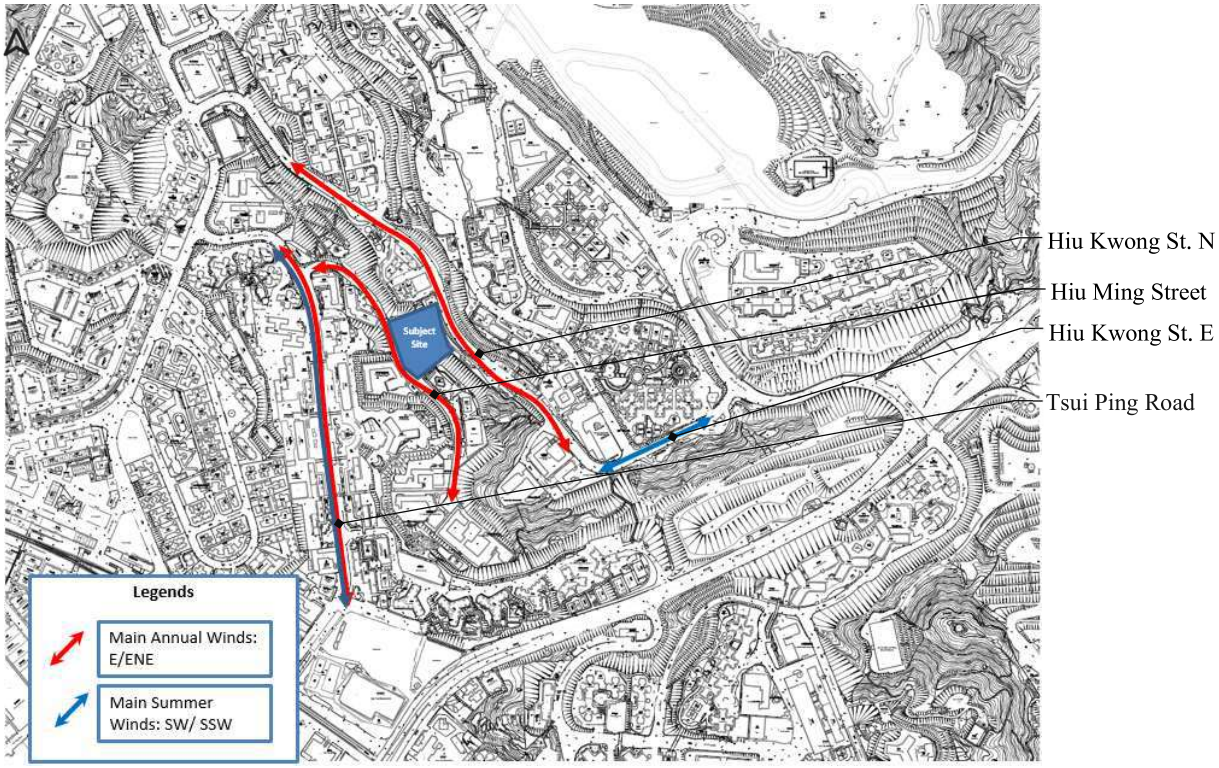



***Figure 4 Road / Street Pattern***

**Open Spaces and Water Body**

3.1.6 Open space favours air movement to the Subject Site and nearby surrounding area. The open space in the area includes Hiu Kwong Street Rest Garden, Sau Mau Ping Memorial Park, Hiu Ming Street Playground and Yuet Wah Street Playground. These open space are likely to favour incoming winds from the E and ENE wind directions, as shown in ***Figure 5***. The closest identified waterbody is Kwan Tong waterbody and wind circulation promoted by the waterbody is considered as less significant as it is located 500m from the Subject Site.

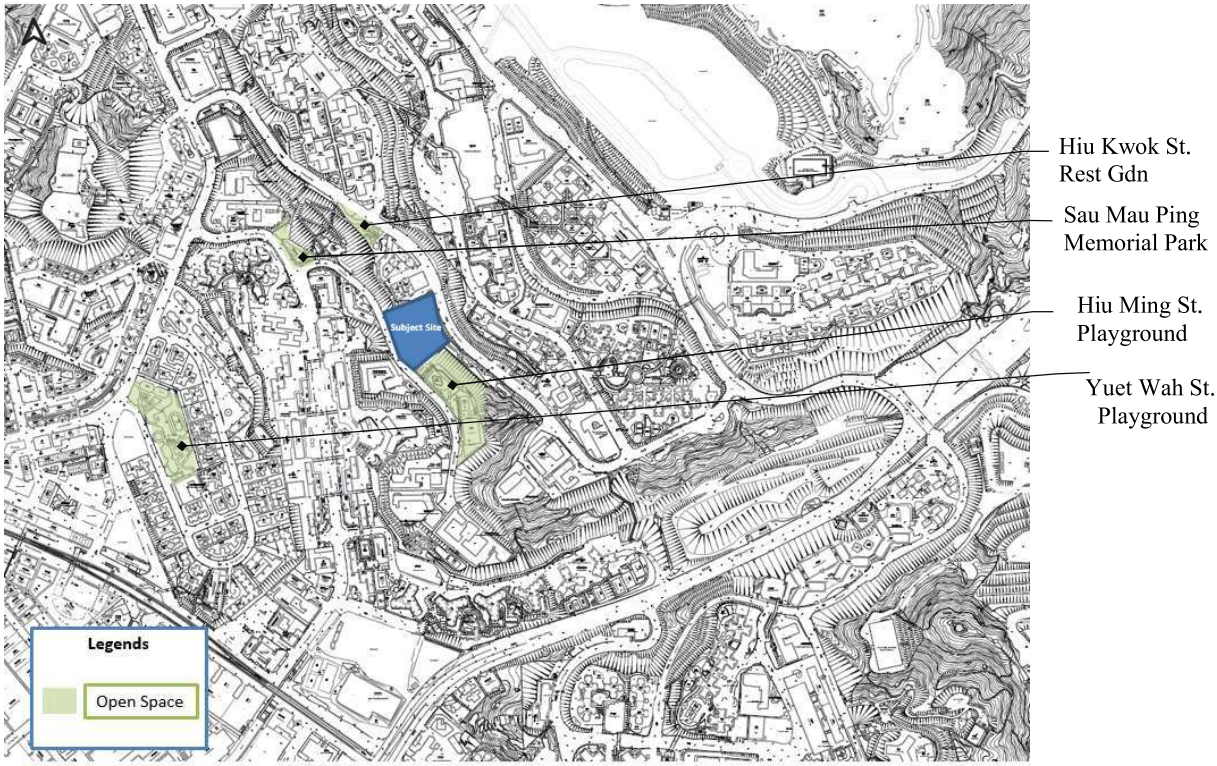



***Figure 5 Open Spaces and Waterbody***

## 4 BASELINE SCHEME AND PROPOSED SCHEME

4.1.1 The Subject Site occupied an site area of about 1.06ha.The proposed development consists of two residential blocks with about 1,088 residential units and one ancillary block with social welfare facilities.

4.1.2 In this study, scheme comparison between baseline and proposed scheme is appropriate to assess overall air ventilation performance in the surrounding area. ***Table 3*** shows the major design parameters under both schemes. The Master Layout Plan for both schemes are show in ***Appendix A***.

***Table 3 Major Design Parameters***

| Major Design Parameters | | Baseline Scheme | Proposed Scheme |
|---|---|---|---|
| Subject Site Area (ha) | | 1.06 (approx.) | 1.06 (approx.) |
| Permitted Plot Ratio (Total) | | 9 (approx.) | 9 (approx.) |
| Permitted GFA ($m^2$) | | <64,343 (approx.) | <64,343 (approx.) |
| Total Domestic GFA ($m^2$) | | < 53,619 | < 53,619 |
| Site Coverage ($m^2$) | AFB | 2,903 (approx.) | 2,930 (approx.) |
| | BLOCK1 & 2 | 2,421 (approx.) | 2,440 (approx.) |
| | EPW | 470 (approx.) | 269 (approx.) |
| Public Housing Development (PHD) | Domestic GFA ($m^2$) | 52,029 (approx.) | 52,028 (approx.) |
| | Non-Domestic GFA ($m^2$) | 773 (approx.) | 764 (approx.) |
| | Design Population | 3,050 (approx.) | 3,050 (approx.) |
| | No. of Residential Blocks | 1 | 2 |
| | No. of Storeys | 41 | Block 1: 1 + 40 = 41 |

| Major Design Parameters | | Baseline Scheme | Proposed Scheme |
|---|---|---|---|
| | | | Block 2: 1+ 39 = 40 |
| | Building Height (mPD) | 147.39 mPD | Block 1: 147.39 mPD<br>Block 2: 144.64 mPD |
| | Building Podium Height (mPD) | 37.35 mPD | Block 1& Block 2: 37.35 mPD |
| | Sky Garden (mPD) | 62.10 mPD | 62.10 mPD |
| Ancillary Facilities Block | Domestic GFA ($m^2$) | 1,305 (approx.) | 1,345 (approx.) |
| | Non-Domestic GFA ($m^2$) | 7,099 (approx.) | 7,173 (approx.) |
| | No. of Storeys | 4 plus 1 basement | 4 plus 1 basement |
| | Building Height (mPD) | 79.45 mPD | 79.45 mPD |

4.1.3 In addition to the major design parameters, good design features including site permeability, ground coverage, and building height have been incorporated in the proposed scheme to further enhance wind circulation.

**Building Separation**

4.1.4 Under both the baseline scheme and the proposed scheme, the separation distance (approx. 16m) between the proposed building blocks and the private residential blocks at the north including Fu Wah Court and Hiu Wah Building are maintained to facilitate air ventilation to pass through the Subject Site to the downwind areas under both proposed and baseline scheme, as shown in ***Figure 6***.

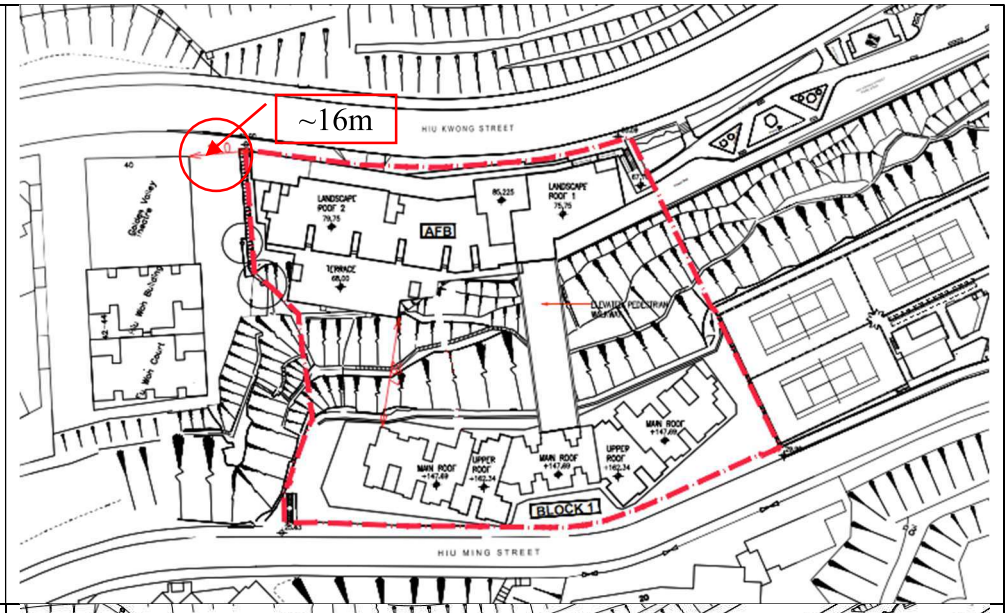
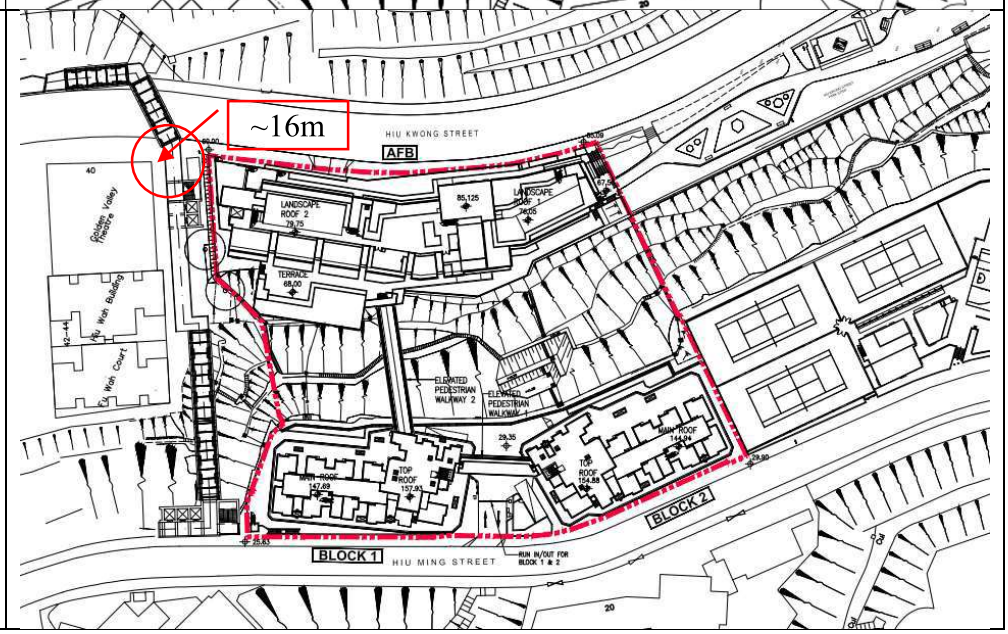
| | |
|---|---|
| **Baseline Scheme** |  |
| **Proposed Scheme** |  |

***Figure 6 Building Separation***

4.1.5 In addition to maintaining building separation between the Subject Site and the nearby private residential buildings, building separations within the Subject Site are maximised to favour incoming winds to penetrate the Subject Site as well as the nearby surrounding areas.

4.1.6 For instance, the residential block 1 is designed to allow building separation from the AFB. Under the proposed scheme, the distance between residential block 1 and AFB is slighted increased (to approx. 34m). Besides, the proposed residential block 1 is divided into two residential blocks under the proposed scheme. An approx. 17m building gap is created under the proposed scheme. These building separation are likely to favour wind circulation in between the Subject Site as well as the surrounding areas, as shown in ***Figure 7***.

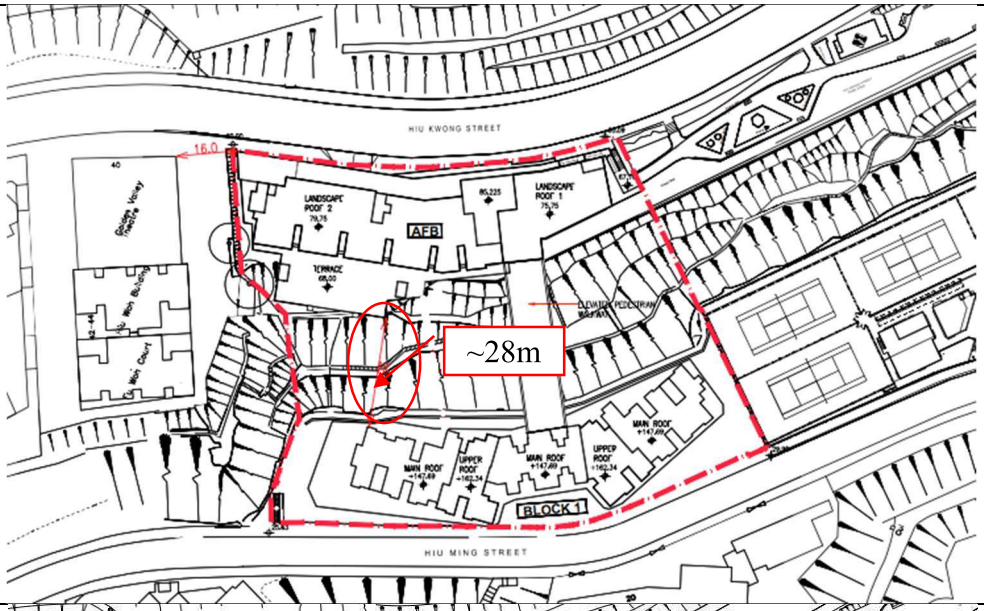
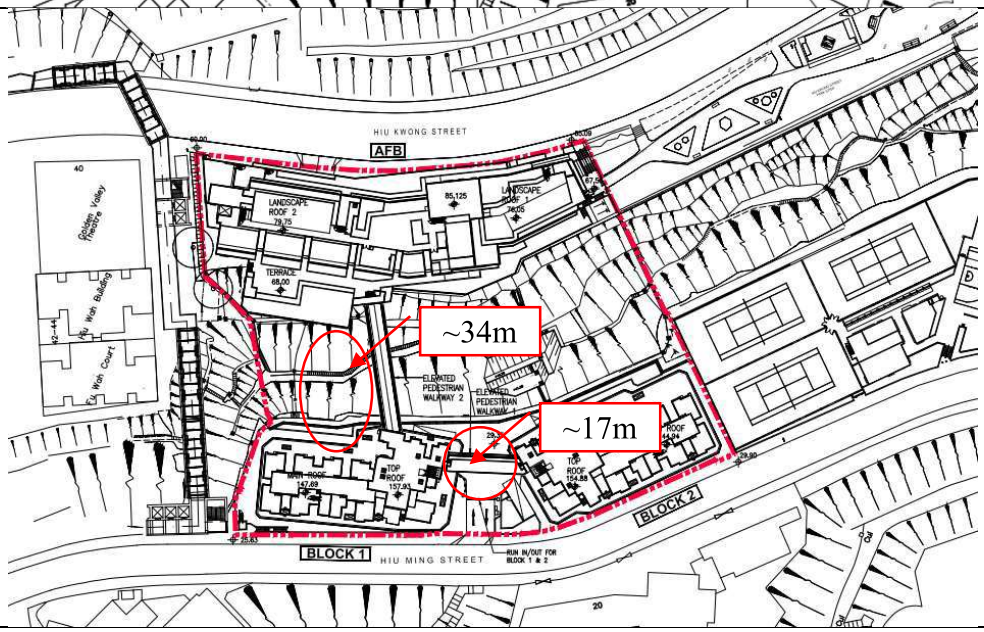
| | |
|---|---|
| **Baseline Scheme** |  |
| **Proposed Scheme** |  |

***Figure 7 Building Separation (within Subject Site)***

## Ground Coverage

4.1.7 As mentioned previously, the residential block 1 is divided into two residential blocks under the proposed scheme, which reduced ground coverage along Hiu Ming Street. The ground coverage is defined by the ratio between building façade and site boundary. Under the proposed scheme, the ground coverage is reduced from approx. 84% to approx. 68% when compared to the baseline scheme, as shown in ***Figure 8***.


***Figure 8*** ***Ground Coverage***

## Site Permeability

4.1.8 Moreover, a large void is designed within the residential block under the level of the sky garden under the proposed scheme. The large void enhances the permeability of the building which favour air penetration to the elevated pedestrian walkway between Block 1 and Block 2, as shown in ***Figure 9.*** The void within the residential blocks enhanced permeability of the proposed development, which allow winds to promote air circulation within the Subject Site and the nearby surrounding areas.

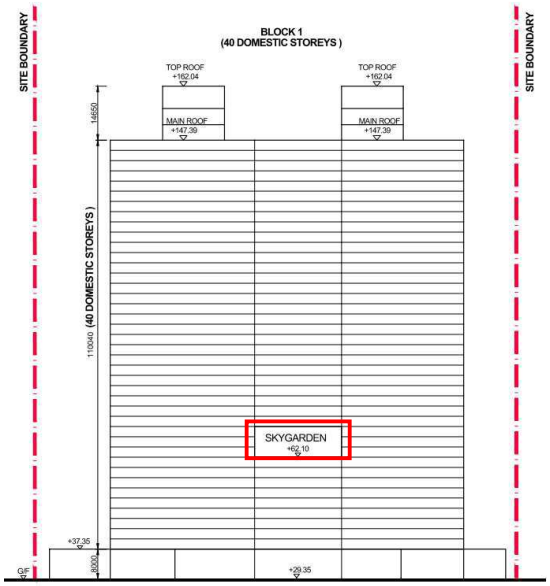
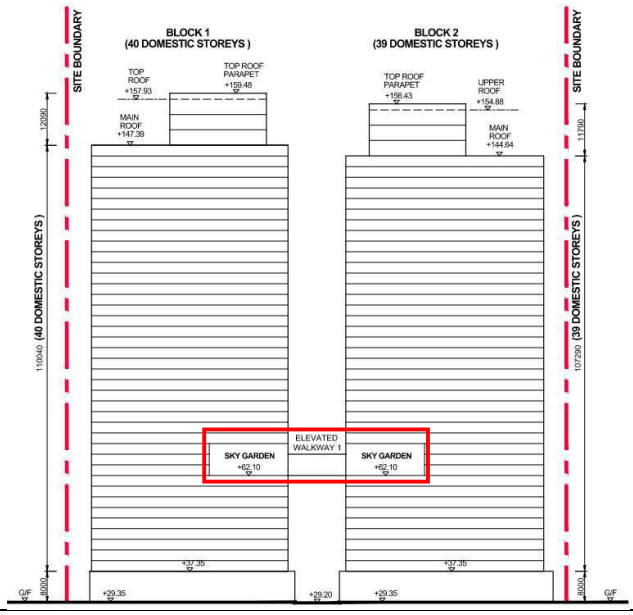
| | |
|---|---|
| **Baseline Scheme** |  |
| **Proposed Scheme** |  |

***Figure 9 Site Permeability***

# 5 ASSESSMENT METHODOLOGY

## 5.1 MODELLING TOOLS

5.1.1 ANSYS FLUENT version 15, as a computational fluid dynamics (CFD) simulation model, has been used for the natural ventilation study. It is a sophisticated modelling method, which takes into account the usual fluid dispersion calculation method under both laminar and turbulence flow stimulation. The equations that the CFD model solves are algebraic equations which result from applying the conservation laws of physics to finite volumes of space and time.

5.1.2 The geometry and simulation options for subject development and surrounding environment have been set up to calculate the wind speed at the development and surrounding ambient. Related wind speeds around the development were assessed by setting up a scaled model of the development with surrounding building structures and topographical features.

5.1.3 There are two Scenarios being assessed by CFD modelling in this Initial AVA Study:

5.1.4 Baseline Scheme: evaluating ventilation performance within H from the boundary of Subject Site with Baseline Scheme in place.

5.1.5 Proposed Scheme: evaluating ventilation performance within H from the boundary of Subject Site with Proposed Scheme in place.

## 5.2 GEOMETRY AND DOMAIN SETTING

5.2.1 Geometry including roads, buildings and terrain was imported to the CFD modelling for an area of approximately 500m radius around the development.

5.2.2 The CFD model set-up is shown in Figure 10.

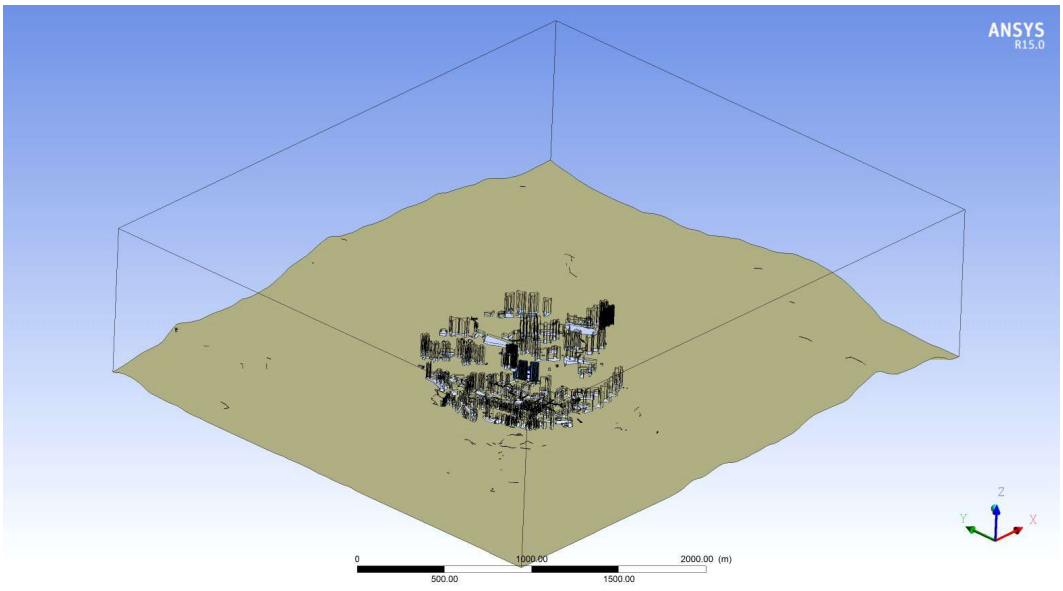



***Figure 10 Model Set-up***

5.2.3 The size of the computational domain of the 3D model is illustrated below:

- x-direction (L) = 3,600m;
- y-direction (W) = 3,600m; and
- z-direction (H) = 920m

5.2.4 It is calculated that the blockage ratio of the model is less than 3.0%.

## 5.3 MESHING SETTING

5.3.1 Unstructured grid is constructed by ANSYS FLUENT version 15 and the grid size can be manually adjusted. Within the assessment area, cells located across the x-axis and y-axis are positioned with smaller intervals than those located further from the site location in order to produce a more precise result at higher resolution where it is required.

5.3.2 The CFD model is developed with the combination of tetrahedral and prism cells. Approximately 12.2 million cells are constructed for the study. The grid arrangement within the assessment height of 2m above ground has been refined to facilitate the pedestrian wind environment study. In order to improve accuracy, smaller gird has been adopted in order to achieve a higher resolution at low levels of z-axis and thus capable of resolving small scale height structures and changes in topography at pedestrian level. A nominal expansion factor of around 1.2 is used. Four prism layers at prism ratio of 1.00 are created at 2m above ground to increase modelling accuracy at pedestrian level. ***Figure 11*** and ***Figure 12*** show the meshing details of the geometries.

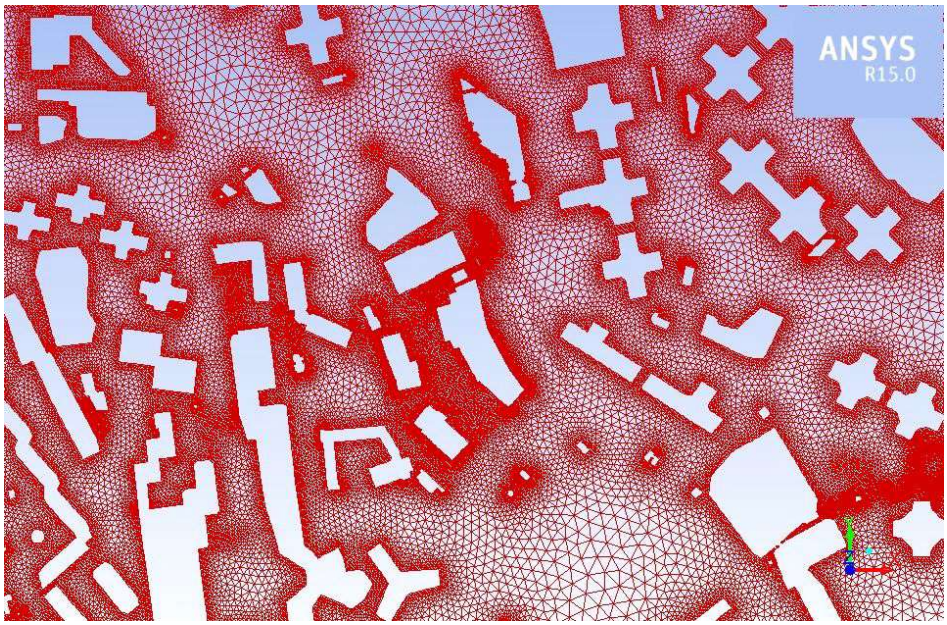



***Figure 11 Mesh Setting***

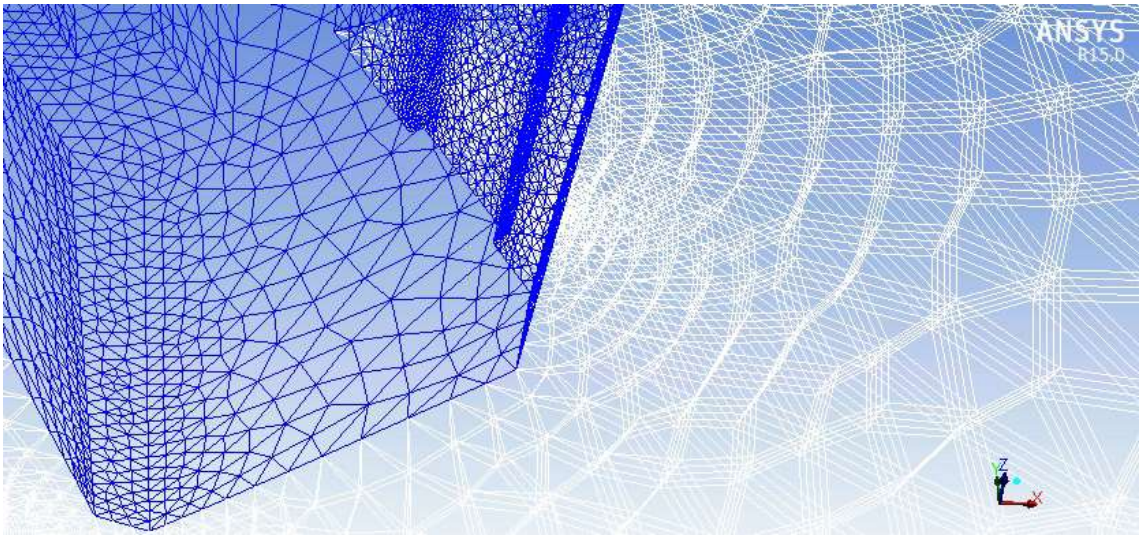



***Figure 12 CFD Model with Prism Layers***

## 5.4 NUMERIC SCHEME SETTING

5.4.1 ANSYS FLUENT offers an unparalleled breadth of turbulence models and the Reynolds stress model (RSM). In this study, the realizable k-epsilon model and a second order discretization scheme are adopted for simulation.

5.4.2 FLUENT uses iterative methods to solve the algebraic system of equations. The termination criterion is usually based on the residuals of the corresponding equations. The termination criterion of 0.001 has been used in this study.

## 5.5 BOUNDARY CONDITION SETTING

5.5.1 The boundary condition is tabulated in Table 4.

***Table 4 Boundary Setting***

| Wind Direction | East | North | South | West | Top | Terrain |
|---|---|---|---|---|---|---|
| E | Velocity inlet | Symmetry | Symmetry | Pressure outlet | Symmetry | Wall |
| ENE | Velocity inlet | Velocity inlet | Pressure outlet | Pressure outlet | Symmetry | Wall |
| ESE | Velocity inlet | Pressure outlet | Velocity inlet | Pressure outlet | Symmetry | Wall |
| NE | Velocity inlet | Velocity inlet | Pressure outlet | Pressure outlet | Symmetry | Wall |
| SSW | Velocity inlet | Velocity inlet | Pressure outlet | Pressure outlet | Symmetry | Wall |
| SE | Velocity inlet | Pressure outlet | Velocity inlet | Pressure outlet | Symmetry | Wall |
| S | Symmetry | Pressure outlet | Velocity inlet | Symmetry | Symmetry | Wall |
| SSE | Velocity inlet | Pressure outlet | Velocity inlet | Pressure outlet | Symmetry | Wall |
| SW | Velocity inlet | Velocity inlet | Pressure outlet | Pressure outlet | Symmetry | Wall |

| Wind Direction | East | North | South | West | Top | Terrain |
|---|---|---|---|---|---|---|
| WSW | Velocity inlet | Velocity inlet | Pressure outlet | Pressure outlet | Symmetry | Wall |

## 5.6 WIND PROFILE

5.6.1 Wind data used in CFD simulation has made reference to the latest simulated data published by Planning Department. The wind profiles from the simulated data are demonstrated in ***Figure 13***.

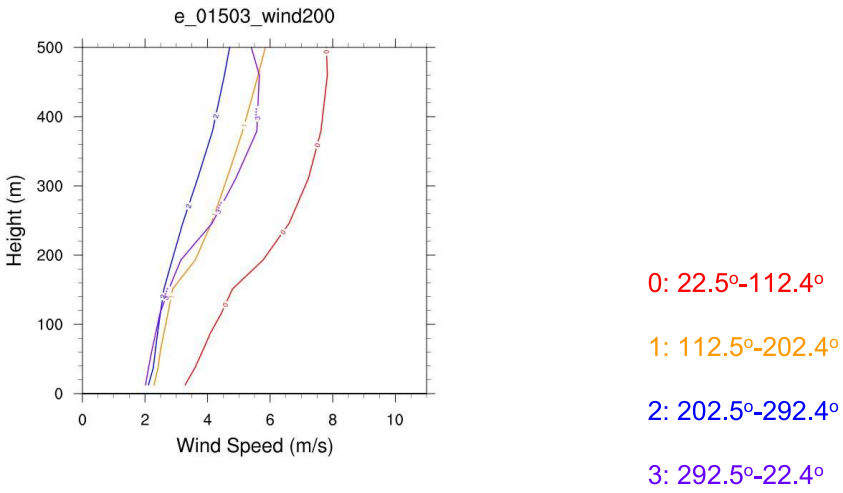



***Figure 13 Wind Profile***

## 5.7 SITE BOUNDARY, ASSESSMENT AREA AND SURROUNDING AREA

5.7.1 It is recommended in the Technical Guide that the Assessment Area and Surrounding Area of the Project should include the Project's surrounding of up to a perpendicular distance H and 2H respectively from the Project boundary, while H being the height of the tallest building of the proposed development.

**Surrounding Buildings and Structures**

5.7.2 All major noise barriers, elevated structures, planned and committed developments within the surrounding area have been modelling in the CFD simulation.

**Assessment Area**

5.7.3 The assessment area covers the surrounding environment of the project, which is up to a perpendicular distance H (where H is the height of the tallest building within the site i.e. 118m of Block 1). However, it is necessary to enlarge the area to distance of 2H up to approximately 236m in order to define a representable assessment area.

5.7.4 The surrounding area should normally up to a perpendicular distance of 2H from the project area boundary, which is approximately 236m for this study. In practice of a conservative approach, a surrounding area 500m measured from the Subject Site boundary.

## 5.8 WIND VELOCITY RATIO

5.8.1 Wind velocity is assessed at 2m above ground level of the proposed residential blocks. Wind Velocity Ratio (VR) should be used as an indicator of wind performance for the AVA. It indicates how much of the wind availability of a location could be experienced and enjoyed by pedestrians. The higher the wind velocity ratio, the less likely would be the impact of the proposed developments on the wind availability.

5.8.2 Wind Velocity Ratio is defined as follows:

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

Where

Vp is the wind velocity at the pedestrian level (2m above ground) after taking into account the effects of buildings; and

$V_\infty$ is the wind availability of the site, i.e. wind velocity at the top of the wind boundary layer.

5.8.3 The assessment on the overall wind performance of the current situation and the proposed developments were analyzed by comparing the weighted-mean wind velocity ratio (VRw') to account for wind coming from the wind directions for which the sum of occurrence frequency is > 75%. VRw' is the sum of the Wind Velocity Ratio of wind from direction i (VRi) multiplied by the probability (Fi) of wind coming from that direction.

$$\mathrm{VR_i} = \frac{\mathrm{V_{pi}}}{\mathrm{V_{\infty i}}}$$

$$\mathrm{VR_W} = \sum_{i=1}^{n} \mathrm{F_i} * \mathrm{VR_i}$$

where

Vpi is the wind velocity at the pedestrian level (2m above ground) when wind comes from direction i

$V_\infty$i is the wind availability of the site, when wind comes from direction i

Fi is the frequency occurrence of wind from direction i

n is the number of wind with sum of occurrence frequency > 75%

VRw is the wind velocity ratio

5.8.4 The normalized weighting (Fi) for each wind direction under annual and summer conditions are summarised in ***Table 5*** and ***Table 6*** respectively.

***Table 5 Weighted Occurrence Frequency (Fi) of Annual Wind Conditions***

| Wind Direction | Occurrence frequency of the wind direction | Normalized weighting (Fi) |
|---|---|---|
| E | 22.6% | 28.2% |
| ENE | 18.7% | 23.3% |
| NE | 9.3% | 11.6% |
| ESE | 7.4% | 9.2% |
| NNE | 7.2% | 9.0% |

| Wind Direction | Occurrence frequency of the wind direction | Normalized weighting (Fi) |
|---|---|---|
| SW | 5.3% | 6.6% |
| SE | 4.9% | 6.1% |
| WSW | 4.7% | 5.9% |
| **Total** | 80.1% | 100% |

***Table 6 Weighted Occurrence Frequency (Fi) of Summer Wind Conditions***

| Wind Direction | Occurrence frequency of the wind direction | Normalized weighting (Fi) |
|---|---|---|
| SW | 13.6% | 17.1% |
| WSW | 12.6% | 15.8% |
| E | 11.1% | 13.9% |
| SSW | 9.8% | 12.3% |
| SE | 8.4% | 10.6% |
| ESE | 8.2% | 10.3% |
| SSE | 8.2% | 10.3% |
| W | 7.7% | 9.7% |
| **Total** | 79.6% | 100% |

## 5.9 TEST POINTS

5.9.1 Test points are the locations where Wind Velocity Ratio (VRs) at 2m ground level is reported. Based on the VR of the test points, the resultant wind environment of the project can be assessed. Perimeter Test Points and Local Test Points are distributed around the Subject Site.

5.9.2 Perimeter Test Points are distributed to areas around perimeters of the project area boundary which are likely to be frequently accessed by pedestrians. Test Points in this group are named with prefix “P” (i.e. P01, P02…).

5.9.3 Overall Test Points are distributed on areas within the assessment area boundary and outside project area boundary, which are frequently accessed by pedestrians. Test points in this group are named with prefix “O” (i.e. O01, O02…).

5.9.4 Location of the perimeter test points and overall test points are shown in Figure 14 and Figure 15 respectively.

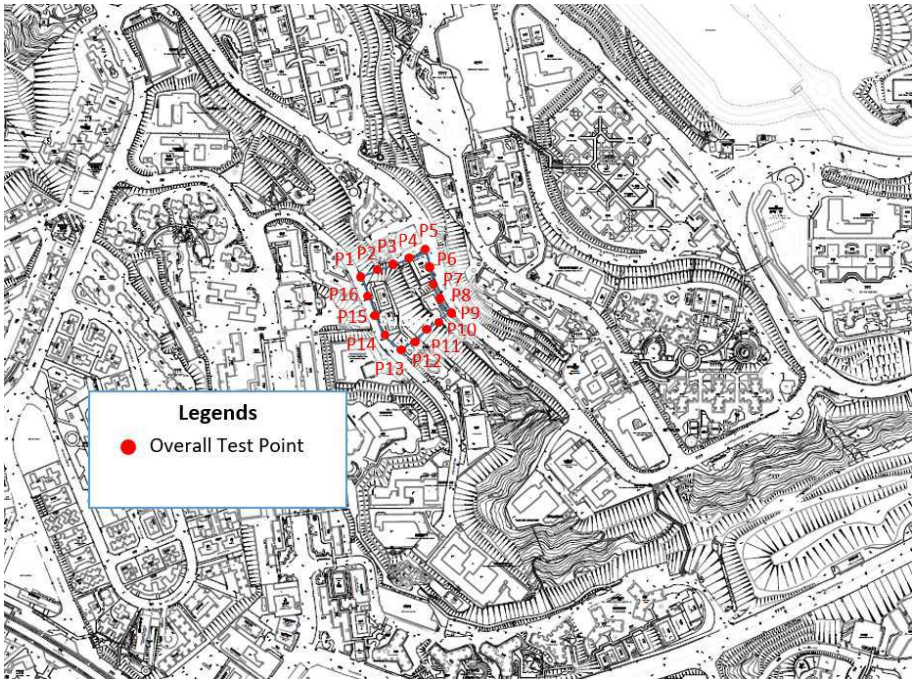



***Figure 14 Location of Perimeter Test Points***

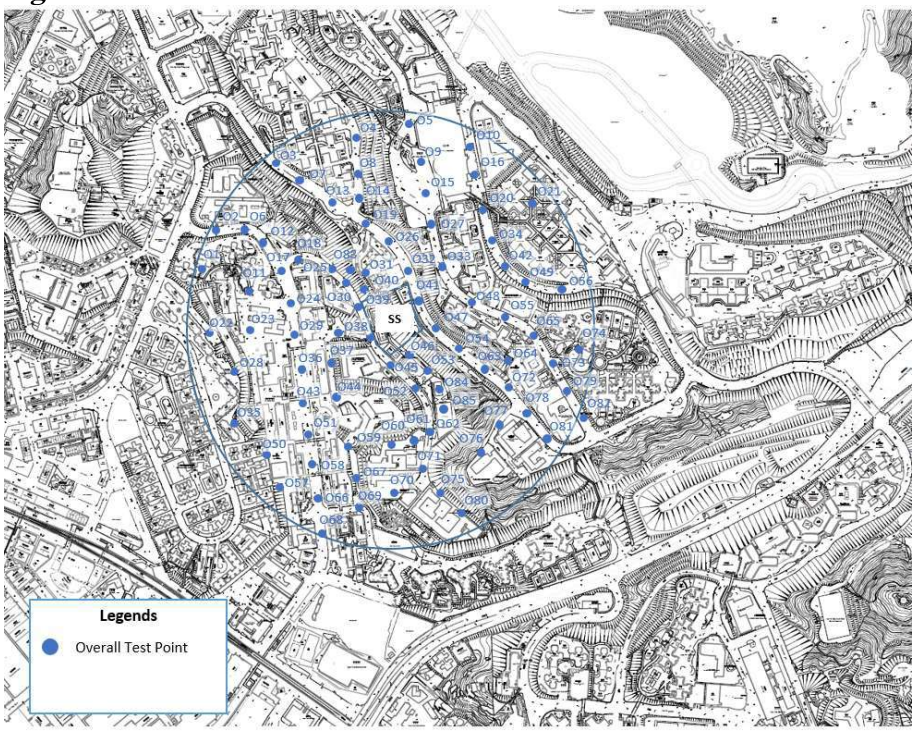



***Figure 15 Location of Overall Test Points***

# 6 INITIAL STUDY FINDINGS

## 6.1 AIR VENTILATION RESULTS

6.1.1 For the air assessment of the schemes, 16 perimeter test points and 84 overall test points are assigned at the pedestrian area. The differences of VRw at each perimeter test point and overall test points between Baseline Scheme and Proposed Scheme under annual and summer wind conditions are presented in ***Appendix B***.

6.1.2 The simulation results of velocity ratio demonstrated in terms of contour and vector plots for all prevailing wind directions are provided in ***Appendix C***.

## 6.2 SITE AIR VENTILATION ASSESSMENT

6.2.1 Site spatial average Velocity Ratios (SVR) are evaluated for each wind direction by considering the average Velocity Ratio modelled at all Perimeter Test Points (16 points) along the boundary of the subject site which are accessible by pedestrians. Weighted site spatial average Velocity Ratios (SVRw) are also determined after taking into account wind probability of the 8 assessed wind directions.

**Annual Wind Conditions**

6.2.2 SVRw results for both the baseline scheme and proposed scheme under annual wind conditions are summarized in ***Table 7*** and ***Figure 16*** Results shows that the SVRw results under proposed scheme is slightly improved from 0.069 to 0.073 indicated a slight improvement of local wind environment under annual wind conditions.

***Table 7 Weighted Site Spatial Average Velocity Ratio (Annual Wind Conditions)***

| Annual Wind Condition | $VR_{average}$ (Baseline Scheme) | $VR_{average}$ (Proposed Scheme) | $VR_{average}$ Change |
|---|---|---|---|
| E | 0.039 | 0.040 | 0.001 |
| ENE | 0.053 | 0.061 | 0.008 |
| NE | 0.053 | 0.061 | 0.008 |
| ESE | 0.111 | 0.104 | -0.007 |
| NNE | 0.078 | 0.094 | 0.016 |
| SW | 0.137 | 0.133 | -0.004 |
| SE | 0.141 | 0.151 | 0.011 |
| WSW | 0.081 | 0.077 | -0.004 |
| **SVRw** | **0.069** | **0.073** | **0.004** |

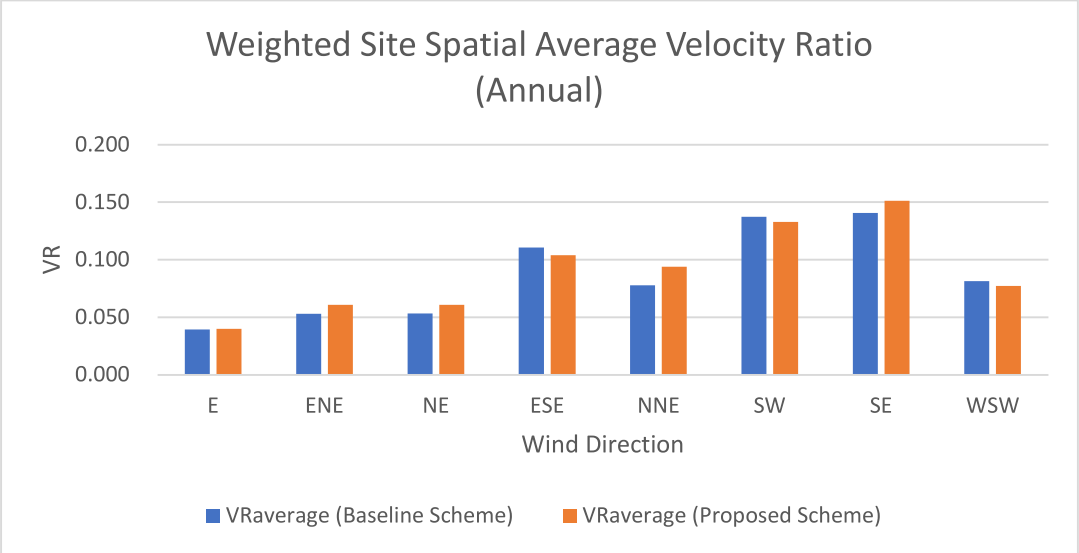



***Figure 16 Weighted Site Spatial Average Velocity Ratio (Annual Wind Conditions)***

**Summer Wind Condition**

6.2.3 On the other hand, under summer wind conditions, the SVRw results for baseline scheme and proposed scheme are 0.101 and 0.100 respectively. The slightly changes in SVRw indicate a similar overall wind environment at pedestrian level is anticipated. The SVRw under summer wind conditions are summarised in ***Table 8*** and ***Figure 17***.

***Table 8 Weighted Site Spatial Average Velocity Ratio (Summer Wind Conditions)***

| Summer Wind Condition | $VR_{average}$ (Baseline Scheme) | $VR_{average}$ (Proposed Scheme) | $VR_{average}$ Change |
|---|---|---|---|
| SW | 0.137 | 0.133 | -0.004 |
| WSW | 0.081 | 0.077 | -0.004 |
| E | 0.039 | 0.040 | 0.001 |
| SSW | 0.104 | 0.088 | -0.015 |
| SE | 0.141 | 0.151 | 0.011 |
| ESE | 0.111 | 0.104 | -0.007 |
| SSE | 0.092 | 0.094 | 0.003 |
| W | 0.105 | 0.129 | 0.023 |
| **SVRw** | **0.101** | **0.100** | **0.001** |

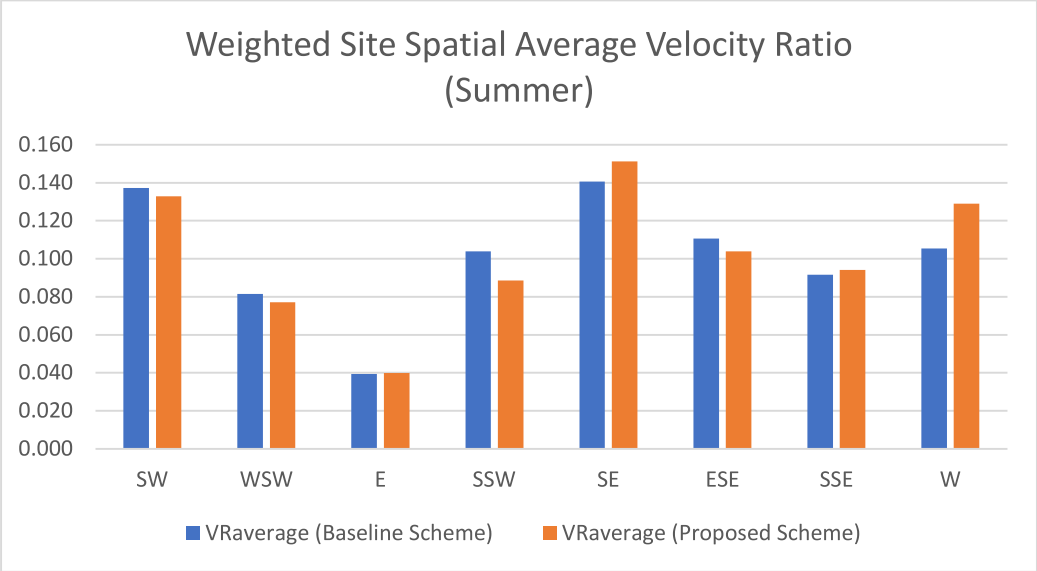



***Figure 17 Weighted Site Spatial Average Velocity Ratio (Summer Wind Conditions)***

## 6.3 LOCAL AIR VENTILATION ASSESSMENT

6.3.1 Local average Velocity Ratios (LVR) are evaluated for each wind direction by considering the average Velocity Ratio modelled at all Overall Test Points (84 points) and Perimeter Test Points (16 points) along the boundary of the subject site which are accessible by pedestrians. Weighted local spatial average Velocity Ratios (LVRw) are also determined after taking into account wind probability of the 8 assessed wind directions.

**Annual Wind Conditions**

6.3.2 The LVRw results for both the baseline scheme and proposed scheme under annual wind conditions are summarized in ***Table 9*** and ***Figure 18***. Results shows that the LVRw under the baseline and proposed scheme are 0.147 and 0.148 respectively, indicating a slightly improved in the overall wind environment at pedestrian level.

***Table 9 Weighted Local Spatial Average Velocity Ratio (Annual Wind Conditions)***

| Annual Wind Condition | $VR_{average}$ (Baseline Scheme) | $VR_{average}$ (Proposed Scheme) | $VR_{average}$ Change |
|---|---|---|---|
| E | 0.125 | 0.126 | 0.001 |
| ENE | 0.147 | 0.150 | 0.003 |
| NE | 0.137 | 0.129 | -0.008 |
| ESE | 0.169 | 0.174 | 0.004 |
| NNE | 0.158 | 0.167 | 0.009 |
| SW | 0.178 | 0.175 | -0.003 |
| SE | 0.199 | 0.207 | 0.008 |
| WSW | 0.126 | 0.127 | 0.001 |
| **LVRw** | **0.147** | **0.148** | **0.002** |

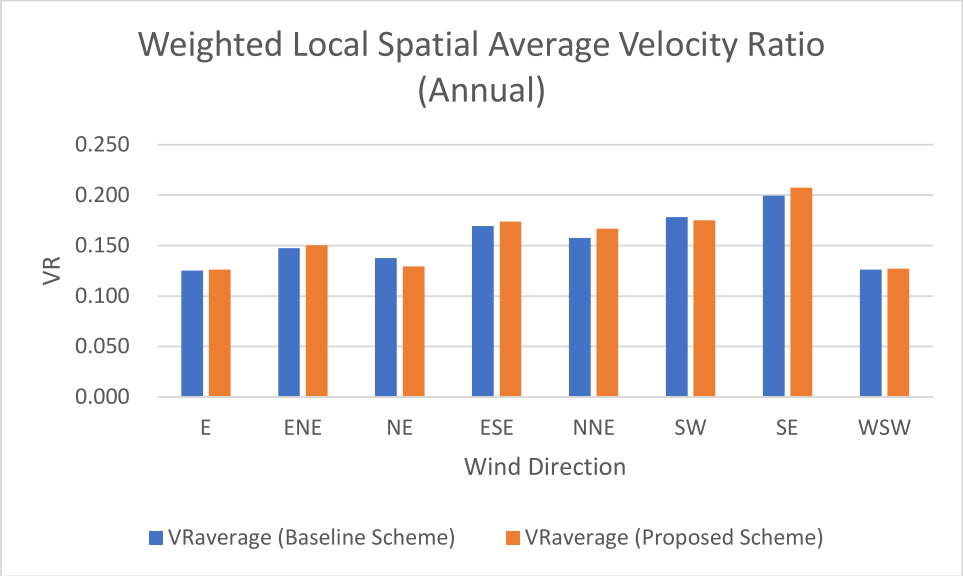



***Figure 18 Weighted Local Spatial Average Velocity Ratio (Annual Wind Conditions)***

**Summer Wind Conditions**

6.3.3 On the other hand, under summer wind conditions, the LVRw results for baseline scheme and proposed scheme are 0.162 and 0.164 respectively. The slightly changes in LVRw indicate a slightly improvement in the overall wind environment at pedestrian level. The LVRw under summer wind conditions are summarized in ***Table 10*** and ***Figure 19***.

***Table 10 Weighted Local Spatial Average Velocity Ratio (Summer Wind Conditions)***

| Summer Wind Condition | $VR_{average}$ (Baseline Scheme) | $VR_{average}$ (Proposed Scheme) | $VR_{average}$ Change |
|---|---|---|---|
| SW | 0.178 | 0.175 | -0.003 |
| WSW | 0.126 | 0.127 | 0.001 |
| E | 0.125 | 0.126 | 0.001 |
| SSW | 0.169 | 0.163 | -0.006 |
| SE | 0.199 | 0.207 | 0.008 |
| ESE | 0.169 | 0.174 | 0.004 |
| SSE | 0.175 | 0.187 | 0.012 |
| W | 0.170 | 0.174 | 0.005 |
| **LVRw** | **0.162** | **0.164** | **0.002** |

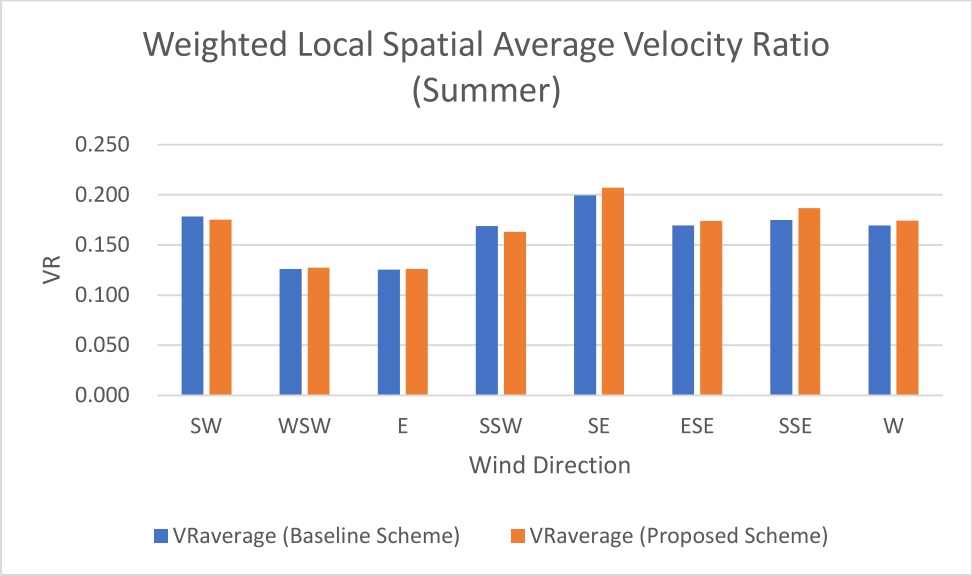



***Figure 19 Weighted Local Spatial Average Velocity Ratio (Summer Wind Conditions)***

# 7 DIRECTIONAL ANALYSIS

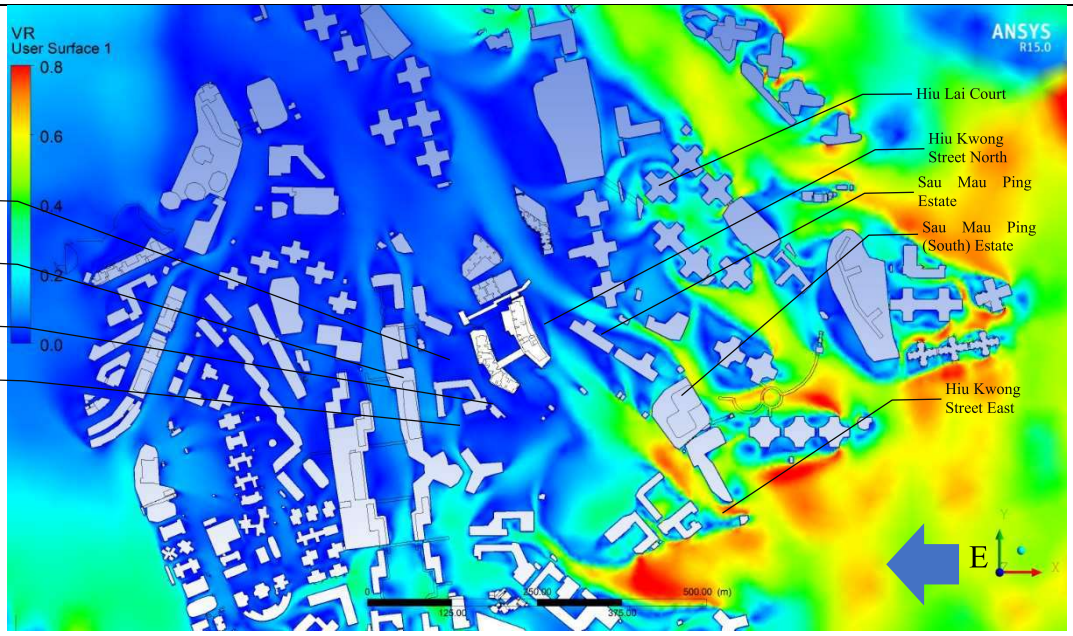
## E Wind & ENE Wind

7.1.1 Under annual prevailing wind conditions, E and ENE winds flowing from the elevated topography of Sau Mau Ping Estate and Sau Mau Ping (South) Estate are likely to flow along the east-west corridor of Hiu Kwok Street East and join the north-south corridor of Hiu Kwong Street North. E winds are expected to travel along the Subject Site and reach the downwind area of high-rise residential development of Tsui Ping (North) Estate and Hiu Lai Court located west of Subject Site.

7.1.2 Under the Proposed Scheme, the building separation between block 1 and the ancillary facility block is enhanced to allow wind to flow freely to the Subject Site. Moreover, ground coverage of the Subject Site along Hiu Ming Street is reduced as compared to the baseline scheme. Therefore, pedestrian wind environmental in downwind areas of Tsui Ping (North) Estate, Tsui Ping Commercial Complex and Mong Man Wai College along the Hiu Ming Street are slightly improved.

7.1.3 Nevertheless, the overall wind environment under both schemes are similar as the proposed development is not located at the upwind location under E and ENE wind conditions. Hence, the wind environment of the Subject Site and the nearby surrounding area is similar under both schemes, as shown in ***Figure 20*** and ***Figure 21***.

**Baseline Scheme (E)**




**Proposed Scheme (E)**

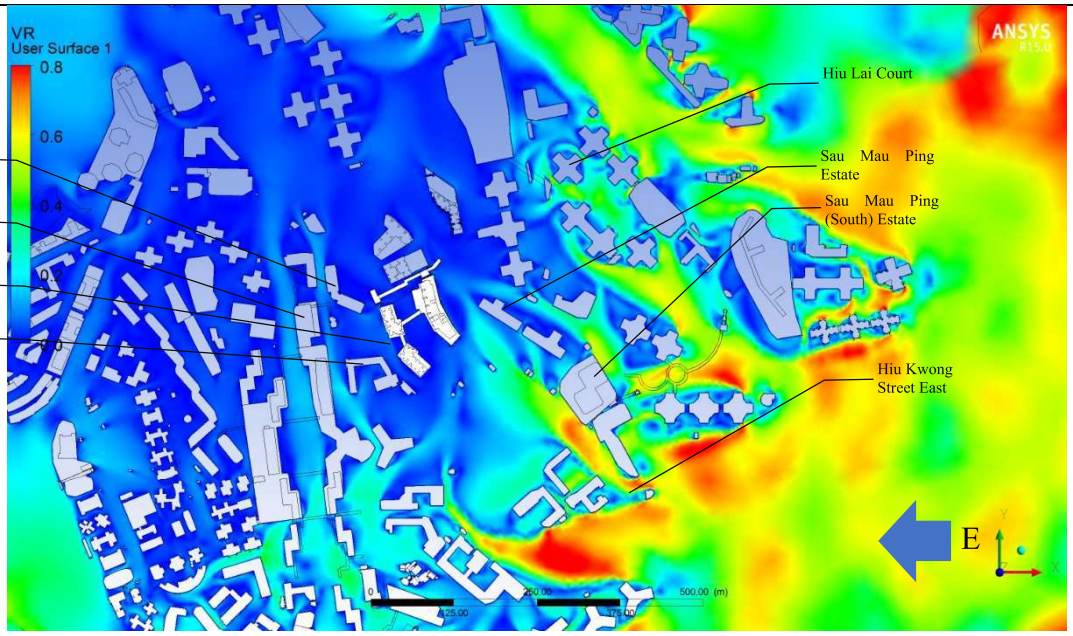



***Figure 20 VR Contour under E Wind Condition***

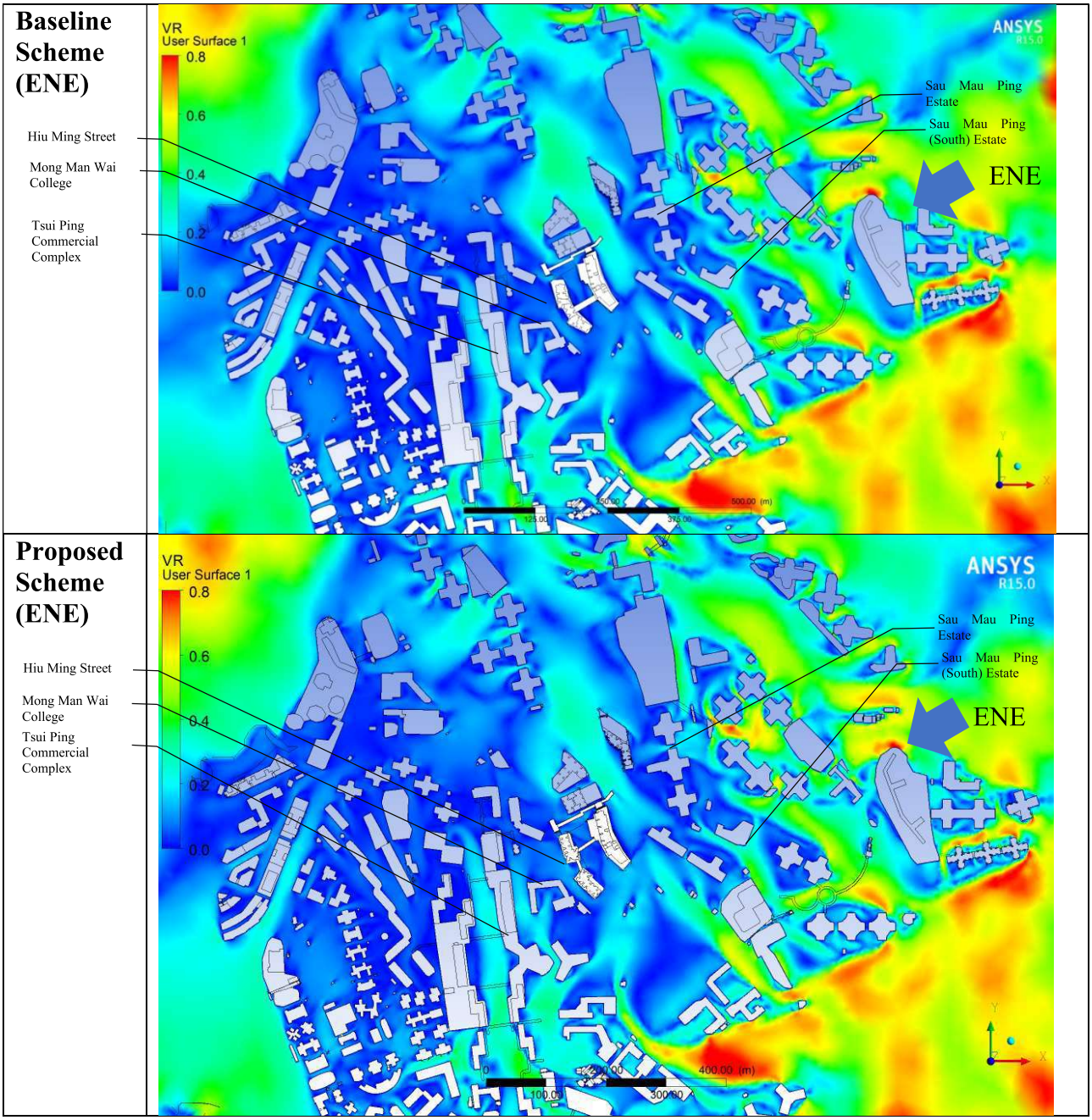



***Figure 21 VR Contour under ENE Wind Condition***

**NE & NNE Wind**

7.1.4 Under NE and NNE wind conditions, incoming winds shall perform similarly. NE and NNE wind flowing from the high-rise residential building of Sau Mau Ping Estate and Sau Mau Ping (South) Estate and reach the downwind area of south of Hiu Ming Street and Tsui Ping (North) Estate.

7.1.5 Under the Proposed Scheme, the building separation residential block 1 is designed to enlarge building separation from the AFB. The enlarged building separation favour wind penetration within the Subject Site as well as the nearby downwind area. In addition, the ground coverage is reduced under the Proposed Scheme to increase wind availability within the Subject Site. Hence, improved wind performance within the Subject Site, Hiu Ming Street, Mong Man Wai College are observed, as shown in ***Figure 22*** and ***Figure 23***.

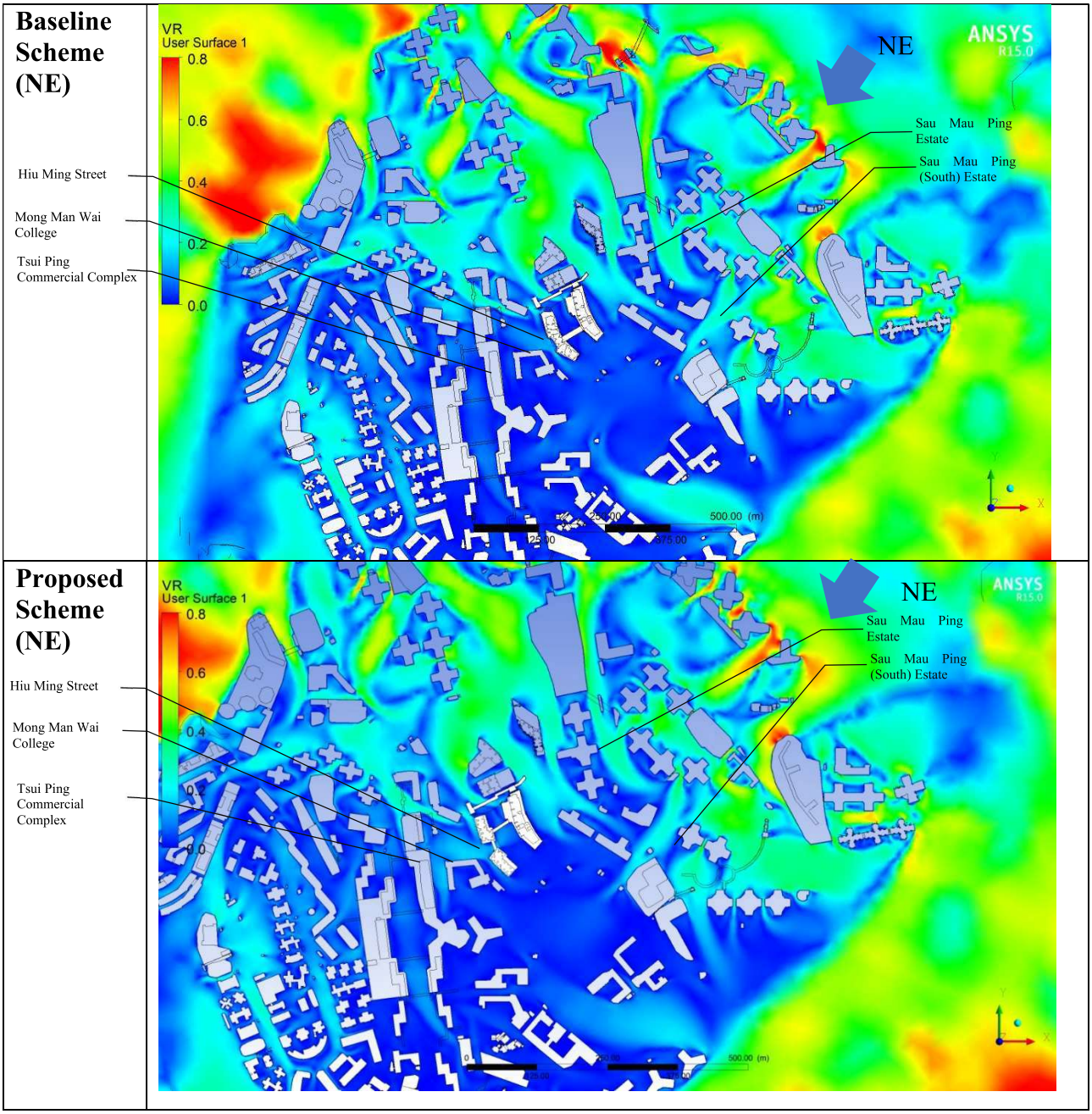



***Figure 22 VR Contour under NE Wind Condition***

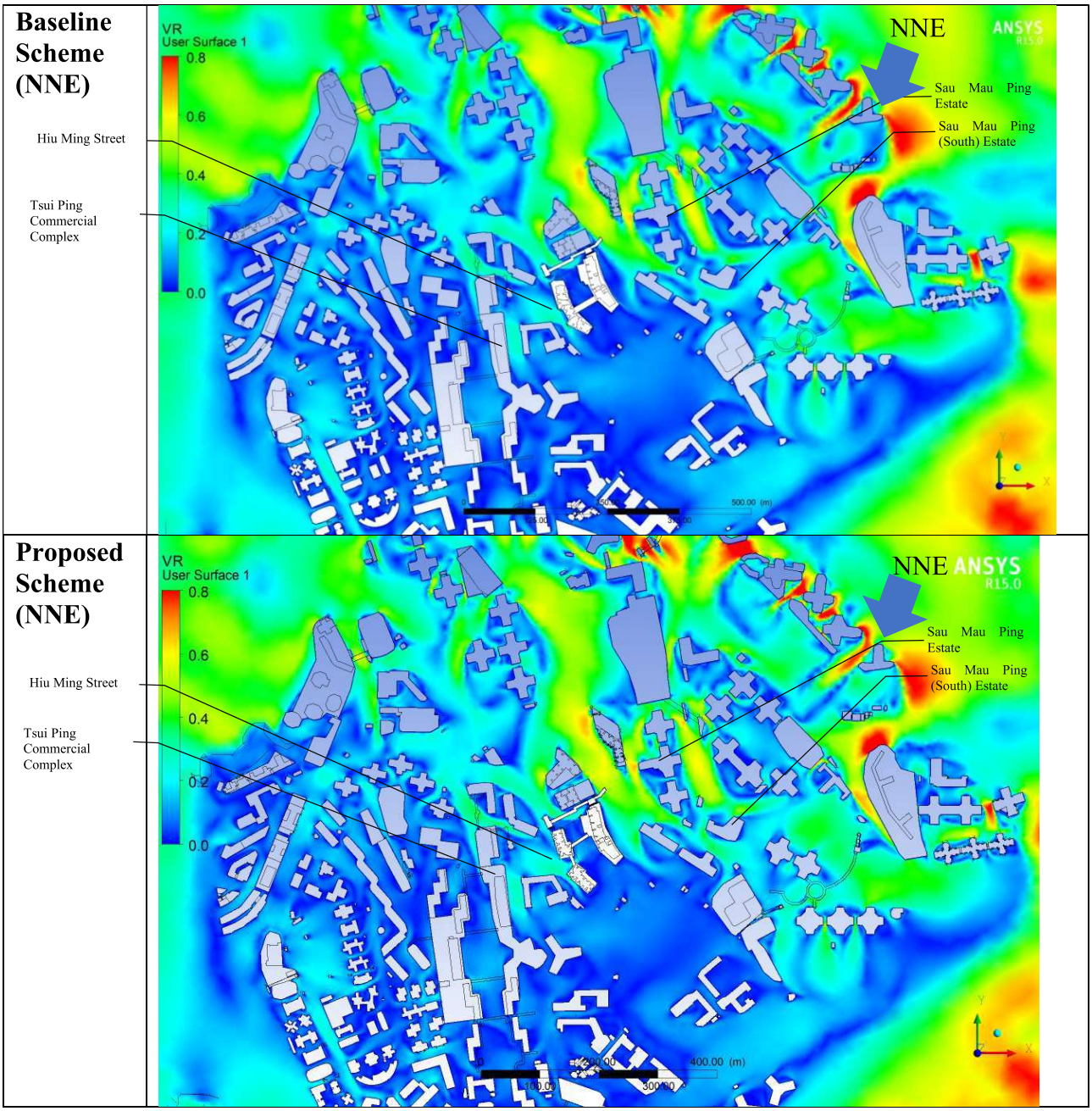



***Figure 23 VR Contour under NNE Wind Condition***

**ESE Wind**

7.1.6 Under ESE Wind condition, ESE wind would flow from the high-rise residential development of Tsui Ping (South) Estate, penetrate the Subject Site and reach the downwind area of Tsui Ping (North) Estate and Tsui Ping Commercial Complex located northwest of the Subject Site.

7.1.7 Under the Proposed Scheme, good design features including reducing ground coverage, enhancing building separation and site permeability have been incorporated in the Proposed Scheme. Meanwhile, similar wind environment between both the Proposed Scheme and the Baseline Scheme are observed, as shown in ***Figure 24***.

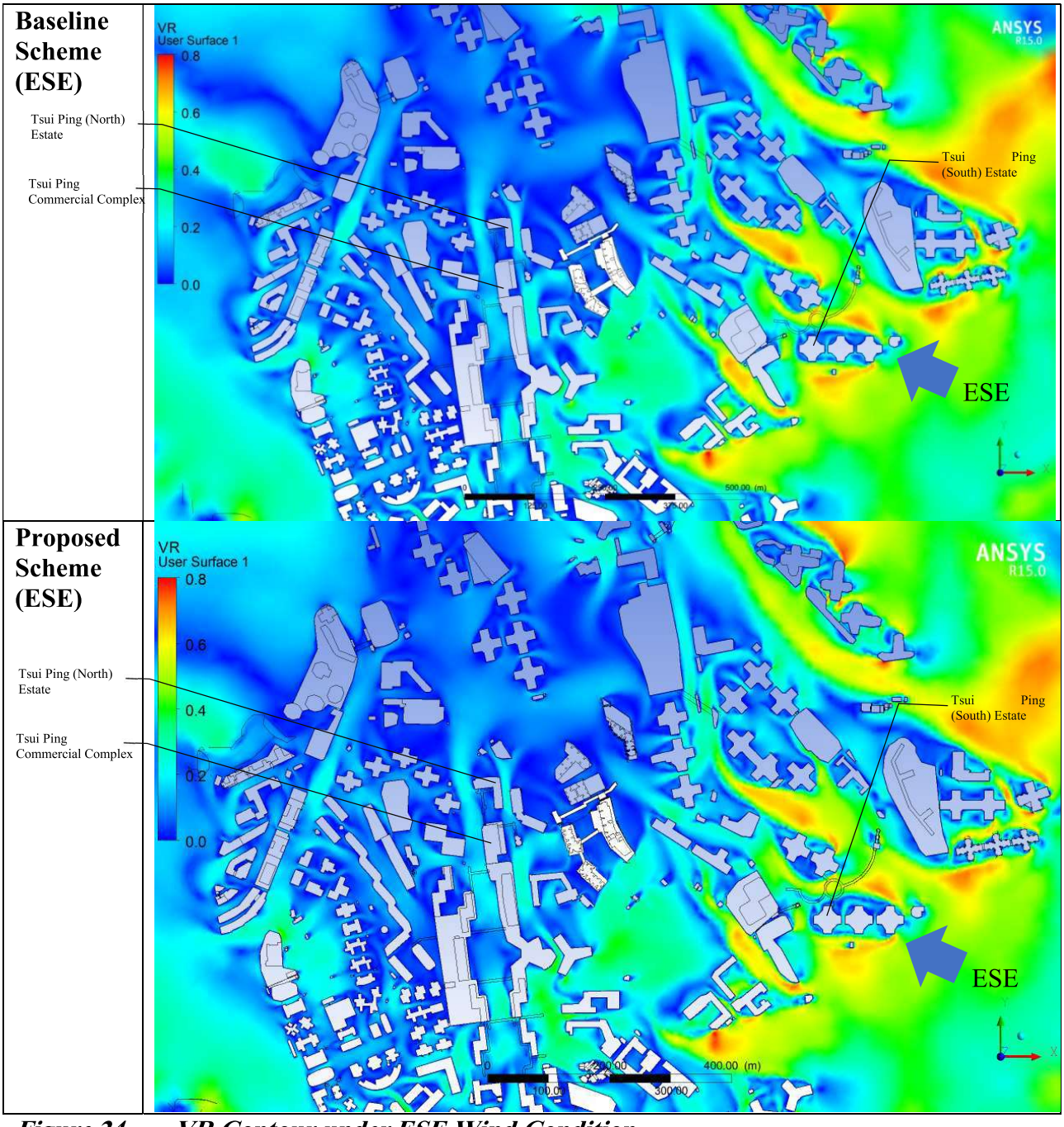



***Figure 24 VR Contour under ESE Wind Condition***

**SW Wind & SSW Wind**

7.1.8 Under summer prevailing wind condition, SW and SSW wind shall performed similarly. SW and SSW wind would flow from the mid-rise to high-rise residential developments of Tsui Ping Commercial Complex and Tsui Ping (North) Estate, then travel to the Subject Site before reaching downwind areas of Hiu Wah Building, Hiu Kwong Court, Hiu Ming Court and further down to Sau Mau Ping Estate.

7.1.9 Under the Proposed Scheme, good design features including reducing ground coverage, enhancing building separation and site permeability have been incorporated in the Proposed Scheme. Meanwhile, similar wind environment between both the Proposed Scheme and the Baseline Scheme is observed, as show in ***Figure 25*** and ***Figure 26***

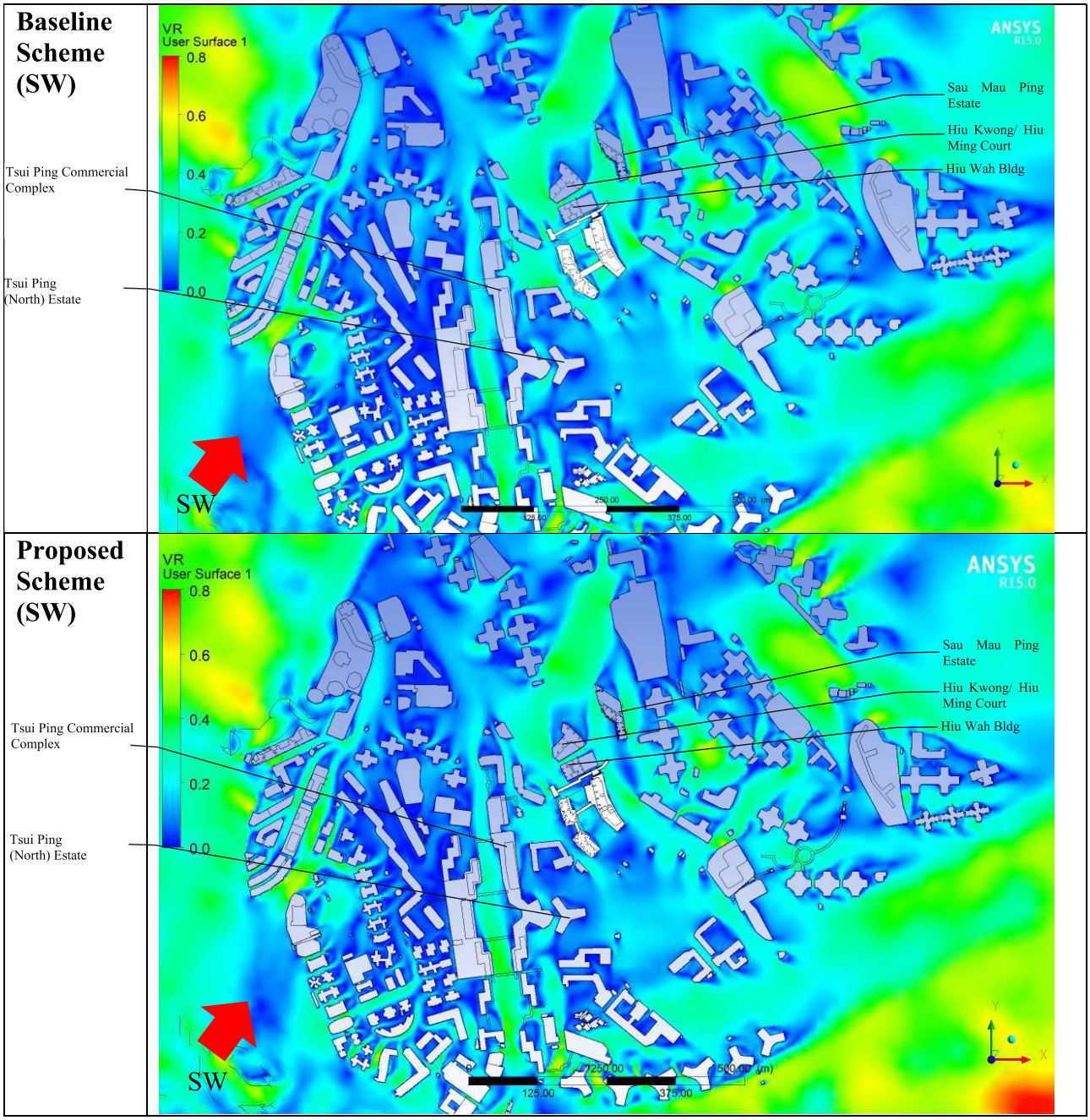



***Figure 25 VR Contour under SW Wind Condition***

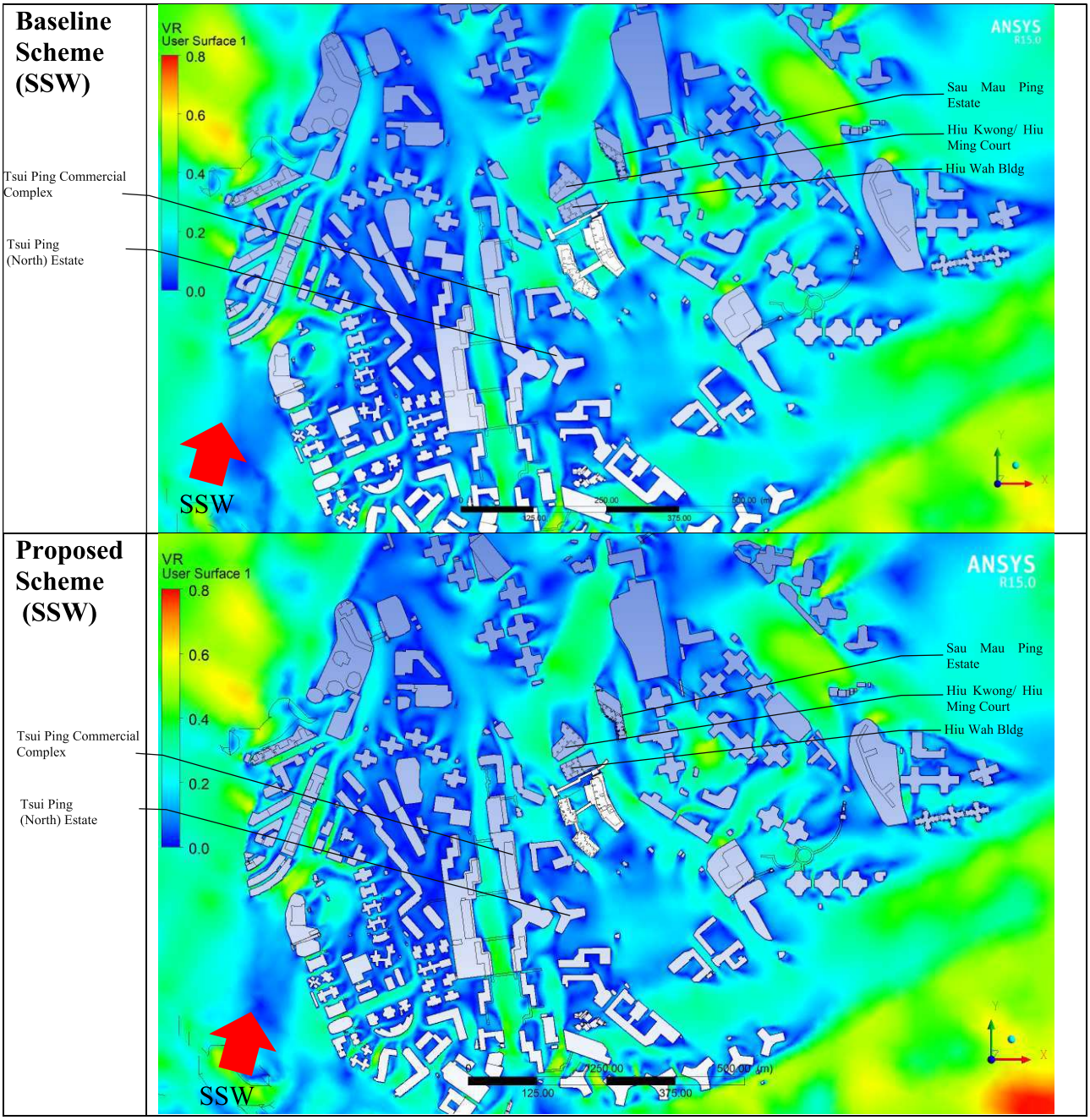



***Figure 26 VR Contour under SSW Wind Condition***

## SE Wind & SSE Wind

7.1.10 Under summer prevailing wind condition, SE and SSE wind shall performed similarly. SE and SSE wind would flow from up wind area of Sau Mau Ping (South) Estate along the Hiu Kwong Street North, then travel to reach the Subject Site and Sau Mau Ping Estate, and further to the downwind areas to the north.

7.1.11 Under the Proposed Scheme, good design features including enhancing building separation and site permeability have been incorporated in the Proposed Scheme. Incoming SE and SSE wind would experience less impedance from building structure. Therefore, pedestrian wind environmental along Hiu Kwong Street North are improved, as shown in ***Figure 27*** and ***Figure 28***.

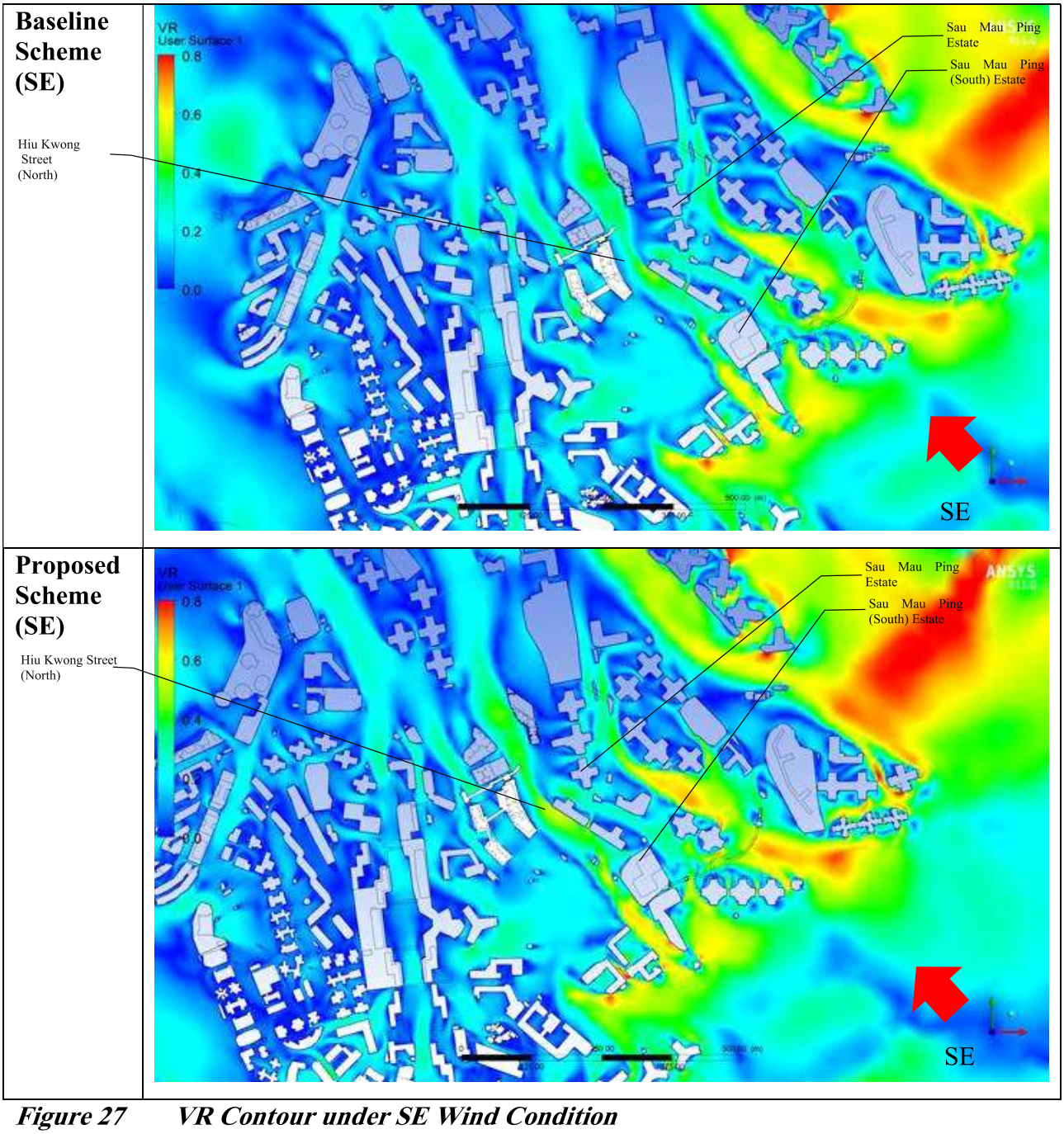
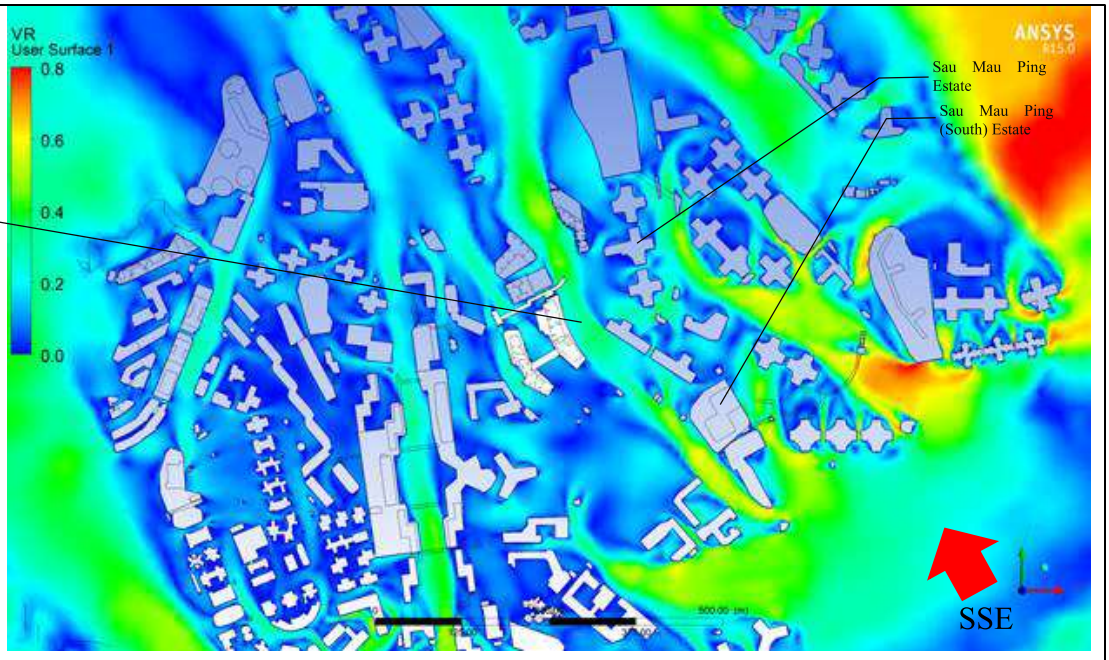



***Figure 27 VR Contour under SE Wind Condition***

**Baseline Scheme (SSE)**




**Proposed Scheme (SSE)**

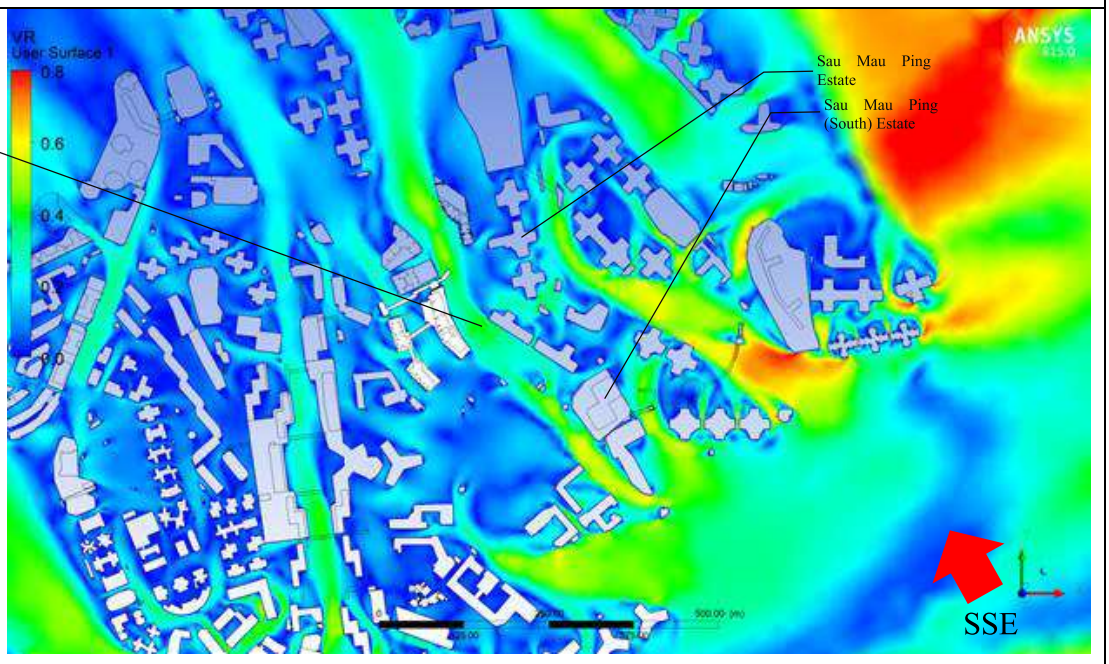



***Figure 28 VR Contour under SSE Wind Condition***

**WSW Wind & W Wind**

7.1.12 Under summer prevailing wind condition, WSW and W wind shall performed similarly. WSW and W wind from the elevated topography will flow along the Hiu Ming Street through Hiu Ming Court and Tsui Ping (North) Estate, then travel to reach the Subject Site and further to the downwind area to Ching Chung Secondary School.

7.1.13 Under the Proposed Scheme, good design features including reducing ground coverage, enhancing building separation and site permeability have been incorporated in the Proposed Scheme. Meanwhile, similar wind environment between both the Proposed Scheme and the Baseline Scheme is observed, as shown in ***Figure 29*** and ***Figure 30***.

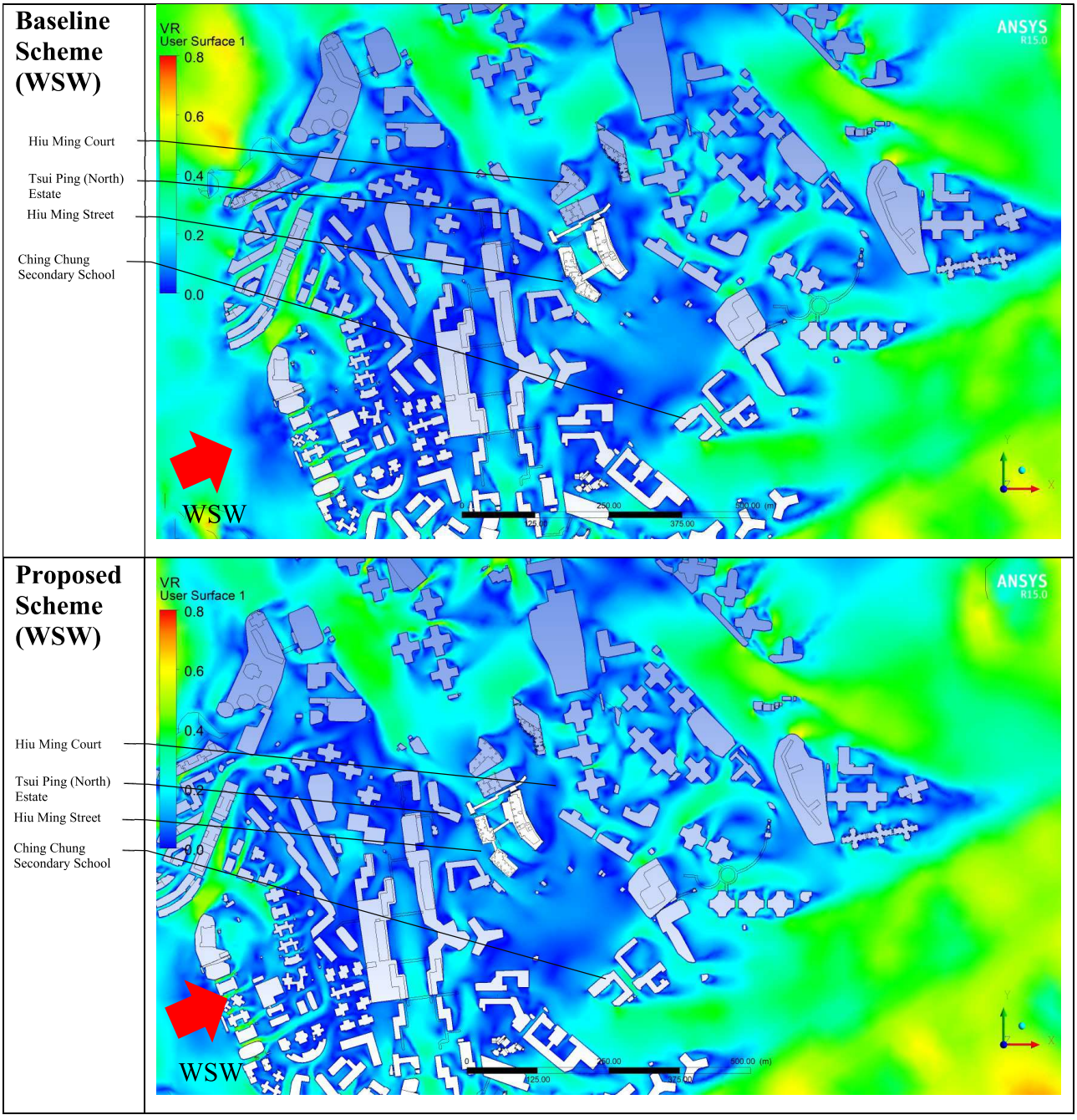



***Figure 29 VR Contour under WSW Wind Condition***

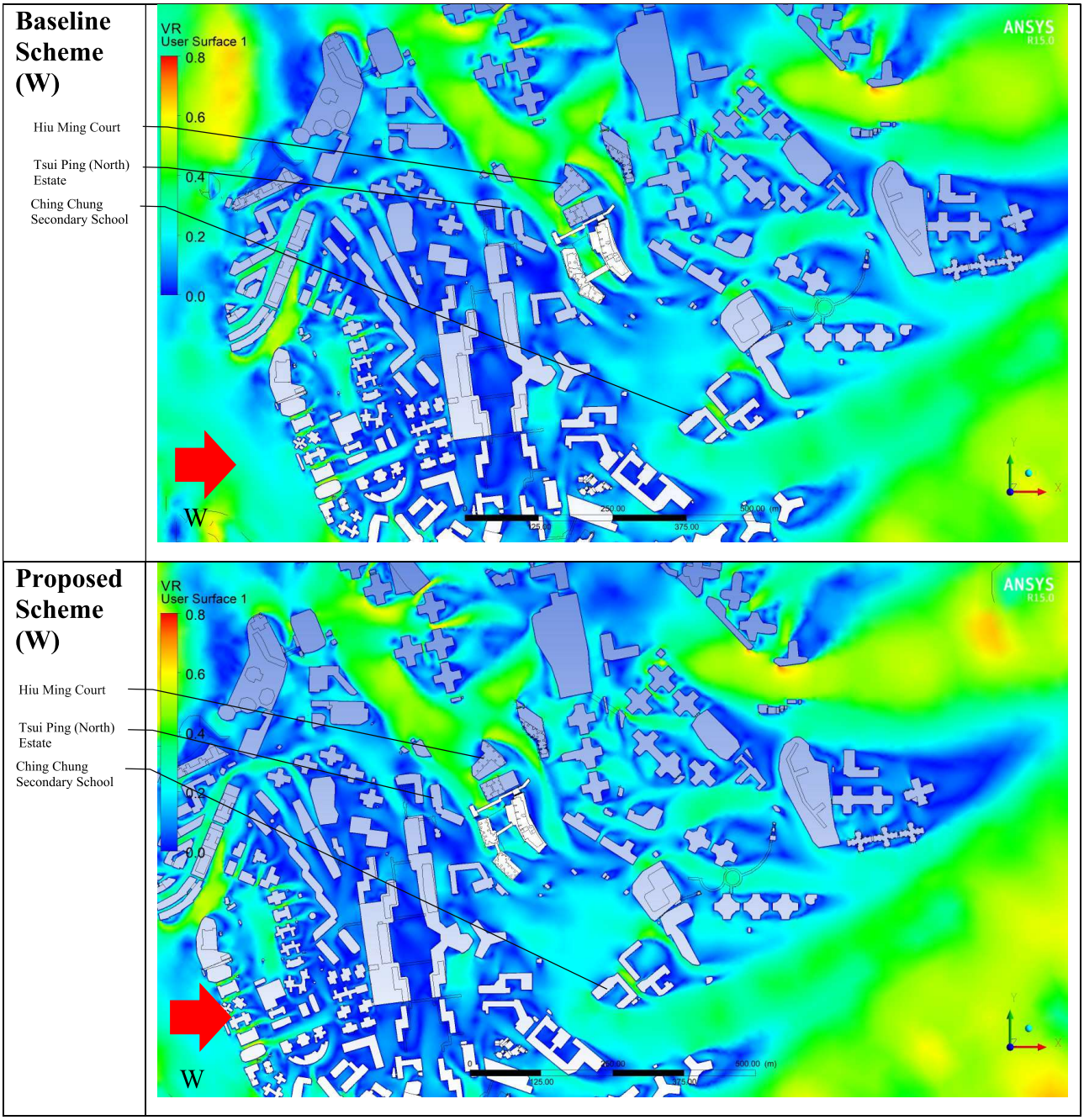



***Figure 30 VR Contour under W Wind Condition***

# 8 CONCLUSION

8.1.1 In this AVA-Initial Study, two scenarios including baseline scheme and proposed scheme for the Subject Site are assessed by CFD modelling.

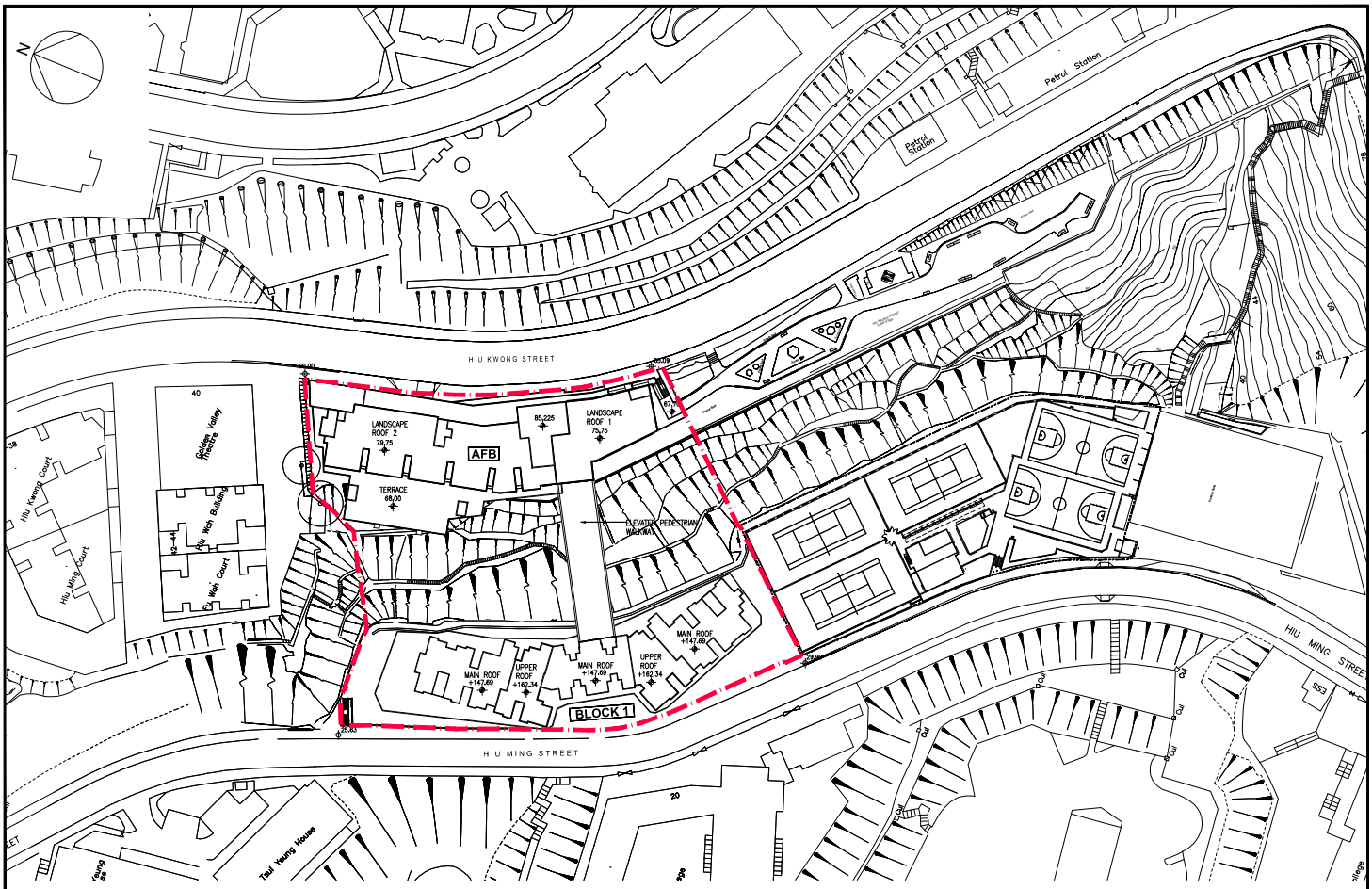
8.1.2 With the implementation of good design features, the proposed scheme provide a similar wind environment around the development. The good design features includes maximizing building separation, minimizing ground coverage and enhancing site permeability would likely to improve wind circulation within the Subject Site and nearby surrounding areas.

8.1.3 Based on the results of wind rose analysis, the most probable annual wind directions is E, accounting for 22.6% of the annul wind occurrence at 500m above ground. The 8 most frequent wind directions include E, ENE, NE, ESE, NNE, SW, SE and WSW which accounting for approximately 80.1% of the annual wind occurrence. The most probable summer wind directions is SW, accounting for 13.6% of the summer wind occurrence at 500m above ground. The 8 most frequent wind directions is SW, WSW, E, SSW, SE, ESE, SSE and W, accounting for approximately 79.6% of summer wind occurrence.

8.1.4 According to the CFD modelling results, similar to slightly improvement in SVRw and LVRw under annual and summer wind conditions are observed under both baseline and proposed scheme.

# *Appendix A*

## *Master Layout Plan (Baseline Scheme & Proposed Scheme)*




BASELINE SCHEME

AVA RE-SUBMISSION
BLOCK PLAN (BASELINE SCHEDME)

PROJECT
PUBLIC HOUSING DEVELOPMENT
AT HIU MING STREET

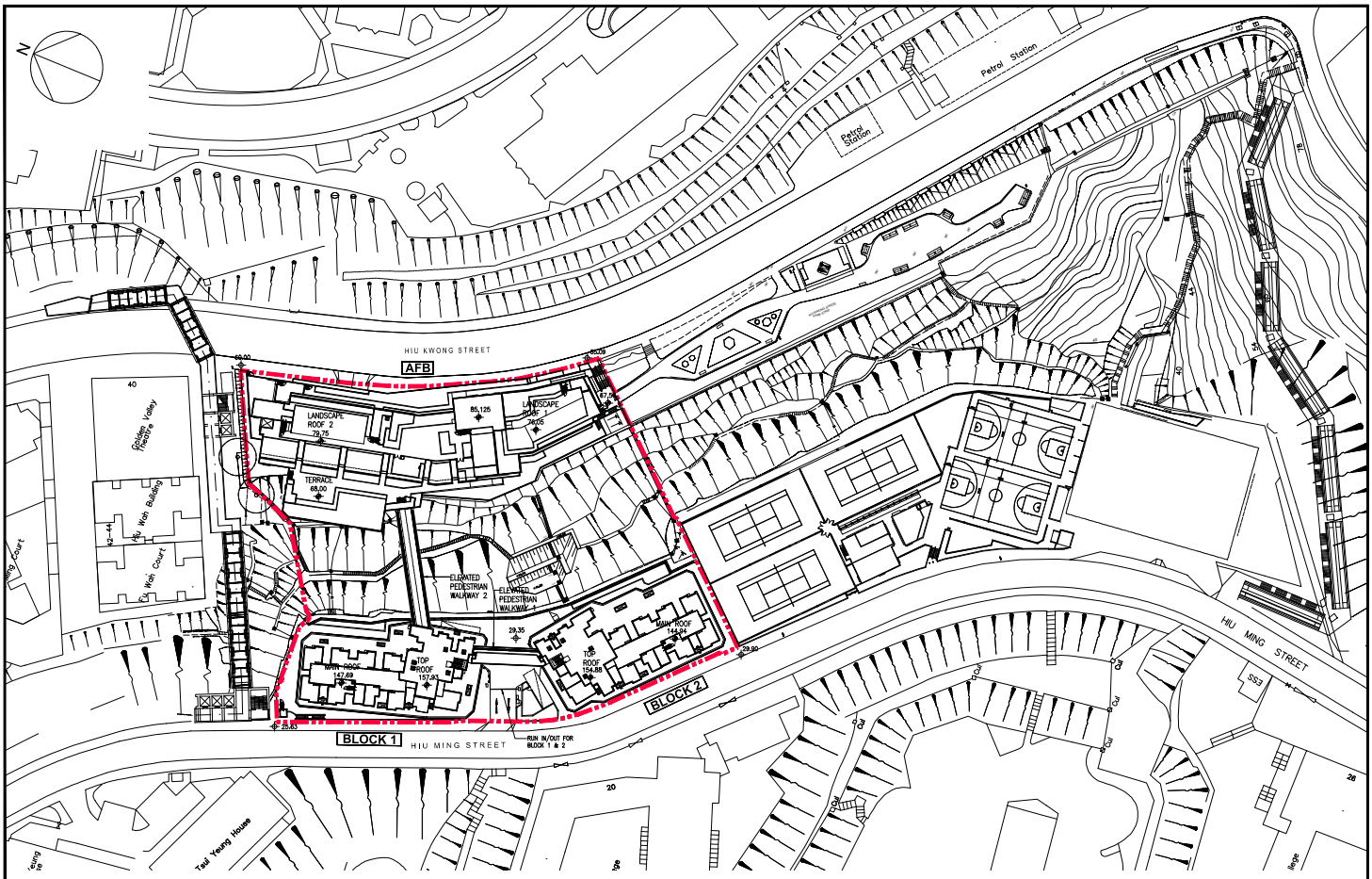
HOUSING DEPARTMENT

P&T Architects and Engineers Ltd
巴馬丹拿建築及工程師有限公司

DRAWING NO. SK/P&T/0142

SCALE: 1:1000 (A3)

DATE: 23-03-2020




PROPOSED SCHEME

AVA RE-SUBMISSION
BLOCK PLAN (PROPOSED SCHEDME)

PROJECT
PUBLIC HOUSING DEVELOPMENT
AT HIU MING STREET

HOUSING DEPARTMENT

P&T Architects and Engineers Ltd
巴馬丹拿建築及工程師有限公司

DRAWING NO. SK/P&T/0143

SCALE: 1:1000 (A3)

日期 DATE: 26-02-2021

# *Appendix B*

# *Detailed Results of Site and Local Spatial VRs*

E wind

| E wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.007 | 0.010 | 0.003 |
| OP 002 | 0.004 | 0.007 | 0.003 |
| OP 003 | 0.028 | 0.037 | 0.009 |
| OP 004 | 0.099 | 0.069 | -0.030 |
| OP 005 | 0.016 | 0.019 | 0.003 |
| OP 006 | 0.008 | 0.024 | 0.016 |
| OP 007 | 0.040 | 0.016 | -0.023 |
| OP 008 | 0.008 | 0.015 | 0.007 |
| OP 009 | 0.053 | 0.062 | 0.009 |
| OP 010 | 0.043 | 0.043 | 0.000 |
| OP 011 | 0.099 | 0.084 | -0.015 |
| OP 012 | 0.012 | 0.026 | 0.014 |
| OP 013 | 0.049 | 0.050 | 0.001 |
| OP 014 | 0.213 | 0.202 | -0.011 |
| OP 015 | 0.035 | 0.030 | -0.005 |
| OP 016 | 0.038 | 0.032 | -0.006 |
| OP 017 | 0.051 | 0.091 | 0.040 |
| OP 018 | 0.043 | 0.054 | 0.011 |
| OP 019 | 0.057 | 0.022 | -0.035 |
| OP 020 | 0.098 | 0.063 | -0.035 |
| OP 021 | 0.012 | 0.025 | 0.012 |
| OP 022 | 0.121 | 0.101 | -0.019 |
| OP 023 | 0.064 | 0.056 | -0.008 |
| OP 024 | 0.068 | 0.052 | -0.017 |
| OP 025 | 0.077 | 0.073 | -0.004 |
| OP 026 | 0.065 | 0.027 | -0.037 |
| OP 027 | 0.025 | 0.008 | -0.016 |
| OP 028 | 0.126 | 0.101 | -0.025 |
| OP 029 | 0.358 | 0.424 | 0.066 |
| OP 030 | 0.024 | 0.032 | 0.008 |
| OP 031 | 0.051 | 0.048 | -0.003 |
| OP 032 | 0.098 | 0.128 | 0.030 |
| OP 033 | 0.011 | 0.009 | -0.003 |
| OP 034 | 0.044 | 0.055 | 0.011 |
| OP 035 | 0.065 | 0.087 | 0.022 |
| OP 036 | 0.133 | 0.090 | -0.044 |
| OP 037 | 0.049 | 0.074 | 0.026 |

| E wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 038 | 0.041 | 0.038 | -0.003 |
| OP 039 | 0.079 | 0.128 | 0.049 |
| OP 040 | 0.104 | 0.161 | 0.057 |
| OP 041 | 0.048 | 0.042 | -0.006 |
| OP 042 | 0.169 | 0.106 | -0.064 |
| OP 043 | 0.037 | 0.101 | 0.064 |
| OP 044 | 0.044 | 0.112 | 0.068 |
| OP 045 | 0.034 | 0.056 | 0.021 |
| OP 046 | 0.039 | 0.070 | 0.032 |
| OP 047 | 0.238 | 0.251 | 0.013 |
| OP 048 | 0.051 | 0.027 | -0.024 |
| OP 049 | 0.172 | 0.182 | 0.010 |
| OP 050 | 0.143 | 0.165 | 0.021 |
| OP 051 | 0.065 | 0.137 | 0.072 |
| OP 052 | 0.216 | 0.193 | -0.023 |
| OP 053 | 0.121 | 0.106 | -0.015 |
| OP 054 | 0.084 | 0.112 | 0.028 |
| OP 055 | 0.315 | 0.323 | 0.008 |
| OP 056 | 0.065 | 0.081 | 0.015 |
| OP 057 | 0.273 | 0.344 | 0.072 |
| OP 058 | 0.611 | 0.625 | 0.015 |
| OP 059 | 0.280 | 0.308 | 0.028 |
| OP 060 | 0.060 | 0.057 | -0.003 |
| OP 061 | 0.069 | 0.053 | -0.017 |
| OP 062 | 0.392 | 0.390 | -0.002 |
| OP 063 | 0.379 | 0.340 | -0.039 |
| OP 064 | 0.090 | 0.075 | -0.016 |
| OP 065 | 0.207 | 0.231 | 0.024 |
| OP 066 | 0.249 | 0.232 | -0.018 |
| OP 067 | 0.033 | 0.081 | 0.048 |
| OP 068 | 0.126 | 0.119 | -0.007 |
| OP 069 | 0.564 | 0.521 | -0.043 |
| OP 070 | 0.677 | 0.631 | -0.046 |
| OP 071 | 0.344 | 0.187 | -0.156 |
| OP 072 | 0.164 | 0.149 | -0.015 |
| OP 073 | 0.528 | 0.600 | 0.072 |
| OP 074 | 0.207 | 0.230 | 0.023 |
| OP 075 | 0.567 | 0.584 | 0.017 |
| OP 076 | 0.424 | 0.383 | -0.041 |

| E wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 077 | 0.258 | 0.249 | -0.009 |
| OP 078 | 0.071 | 0.060 | -0.011 |
| OP 079 | 0.575 | 0.589 | 0.014 |
| OP 080 | 0.084 | 0.042 | -0.042 |
| OP 081 | 0.040 | 0.040 | 0.000 |
| OP 082 | 0.040 | 0.050 | 0.009 |
| OP 083 | 0.071 | 0.037 | -0.034 |
| OP 084 | 0.055 | 0.033 | -0.022 |
| Perimeter Test Points | | | |
| P 001 | 0.055 | 0.054 | -0.002 |
| P 002 | 0.031 | 0.033 | 0.003 |
| P 003 | 0.022 | 0.028 | 0.006 |
| P 004 | 0.006 | 0.008 | 0.002 |
| P 005 | 0.021 | 0.026 | 0.005 |
| P 006 | 0.012 | 0.011 | -0.001 |
| P 007 | 0.031 | 0.032 | 0.002 |
| P 008 | 0.058 | 0.057 | -0.001 |
| P 009 | 0.093 | 0.088 | -0.005 |
| P 010 | 0.100 | 0.095 | -0.005 |
| P 011 | 0.069 | 0.065 | -0.003 |
| P 012 | 0.004 | 0.006 | 0.002 |
| P 013 | 0.016 | 0.017 | 0.001 |
| P 014 | 0.033 | 0.003 | -0.030 |
| P 015 | 0.046 | 0.066 | 0.020 |
| P 016 | 0.033 | 0.046 | 0.014 |

ENE Wind

| ENE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.010 | 0.018 | 0.008 |
| OP 002 | 0.067 | 0.065 | -0.002 |
| OP 003 | 0.029 | 0.036 | 0.007 |
| OP 004 | 0.293 | 0.238 | -0.055 |
| OP 005 | 0.073 | 0.067 | -0.006 |
| OP 006 | 0.110 | 0.056 | -0.054 |
| OP 007 | 0.286 | 0.277 | -0.009 |
| OP 008 | 0.026 | 0.030 | 0.004 |
| OP 009 | 0.089 | 0.106 | 0.018 |
| OP 010 | 0.030 | 0.040 | 0.010 |
| OP 011 | 0.343 | 0.295 | -0.049 |
| OP 012 | 0.138 | 0.121 | -0.018 |
| OP 013 | 0.145 | 0.098 | -0.047 |
| OP 014 | 0.263 | 0.253 | -0.010 |
| OP 015 | 0.047 | 0.052 | 0.004 |
| OP 016 | 0.058 | 0.038 | -0.021 |
| OP 017 | 0.033 | 0.027 | -0.006 |
| OP 018 | 0.059 | 0.032 | -0.027 |
| OP 019 | 0.176 | 0.094 | -0.082 |
| OP 020 | 0.264 | 0.239 | -0.025 |
| OP 021 | 0.127 | 0.095 | -0.032 |
| OP 022 | 0.187 | 0.166 | -0.022 |
| OP 023 | 0.063 | 0.053 | -0.010 |
| OP 024 | 0.036 | 0.052 | 0.016 |
| OP 025 | 0.127 | 0.121 | -0.006 |
| OP 026 | 0.062 | 0.032 | -0.030 |
| OP 027 | 0.057 | 0.027 | -0.029 |
| OP 028 | 0.294 | 0.271 | -0.024 |
| OP 029 | 0.557 | 0.651 | 0.094 |
| OP 030 | 0.005 | 0.006 | 0.002 |
| OP 031 | 0.045 | 0.062 | 0.017 |
| OP 032 | 0.169 | 0.253 | 0.084 |
| OP 033 | 0.062 | 0.070 | 0.008 |
| OP 034 | 0.060 | 0.084 | 0.024 |
| OP 035 | 0.206 | 0.162 | -0.044 |
| OP 036 | 0.112 | 0.054 | -0.058 |
| OP 037 | 0.312 | 0.245 | -0.067 |
| OP 038 | 0.042 | 0.035 | -0.007 |

| ENE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.158 | 0.188 | 0.030 |
| OP 040 | 0.137 | 0.190 | 0.053 |
| OP 041 | 0.114 | 0.079 | -0.035 |
| OP 042 | 0.093 | 0.056 | -0.036 |
| OP 043 | 0.094 | 0.146 | 0.052 |
| OP 044 | 0.097 | 0.120 | 0.023 |
| OP 045 | 0.047 | 0.034 | -0.013 |
| OP 046 | 0.109 | 0.150 | 0.041 |
| OP 047 | 0.164 | 0.200 | 0.036 |
| OP 048 | 0.019 | 0.029 | 0.010 |
| OP 049 | 0.173 | 0.158 | -0.015 |
| OP 050 | 0.058 | 0.096 | 0.038 |
| OP 051 | 0.222 | 0.311 | 0.089 |
| OP 052 | 0.173 | 0.200 | 0.027 |
| OP 053 | 0.175 | 0.199 | 0.024 |
| OP 054 | 0.101 | 0.120 | 0.019 |
| OP 055 | 0.220 | 0.261 | 0.041 |
| OP 056 | 0.037 | 0.069 | 0.032 |
| OP 057 | 0.214 | 0.221 | 0.007 |
| OP 058 | 0.524 | 0.542 | 0.018 |
| OP 059 | 0.304 | 0.330 | 0.027 |
| OP 060 | 0.106 | 0.074 | -0.032 |
| OP 061 | 0.041 | 0.049 | 0.007 |
| OP 062 | 0.241 | 0.258 | 0.017 |
| OP 063 | 0.218 | 0.200 | -0.019 |
| OP 064 | 0.090 | 0.056 | -0.034 |
| OP 065 | 0.296 | 0.277 | -0.019 |
| OP 066 | 0.270 | 0.223 | -0.047 |
| OP 067 | 0.216 | 0.304 | 0.088 |
| OP 068 | 0.248 | 0.296 | 0.048 |
| OP 069 | 0.331 | 0.363 | 0.032 |
| OP 070 | 0.525 | 0.562 | 0.037 |
| OP 071 | 0.167 | 0.159 | -0.008 |
| OP 072 | 0.182 | 0.184 | 0.002 |
| OP 073 | 0.524 | 0.563 | 0.038 |
| OP 074 | 0.184 | 0.214 | 0.030 |
| OP 075 | 0.441 | 0.470 | 0.029 |
| OP 076 | 0.034 | 0.026 | -0.007 |
| OP 077 | 0.112 | 0.119 | 0.007 |

| ENE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.060 | 0.051 | -0.009 |
| OP 079 | 0.536 | 0.524 | -0.012 |
| OP 080 | 0.149 | 0.143 | -0.006 |
| OP 081 | 0.101 | 0.112 | 0.011 |
| OP 082 | 0.048 | 0.052 | 0.003 |
| OP 083 | 0.228 | 0.214 | -0.014 |
| OP 084 | 0.248 | 0.244 | -0.004 |
| Perimeter Test Points | | | |
| P 001 | 0.066 | 0.053 | -0.012 |
| P 002 | 0.071 | 0.057 | -0.014 |
| P 003 | 0.081 | 0.075 | -0.006 |
| P 004 | 0.051 | 0.039 | -0.012 |
| P 005 | 0.042 | 0.052 | 0.010 |
| P 006 | 0.014 | 0.017 | 0.004 |
| P 007 | 0.019 | 0.025 | 0.006 |
| P 008 | 0.005 | 0.005 | 0.001 |
| P 009 | 0.085 | 0.113 | 0.028 |
| P 010 | 0.094 | 0.138 | 0.044 |
| P 011 | 0.090 | 0.127 | 0.037 |
| P 012 | 0.057 | 0.077 | 0.020 |
| P 013 | 0.058 | 0.082 | 0.025 |
| P 014 | 0.070 | 0.052 | -0.018 |
| P 015 | 0.017 | 0.022 | 0.005 |
| P 016 | 0.029 | 0.038 | 0.009 |

NE Wind

| NE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.236 | 0.192 | -0.045 |
| OP 002 | 0.248 | 0.217 | -0.031 |
| OP 003 | 0.403 | 0.357 | -0.045 |
| OP 004 | 0.404 | 0.325 | -0.078 |
| OP 005 | 0.251 | 0.224 | -0.027 |
| OP 006 | 0.310 | 0.419 | 0.109 |
| OP 007 | 0.465 | 0.346 | -0.119 |
| OP 008 | 0.080 | 0.099 | 0.020 |
| OP 009 | 0.278 | 0.289 | 0.011 |
| OP 010 | 0.119 | 0.154 | 0.036 |
| OP 011 | 0.414 | 0.379 | -0.035 |
| OP 012 | 0.131 | 0.230 | 0.099 |
| OP 013 | 0.218 | 0.305 | 0.087 |
| OP 014 | 0.325 | 0.279 | -0.045 |
| OP 015 | 0.092 | 0.064 | -0.027 |
| OP 016 | 0.070 | 0.049 | -0.021 |
| OP 017 | 0.223 | 0.245 | 0.022 |
| OP 018 | 0.173 | 0.136 | -0.037 |
| OP 019 | 0.242 | 0.254 | 0.012 |
| OP 020 | 0.267 | 0.242 | -0.025 |
| OP 021 | 0.253 | 0.224 | -0.030 |
| OP 022 | 0.238 | 0.225 | -0.013 |
| OP 023 | 0.305 | 0.302 | -0.003 |
| OP 024 | 0.014 | 0.019 | 0.004 |
| OP 025 | 0.149 | 0.194 | 0.045 |
| OP 026 | 0.116 | 0.102 | -0.014 |
| OP 027 | 0.102 | 0.133 | 0.031 |
| OP 028 | 0.284 | 0.274 | -0.010 |
| OP 029 | 0.353 | 0.408 | 0.055 |
| OP 030 | 0.176 | 0.189 | 0.013 |
| OP 031 | 0.057 | 0.037 | -0.020 |
| OP 032 | 0.041 | 0.038 | -0.003 |
| OP 033 | 0.066 | 0.102 | 0.036 |
| OP 034 | 0.055 | 0.067 | 0.012 |
| OP 035 | 0.151 | 0.186 | 0.035 |
| OP 036 | 0.261 | 0.201 | -0.060 |
| OP 037 | 0.139 | 0.145 | 0.007 |
| OP 038 | 0.047 | 0.077 | 0.030 |

| NE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.068 | 0.071 | 0.003 |
| OP 040 | 0.029 | 0.035 | 0.006 |
| OP 041 | 0.030 | 0.015 | -0.015 |
| OP 042 | 0.022 | 0.032 | 0.011 |
| OP 043 | 0.049 | 0.056 | 0.006 |
| OP 044 | 0.008 | 0.013 | 0.005 |
| OP 045 | 0.026 | 0.039 | 0.012 |
| OP 046 | 0.046 | 0.025 | -0.021 |
| OP 047 | 0.060 | 0.026 | -0.033 |
| OP 048 | 0.061 | 0.057 | -0.005 |
| OP 049 | 0.178 | 0.118 | -0.060 |
| OP 050 | 0.258 | 0.160 | -0.097 |
| OP 051 | 0.072 | 0.079 | 0.007 |
| OP 052 | 0.009 | 0.010 | 0.001 |
| OP 053 | 0.056 | 0.024 | -0.032 |
| OP 054 | 0.048 | 0.023 | -0.025 |
| OP 055 | 0.053 | 0.037 | -0.016 |
| OP 056 | 0.025 | 0.032 | 0.006 |
| OP 057 | 0.145 | 0.153 | 0.008 |
| OP 058 | 0.451 | 0.402 | -0.049 |
| OP 059 | 0.045 | 0.028 | -0.017 |
| OP 060 | 0.063 | 0.025 | -0.038 |
| OP 061 | 0.054 | 0.043 | -0.011 |
| OP 062 | 0.044 | 0.038 | -0.006 |
| OP 063 | 0.169 | 0.208 | 0.039 |
| OP 064 | 0.384 | 0.307 | -0.076 |
| OP 065 | 0.007 | 0.014 | 0.007 |
| OP 066 | 0.047 | 0.040 | -0.006 |
| OP 067 | 0.072 | 0.036 | -0.035 |
| OP 068 | 0.085 | 0.059 | -0.026 |
| OP 069 | 0.047 | 0.031 | -0.017 |
| OP 070 | 0.014 | 0.010 | -0.004 |
| OP 071 | 0.203 | 0.190 | -0.013 |
| OP 072 | 0.041 | 0.029 | -0.012 |
| OP 073 | 0.180 | 0.090 | -0.090 |
| OP 074 | 0.028 | 0.015 | -0.014 |
| OP 075 | 0.027 | 0.029 | 0.003 |
| OP 076 | 0.150 | 0.141 | -0.008 |
| OP 077 | 0.024 | 0.018 | -0.006 |

| NE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.092 | 0.054 | -0.038 |
| OP 079 | 0.047 | 0.062 | 0.015 |
| OP 080 | 0.336 | 0.243 | -0.093 |
| OP 081 | 0.302 | 0.227 | -0.075 |
| OP 082 | 0.197 | 0.158 | -0.040 |
| OP 083 | 0.412 | 0.375 | -0.038 |
| OP 084 | 0.379 | 0.363 | -0.016 |
| Perimeter Test Points | | | |
| P 001 | 0.189 | 0.196 | 0.008 |
| P 002 | 0.050 | 0.053 | 0.004 |
| P 003 | 0.018 | 0.020 | 0.002 |
| P 004 | 0.069 | 0.073 | 0.004 |
| P 005 | 0.051 | 0.040 | -0.011 |
| P 006 | 0.008 | 0.023 | 0.015 |
| P 007 | 0.013 | 0.039 | 0.026 |
| P 008 | 0.005 | 0.026 | 0.021 |
| P 009 | 0.044 | 0.040 | -0.004 |
| P 010 | 0.005 | 0.008 | 0.003 |
| P 011 | 0.045 | 0.028 | -0.018 |
| P 012 | 0.005 | 0.010 | 0.005 |
| P 013 | 0.066 | 0.065 | -0.001 |
| P 014 | 0.089 | 0.090 | 0.001 |
| P 015 | 0.118 | 0.135 | 0.017 |
| P 016 | 0.075 | 0.125 | 0.050 |

ESE Wind

| ESE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.072 | 0.078 | 0.006 |
| OP 002 | 0.010 | 0.014 | 0.004 |
| OP 003 | 0.040 | 0.049 | 0.009 |
| OP 004 | 0.046 | 0.045 | -0.001 |
| OP 005 | 0.037 | 0.033 | -0.004 |
| OP 006 | 0.043 | 0.044 | 0.001 |
| OP 007 | 0.224 | 0.217 | -0.006 |
| OP 008 | 0.134 | 0.121 | -0.013 |
| OP 009 | 0.108 | 0.116 | 0.008 |
| OP 010 | 0.067 | 0.064 | -0.003 |
| OP 011 | 0.109 | 0.124 | 0.016 |
| OP 012 | 0.123 | 0.127 | 0.003 |
| OP 013 | 0.042 | 0.025 | -0.017 |
| OP 014 | 0.276 | 0.281 | 0.004 |
| OP 015 | 0.085 | 0.092 | 0.008 |
| OP 016 | 0.037 | 0.048 | 0.012 |
| OP 017 | 0.200 | 0.211 | 0.012 |
| OP 018 | 0.076 | 0.057 | -0.019 |
| OP 019 | 0.020 | 0.030 | 0.011 |
| OP 020 | 0.023 | 0.033 | 0.010 |
| OP 021 | 0.100 | 0.120 | 0.020 |
| OP 022 | 0.221 | 0.266 | 0.045 |
| OP 023 | 0.243 | 0.231 | -0.012 |
| OP 024 | 0.148 | 0.154 | 0.006 |
| OP 025 | 0.170 | 0.184 | 0.015 |
| OP 026 | 0.018 | 0.029 | 0.010 |
| OP 027 | 0.041 | 0.048 | 0.006 |
| OP 028 | 0.131 | 0.123 | -0.008 |
| OP 029 | 0.160 | 0.164 | 0.003 |
| OP 030 | 0.138 | 0.131 | -0.007 |
| OP 031 | 0.114 | 0.128 | 0.014 |
| OP 032 | 0.166 | 0.189 | 0.023 |
| OP 033 | 0.130 | 0.157 | 0.026 |
| OP 034 | 0.125 | 0.136 | 0.012 |
| OP 035 | 0.008 | 0.015 | 0.008 |
| OP 036 | 0.050 | 0.076 | 0.026 |
| OP 037 | 0.540 | 0.562 | 0.022 |
| OP 038 | 0.051 | 0.044 | -0.007 |

| ESE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.151 | 0.144 | -0.007 |
| OP 040 | 0.245 | 0.247 | 0.001 |
| OP 041 | 0.024 | 0.036 | 0.012 |
| OP 042 | 0.217 | 0.181 | -0.036 |
| OP 043 | 0.054 | 0.098 | 0.044 |
| OP 044 | 0.074 | 0.110 | 0.037 |
| OP 045 | 0.244 | 0.200 | -0.043 |
| OP 046 | 0.294 | 0.256 | -0.038 |
| OP 047 | 0.211 | 0.152 | -0.059 |
| OP 048 | 0.131 | 0.143 | 0.012 |
| OP 049 | 0.157 | 0.208 | 0.051 |
| OP 050 | 0.639 | 0.617 | -0.022 |
| OP 051 | 0.166 | 0.211 | 0.046 |
| OP 052 | 0.212 | 0.311 | 0.099 |
| OP 053 | 0.382 | 0.371 | -0.011 |
| OP 054 | 0.307 | 0.323 | 0.015 |
| OP 055 | 0.221 | 0.131 | -0.089 |
| OP 056 | 0.135 | 0.141 | 0.006 |
| OP 057 | 0.418 | 0.458 | 0.039 |
| OP 058 | 0.641 | 0.651 | 0.010 |
| OP 059 | 0.306 | 0.374 | 0.068 |
| OP 060 | 0.273 | 0.216 | -0.057 |
| OP 061 | 0.208 | 0.276 | 0.068 |
| OP 062 | 0.116 | 0.058 | -0.058 |
| OP 063 | 0.362 | 0.353 | -0.010 |
| OP 064 | 0.148 | 0.070 | -0.077 |
| OP 065 | 0.162 | 0.186 | 0.024 |
| OP 066 | 0.305 | 0.347 | 0.042 |
| OP 067 | 0.137 | 0.140 | 0.004 |
| OP 068 | 0.132 | 0.087 | -0.045 |
| OP 069 | 0.168 | 0.119 | -0.049 |
| OP 070 | 0.579 | 0.538 | -0.041 |
| OP 071 | 0.411 | 0.407 | -0.004 |
| OP 072 | 0.055 | 0.102 | 0.047 |
| OP 073 | 0.398 | 0.459 | 0.061 |
| OP 074 | 0.175 | 0.336 | 0.160 |
| OP 075 | 0.537 | 0.555 | 0.018 |
| OP 076 | 0.388 | 0.350 | -0.039 |
| OP 077 | 0.151 | 0.178 | 0.027 |

| ESE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.070 | 0.105 | 0.035 |
| OP 079 | 0.482 | 0.487 | 0.005 |
| OP 080 | 0.038 | 0.053 | 0.016 |
| OP 081 | 0.079 | 0.091 | 0.012 |
| OP 082 | 0.104 | 0.112 | 0.008 |
| OP 083 | 0.098 | 0.100 | 0.003 |
| OP 084 | 0.037 | 0.065 | 0.029 |
| Perimeter Test Points | | | |
| P 001 | 0.097 | 0.103 | 0.006 |
| P 002 | 0.087 | 0.035 | -0.052 |
| P 003 | 0.060 | 0.037 | -0.023 |
| P 004 | 0.038 | 0.046 | 0.008 |
| P 005 | 0.015 | 0.003 | -0.012 |
| P 006 | 0.035 | 0.071 | 0.035 |
| P 007 | 0.028 | 0.063 | 0.034 |
| P 008 | 0.025 | 0.072 | 0.047 |
| P 009 | 0.115 | 0.231 | 0.115 |
| P 010 | 0.264 | 0.274 | 0.010 |
| P 011 | 0.287 | 0.250 | -0.037 |
| P 012 | 0.272 | 0.198 | -0.075 |
| P 013 | 0.164 | 0.097 | -0.068 |
| P 014 | 0.063 | 0.023 | -0.041 |
| P 015 | 0.099 | 0.039 | -0.060 |
| P 016 | 0.119 | 0.122 | 0.002 |

NNE Wind

| NNE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.121 | 0.165 | 0.043 |
| OP 002 | 0.179 | 0.196 | 0.017 |
| OP 003 | 0.154 | 0.194 | 0.040 |
| OP 004 | 0.311 | 0.332 | 0.021 |
| OP 005 | 0.167 | 0.150 | -0.018 |
| OP 006 | 0.466 | 0.444 | -0.022 |
| OP 007 | 0.509 | 0.487 | -0.023 |
| OP 008 | 0.159 | 0.186 | 0.026 |
| OP 009 | 0.068 | 0.059 | -0.009 |
| OP 010 | 0.165 | 0.171 | 0.006 |
| OP 011 | 0.496 | 0.508 | 0.012 |
| OP 012 | 0.151 | 0.129 | -0.022 |
| OP 013 | 0.152 | 0.159 | 0.007 |
| OP 014 | 0.220 | 0.219 | -0.002 |
| OP 015 | 0.043 | 0.075 | 0.031 |
| OP 016 | 0.124 | 0.130 | 0.006 |
| OP 017 | 0.215 | 0.243 | 0.028 |
| OP 018 | 0.232 | 0.241 | 0.009 |
| OP 019 | 0.068 | 0.051 | -0.017 |
| OP 020 | 0.422 | 0.438 | 0.015 |
| OP 021 | 0.471 | 0.565 | 0.094 |
| OP 022 | 0.543 | 0.547 | 0.004 |
| OP 023 | 0.568 | 0.593 | 0.024 |
| OP 024 | 0.083 | 0.067 | -0.017 |
| OP 025 | 0.070 | 0.076 | 0.006 |
| OP 026 | 0.269 | 0.278 | 0.009 |
| OP 027 | 0.102 | 0.110 | 0.008 |
| OP 028 | 0.555 | 0.579 | 0.024 |
| OP 029 | 0.116 | 0.189 | 0.072 |
| OP 030 | 0.405 | 0.479 | 0.074 |
| OP 031 | 0.023 | 0.045 | 0.023 |
| OP 032 | 0.007 | 0.013 | 0.007 |
| OP 033 | 0.149 | 0.180 | 0.032 |
| OP 034 | 0.177 | 0.181 | 0.005 |
| OP 035 | 0.228 | 0.365 | 0.137 |
| OP 036 | 0.483 | 0.532 | 0.049 |
| OP 037 | 0.306 | 0.332 | 0.026 |
| OP 038 | 0.087 | 0.085 | -0.002 |

| NNE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.028 | 0.031 | 0.003 |
| OP 040 | 0.248 | 0.250 | 0.001 |
| OP 041 | 0.109 | 0.036 | -0.072 |
| OP 042 | 0.129 | 0.245 | 0.116 |
| OP 043 | 0.123 | 0.104 | -0.019 |
| OP 044 | 0.135 | 0.134 | -0.001 |
| OP 045 | 0.105 | 0.096 | -0.010 |
| OP 046 | 0.023 | 0.074 | 0.050 |
| OP 047 | 0.099 | 0.162 | 0.062 |
| OP 048 | 0.140 | 0.195 | 0.055 |
| OP 049 | 0.109 | 0.147 | 0.038 |
| OP 050 | 0.206 | 0.160 | -0.046 |
| OP 051 | 0.113 | 0.122 | 0.009 |
| OP 052 | 0.048 | 0.034 | -0.014 |
| OP 053 | 0.138 | 0.116 | -0.022 |
| OP 054 | 0.104 | 0.087 | -0.018 |
| OP 055 | 0.088 | 0.067 | -0.021 |
| OP 056 | 0.038 | 0.057 | 0.019 |
| OP 057 | 0.110 | 0.184 | 0.073 |
| OP 058 | 0.380 | 0.355 | -0.026 |
| OP 059 | 0.063 | 0.065 | 0.002 |
| OP 060 | 0.094 | 0.078 | -0.016 |
| OP 061 | 0.028 | 0.016 | -0.012 |
| OP 062 | 0.085 | 0.057 | -0.028 |
| OP 063 | 0.116 | 0.119 | 0.003 |
| OP 064 | 0.270 | 0.141 | -0.129 |
| OP 065 | 0.032 | 0.024 | -0.008 |
| OP 066 | 0.093 | 0.087 | -0.006 |
| OP 067 | 0.028 | 0.021 | -0.007 |
| OP 068 | 0.016 | 0.037 | 0.021 |
| OP 069 | 0.082 | 0.057 | -0.026 |
| OP 070 | 0.031 | 0.018 | -0.013 |
| OP 071 | 0.195 | 0.259 | 0.064 |
| OP 072 | 0.114 | 0.077 | -0.037 |
| OP 073 | 0.032 | 0.037 | 0.005 |
| OP 074 | 0.120 | 0.111 | -0.009 |
| OP 075 | 0.063 | 0.068 | 0.006 |
| OP 076 | 0.196 | 0.187 | -0.009 |
| OP 077 | 0.046 | 0.065 | 0.019 |

| NNE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.020 | 0.067 | 0.047 |
| OP 079 | 0.163 | 0.135 | -0.028 |
| OP 080 | 0.158 | 0.091 | -0.067 |
| OP 081 | 0.191 | 0.188 | -0.003 |
| OP 082 | 0.115 | 0.114 | -0.001 |
| OP 083 | 0.301 | 0.293 | -0.008 |
| OP 084 | 0.322 | 0.335 | 0.013 |
| Perimeter Test Points | | | |
| P 001 | 0.250 | 0.218 | -0.032 |
| P 002 | 0.055 | 0.066 | 0.011 |
| P 003 | 0.041 | 0.053 | 0.013 |
| P 004 | 0.105 | 0.176 | 0.072 |
| P 005 | 0.050 | 0.100 | 0.050 |
| P 006 | 0.072 | 0.022 | -0.050 |
| P 007 | 0.045 | 0.070 | 0.025 |
| P 008 | 0.033 | 0.090 | 0.057 |
| P 009 | 0.027 | 0.024 | -0.003 |
| P 010 | 0.025 | 0.071 | 0.045 |
| P 011 | 0.018 | 0.068 | 0.050 |
| P 012 | 0.032 | 0.023 | -0.008 |
| P 013 | 0.079 | 0.017 | -0.062 |
| P 014 | 0.148 | 0.143 | -0.005 |
| P 015 | 0.213 | 0.247 | 0.034 |
| P 016 | 0.050 | 0.115 | 0.065 |

SW Wind

| SW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.136 | 0.142 | 0.006 |
| OP 002 | 0.032 | 0.043 | 0.011 |
| OP 003 | 0.069 | 0.086 | 0.017 |
| OP 004 | 0.378 | 0.382 | 0.004 |
| OP 005 | 0.110 | 0.085 | -0.025 |
| OP 006 | 0.317 | 0.333 | 0.017 |
| OP 007 | 0.031 | 0.047 | 0.017 |
| OP 008 | 0.027 | 0.053 | 0.027 |
| OP 009 | 0.133 | 0.127 | -0.007 |
| OP 010 | 0.217 | 0.204 | -0.013 |
| OP 011 | 0.290 | 0.406 | 0.116 |
| OP 012 | 0.066 | 0.092 | 0.027 |
| OP 013 | 0.294 | 0.285 | -0.009 |
| OP 014 | 0.050 | 0.056 | 0.006 |
| OP 015 | 0.060 | 0.033 | -0.027 |
| OP 016 | 0.126 | 0.107 | -0.019 |
| OP 017 | 0.119 | 0.127 | 0.008 |
| OP 018 | 0.132 | 0.114 | -0.018 |
| OP 019 | 0.300 | 0.288 | -0.012 |
| OP 020 | 0.145 | 0.142 | -0.003 |
| OP 021 | 0.384 | 0.275 | -0.109 |
| OP 022 | 0.235 | 0.194 | -0.042 |
| OP 023 | 0.343 | 0.335 | -0.008 |
| OP 024 | 0.025 | 0.037 | 0.012 |
| OP 025 | 0.182 | 0.181 | -0.001 |
| OP 026 | 0.258 | 0.174 | -0.084 |
| OP 027 | 0.259 | 0.311 | 0.052 |
| OP 028 | 0.316 | 0.235 | -0.081 |
| OP 029 | 0.107 | 0.137 | 0.030 |
| OP 030 | 0.094 | 0.187 | 0.094 |
| OP 031 | 0.015 | 0.029 | 0.015 |
| OP 032 | 0.204 | 0.238 | 0.034 |
| OP 033 | 0.284 | 0.211 | -0.073 |
| OP 034 | 0.251 | 0.202 | -0.049 |
| OP 035 | 0.296 | 0.213 | -0.083 |
| OP 036 | 0.419 | 0.503 | 0.084 |
| OP 037 | 0.345 | 0.325 | -0.019 |
| OP 038 | 0.045 | 0.059 | 0.014 |

| SW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.264 | 0.343 | 0.079 |
| OP 040 | 0.040 | 0.042 | 0.002 |
| OP 041 | 0.247 | 0.178 | -0.069 |
| OP 042 | 0.246 | 0.264 | 0.018 |
| OP 043 | 0.298 | 0.264 | -0.034 |
| OP 044 | 0.093 | 0.119 | 0.026 |
| OP 045 | 0.154 | 0.118 | -0.035 |
| OP 046 | 0.116 | 0.036 | -0.081 |
| OP 047 | 0.142 | 0.205 | 0.064 |
| OP 048 | 0.173 | 0.095 | -0.078 |
| OP 049 | 0.194 | 0.255 | 0.060 |
| OP 050 | 0.254 | 0.233 | -0.021 |
| OP 051 | 0.373 | 0.387 | 0.014 |
| OP 052 | 0.232 | 0.211 | -0.021 |
| OP 053 | 0.136 | 0.153 | 0.017 |
| OP 054 | 0.151 | 0.111 | -0.040 |
| OP 055 | 0.231 | 0.245 | 0.014 |
| OP 056 | 0.257 | 0.237 | -0.020 |
| OP 057 | 0.293 | 0.191 | -0.102 |
| OP 058 | 0.055 | 0.089 | 0.033 |
| OP 059 | 0.064 | 0.191 | 0.127 |
| OP 060 | 0.121 | 0.099 | -0.022 |
| OP 061 | 0.109 | 0.134 | 0.025 |
| OP 062 | 0.163 | 0.149 | -0.014 |
| OP 063 | 0.241 | 0.199 | -0.043 |
| OP 064 | 0.281 | 0.236 | -0.044 |
| OP 065 | 0.325 | 0.346 | 0.021 |
| OP 066 | 0.225 | 0.258 | 0.033 |
| OP 067 | 0.161 | 0.159 | -0.002 |
| OP 068 | 0.130 | 0.116 | -0.014 |
| OP 069 | 0.237 | 0.205 | -0.031 |
| OP 070 | 0.196 | 0.203 | 0.007 |
| OP 071 | 0.169 | 0.175 | 0.006 |
| OP 072 | 0.361 | 0.385 | 0.024 |
| OP 073 | 0.228 | 0.233 | 0.005 |
| OP 074 | 0.021 | 0.051 | 0.030 |
| OP 075 | 0.232 | 0.233 | 0.000 |
| OP 076 | 0.212 | 0.176 | -0.036 |
| OP 077 | 0.145 | 0.140 | -0.006 |

| SW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.174 | 0.170 | -0.004 |
| OP 079 | 0.070 | 0.040 | -0.029 |
| OP 080 | 0.039 | 0.060 | 0.021 |
| OP 081 | 0.043 | 0.038 | -0.005 |
| OP 082 | 0.148 | 0.136 | -0.012 |
| OP 083 | 0.300 | 0.300 | 0.000 |
| OP 084 | 0.203 | 0.177 | -0.027 |
| Perimeter Test Points | | | |
| P 001 | 0.196 | 0.129 | -0.067 |
| P 002 | 0.141 | 0.183 | 0.042 |
| P 003 | 0.231 | 0.184 | -0.048 |
| P 004 | 0.172 | 0.044 | -0.128 |
| P 005 | 0.043 | 0.033 | -0.010 |
| P 006 | 0.115 | 0.191 | 0.077 |
| P 007 | 0.071 | 0.173 | 0.102 |
| P 008 | 0.042 | 0.164 | 0.123 |
| P 009 | 0.044 | 0.063 | 0.019 |
| P 010 | 0.116 | 0.142 | 0.025 |
| P 011 | 0.145 | 0.159 | 0.015 |
| P 012 | 0.145 | 0.102 | -0.044 |
| P 013 | 0.270 | 0.189 | -0.081 |
| P 014 | 0.155 | 0.108 | -0.046 |
| P 015 | 0.163 | 0.131 | -0.033 |
| P 016 | 0.146 | 0.132 | -0.015 |

SE Wind

| SE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.128 | 0.145 | 0.017 |
| OP 002 | 0.138 | 0.126 | -0.012 |
| OP 003 | 0.242 | 0.229 | -0.012 |
| OP 004 | 0.188 | 0.282 | 0.094 |
| OP 005 | 0.073 | 0.062 | -0.011 |
| OP 006 | 0.088 | 0.095 | 0.007 |
| OP 007 | 0.183 | 0.238 | 0.055 |
| OP 008 | 0.097 | 0.136 | 0.039 |
| OP 009 | 0.230 | 0.222 | -0.008 |
| OP 010 | 0.195 | 0.170 | -0.025 |
| OP 011 | 0.283 | 0.353 | 0.071 |
| OP 012 | 0.104 | 0.108 | 0.004 |
| OP 013 | 0.088 | 0.073 | -0.016 |
| OP 014 | 0.257 | 0.287 | 0.030 |
| OP 015 | 0.045 | 0.048 | 0.002 |
| OP 016 | 0.102 | 0.113 | 0.011 |
| OP 017 | 0.321 | 0.301 | -0.020 |
| OP 018 | 0.239 | 0.180 | -0.059 |
| OP 019 | 0.327 | 0.301 | -0.025 |
| OP 020 | 0.369 | 0.358 | -0.011 |
| OP 021 | 0.087 | 0.077 | -0.009 |
| OP 022 | 0.175 | 0.351 | 0.175 |
| OP 023 | 0.291 | 0.295 | 0.004 |
| OP 024 | 0.124 | 0.093 | -0.031 |
| OP 025 | 0.142 | 0.169 | 0.027 |
| OP 026 | 0.164 | 0.048 | -0.115 |
| OP 027 | 0.192 | 0.107 | -0.085 |
| OP 028 | 0.370 | 0.413 | 0.043 |
| OP 029 | 0.156 | 0.085 | -0.071 |
| OP 030 | 0.122 | 0.093 | -0.029 |
| OP 031 | 0.038 | 0.050 | 0.011 |
| OP 032 | 0.190 | 0.190 | 0.001 |
| OP 033 | 0.197 | 0.159 | -0.038 |
| OP 034 | 0.048 | 0.120 | 0.072 |
| OP 035 | 0.303 | 0.260 | -0.043 |
| OP 036 | 0.117 | 0.126 | 0.009 |
| OP 037 | 0.488 | 0.502 | 0.014 |
| OP 038 | 0.071 | 0.065 | -0.006 |

| SE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.168 | 0.157 | -0.011 |
| OP 040 | 0.209 | 0.192 | -0.017 |
| OP 041 | 0.175 | 0.168 | -0.007 |
| OP 042 | 0.247 | 0.494 | 0.247 |
| OP 043 | 0.102 | 0.102 | 0.001 |
| OP 044 | 0.045 | 0.021 | -0.025 |
| OP 045 | 0.231 | 0.187 | -0.044 |
| OP 046 | 0.179 | 0.165 | -0.014 |
| OP 047 | 0.126 | 0.235 | 0.109 |
| OP 048 | 0.130 | 0.092 | -0.039 |
| OP 049 | 0.125 | 0.155 | 0.030 |
| OP 050 | 0.606 | 0.638 | 0.033 |
| OP 051 | 0.160 | 0.157 | -0.003 |
| OP 052 | 0.127 | 0.132 | 0.005 |
| OP 053 | 0.214 | 0.206 | -0.008 |
| OP 054 | 0.199 | 0.213 | 0.013 |
| OP 055 | 0.029 | 0.056 | 0.027 |
| OP 056 | 0.279 | 0.296 | 0.017 |
| OP 057 | 0.330 | 0.327 | -0.003 |
| OP 058 | 0.587 | 0.636 | 0.049 |
| OP 059 | 0.151 | 0.152 | 0.001 |
| OP 060 | 0.285 | 0.262 | -0.023 |
| OP 061 | 0.299 | 0.305 | 0.006 |
| OP 062 | 0.110 | 0.039 | -0.071 |
| OP 063 | 0.216 | 0.285 | 0.069 |
| OP 064 | 0.274 | 0.549 | 0.274 |
| OP 065 | 0.165 | 0.119 | -0.046 |
| OP 066 | 0.204 | 0.206 | 0.002 |
| OP 067 | 0.047 | 0.027 | -0.020 |
| OP 068 | 0.103 | 0.092 | -0.011 |
| OP 069 | 0.204 | 0.408 | 0.204 |
| OP 070 | 0.568 | 0.579 | 0.011 |
| OP 071 | 0.556 | 0.503 | -0.053 |
| OP 072 | 0.217 | 0.185 | -0.032 |
| OP 073 | 0.351 | 0.289 | -0.062 |
| OP 074 | 0.123 | 0.219 | 0.095 |
| OP 075 | 0.534 | 0.558 | 0.024 |
| OP 076 | 0.492 | 0.389 | -0.103 |
| OP 077 | 0.146 | 0.066 | -0.080 |

| SE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.294 | 0.279 | -0.015 |
| OP 079 | 0.312 | 0.327 | 0.015 |
| OP 080 | 0.170 | 0.178 | 0.007 |
| OP 081 | 0.162 | 0.158 | -0.004 |
| OP 082 | 0.165 | 0.171 | 0.005 |
| OP 083 | 0.102 | 0.091 | -0.011 |
| OP 084 | 0.202 | 0.221 | 0.019 |
| Perimeter Test Points | | | |
| P 001 | 0.199 | 0.156 | -0.043 |
| P 002 | 0.187 | 0.264 | 0.078 |
| P 003 | 0.056 | 0.066 | 0.010 |
| P 004 | 0.183 | 0.204 | 0.021 |
| P 005 | 0.204 | 0.243 | 0.039 |
| P 006 | 0.070 | 0.141 | 0.070 |
| P 007 | 0.060 | 0.120 | 0.060 |
| P 008 | 0.045 | 0.090 | 0.045 |
| P 009 | 0.079 | 0.157 | 0.079 |
| P 010 | 0.152 | 0.176 | 0.024 |
| P 011 | 0.113 | 0.148 | 0.035 |
| P 012 | 0.144 | 0.226 | 0.083 |
| P 013 | 0.026 | 0.083 | 0.057 |
| P 014 | 0.187 | 0.075 | -0.112 |
| P 015 | 0.311 | 0.143 | -0.168 |
| P 016 | 0.234 | 0.127 | -0.108 |

WSW Wind

| WSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.044 | 0.078 | 0.033 |
| OP 002 | 0.048 | 0.085 | 0.036 |
| OP 003 | 0.351 | 0.376 | 0.025 |
| OP 004 | 0.191 | 0.178 | -0.014 |
| OP 005 | 0.038 | 0.067 | 0.029 |
| OP 006 | 0.247 | 0.244 | -0.003 |
| OP 007 | 0.104 | 0.086 | -0.018 |
| OP 008 | 0.065 | 0.110 | 0.045 |
| OP 009 | 0.281 | 0.331 | 0.049 |
| OP 010 | 0.198 | 0.205 | 0.006 |
| OP 011 | 0.261 | 0.268 | 0.007 |
| OP 012 | 0.120 | 0.116 | -0.004 |
| OP 013 | 0.028 | 0.032 | 0.004 |
| OP 014 | 0.034 | 0.032 | -0.002 |
| OP 015 | 0.098 | 0.099 | 0.001 |
| OP 016 | 0.069 | 0.062 | -0.007 |
| OP 017 | 0.040 | 0.099 | 0.059 |
| OP 018 | 0.144 | 0.160 | 0.017 |
| OP 019 | 0.162 | 0.164 | 0.002 |
| OP 020 | 0.129 | 0.137 | 0.008 |
| OP 021 | 0.151 | 0.132 | -0.019 |
| OP 022 | 0.171 | 0.146 | -0.026 |
| OP 023 | 0.139 | 0.204 | 0.065 |
| OP 024 | 0.199 | 0.190 | -0.009 |
| OP 025 | 0.027 | 0.007 | -0.020 |
| OP 026 | 0.158 | 0.161 | 0.004 |
| OP 027 | 0.059 | 0.032 | -0.027 |
| OP 028 | 0.029 | 0.047 | 0.017 |
| OP 029 | 0.122 | 0.140 | 0.018 |
| OP 030 | 0.089 | 0.123 | 0.034 |
| OP 031 | 0.066 | 0.085 | 0.019 |
| OP 032 | 0.095 | 0.042 | -0.053 |
| OP 033 | 0.093 | 0.100 | 0.007 |
| OP 034 | 0.139 | 0.167 | 0.028 |
| OP 035 | 0.025 | 0.031 | 0.005 |
| OP 036 | 0.280 | 0.175 | -0.105 |
| OP 037 | 0.173 | 0.168 | -0.005 |
| OP 038 | 0.058 | 0.044 | -0.015 |

| WSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.076 | 0.114 | 0.038 |
| OP 040 | 0.054 | 0.080 | 0.027 |
| OP 041 | 0.225 | 0.159 | -0.066 |
| OP 042 | 0.053 | 0.027 | -0.027 |
| OP 043 | 0.099 | 0.166 | 0.068 |
| OP 044 | 0.057 | 0.103 | 0.046 |
| OP 045 | 0.151 | 0.136 | -0.015 |
| OP 046 | 0.104 | 0.094 | -0.010 |
| OP 047 | 0.115 | 0.104 | -0.012 |
| OP 048 | 0.233 | 0.186 | -0.047 |
| OP 049 | 0.179 | 0.172 | -0.007 |
| OP 050 | 0.337 | 0.371 | 0.034 |
| OP 051 | 0.166 | 0.212 | 0.047 |
| OP 052 | 0.226 | 0.209 | -0.017 |
| OP 053 | 0.096 | 0.089 | -0.008 |
| OP 054 | 0.102 | 0.089 | -0.014 |
| OP 055 | 0.094 | 0.089 | -0.005 |
| OP 056 | 0.076 | 0.047 | -0.029 |
| OP 057 | 0.233 | 0.256 | 0.023 |
| OP 058 | 0.102 | 0.107 | 0.005 |
| OP 059 | 0.100 | 0.071 | -0.029 |
| OP 060 | 0.085 | 0.023 | -0.062 |
| OP 061 | 0.017 | 0.034 | 0.017 |
| OP 062 | 0.098 | 0.075 | -0.022 |
| OP 063 | 0.061 | 0.090 | 0.029 |
| OP 064 | 0.110 | 0.117 | 0.007 |
| OP 065 | 0.159 | 0.187 | 0.028 |
| OP 066 | 0.190 | 0.192 | 0.002 |
| OP 067 | 0.082 | 0.094 | 0.012 |
| OP 068 | 0.094 | 0.141 | 0.047 |
| OP 069 | 0.124 | 0.101 | -0.023 |
| OP 070 | 0.048 | 0.063 | 0.014 |
| OP 071 | 0.182 | 0.200 | 0.018 |
| OP 072 | 0.257 | 0.247 | -0.010 |
| OP 073 | 0.191 | 0.181 | -0.010 |
| OP 074 | 0.212 | 0.177 | -0.036 |
| OP 075 | 0.242 | 0.235 | -0.007 |
| OP 076 | 0.226 | 0.191 | -0.035 |
| OP 077 | 0.097 | 0.146 | 0.049 |

| WSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.265 | 0.208 | -0.057 |
| OP 079 | 0.116 | 0.100 | -0.016 |
| OP 080 | 0.207 | 0.217 | 0.010 |
| OP 081 | 0.092 | 0.079 | -0.013 |
| OP 082 | 0.255 | 0.250 | -0.004 |
| OP 083 | 0.203 | 0.216 | 0.013 |
| OP 084 | 0.097 | 0.123 | 0.026 |
| Perimeter Test Points | | | |
| P 001 | 0.185 | 0.111 | -0.074 |
| P 002 | 0.074 | 0.126 | 0.053 |
| P 003 | 0.116 | 0.114 | -0.002 |
| P 004 | 0.101 | 0.068 | -0.034 |
| P 005 | 0.052 | 0.027 | -0.025 |
| P 006 | 0.031 | 0.063 | 0.031 |
| P 007 | 0.026 | 0.052 | 0.026 |
| P 008 | 0.015 | 0.030 | 0.015 |
| P 009 | 0.012 | 0.024 | 0.012 |
| P 010 | 0.107 | 0.095 | -0.012 |
| P 011 | 0.056 | 0.113 | 0.056 |
| P 012 | 0.089 | 0.044 | -0.044 |
| P 013 | 0.197 | 0.131 | -0.066 |
| P 014 | 0.124 | 0.103 | -0.021 |
| P 015 | 0.081 | 0.090 | 0.008 |
| P 016 | 0.037 | 0.042 | 0.006 |

SSE Wind

| SSE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.072 | 0.120 | 0.048 |
| OP 002 | 0.045 | 0.090 | 0.045 |
| OP 003 | 0.100 | 0.199 | 0.100 |
| OP 004 | 0.140 | 0.279 | 0.140 |
| OP 005 | 0.037 | 0.065 | 0.028 |
| OP 006 | 0.043 | 0.067 | 0.024 |
| OP 007 | 0.224 | 0.103 | -0.121 |
| OP 008 | 0.134 | 0.145 | 0.011 |
| OP 009 | 0.108 | 0.191 | 0.083 |
| OP 010 | 0.070 | 0.140 | 0.070 |
| OP 011 | 0.171 | 0.342 | 0.171 |
| OP 012 | 0.123 | 0.081 | -0.043 |
| OP 013 | 0.042 | 0.083 | 0.040 |
| OP 014 | 0.276 | 0.122 | -0.155 |
| OP 015 | 0.085 | 0.042 | -0.043 |
| OP 016 | 0.037 | 0.050 | 0.013 |
| OP 017 | 0.200 | 0.250 | 0.050 |
| OP 018 | 0.076 | 0.151 | 0.075 |
| OP 019 | 0.101 | 0.201 | 0.101 |
| OP 020 | 0.174 | 0.347 | 0.174 |
| OP 021 | 0.100 | 0.058 | -0.042 |
| OP 022 | 0.221 | 0.267 | 0.047 |
| OP 023 | 0.243 | 0.317 | 0.074 |
| OP 024 | 0.148 | 0.116 | -0.031 |
| OP 025 | 0.170 | 0.228 | 0.059 |
| OP 026 | 0.051 | 0.102 | 0.051 |
| OP 027 | 0.041 | 0.079 | 0.038 |
| OP 028 | 0.236 | 0.472 | 0.236 |
| OP 029 | 0.160 | 0.043 | -0.118 |
| OP 030 | 0.138 | 0.039 | -0.098 |
| OP 031 | 0.114 | 0.064 | -0.050 |
| OP 032 | 0.166 | 0.282 | 0.116 |
| OP 033 | 0.130 | 0.076 | -0.054 |
| OP 034 | 0.125 | 0.163 | 0.038 |
| OP 035 | 0.112 | 0.224 | 0.112 |
| OP 036 | 0.090 | 0.180 | 0.090 |
| OP 037 | 0.540 | 0.432 | -0.108 |
| OP 038 | 0.051 | 0.045 | -0.005 |

| SSE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.151 | 0.283 | 0.132 |
| OP 040 | 0.245 | 0.146 | -0.099 |
| OP 041 | 0.024 | 0.178 | 0.154 |
| OP 042 | 0.217 | 0.365 | 0.148 |
| OP 043 | 0.054 | 0.279 | 0.225 |
| OP 044 | 0.074 | 0.035 | -0.039 |
| OP 045 | 0.244 | 0.165 | -0.079 |
| OP 046 | 0.294 | 0.097 | -0.197 |
| OP 047 | 0.211 | 0.284 | 0.074 |
| OP 048 | 0.131 | 0.146 | 0.015 |
| OP 049 | 0.157 | 0.066 | -0.091 |
| OP 050 | 0.639 | 0.503 | -0.136 |
| OP 051 | 0.166 | 0.379 | 0.214 |
| OP 052 | 0.212 | 0.102 | -0.110 |
| OP 053 | 0.382 | 0.078 | -0.304 |
| OP 054 | 0.307 | 0.078 | -0.229 |
| OP 055 | 0.221 | 0.327 | 0.106 |
| OP 056 | 0.135 | 0.143 | 0.008 |
| OP 057 | 0.418 | 0.170 | -0.248 |
| OP 058 | 0.641 | 0.521 | -0.121 |
| OP 059 | 0.306 | 0.090 | -0.216 |
| OP 060 | 0.273 | 0.175 | -0.098 |
| OP 061 | 0.208 | 0.111 | -0.097 |
| OP 062 | 0.116 | 0.208 | 0.093 |
| OP 063 | 0.362 | 0.318 | -0.044 |
| OP 064 | 0.148 | 0.238 | 0.090 |
| OP 065 | 0.162 | 0.367 | 0.205 |
| OP 066 | 0.305 | 0.115 | -0.190 |
| OP 067 | 0.137 | 0.201 | 0.064 |
| OP 068 | 0.132 | 0.266 | 0.134 |
| OP 069 | 0.168 | 0.362 | 0.194 |
| OP 070 | 0.579 | 0.529 | -0.050 |
| OP 071 | 0.411 | 0.392 | -0.019 |
| OP 072 | 0.084 | 0.336 | 0.252 |
| OP 073 | 0.398 | 0.485 | 0.087 |
| OP 074 | 0.175 | 0.189 | 0.013 |
| OP 075 | 0.537 | 0.534 | -0.003 |
| OP 076 | 0.388 | 0.401 | 0.012 |
| OP 077 | 0.151 | 0.061 | -0.090 |

| SSE wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.070 | 0.133 | 0.063 |
| OP 079 | 0.482 | 0.385 | -0.097 |
| OP 080 | 0.113 | 0.227 | 0.113 |
| OP 081 | 0.079 | 0.116 | 0.037 |
| OP 082 | 0.104 | 0.134 | 0.030 |
| OP 083 | 0.098 | 0.085 | -0.013 |
| OP 084 | 0.037 | 0.108 | 0.072 |
| Perimeter Test Points | | | |
| P 001 | 0.097 | 0.146 | 0.049 |
| P 002 | 0.128 | 0.256 | 0.128 |
| P 003 | 0.060 | 0.036 | -0.024 |
| P 004 | 0.061 | 0.122 | 0.061 |
| P 005 | 0.016 | 0.031 | 0.016 |
| P 006 | 0.004 | 0.008 | 0.004 |
| P 007 | 0.003 | 0.006 | 0.003 |
| P 008 | 0.033 | 0.067 | 0.033 |
| P 009 | 0.003 | 0.002 | -0.001 |
| P 010 | 0.264 | 0.210 | -0.054 |
| P 011 | 0.064 | 0.091 | 0.027 |
| P 012 | 0.272 | 0.066 | -0.206 |
| P 013 | 0.164 | 0.168 | 0.004 |
| P 014 | 0.078 | 0.097 | 0.019 |
| P 015 | 0.099 | 0.080 | -0.020 |
| P 016 | 0.119 | 0.121 | 0.001 |

W Wind

| W wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.219 | 0.242 | 0.023 |
| OP 002 | 0.020 | 0.047 | 0.027 |
| OP 003 | 0.198 | 0.188 | -0.010 |
| OP 004 | 0.442 | 0.420 | -0.022 |
| OP 005 | 0.123 | 0.092 | -0.032 |
| OP 006 | 0.376 | 0.364 | -0.011 |
| OP 007 | 0.179 | 0.145 | -0.035 |
| OP 008 | 0.098 | 0.080 | -0.018 |
| OP 009 | 0.161 | 0.201 | 0.040 |
| OP 010 | 0.215 | 0.183 | -0.032 |
| OP 011 | 0.362 | 0.344 | -0.018 |
| OP 012 | 0.055 | 0.094 | 0.039 |
| OP 013 | 0.265 | 0.255 | -0.010 |
| OP 014 | 0.216 | 0.167 | -0.049 |
| OP 015 | 0.042 | 0.021 | -0.021 |
| OP 016 | 0.207 | 0.184 | -0.023 |
| OP 017 | 0.146 | 0.182 | 0.036 |
| OP 018 | 0.172 | 0.144 | -0.029 |
| OP 019 | 0.296 | 0.252 | -0.044 |
| OP 020 | 0.183 | 0.091 | -0.091 |
| OP 021 | 0.299 | 0.268 | -0.031 |
| OP 022 | 0.286 | 0.251 | -0.035 |
| OP 023 | 0.277 | 0.284 | 0.007 |
| OP 024 | 0.059 | 0.125 | 0.065 |
| OP 025 | 0.242 | 0.252 | 0.011 |
| OP 026 | 0.232 | 0.204 | -0.028 |
| OP 027 | 0.203 | 0.305 | 0.102 |
| OP 028 | 0.229 | 0.209 | -0.020 |
| OP 029 | 0.038 | 0.084 | 0.046 |
| OP 030 | 0.305 | 0.342 | 0.037 |
| OP 031 | 0.048 | 0.052 | 0.003 |
| OP 032 | 0.290 | 0.348 | 0.058 |
| OP 033 | 0.213 | 0.153 | -0.060 |
| OP 034 | 0.203 | 0.149 | -0.055 |
| OP 035 | 0.121 | 0.161 | 0.040 |
| OP 036 | 0.303 | 0.386 | 0.083 |
| OP 037 | 0.257 | 0.321 | 0.064 |
| OP 038 | 0.008 | 0.008 | 0.000 |

| W wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.319 | 0.335 | 0.016 |
| OP 040 | 0.070 | 0.052 | -0.017 |
| OP 041 | 0.211 | 0.158 | -0.053 |
| OP 042 | 0.266 | 0.246 | -0.020 |
| OP 043 | 0.326 | 0.337 | 0.011 |
| OP 044 | 0.089 | 0.070 | -0.019 |
| OP 045 | 0.073 | 0.088 | 0.015 |
| OP 046 | 0.110 | 0.099 | -0.012 |
| OP 047 | 0.168 | 0.151 | -0.017 |
| OP 048 | 0.074 | 0.119 | 0.044 |
| OP 049 | 0.180 | 0.177 | -0.003 |
| OP 050 | 0.164 | 0.157 | -0.007 |
| OP 051 | 0.417 | 0.413 | -0.003 |
| OP 052 | 0.046 | 0.085 | 0.039 |
| OP 053 | 0.053 | 0.071 | 0.018 |
| OP 054 | 0.060 | 0.078 | 0.017 |
| OP 055 | 0.154 | 0.135 | -0.020 |
| OP 056 | 0.228 | 0.210 | -0.018 |
| OP 057 | 0.096 | 0.112 | 0.016 |
| OP 058 | 0.119 | 0.088 | -0.031 |
| OP 059 | 0.169 | 0.114 | -0.055 |
| OP 060 | 0.090 | 0.095 | 0.005 |
| OP 061 | 0.172 | 0.203 | 0.031 |
| OP 062 | 0.127 | 0.107 | -0.020 |
| OP 063 | 0.127 | 0.151 | 0.025 |
| OP 064 | 0.177 | 0.173 | -0.004 |
| OP 065 | 0.365 | 0.353 | -0.012 |
| OP 066 | 0.166 | 0.133 | -0.033 |
| OP 067 | 0.098 | 0.049 | -0.049 |
| OP 068 | 0.084 | 0.074 | -0.010 |
| OP 069 | 0.185 | 0.183 | -0.002 |
| OP 070 | 0.124 | 0.074 | -0.050 |
| OP 071 | 0.191 | 0.178 | -0.013 |
| OP 072 | 0.386 | 0.389 | 0.002 |
| OP 073 | 0.123 | 0.096 | -0.028 |
| OP 074 | 0.081 | 0.083 | 0.002 |
| OP 075 | 0.142 | 0.162 | 0.019 |
| OP 076 | 0.187 | 0.168 | -0.019 |
| OP 077 | 0.101 | 0.117 | 0.016 |

| W wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.189 | 0.178 | -0.011 |
| OP 079 | 0.043 | 0.037 | -0.006 |
| OP 080 | 0.080 | 0.038 | -0.041 |
| OP 081 | 0.131 | 0.146 | 0.016 |
| OP 082 | 0.178 | 0.186 | 0.009 |
| OP 083 | 0.346 | 0.311 | -0.035 |
| OP 084 | 0.344 | 0.310 | -0.034 |
| Perimeter Test Points | | | |
| P 001 | 0.154 | 0.116 | -0.038 |
| P 002 | 0.123 | 0.174 | 0.051 |
| P 003 | 0.222 | 0.175 | -0.048 |
| P 004 | 0.114 | 0.102 | -0.011 |
| P 005 | 0.025 | 0.049 | 0.025 |
| P 006 | 0.009 | 0.006 | -0.003 |
| P 007 | 0.003 | 0.004 | 0.001 |
| P 008 | 0.017 | 0.043 | 0.026 |
| P 009 | 0.003 | 0.002 | -0.002 |
| P 010 | 0.215 | 0.188 | -0.027 |
| P 011 | 0.097 | 0.142 | 0.045 |
| P 012 | 0.109 | 0.063 | -0.045 |
| P 013 | 0.115 | 0.120 | 0.005 |
| P 014 | 0.126 | 0.066 | -0.060 |
| P 015 | 0.176 | 0.088 | -0.088 |
| P 016 | 0.156 | 0.078 | -0.078 |

SSW Wind

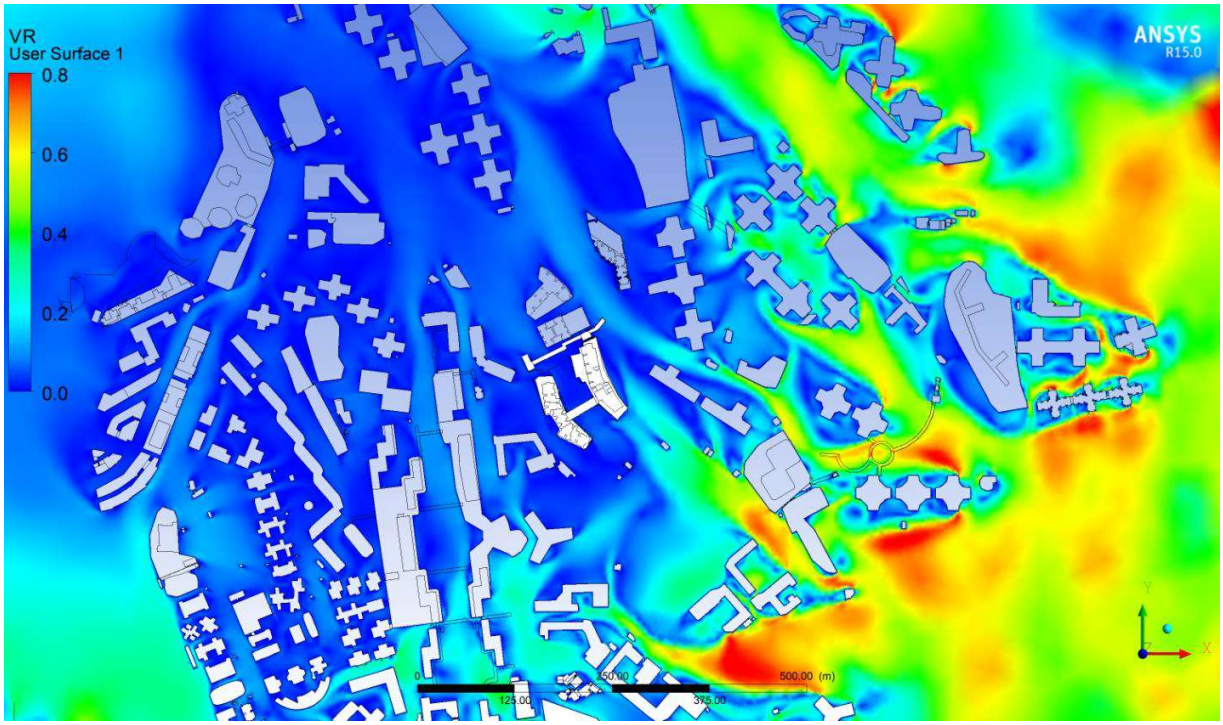
| SSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 001 | 0.177 | 0.139 | -0.038 |
| OP 002 | 0.248 | 0.221 | -0.027 |
| OP 003 | 0.422 | 0.417 | -0.005 |
| OP 004 | 0.129 | 0.085 | -0.044 |
| OP 005 | 0.195 | 0.183 | -0.013 |
| OP 006 | 0.291 | 0.295 | 0.004 |
| OP 007 | 0.199 | 0.207 | 0.007 |
| OP 008 | 0.173 | 0.198 | 0.025 |
| OP 009 | 0.358 | 0.324 | -0.034 |
| OP 010 | 0.464 | 0.451 | -0.014 |
| OP 011 | 0.387 | 0.353 | -0.034 |
| OP 012 | 0.203 | 0.159 | -0.044 |
| OP 013 | 0.274 | 0.271 | -0.003 |
| OP 014 | 0.157 | 0.212 | 0.055 |
| OP 015 | 0.096 | 0.079 | -0.016 |
| OP 016 | 0.051 | 0.045 | -0.007 |
| OP 017 | 0.203 | 0.197 | -0.006 |
| OP 018 | 0.124 | 0.112 | -0.012 |
| OP 019 | 0.427 | 0.411 | -0.016 |
| OP 020 | 0.524 | 0.518 | -0.005 |
| OP 021 | 0.242 | 0.256 | 0.013 |
| OP 022 | 0.188 | 0.135 | -0.053 |
| OP 023 | 0.109 | 0.152 | 0.043 |
| OP 024 | 0.058 | 0.067 | 0.009 |
| OP 025 | 0.077 | 0.078 | 0.000 |
| OP 026 | 0.290 | 0.297 | 0.007 |
| OP 027 | 0.160 | 0.201 | 0.042 |
| OP 028 | 0.178 | 0.155 | -0.024 |
| OP 029 | 0.303 | 0.289 | -0.014 |
| OP 030 | 0.228 | 0.216 | -0.012 |
| OP 031 | 0.050 | 0.053 | 0.003 |
| OP 032 | 0.095 | 0.093 | -0.001 |
| OP 033 | 0.033 | 0.033 | 0.001 |
| OP 034 | 0.033 | 0.041 | 0.008 |
| OP 035 | 0.293 | 0.240 | -0.053 |
| OP 036 | 0.193 | 0.207 | 0.014 |
| OP 037 | 0.148 | 0.217 | 0.069 |
| OP 038 | 0.048 | 0.032 | -0.016 |

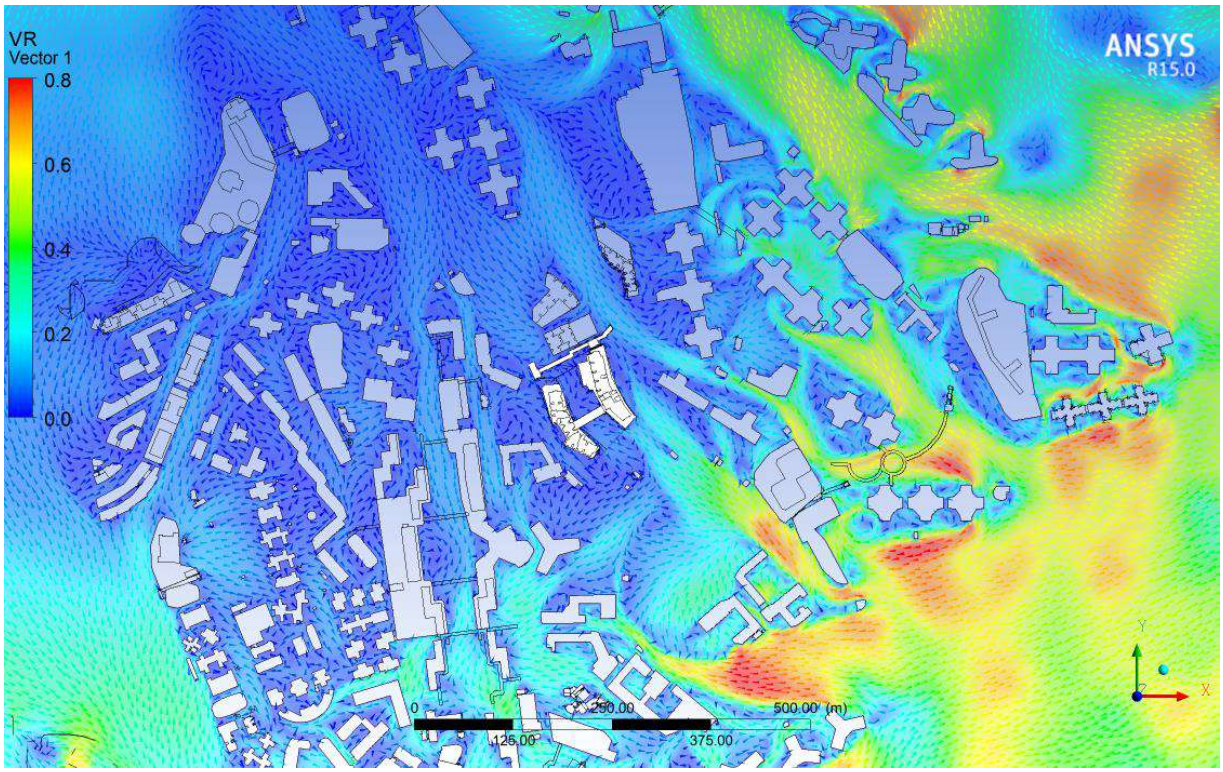
| SSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 039 | 0.020 | 0.030 | 0.010 |
| OP 040 | 0.186 | 0.187 | 0.002 |
| OP 041 | 0.243 | 0.179 | -0.064 |
| OP 042 | 0.266 | 0.269 | 0.003 |
| OP 043 | 0.069 | 0.031 | -0.038 |
| OP 044 | 0.034 | 0.075 | 0.041 |
| OP 045 | 0.144 | 0.169 | 0.025 |
| OP 046 | 0.065 | 0.157 | 0.092 |
| OP 047 | 0.156 | 0.189 | 0.033 |
| OP 048 | 0.076 | 0.091 | 0.015 |
| OP 049 | 0.213 | 0.203 | -0.010 |
| OP 050 | 0.348 | 0.336 | -0.012 |
| OP 051 | 0.040 | 0.046 | 0.005 |
| OP 052 | 0.247 | 0.263 | 0.016 |
| OP 053 | 0.170 | 0.194 | 0.025 |
| OP 054 | 0.127 | 0.160 | 0.033 |
| OP 055 | 0.165 | 0.122 | -0.044 |
| OP 056 | 0.098 | 0.080 | -0.017 |
| OP 057 | 0.175 | 0.155 | -0.021 |
| OP 058 | 0.087 | 0.098 | 0.011 |
| OP 059 | 0.242 | 0.227 | -0.015 |
| OP 060 | 0.136 | 0.127 | -0.010 |
| OP 061 | 0.075 | 0.072 | -0.002 |
| OP 062 | 0.181 | 0.203 | 0.022 |
| OP 063 | 0.125 | 0.161 | 0.036 |
| OP 064 | 0.265 | 0.239 | -0.026 |
| OP 065 | 0.041 | 0.016 | -0.025 |
| OP 066 | 0.032 | 0.056 | 0.024 |
| OP 067 | 0.090 | 0.101 | 0.011 |
| OP 068 | 0.181 | 0.183 | 0.002 |
| OP 069 | 0.220 | 0.249 | 0.029 |
| OP 070 | 0.151 | 0.179 | 0.028 |
| OP 071 | 0.193 | 0.172 | -0.021 |
| OP 072 | 0.029 | 0.102 | 0.073 |
| OP 073 | 0.253 | 0.262 | 0.009 |
| OP 074 | 0.068 | 0.100 | 0.032 |
| OP 075 | 0.093 | 0.119 | 0.026 |
| OP 076 | 0.197 | 0.197 | 0.000 |
| OP 077 | 0.143 | 0.163 | 0.020 |

| SSW wind | Baseline Scheme | Proposed Scheme | Difference in VR between proposed and baseline scheme |
|---|---|---|---|
| OP 078 | 0.193 | 0.176 | -0.017 |
| OP 079 | 0.256 | 0.267 | 0.012 |
| OP 080 | 0.145 | 0.159 | 0.014 |
| OP 081 | 0.045 | 0.051 | 0.006 |
| OP 082 | 0.470 | 0.478 | 0.008 |
| OP 083 | 0.377 | 0.332 | -0.045 |
| OP 084 | 0.311 | 0.292 | -0.020 |
| Perimeter Test Points | | | |
| P 001 | 0.312 | 0.235 | -0.076 |
| P 002 | 0.114 | 0.228 | 0.114 |
| P 003 | 0.229 | 0.205 | -0.024 |
| P 004 | 0.028 | 0.049 | 0.021 |
| P 005 | 0.017 | 0.035 | 0.017 |
| P 006 | 0.003 | 0.001 | -0.002 |
| P 007 | 0.001 | 0.000 | 0.000 |
| P 008 | 0.009 | 0.013 | 0.004 |
| P 009 | 0.003 | 0.001 | -0.001 |
| P 010 | 0.070 | 0.209 | 0.139 |
| P 011 | 0.131 | 0.074 | -0.057 |
| P 012 | 0.019 | 0.051 | 0.032 |
| P 013 | 0.200 | 0.242 | 0.042 |
| P 014 | 0.218 | 0.225 | 0.007 |
| P 015 | 0.165 | 0.224 | 0.059 |
| P 016 | 0.170 | 0.272 | 0.102 |

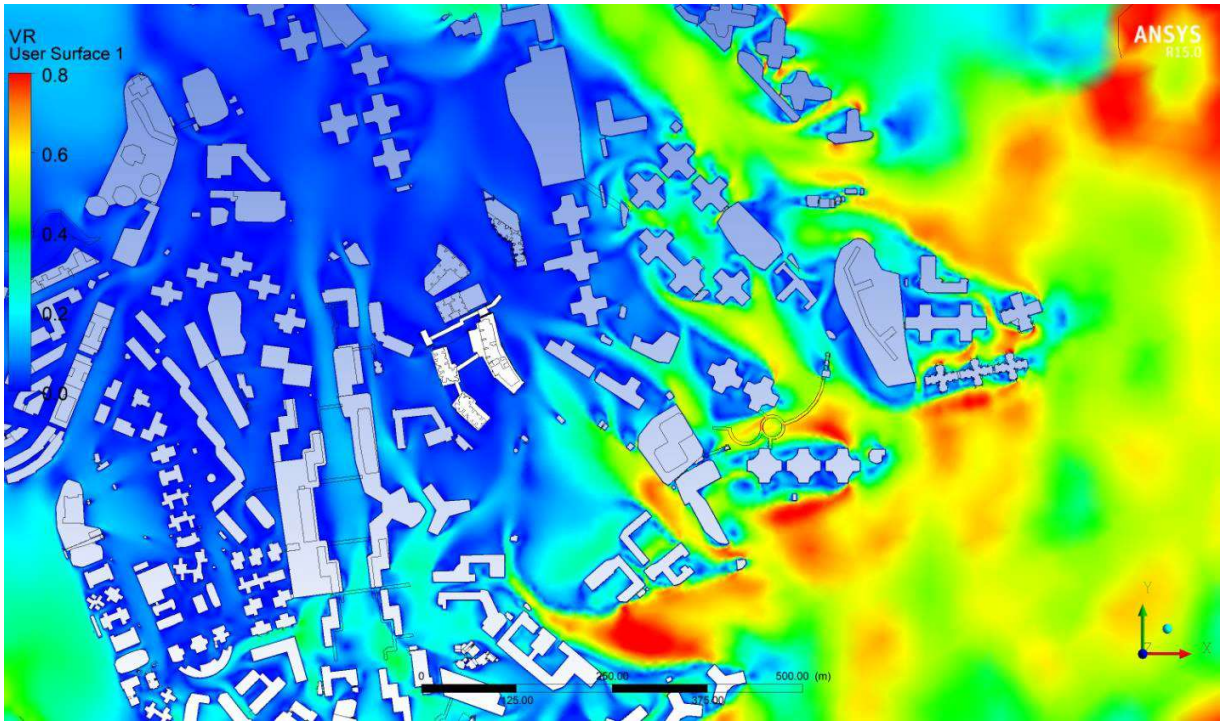
# *Appendix C*
# *VR Contour and Vector Plots*

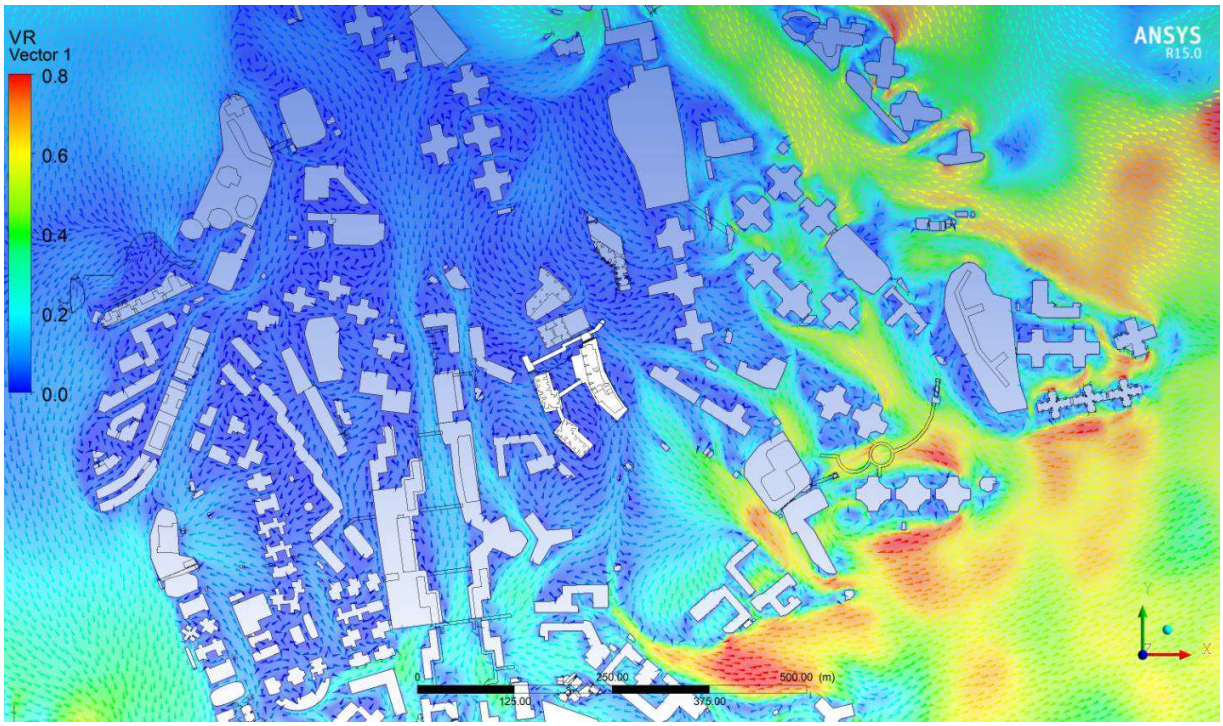
E Baseline Scheme



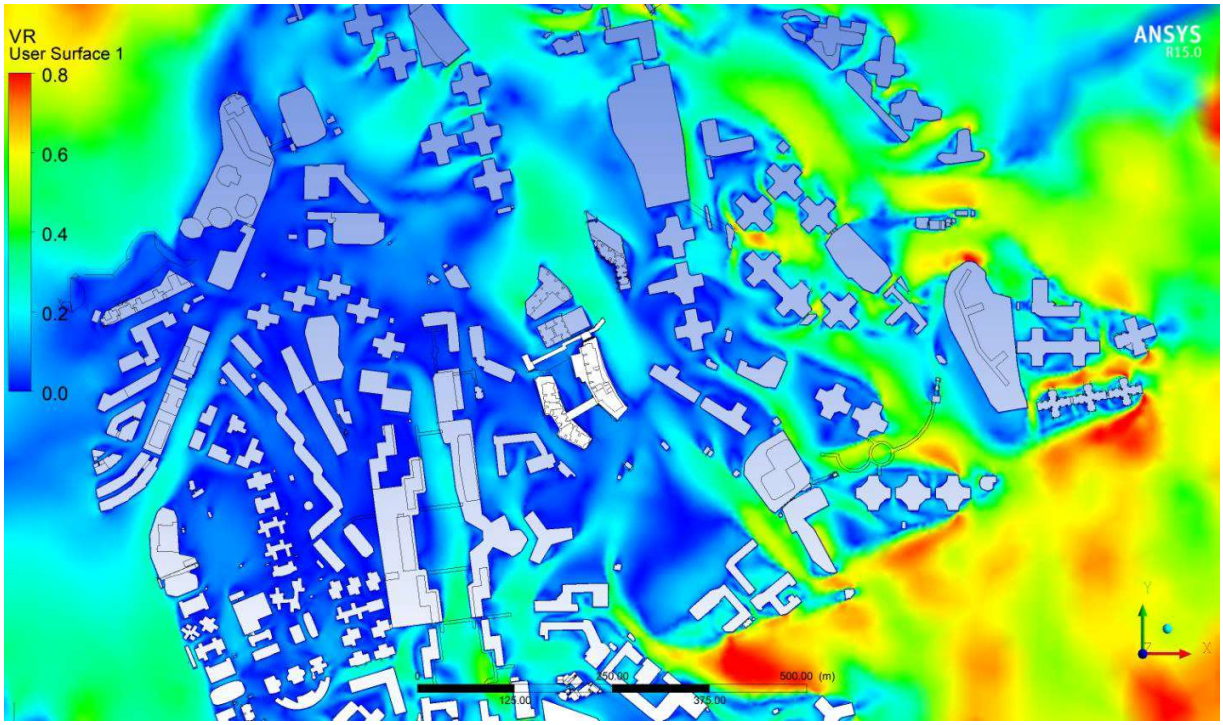



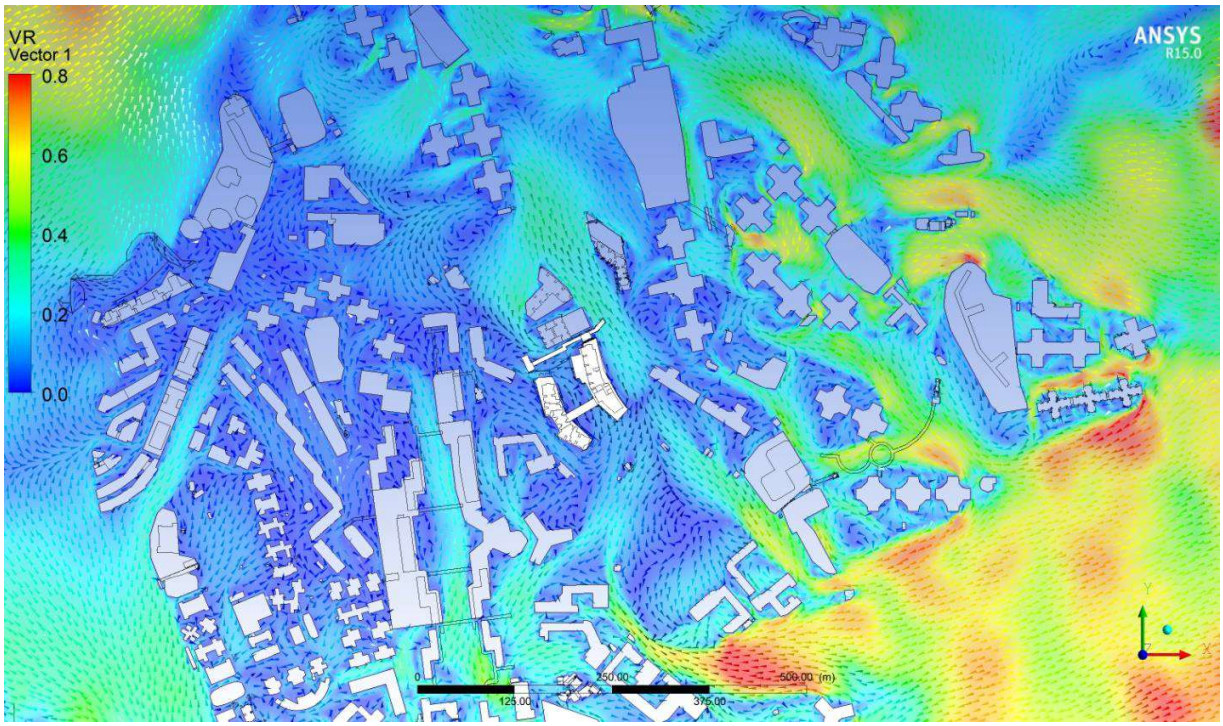
E Proposed Scheme



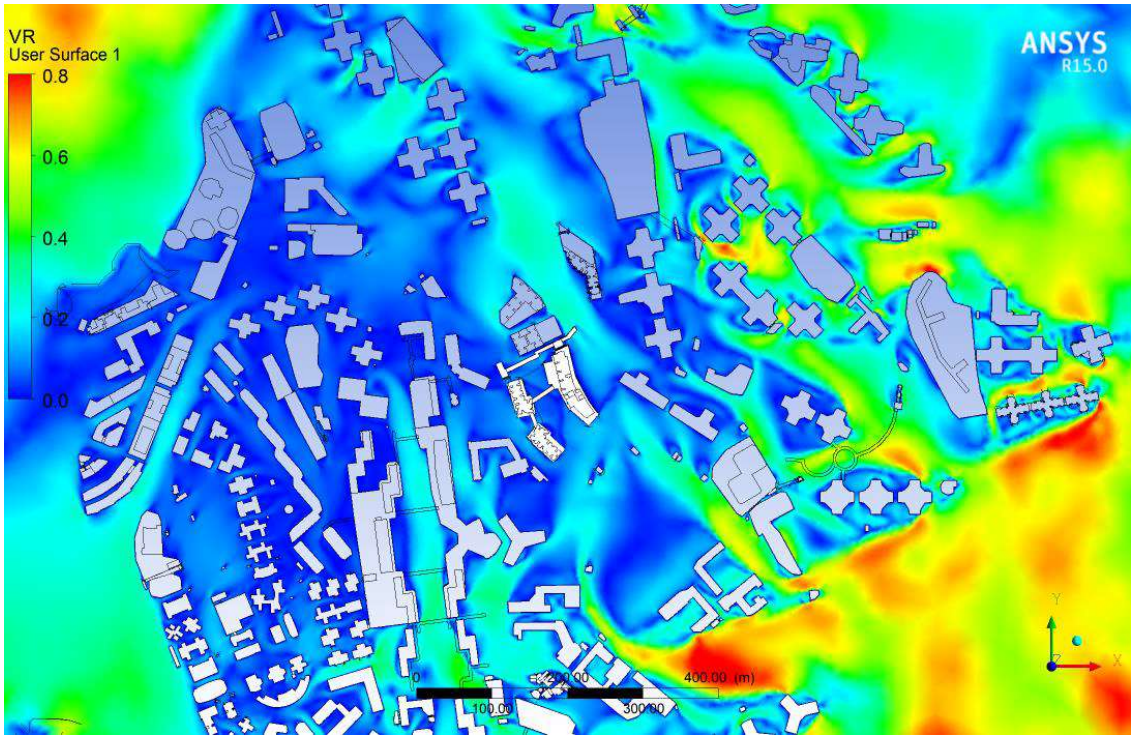



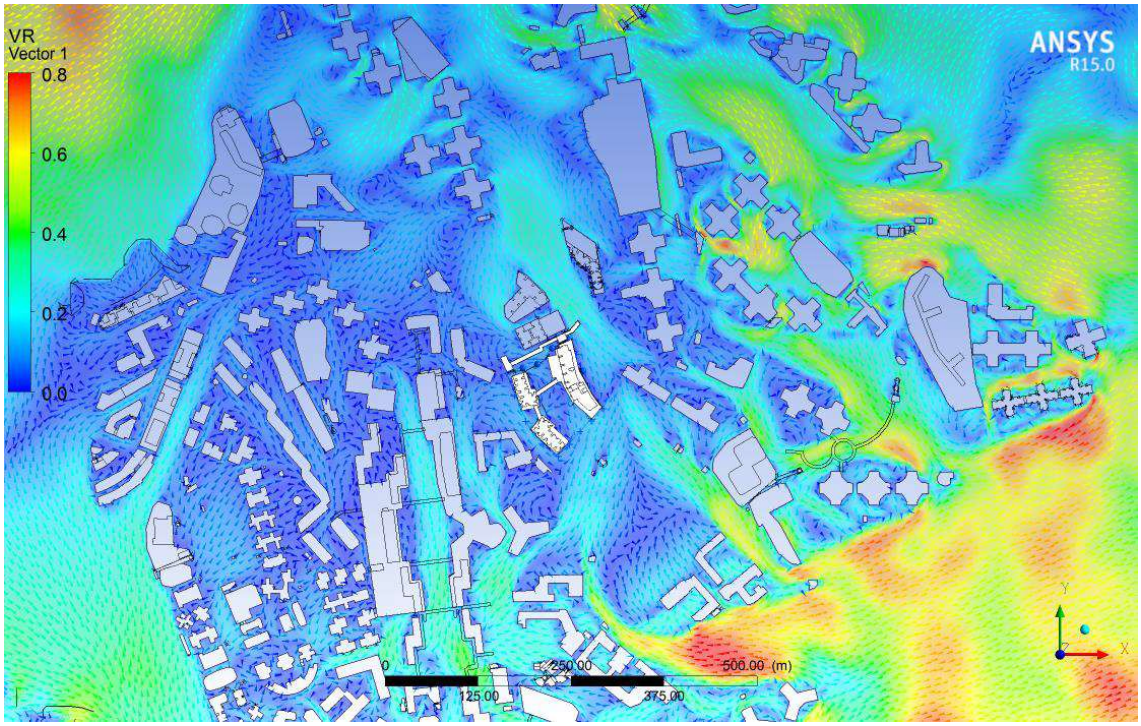
ENE Baseline Scheme



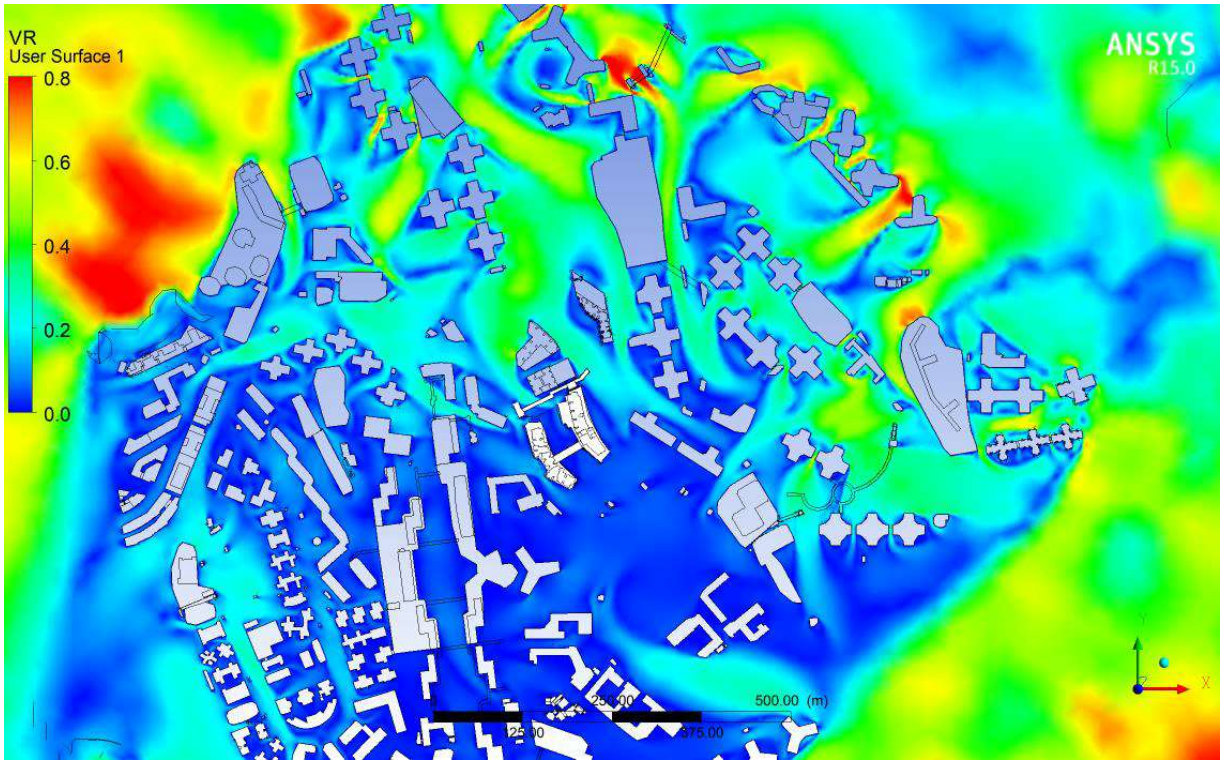



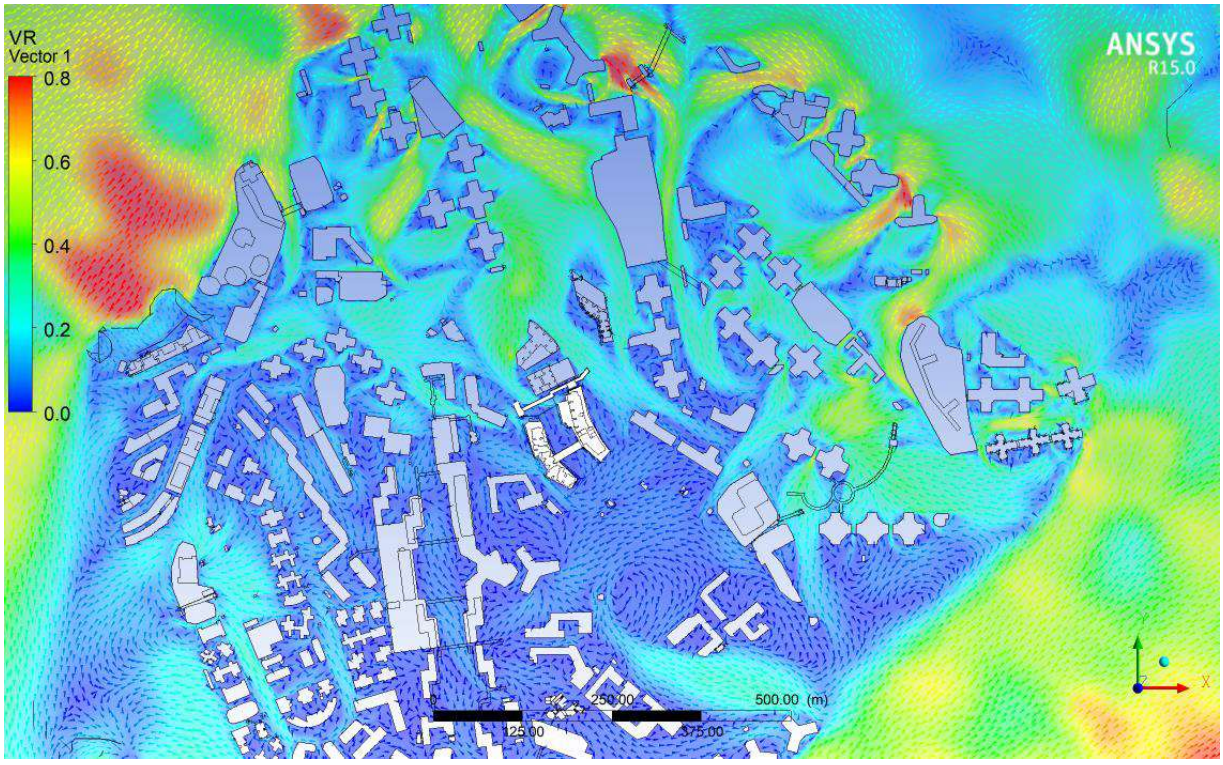
ENE Proposed Scheme



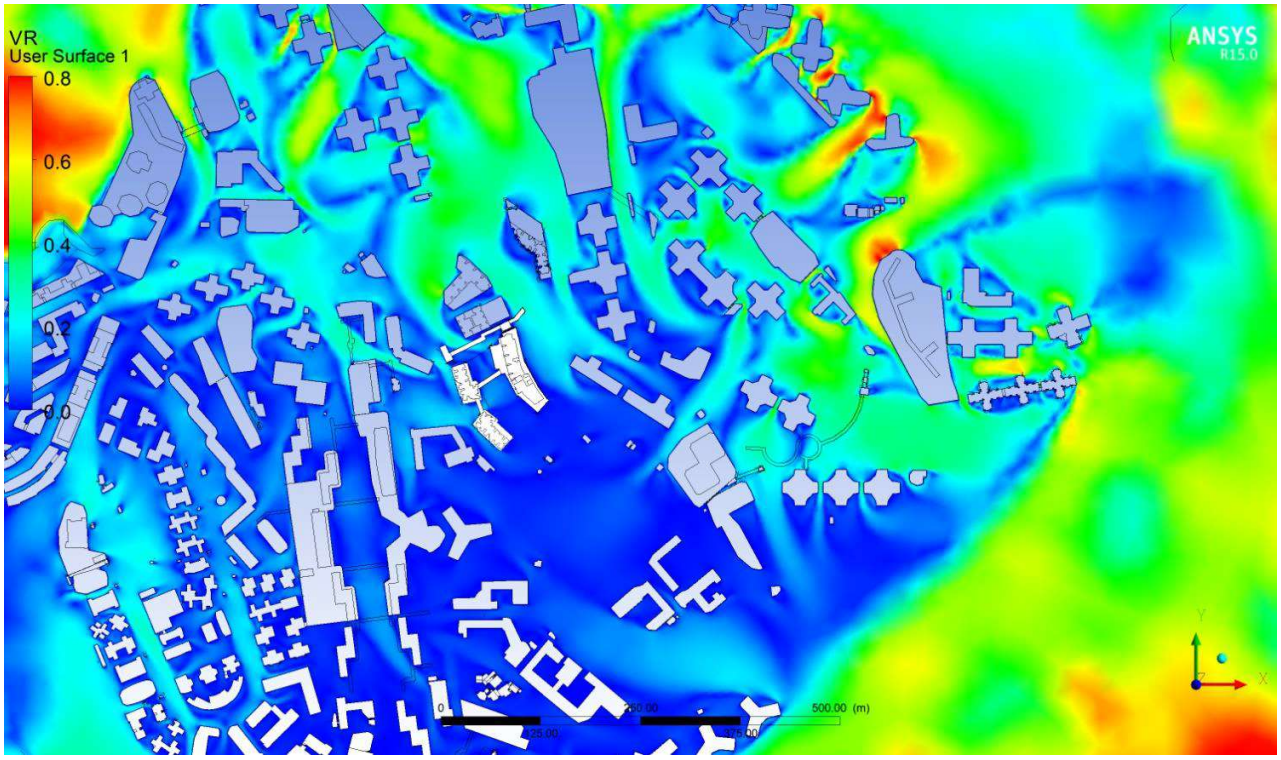



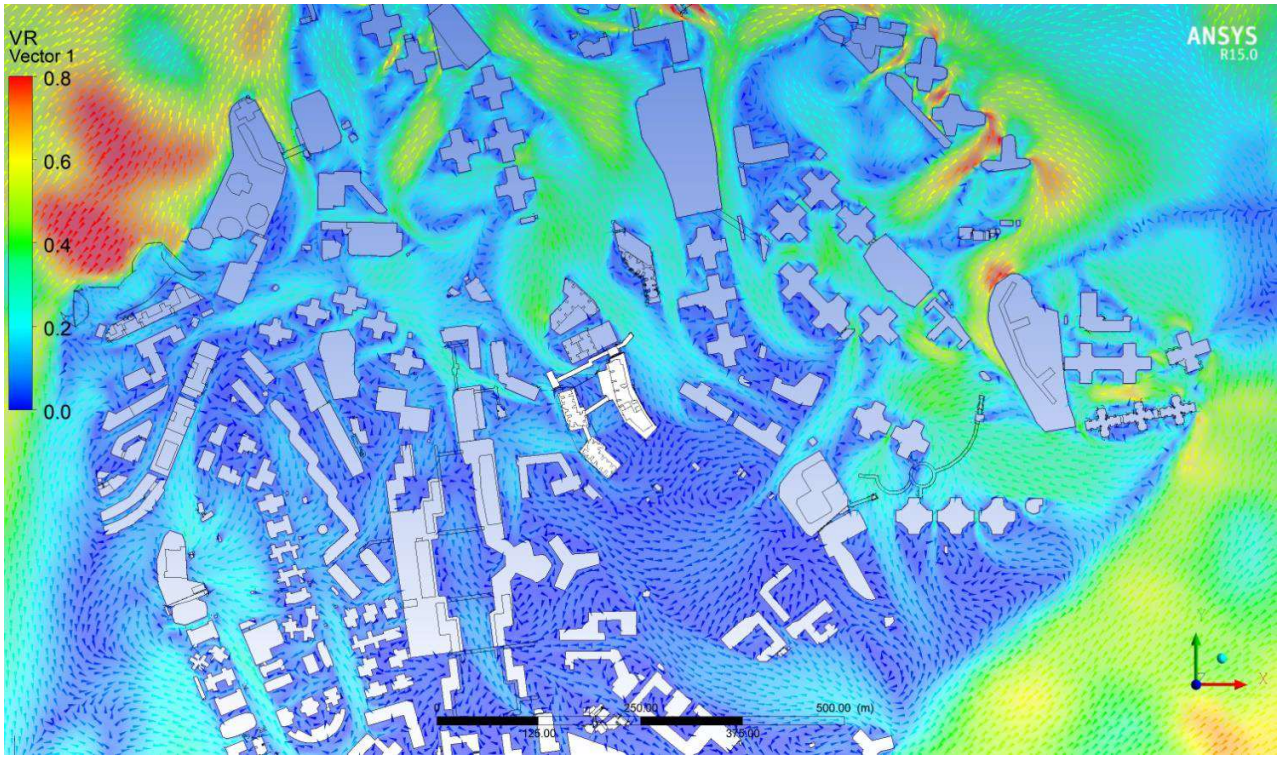
NE Baseline Scheme



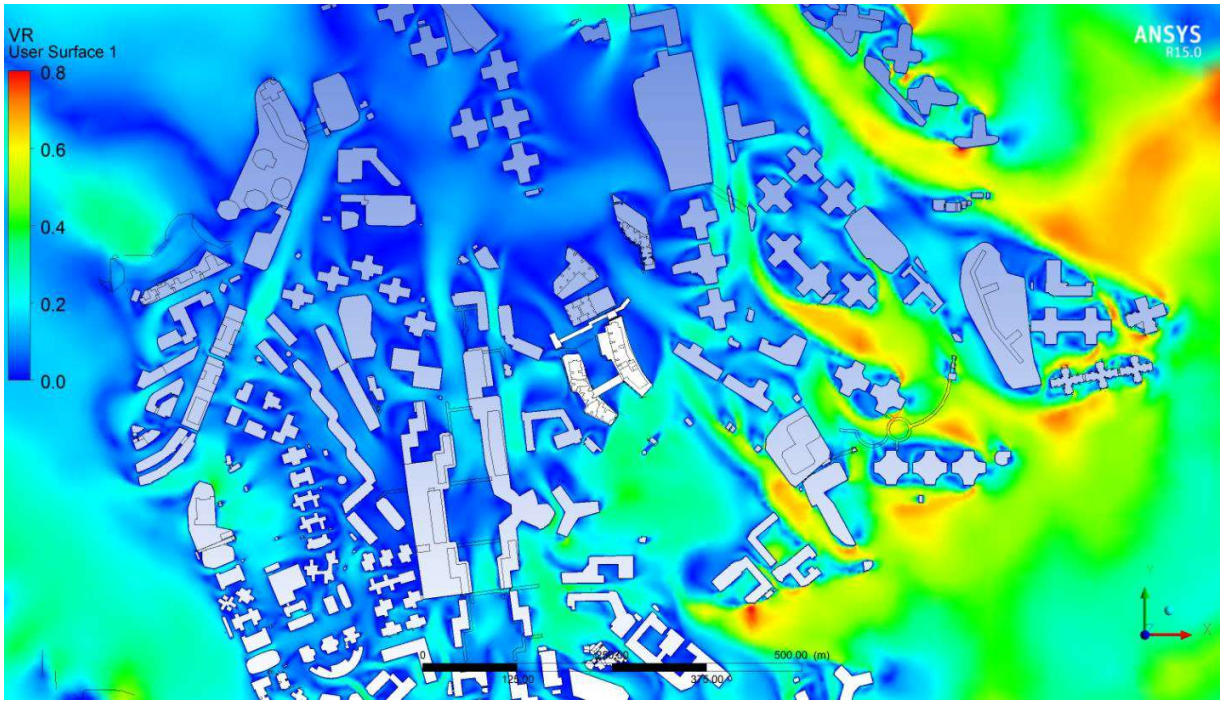



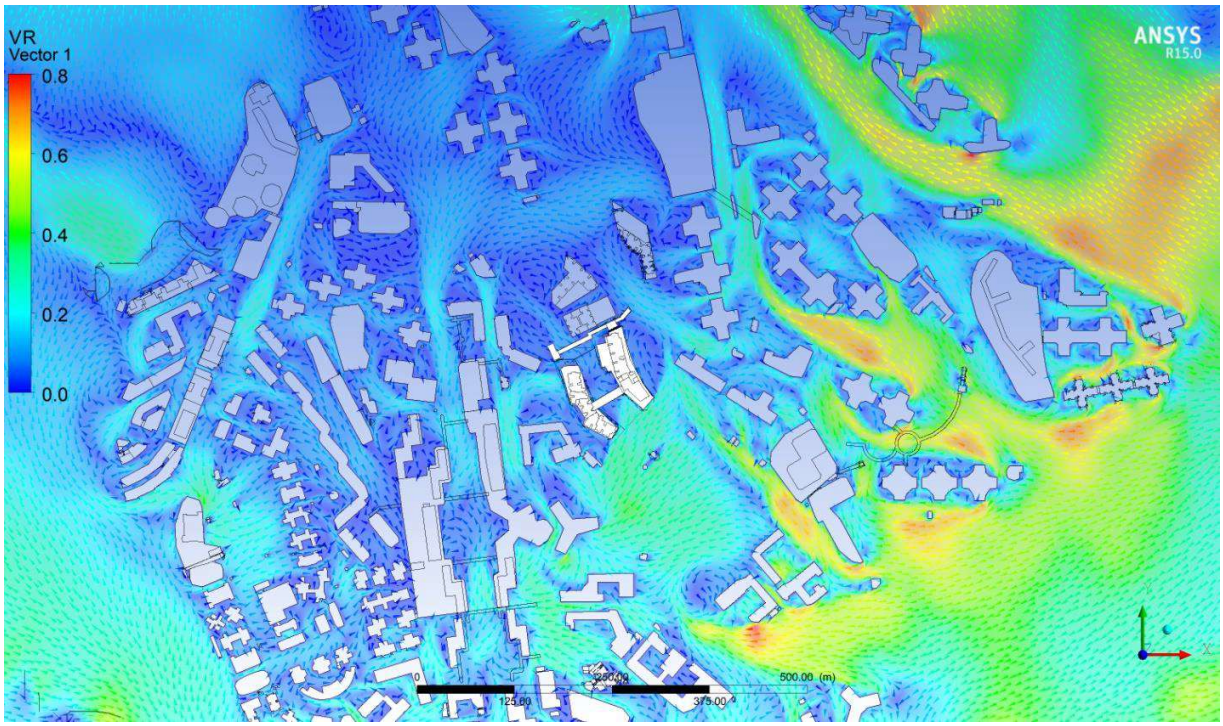
NE Proposed Scheme



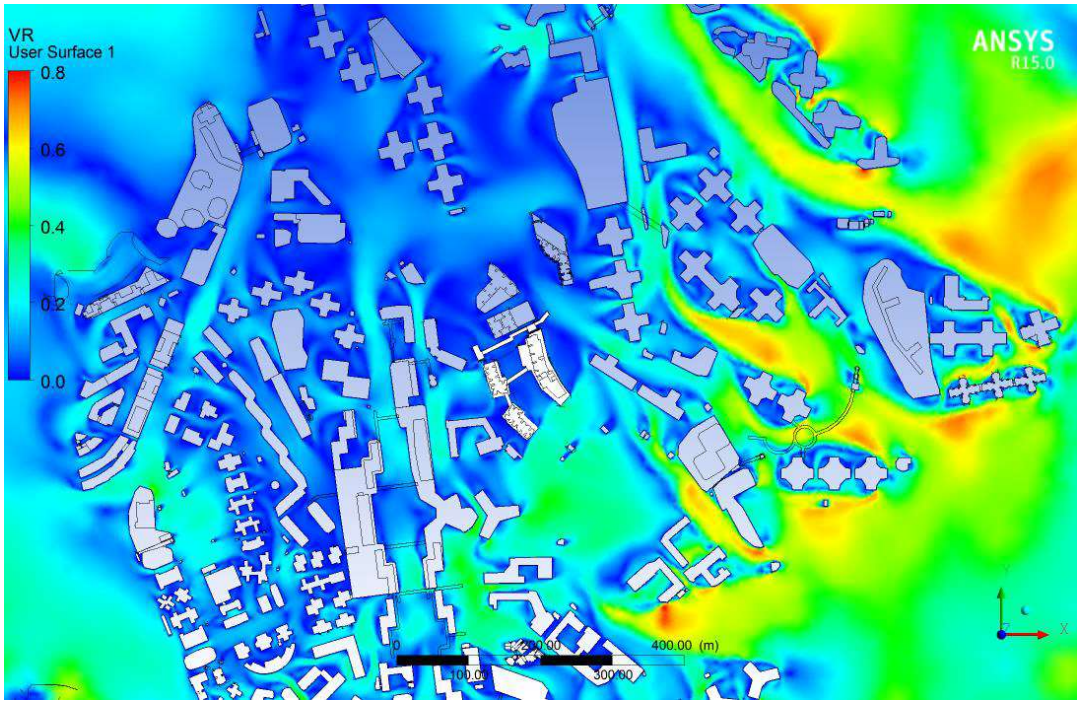



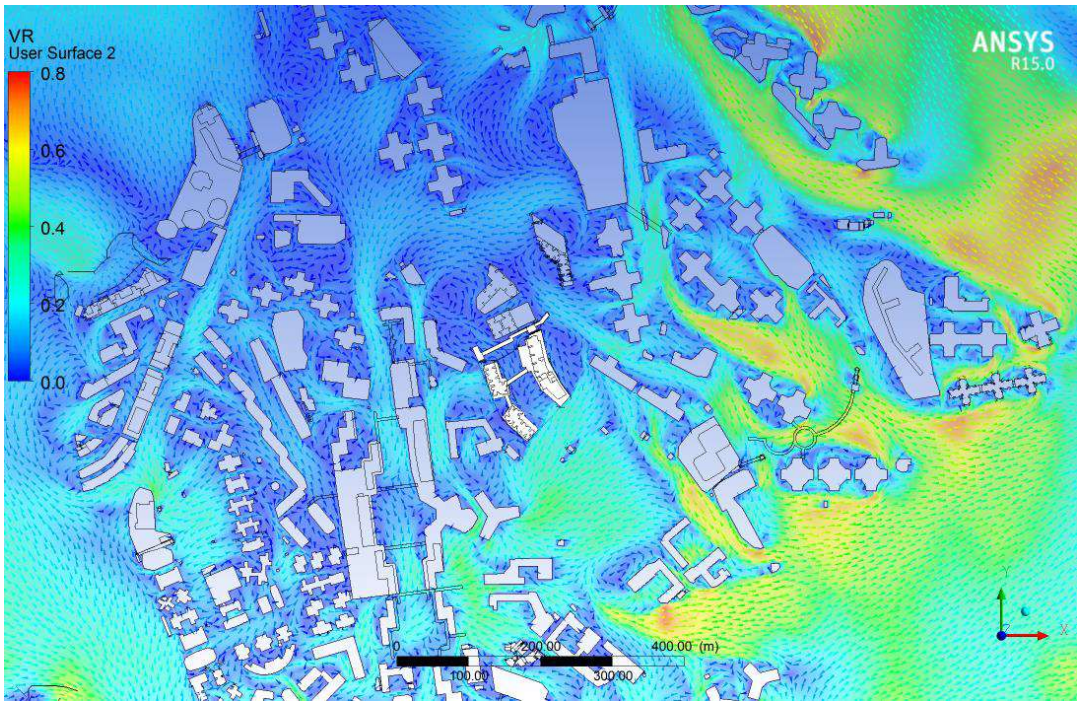
ESE Baseline Scheme



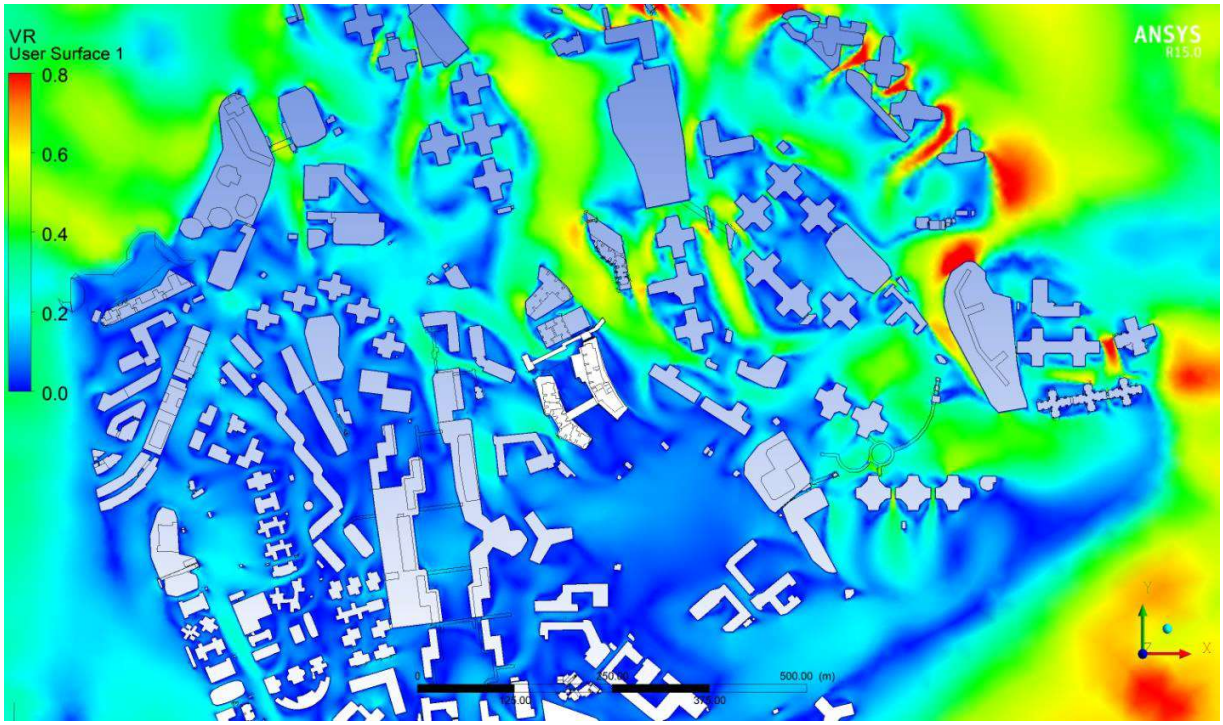



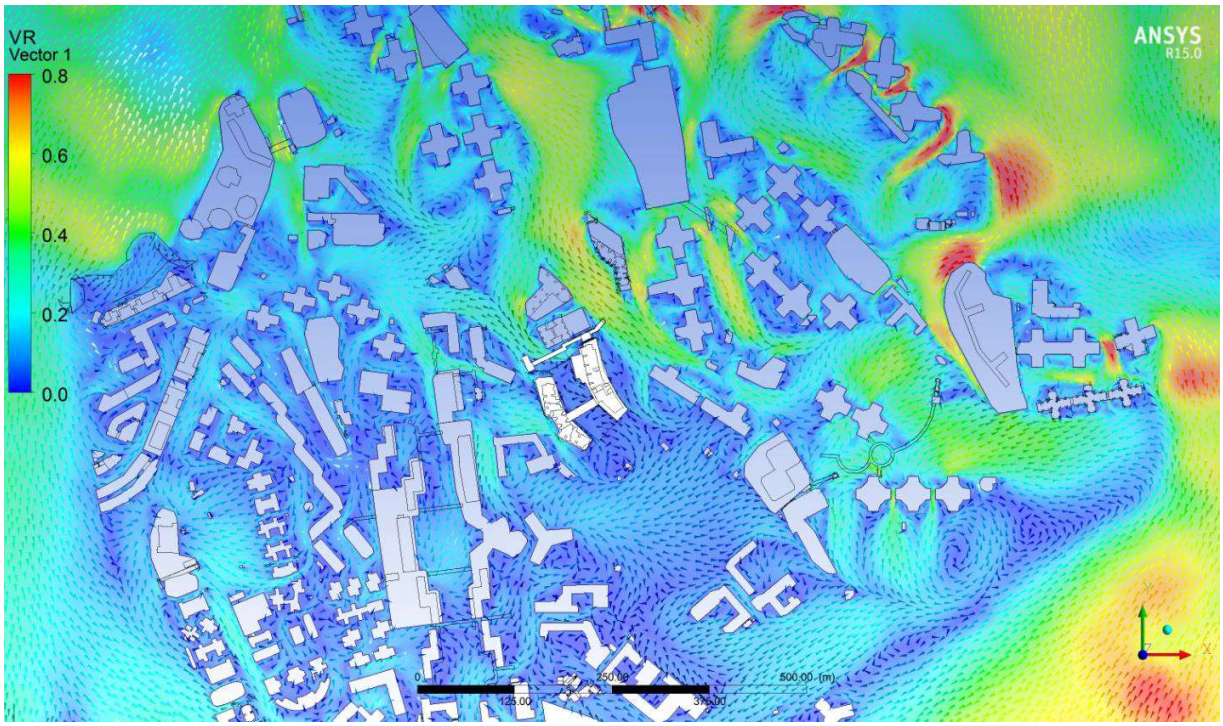
ESE Proposed Scheme



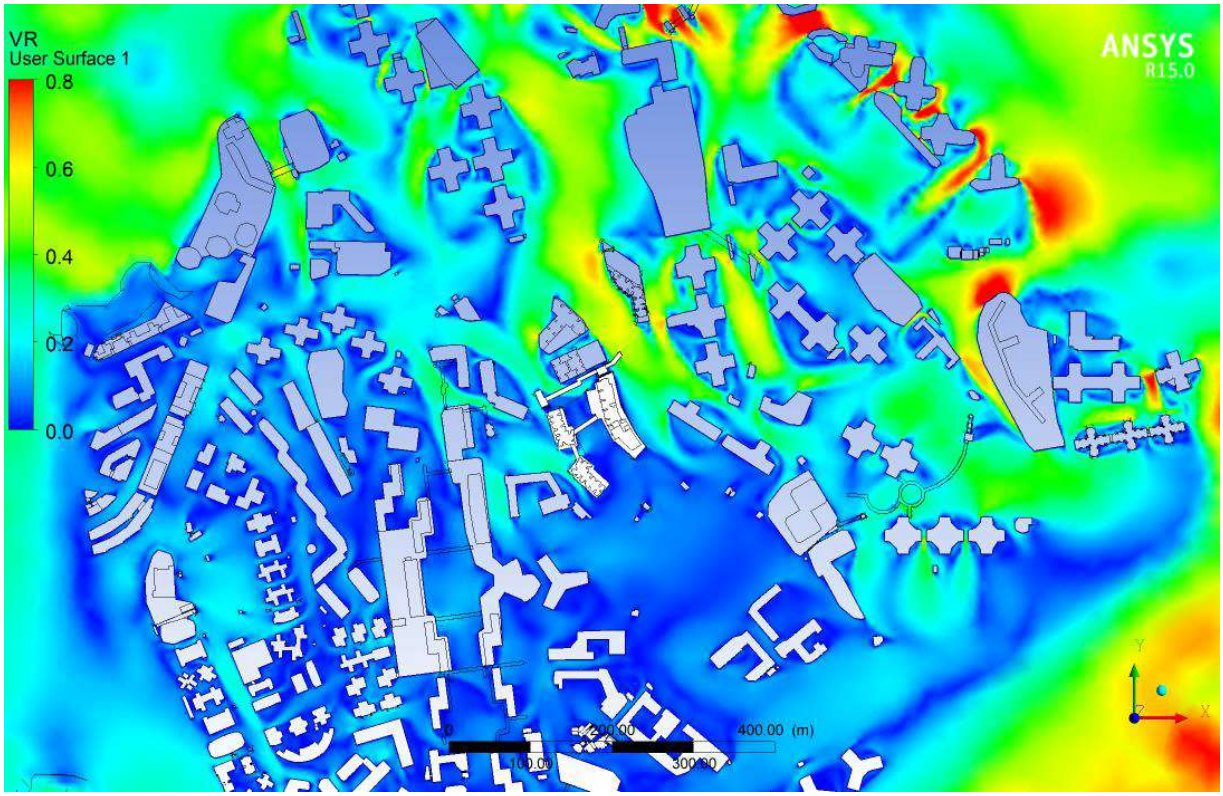



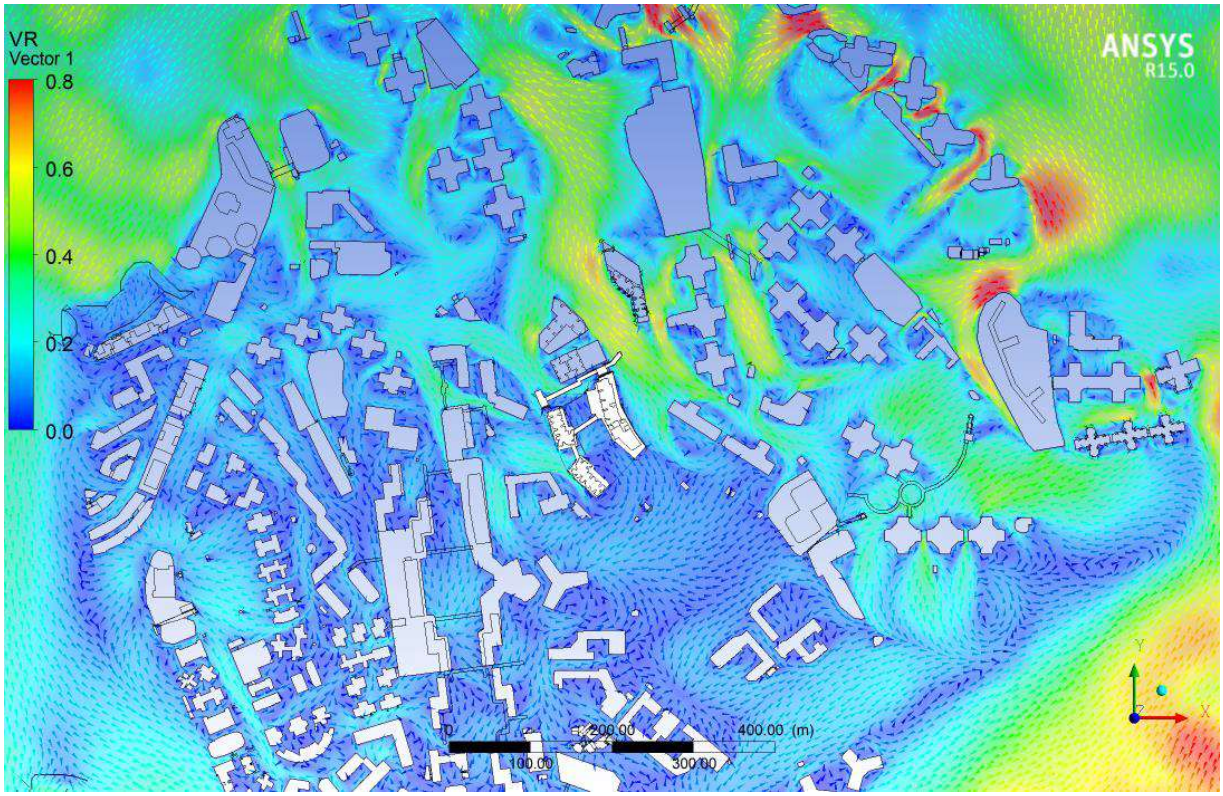
NNE Baseline Scheme



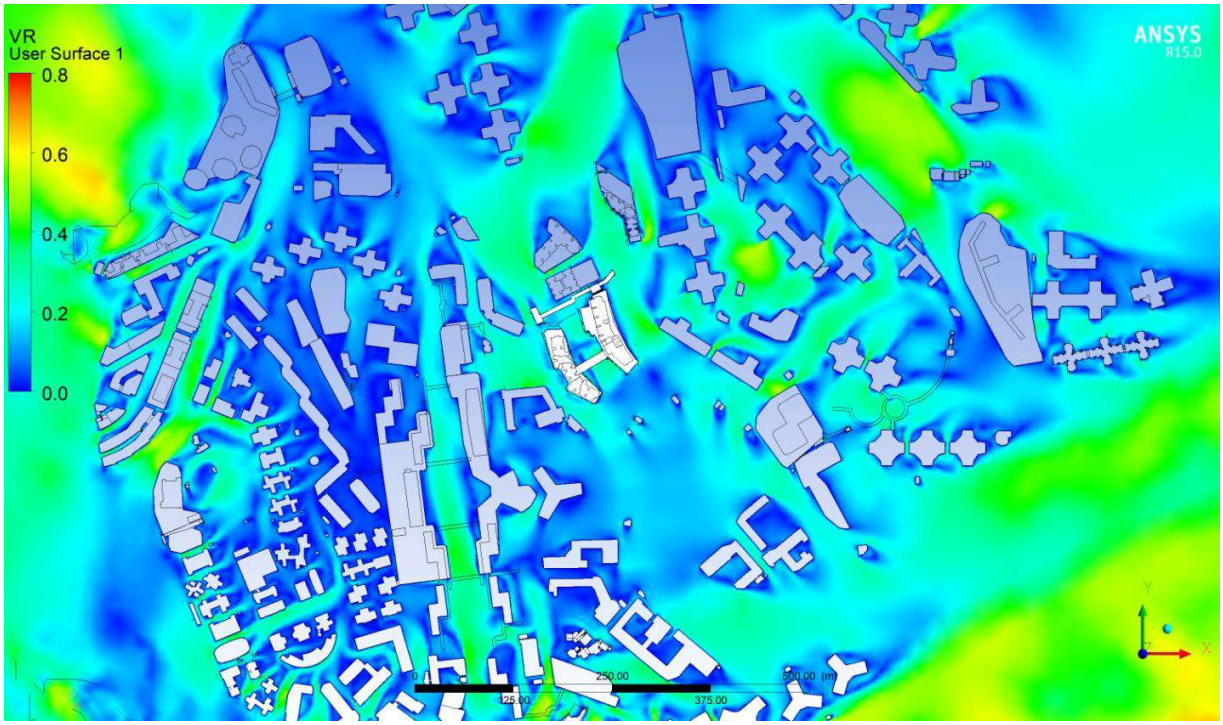



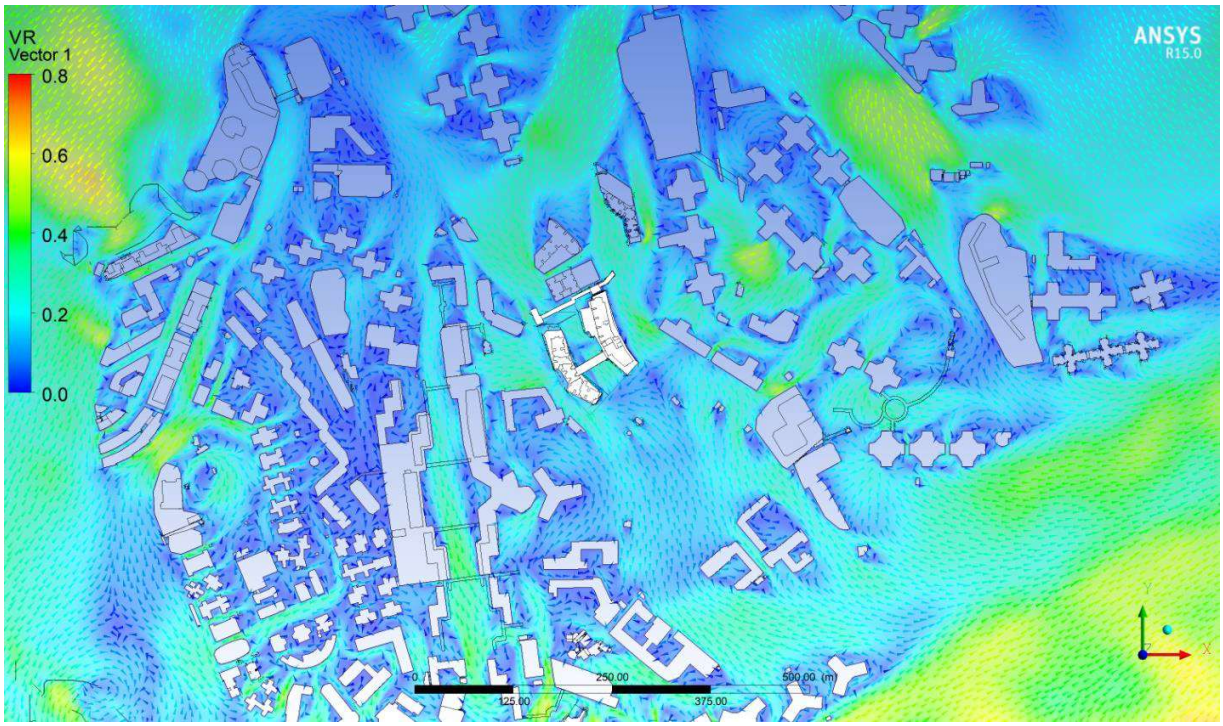
NNE Proposed Scheme



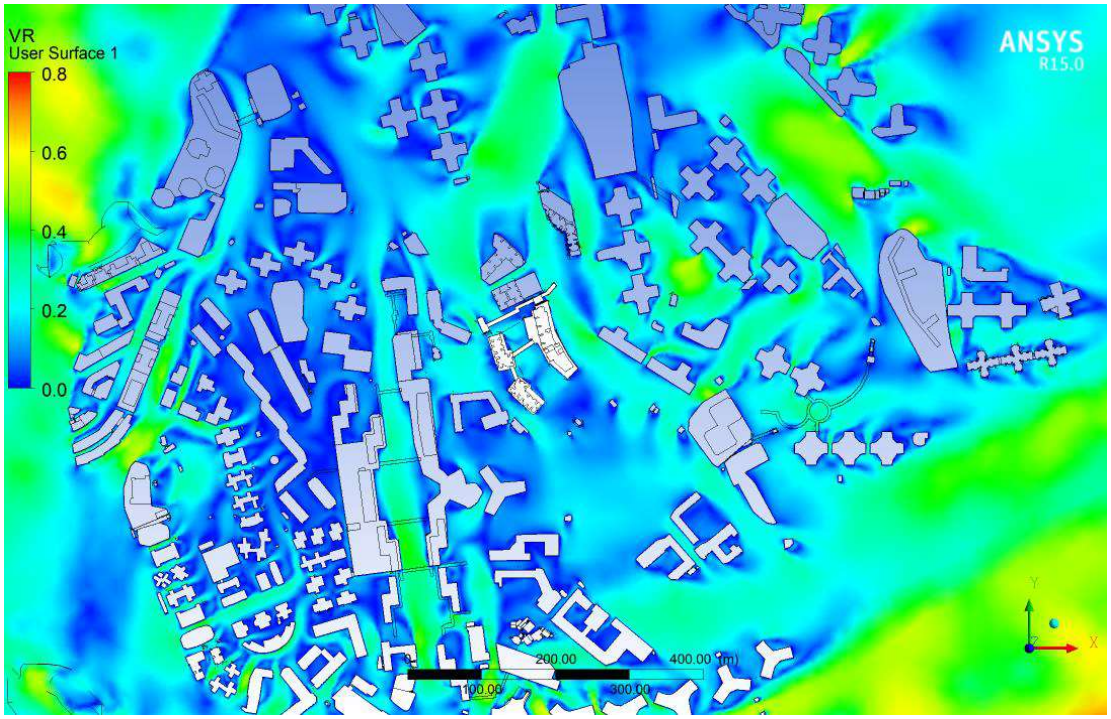



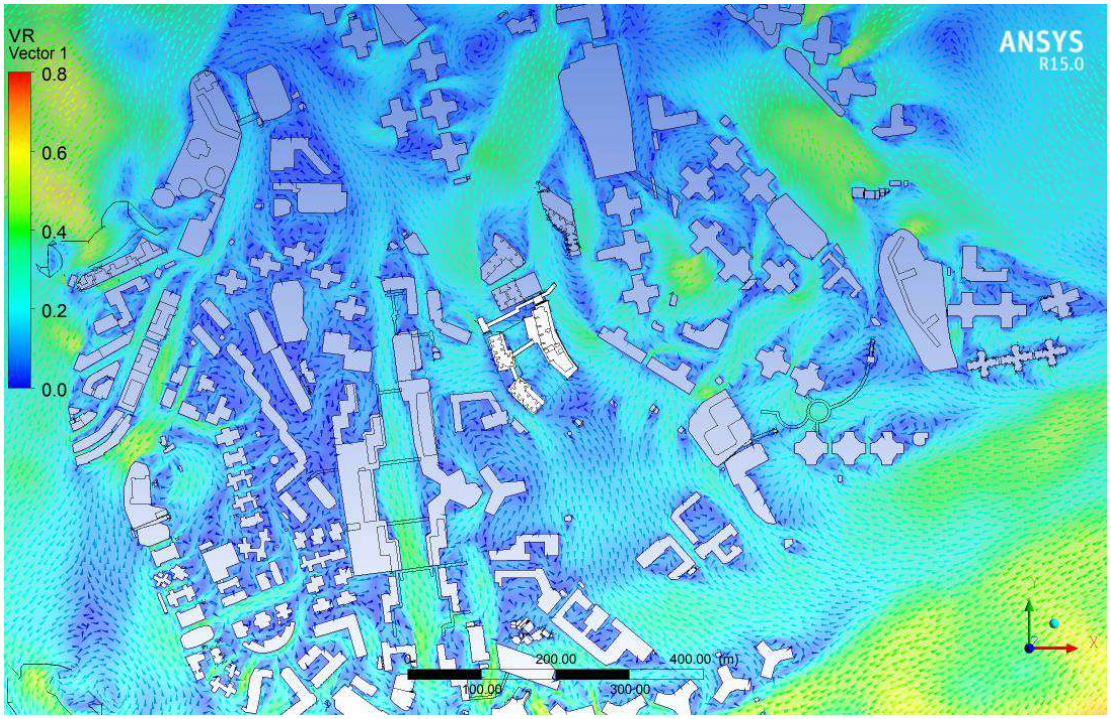
SW Baseline Scheme



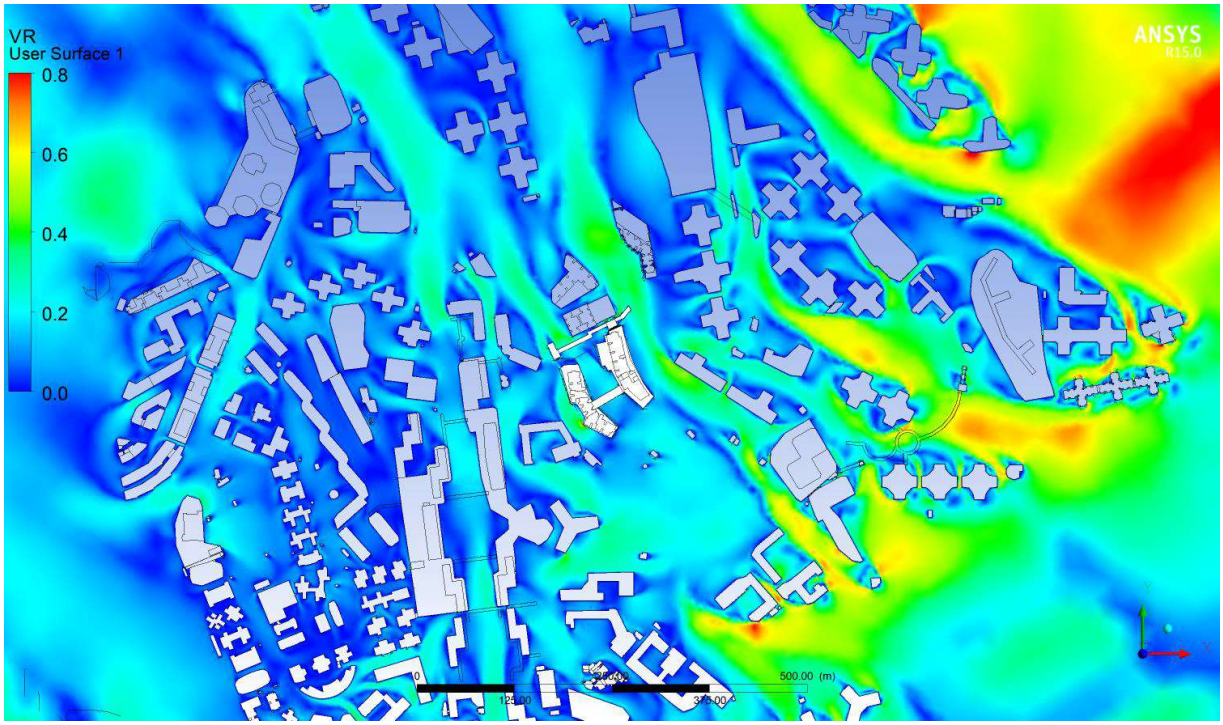



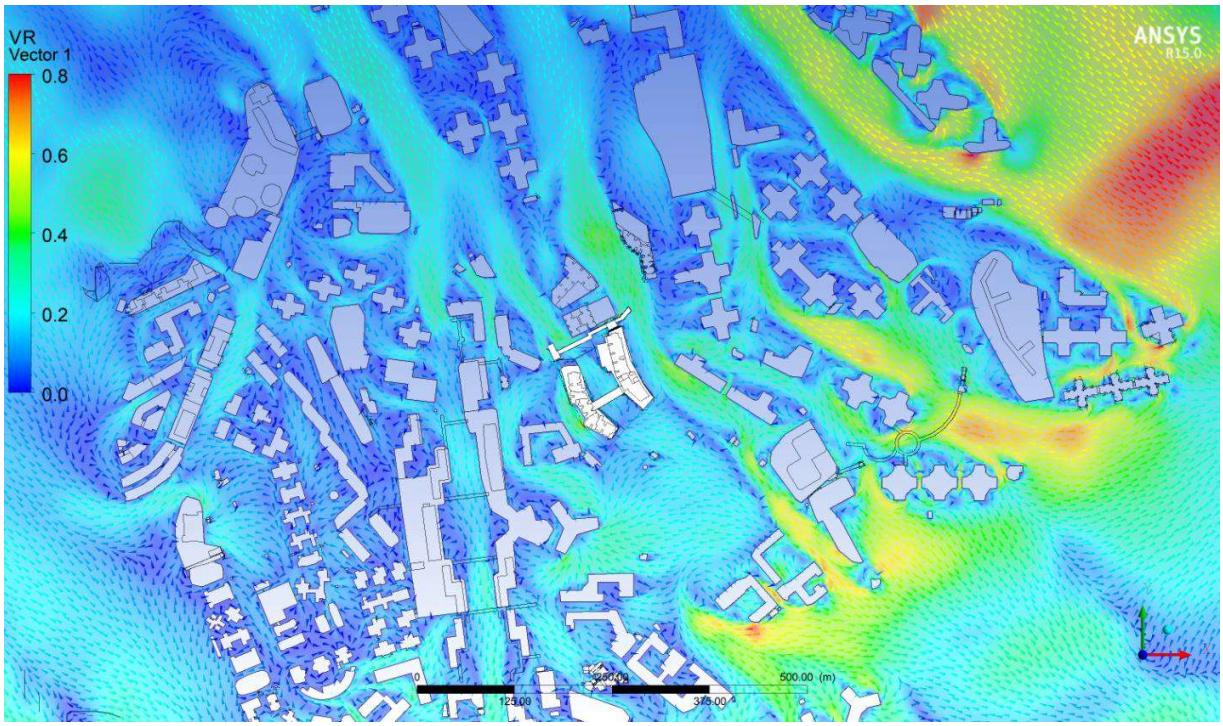
SW Proposed Scheme



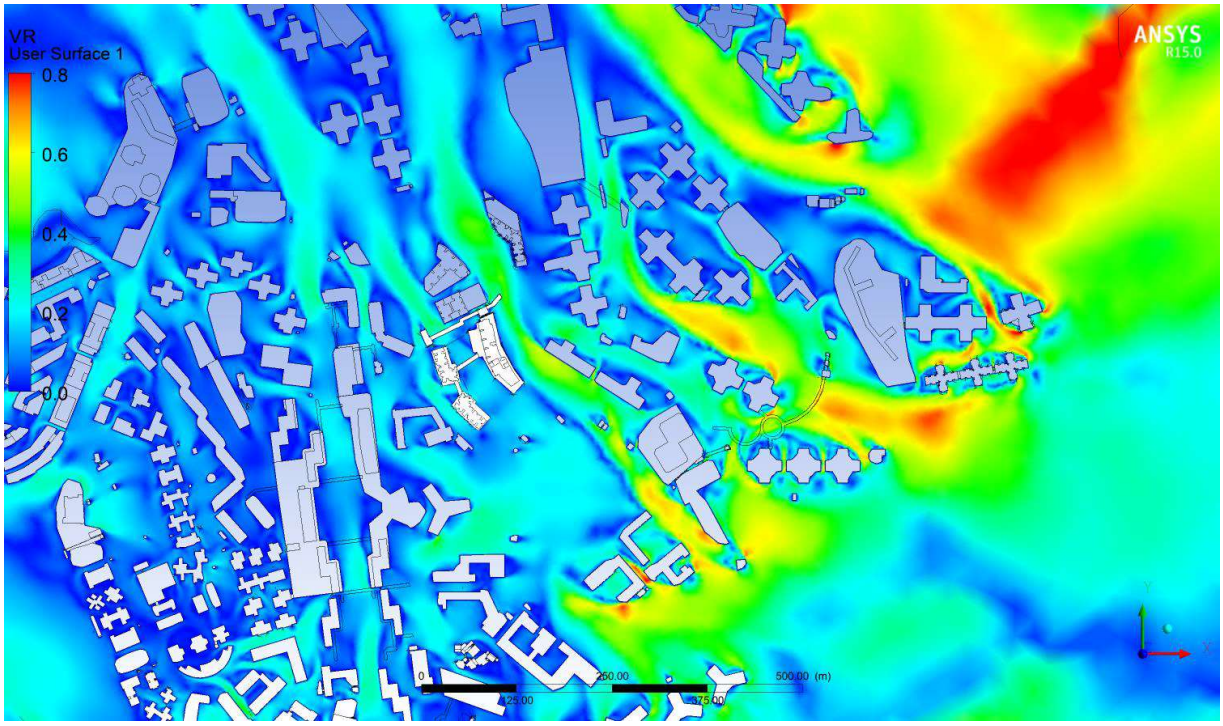



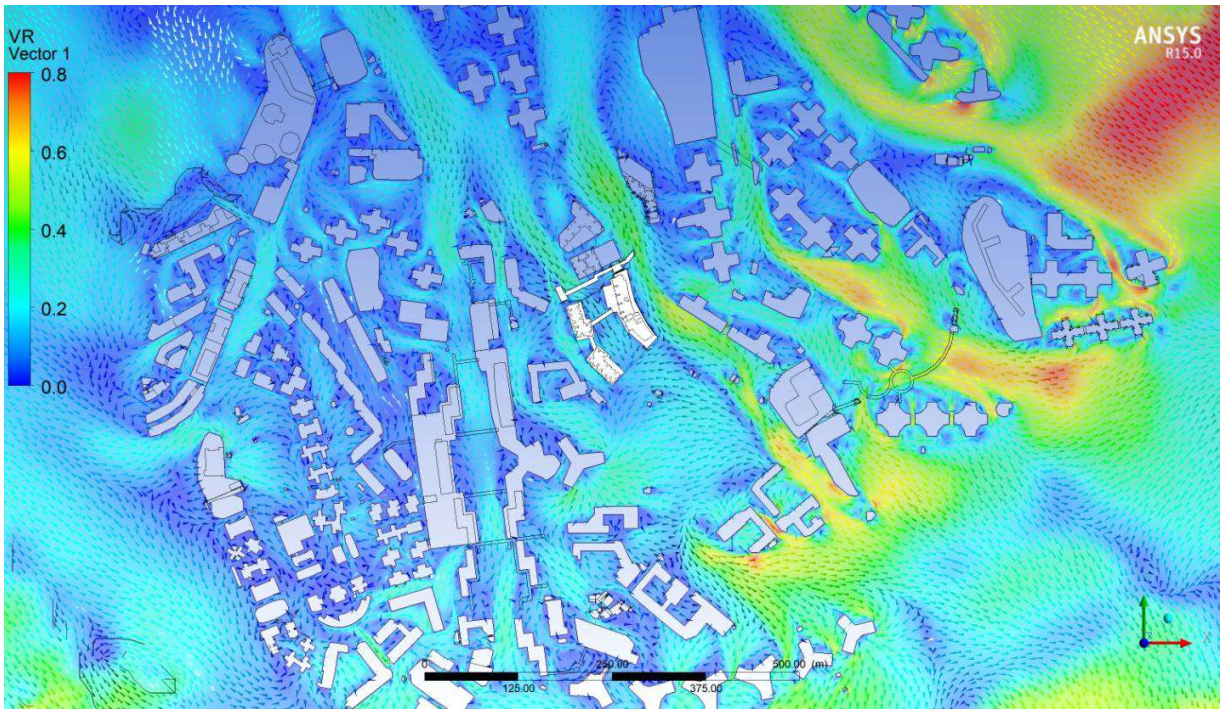
SE Baseline Scheme



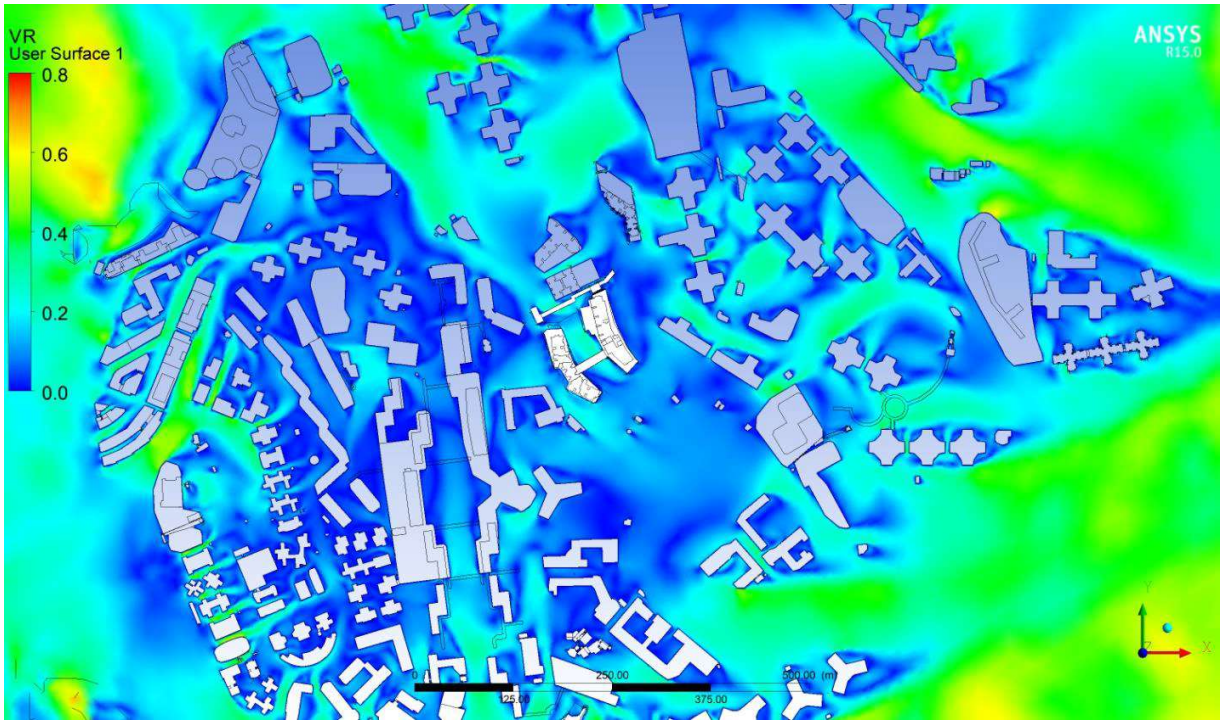



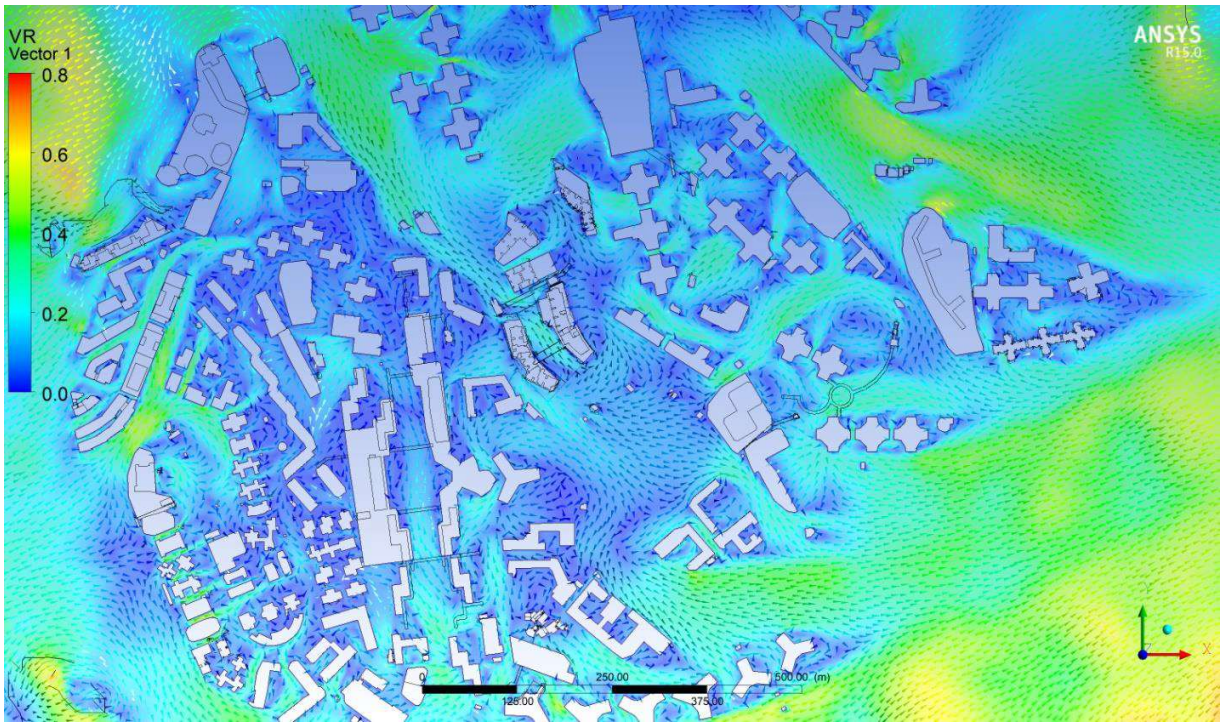
SE Proposed Scheme



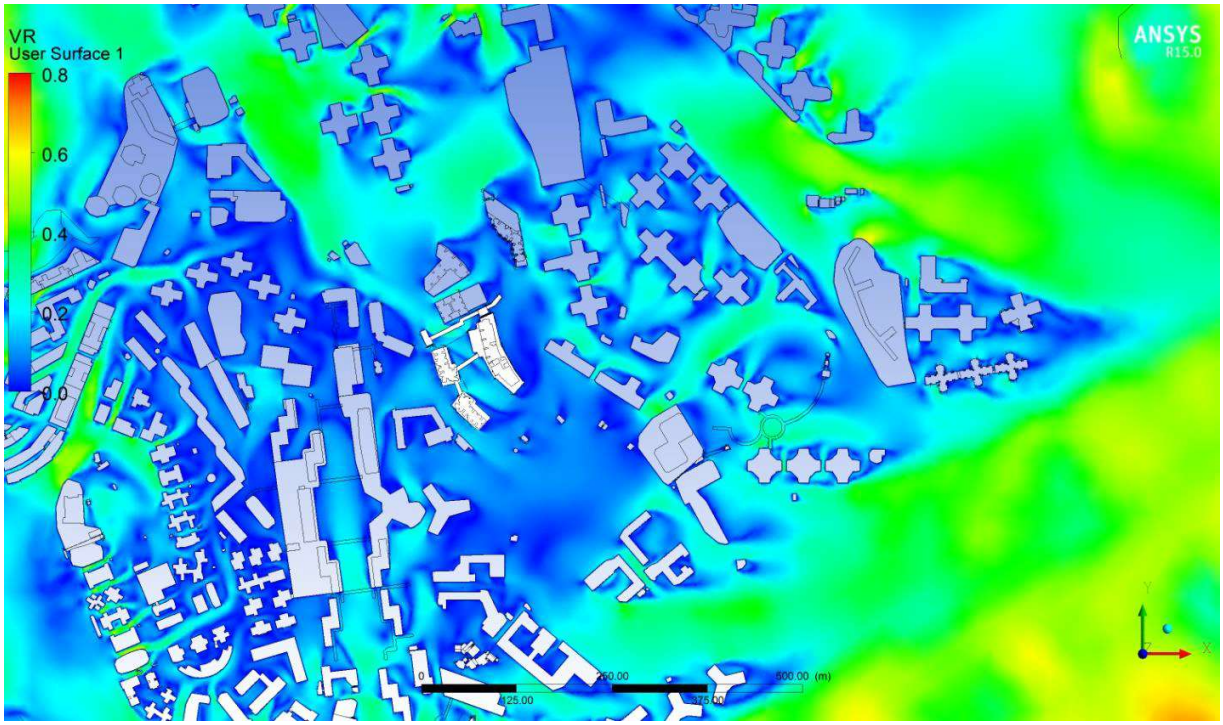



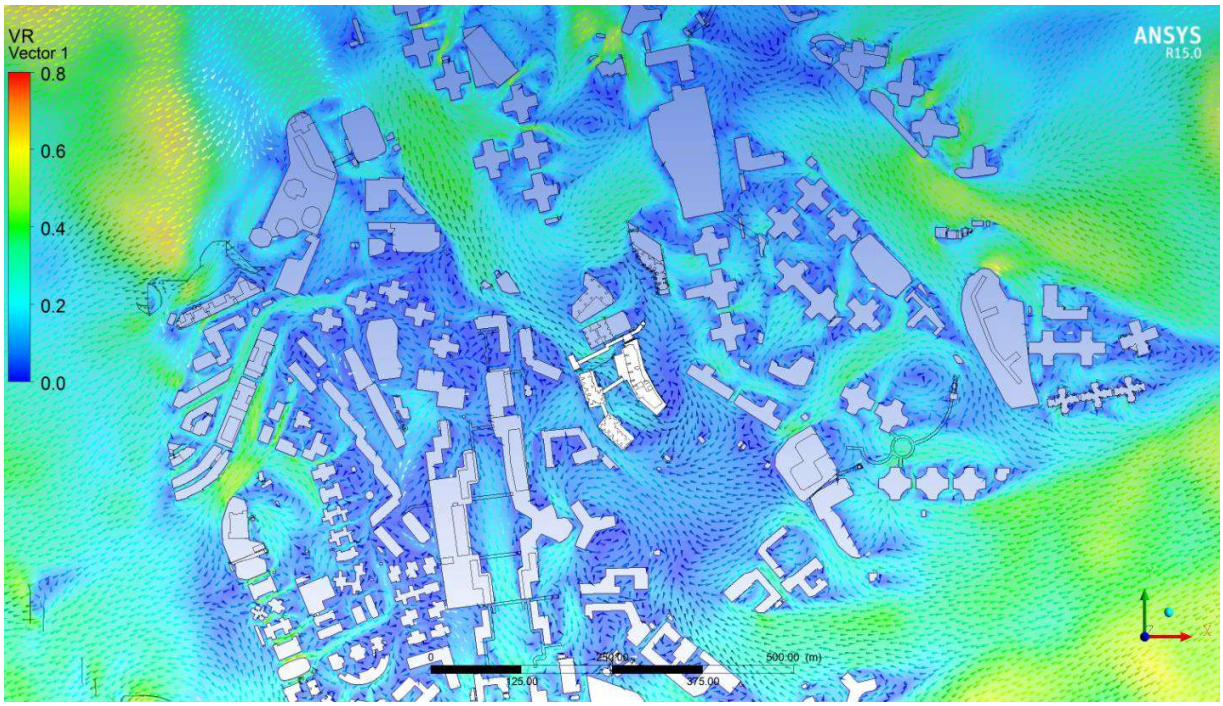
WSW Baseline Scheme



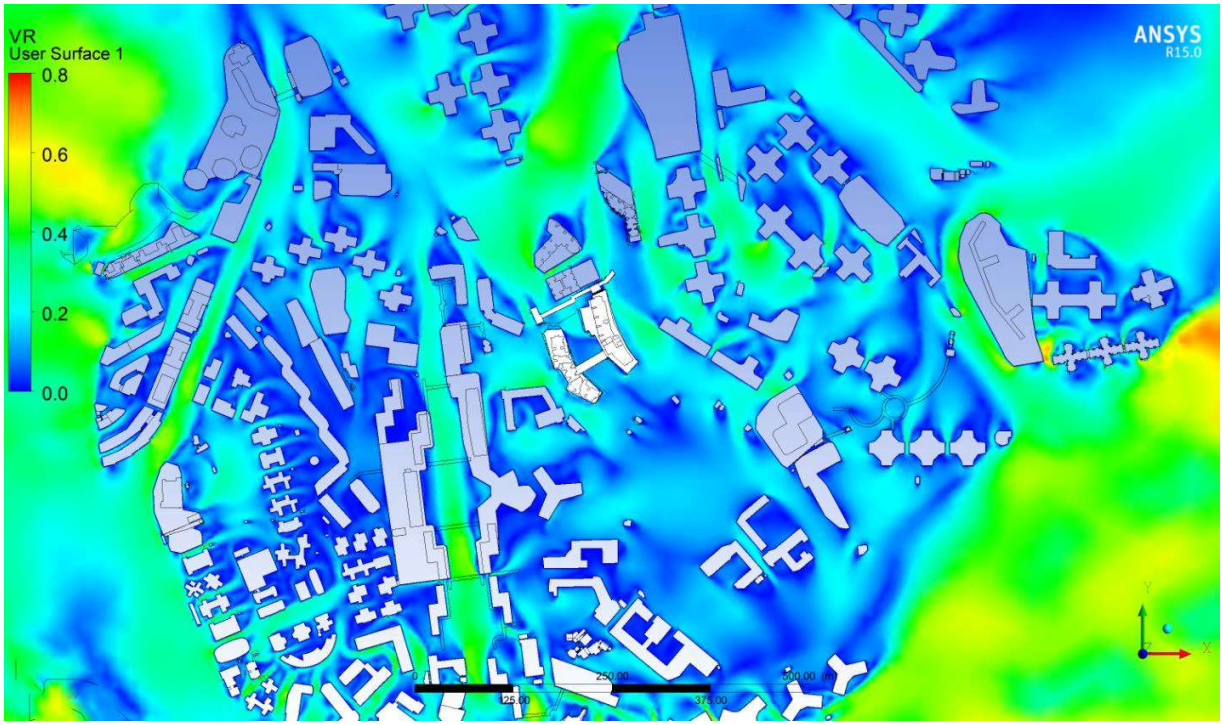



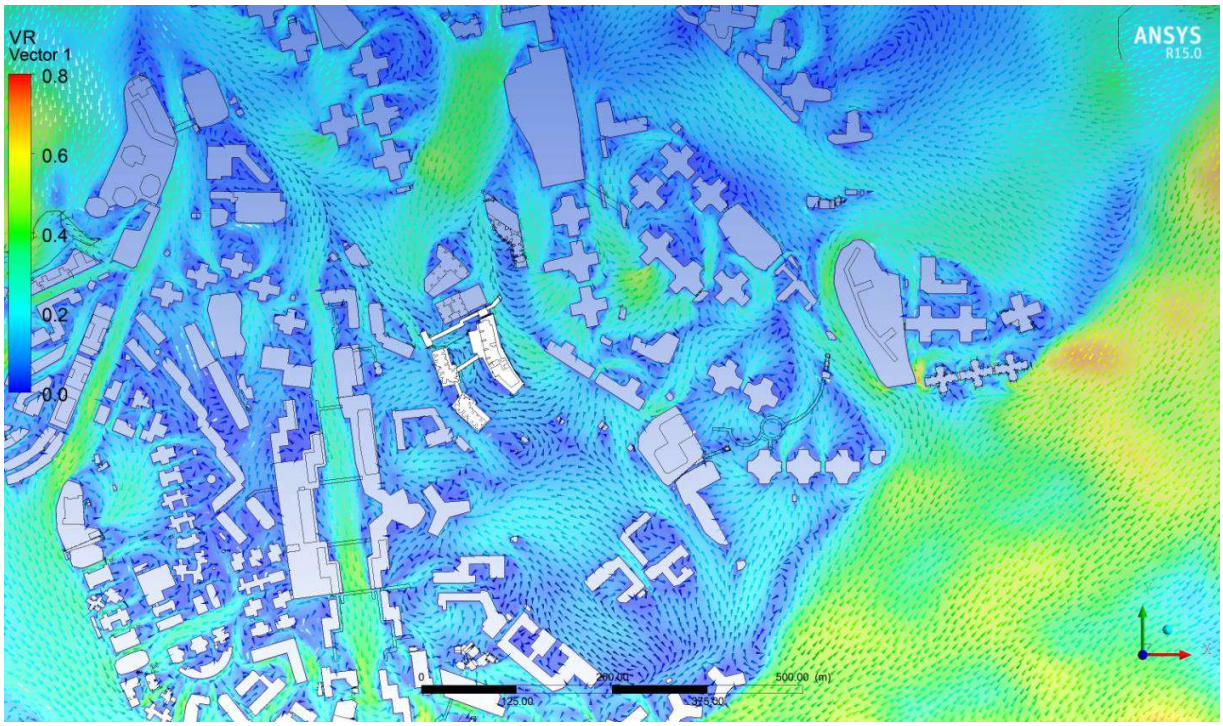
WSW Proposed Scheme



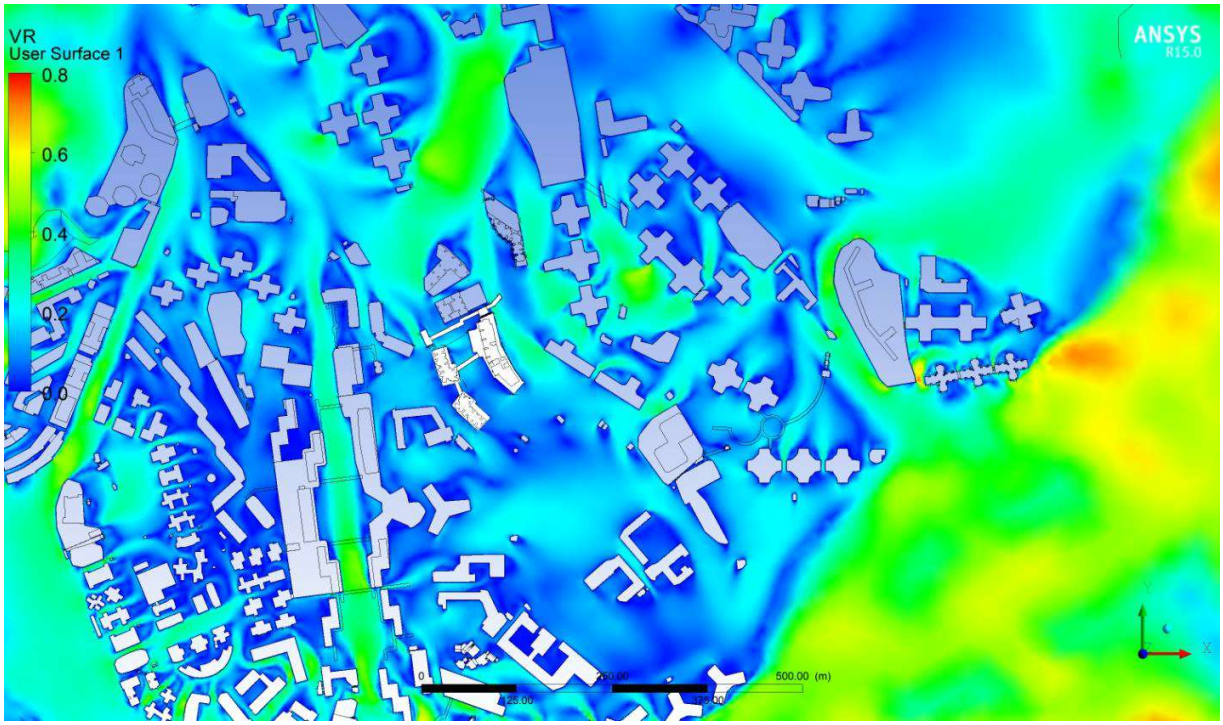



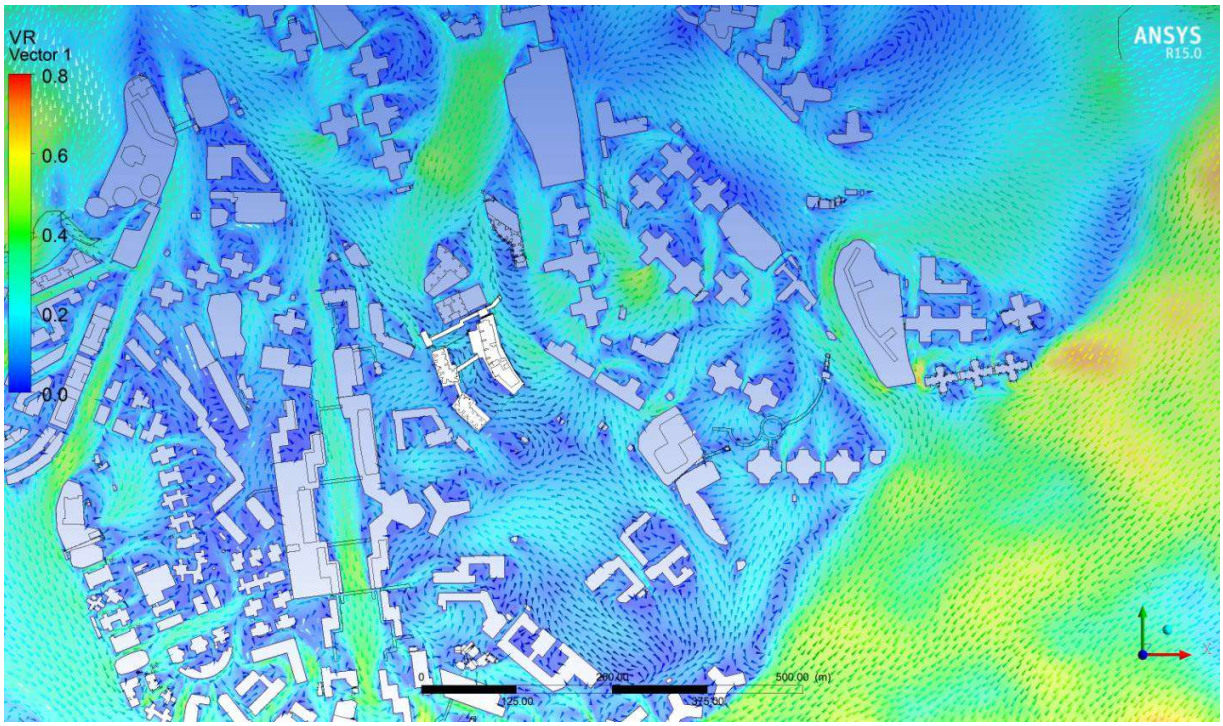
SSW Baseline Scheme



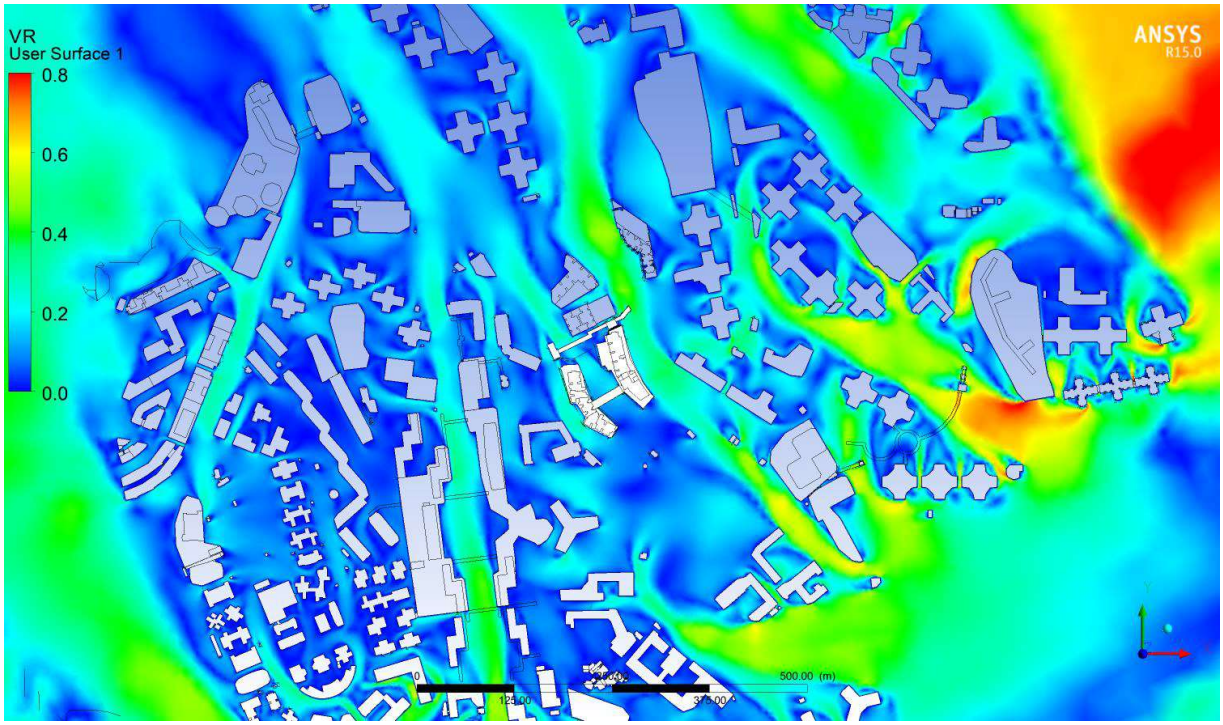



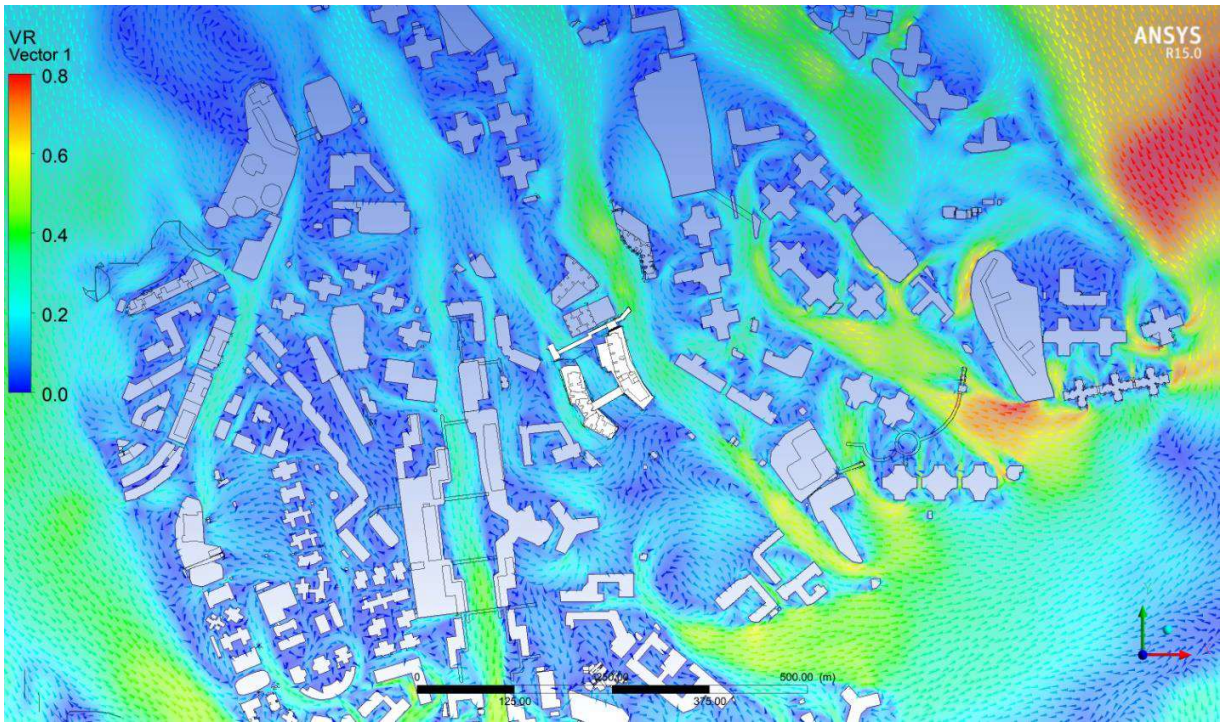
SSW Proposed Scheme



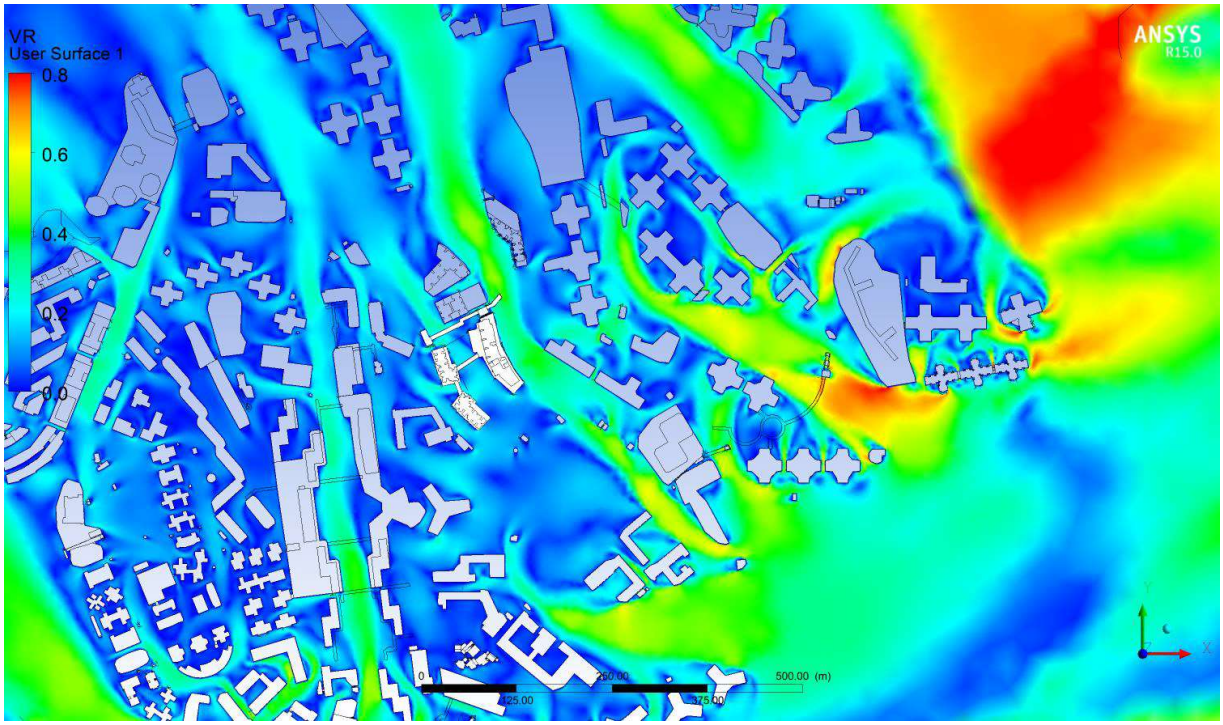



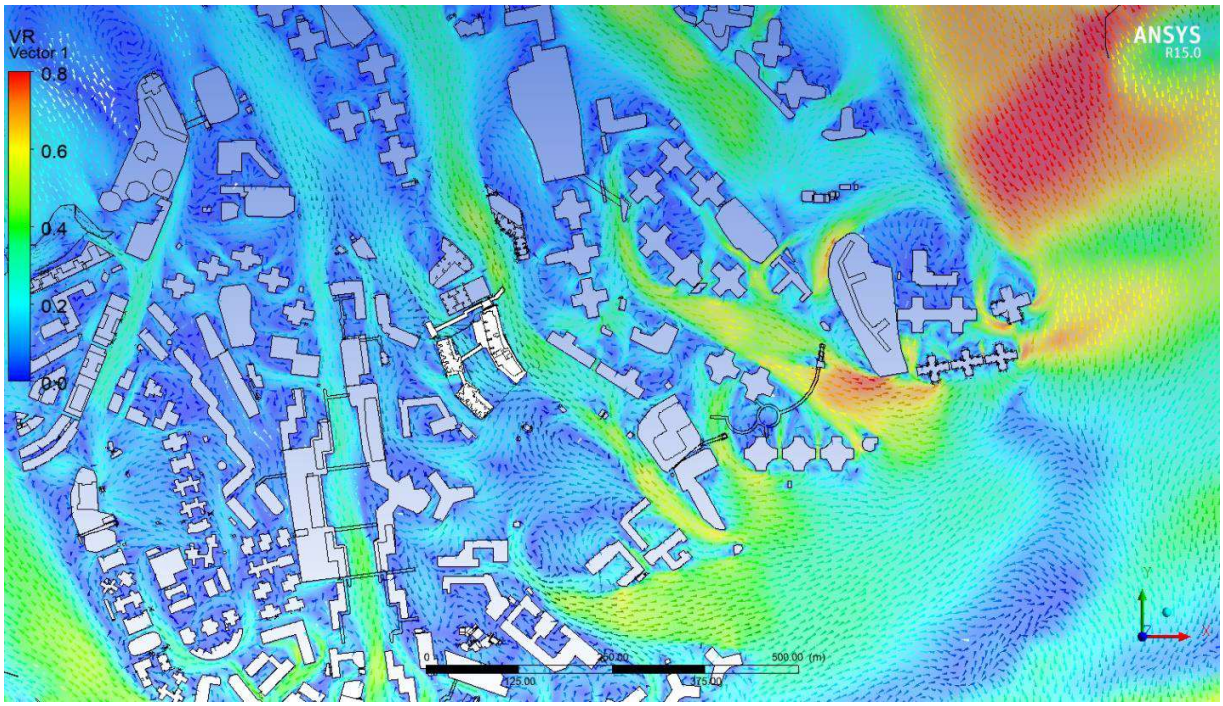
SSE Baseline Scheme



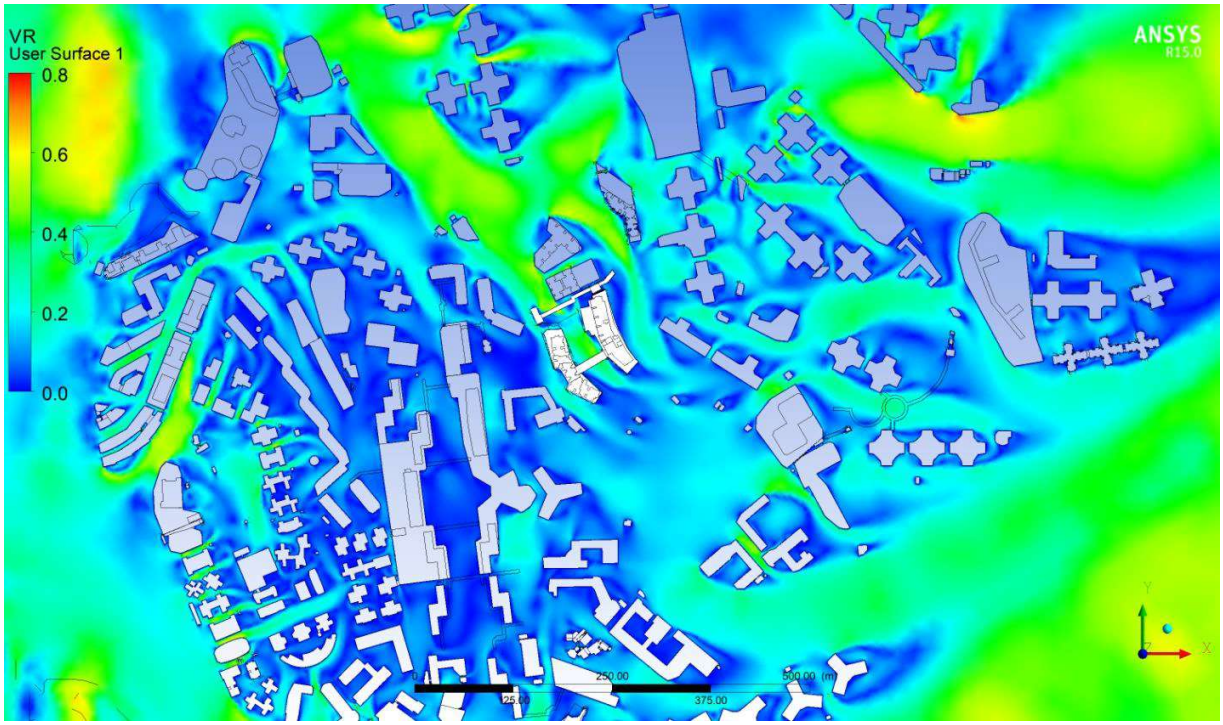



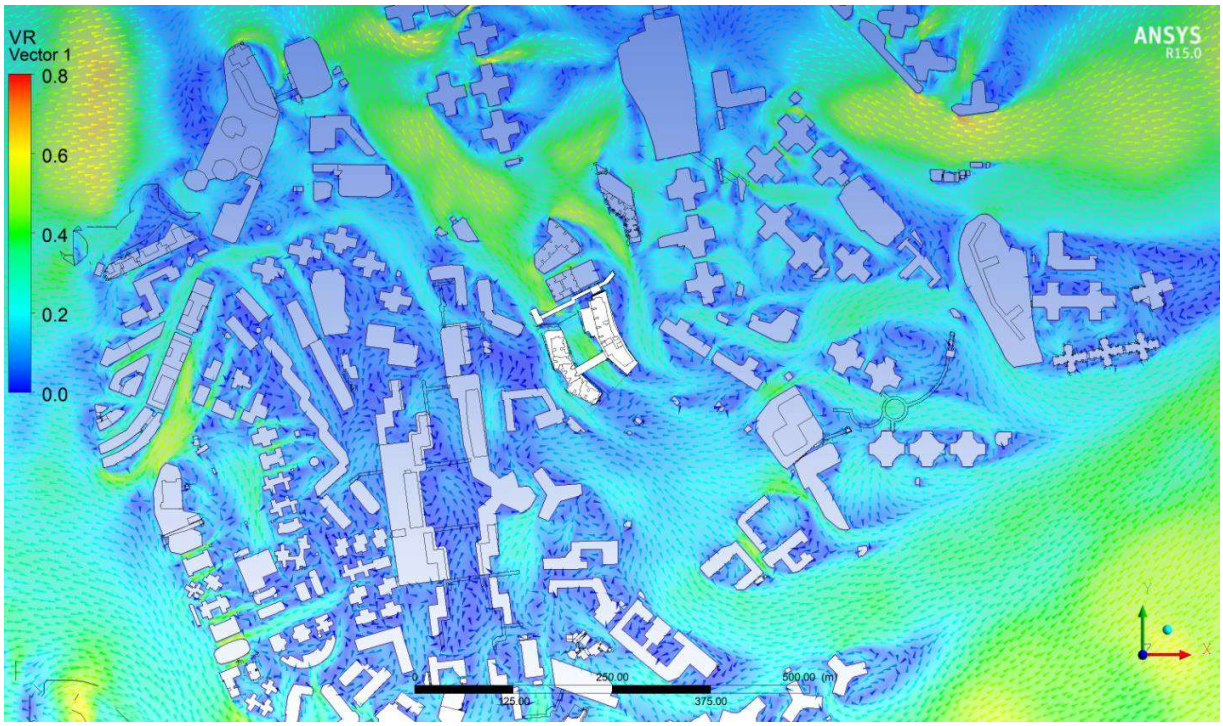
SSE Proposed Scheme



W Baseline Scheme



W Proposed Scheme