Report on

Air Ventilation Assessment

Proposed Amendment to the Approved Wan Chai Outline Zoning Plan No. S/H5/31 from "Comprehensive Development Area", "Residential (Group C)", "Open Space" and "Government, Institution or Community" zones and Area shown as "Road" to "Other Specified Uses (Residential Development with Historic Building Conserved" and "Other Specified Uses (Elevated Walkway)" at Nos. 1, 1A, 2 and 3 Hill Side Terrace, No. 55 Ship Street (a.k.a. Nam Koo Terrace), Nos. 1 - 5 Schooner Street, No. 53 Ship Street, No. 18 Sau Wa Fong Inland Lot No. 9048 and adjoining Government Land, Wan Chai

By

WSP (Asia) Limited

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Not in Use

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Executive Summary

WSP (Asia) Limited ("WSP") has been instructed to prepare this Air Ventilation Assessment ("AVA") in support of the Section 12A Planning Application (“S12A”)/ Rezoning Request (“RR”) to amend the Approved Wan Chai Outline Zoning Plan No. S/H5/31 (the “Approved OZP”) at Nos. 1, 1A, 2 and 3 Hill Side Terrace (“HST”), No. 55 Ship Street [a.k.a Nam Koo Terrace (“NKT”)], Nos. 1 - 5 Schooner Street, No. 53 Ship Street, No. 18 Sau Wa Fong, Inland Lot No. 9048 (“IL 9048”) and adjoining Government Land, Wan Chai (the “Site”/ “Rezoning Site”).

The Rezoning Site is currently zoned “Comprehensive Development Area” (“CDA”) and “Residential (Group C)” (“R(C)”) and minor encroachment into the “Open Space” (“O”) and “Government, Institution or Community” (“G/IC”) and falls into area shown as ‘Road’ on the Approved OZP gazetted on 12 May 2023. The Applicant proposed to rezone the Site to “Other Specified Uses (Residential Development with Historical Building Conserved)” (“OU(RDHBC)”) and “Other Specified Uses (Elevated Walkway)” (“OU(EW)”) zone to facilitate a Comprehensive Residential Development with supporting commercial uses and conservation of the NKT in-situ. The RR also seeks to relax the plot ratio (“PR”) restriction to the level permitted under Building (Planning) Regulations (“B(P)R”) and building height (“BH”) restriction to 120mPD correspondingly. An Indicative Development Scheme (“IDS”) is put forth to demonstrate the development intention and the feasibility of the Proposed “OU(RDHBC)” zone. Figure A below shows the location of the Rezoning Site with a site area of approx. 3,140.7m^2.

① Hill Side Terrace (HST)
② Nam Koo Terrace (NKT)
③ Former Miu Kang Terrace (MKT)
④ I.L. 9048 (Schooner Street)
⑤ Steps (Rt of way to HST)
⑥ West Slopes (Gov’t)
⑦ South Slopes (Gov’t)
⑧ I.L. 199 RP (Sau Wa Fong)
⑨ Proposed Barrier Free Access (BFA)

Figure A. Rezoning Site Location

The objective of this Air Ventilation Assessment (AVA) Report is to study the pedestrian level natural ventilation around the Rezoning Site. The Baseline Scheme and Indicative Development Scheme have been analyzed in detail for comparison.

The Baseline Scheme (Figure B refers) is a S16 Approved Scheme which comprises of a 17-storey residential block above an open space open to public and a 3-storey podium (details refer to Appendix B). In the Baseline Scheme, the podium of Nam Koo Terrace and Hillside Terrace at approx. +34.0mPD will be extended to the northeastern side of the Site and will be used as open space, i.e. a three-level podium up to +34.0mPD for open space will be built within the existing lot boundary of Former Miu Kang Terrace. In addition, a 17-storey residential block of +91.0mPD which covers approx. 689.0m^2 open space will be constructed to the west of Nam Koo Terrace. A ~5m high void above podium level will be provided to improve the air permeability at lower portions of the proposed development. On the other hand, a podium at +34.0mPD occupying the space of both I.L.9048 and the steps in front of the Hillside Terrace (along Schooner Street) will be built. Under the podium level (new elevated platform), a setback will also be provided along Schooner Street which aims to provide a wider wind channel at the pedestrian level of Schooner Street. The existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP remains unchanged. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ. Overall, the total area of open space and covered open space is approx. 2,669.0m^2. The proposed Plot Ratio is approx. 5.136 with the GFA provided of approx. 14,528.0m^2.

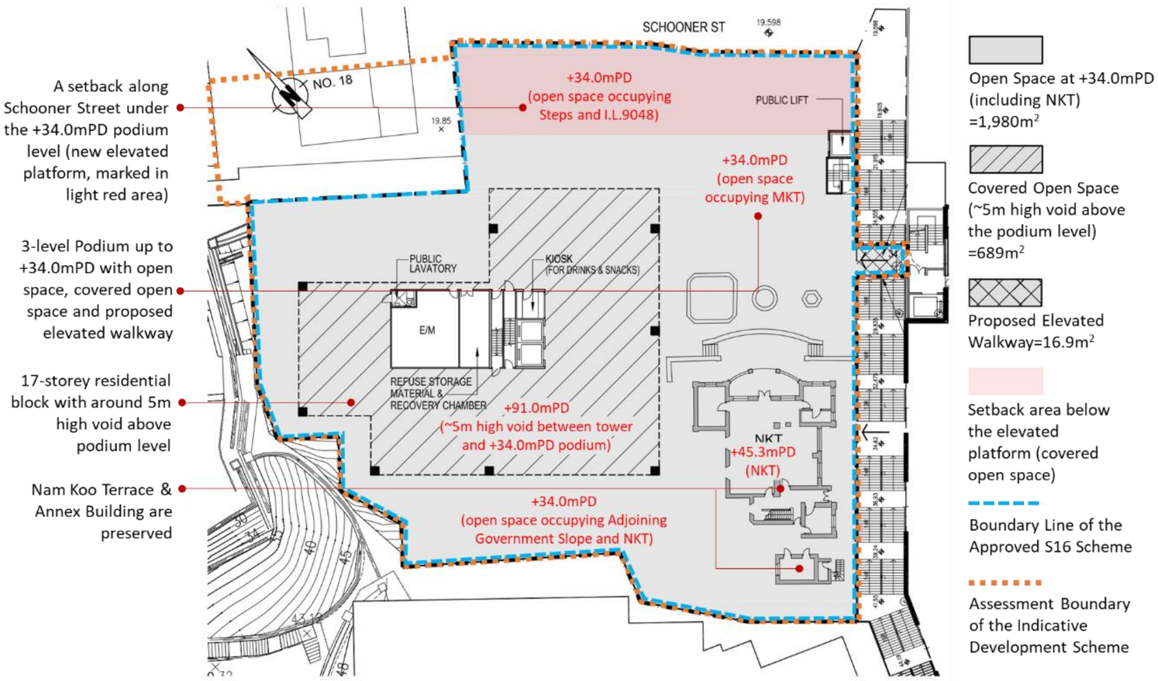


Figure B. Baseline Scheme Plan

Figure C shows the Indicative Development Scheme comprises of a 24-storey residential and commercial building over an Open Space open to public and three (3) podium levels with new design features (details refer to Appendix C). Similar to the design feature in the Baseline Scheme, a three-level podium up to +33.6mPD for open space will be built. In addition, a 24-storey residential block of +119.6mPD high which covers approx. 1,285.7m^2 covered open space will be constructed on the west of Nam Koo Terrace and on top of the podium with a ~6m high void and open space above podium level.

To further enhance air permeability and ventilation environment in downstream area, the existing 6-storey residential building (No.18 Sau Wa Fong) will be demolished and developed into an at-grade open space. Moreover, a ground floor setback of approx. 3m will be provided to widen Schooner Street so as to accommodate a wider wind channel at pedestrian level of Schooner Street. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ, while its Annex Building to the south will be removed. Overall, the Indicative Development Scheme yields a total GFA of approx. 28,884.9m^2 with a total Plot Ratio of approx. 9.197. A total of approx. 3,179.9m^2 of open space open to public will be provided.

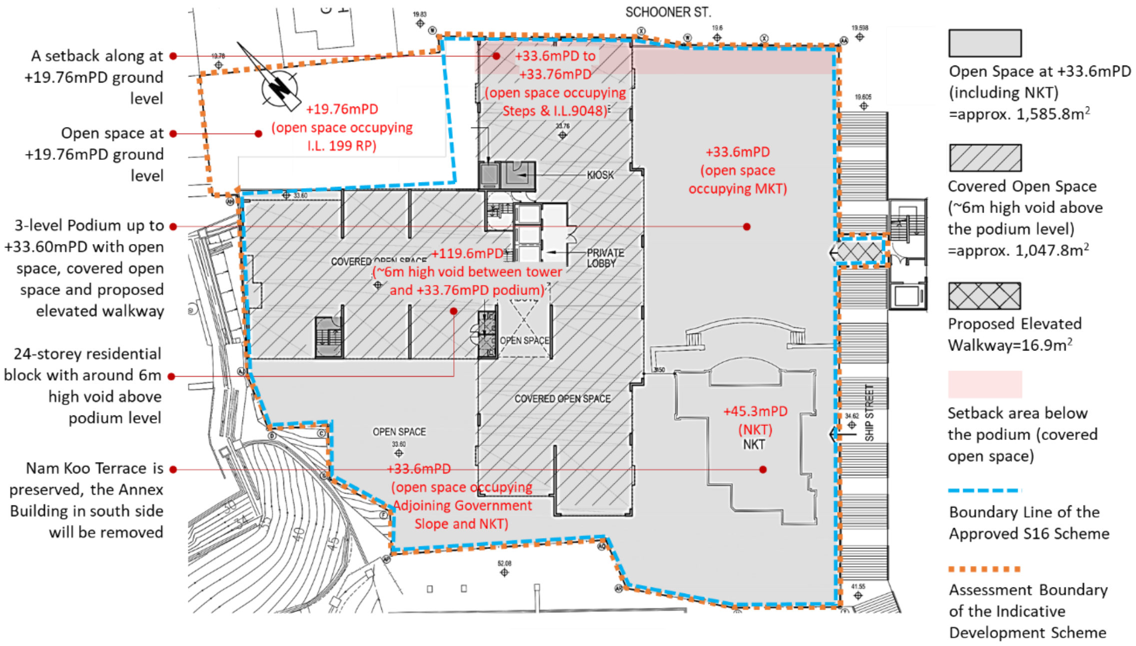


Figure C. Indicative Development Scheme Plan

To ensure a better natural ventilation around the Rezoning Site, detailed 3D Computational Fluid Dynamic (CFD) simulations have been conducted for comparing the Baseline Scheme and the Indicative Development Scheme. With the considerations of both annual and summer (June to August) prevailing wind directions in Wan Chai, and following the methodology outlined in "Technical Guide for Air Ventilation Assessment for Developments in Hong Kong" in Technical Circular No.1/06 by Housing, Planning and Lands Bureau and Environment, Transport and Work Bureau, the pedestrian level wind environment around the Rezoning Site is analyzed and compared in detail.

The coverage of the Rezoning Site is relatively small when compared to the Assessment Area coverage, which is defined based on the height of the tallest building around, i.e. Hopewell Centre (HC) (~200m high), and the distance between the main roads and the Site. When comparing the two schemes, the Baseline Scheme has adopted a design concept to build a podium at +34.0mPD along Schooner Street, whereas the Indicative Development Scheme maintains a podium of similar height at +33.6mPD, together with the increased provision of open space by the amalgamation of No. 18 Sau Wa Fong and the demolishment of the existing building there to further increasing air permeability and ventilation environment in downstream area.

Based on the 3D CFD simulation findings on the weighted velocity ratio (VR) contours for both annual and summer prevailing wind directions, it is noted that there are no stagnant zones on the pedestrian level along the three main roads, i.e. Kennedy Road, Queen's Road East and Johnston Road for both Baseline Scheme and Indicative Development Scheme. Moreover, the variations of weighted VR of these main roads are of a very small range with respect to the two schemes.

For quantitative comparison, the Site Velocity Ratio (SVR) and Local Velocity Ratio (LVR) for each scheme under both annual and summer prevailing wind directions are summarized as follows:

Scheme	Annual		Summer	
	Baseline	Indicative Development	Baseline	Indicative Development
SVR	0.04	0.05	0.06	0.07
LVR	0.08	0.08	0.08	0.08

More detailed comparisons of weighted VR on each location for each scheme under both annual and summer prevailing winds are outlined as follows:

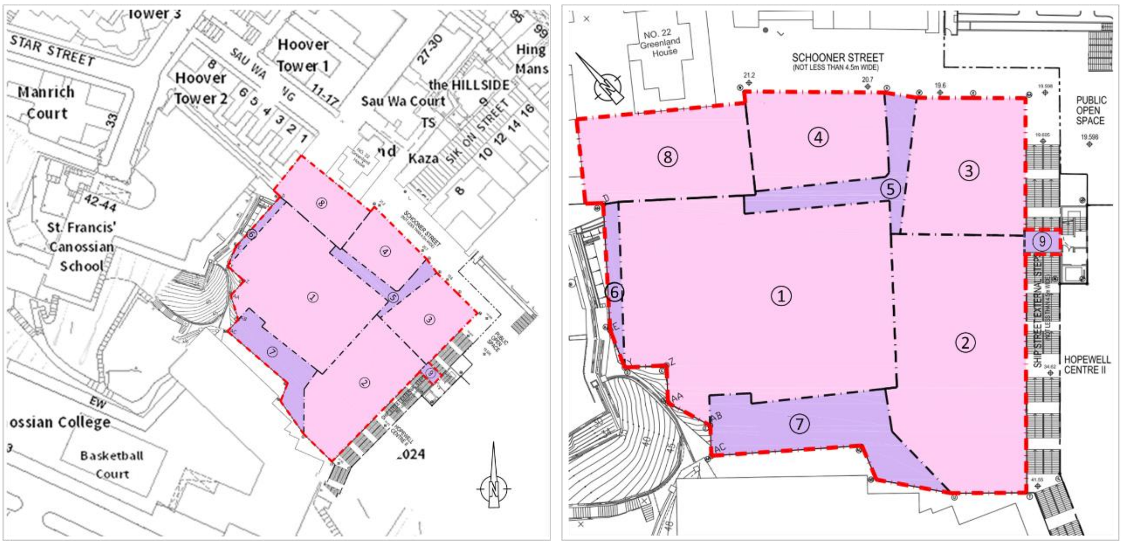
No.	Location Name	Annual		Summer	
		Baseline	Indicative Development	Baseline	Indicative Development
1	Hennessey Road	0.22	0.22	0.16	0.16
2	Johnston Road	0.11	0.11	0.09	0.09
3	Thomson Road Johnston Road Junction	0.11	0.11	0.07	0.07
4	Anton Street	0.12	0.12	0.09	0.09
5	Landale Street	0.07	0.07	0.07	0.07
6	Li Chit Street	0.04	0.04	0.04	0.04
7	Gresson Street	0.07	0.07	0.04	0.04
8	Lun Fat Street	0.05	0.05	0.04	0.03
9	Ship Street (North of QRE)	0.09	0.09	0.05	0.05
10	Tai Wong Street West	0.08	0.07	0.05	0.05
11	Tai Wong Street East	0.06	0.06	0.05	0.04
12	Swatow Street	0.06	0.06	0.04	0.05

No.	Location Name	Annual		Summer	
		Baseline	Indicative Development	Baseline	Indicative Development
13	Amoy Street	0.05	0.05	0.06	0.06
14	St. Francis' Canossian School	0.02	0.02	0.03	0.03
15	Queen's Road East (QRE)	0.12	0.13	0.12	0.12
16	Wing Fung Street	0.07	0.07	0.09	0.09
17	Sun Street & Moon Street	0.04	0.04	0.05	0.06
18	St. Francis Yard	0.02	0.02	0.03	0.02
19	Star Street	0.05	0.05	0.08	0.08
20	St. Francis Street	0.03	0.03	0.04	0.04
21	Sau Wa Fong	0.03	0.04	0.04	0.04
22	Schooner Street	0.02	0.03	0.02	0.03
23	Sik On Street	0.02	0.03	0.03	0.04
24	Ship Street (South of QRE)	0.03	0.03	0.03	0.03
25	Ship Street Garden	0.03	0.03	0.03	0.03
26	Kennedy Road	0.10	0.10	0.13	0.13
27	Monmouth Terrace	0.07	0.06	0.08	0.08
28	Back Lane on N Side of HC II Podium	0.05	0.05	0.07	0.07
29	Bowen Road	0.20	0.20	0.23	0.23
30	St. Francis Canossian College	0.02	0.02	0.04	0.04
31	Lee Tung Avenue	0.07	0.07	0.06	0.06
32	Electric Street	0.05	0.05	0.08	0.08
33	Bowen Road Temporary Sitting-out Area	0.12	0.12	0.18	0.18
34	Monmouth Terrace Playground	0.03	0.03	0.05	0.06
35	Kwong Ming Street Children's Playground	0.02	0.02	0.04	0.04
36	Site Perimeter (SVR)	0.04	0.05	0.06	0.07
37	Special Test Points	0.05	0.05	0.06	0.07

1. Introduction

WSP (Asia) Limited ("WSP") has been instructed to prepare this Air Ventilation Assessment ("AVA") in support of the Section 12A Planning Application ("S12A")/ Rezoning Request ("RR") to amend the Approved Wan Chai Outline Zoning Plan No. S/H5/31 (the "Approved OZP") at Nos. 1, 1A, 2 and 3 Hill Side Terrace ("HST"), No. 55 Ship Street [a.k.a Nam Koo Terrace ("NKT")], Nos. 1 - 5 Schooner Street, No. 53 Ship Street, No. 18 Sau Wa Fong, Inland Lot No. 9048 ("IL 9048") and adjoining Government Land, Wan Chai (the "Site"/ "Rezoning Site").

The Rezoning Site is currently zoned "Comprehensive Development Area" ("CDA") and "Residential (Group C)" ("R(C)") and minor encroachment into the "Open Space" ("O") and "Government, Institution or Community" ("G/IC") and falls into area shown as 'Road' on the Approved OZP gazetted on 12 May 2023. The Applicant proposed to rezone the Site to "Other Specified Uses (Residential Development with Historical Building Conserved)" ("OU(RDHBC)") and "Other Specified Uses (Elevated Walkway)" ("OU(EW)") zone to facilitate a Comprehensive Residential Development with supporting commercial uses and conservation of the NKT in-situ. The RR also seeks to relax the plot ratio ("PR") restriction to the level permitted under Building (Planning) Regulations ("B(P)R") and building height ("BH") restriction to 120mPD correspondingly. An Indicative Development Scheme ("IDS") is put forth to demonstrate the development intention and the feasibility of the Proposed "OU(RDHBC)" zone. Figure 1.1 shows the location of the Rezoning Site. The Rezoning Site, with a total site area of approx. 3,140.7m^2, is located at southwestern part of Wan Chai. It is bounded by Schooner Street and Greenland House to the north, Ship Street to the east, St. Francis' Canossian College to the south and St. Francis' Canossian School to the west. The Indicative Development Scheme consists of a 24-storey residential tower of 119.6mPD over three (3) podium levels. The historical building at Nam Koo Terrace is preserved in-situ, while the annex building in its south side will be removed. The total area of open space and covered open space is approx. 3,179.9m^2 and 1,285.7m^2 respectively (Appendix C refers).



① Hill Side Terrace (HST)	④ I.L. 9048 (Schooner Street)	⑦ South Slopes (Gov't)
② Nam Koo Terrace (NKT)	⑤ Steps (Rt of way to HST)	⑧ I.L. 199 RP (Sau Wa Fong)
③ Former Miu Kang Terrace (MKT)	⑥ West Slopes (Gov't)	⑨ Proposed Barrier Free Access (BFA)

Figure 1.1 Rezoning Site Location

Wan Chai is a highly congested urban area where many buildings are packed closely to each other. The residential building form might influence the pedestrian wind environment to its surrounding areas. As such, detailed Air Ventilation Assessment (AVA) by using three-dimensional (3D) Computational Fluid Dynamics (CFD) analysis has been conducted to study the effects of surrounding pedestrian wind environment caused by the development.

The objective of this AVA Report is to study the pedestrian level natural ventilation around the Rezoning Site. Baseline Scheme and Indicative Development Scheme have been analyzed in detail for comparison. The two schemes are outlined as follows:

1.1. *Baseline Scheme*

The Baseline Scheme (Figure 1.1.1 refers) is a S16 Approved Scheme which comprises of a 17-storey residential block above an open space open to public and a 3-storey podium (details refer to Appendix B). In the Baseline Scheme, the podium of Nam Koo Terrace and Hillside Terrace at approx. +34.0mPD will be extended to the northeastern side of the Site and will be used as open space, i.e. a three-level podium up to +34.0mPD for open space will be built within the existing lot boundary of Former Miu Kang Terrace. In addition, a 17-storey residential block of +91.0mPD which covers approx. 689.0m^2 open space will be constructed to the west of Nam Koo Terrace. A ~5m high void above podium level will be provided to improve the air permeability at lower portions of the proposed development. On the other hand, a podium at +34.0mPD occupying the space of both I.L.9048 and the steps in front of the Hillside Terrace (along Schooner Street) will be built. Under the podium level (new elevated platform), a setback will also be provided along Schooner Street which aims to provide a wider wind channel at the pedestrian level of Schooner Street. The existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP remains unchanged. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ. Overall, the total area of open space and covered open space is approx. 2,669.0m^2. The proposed Plot Ratio is approx. 5.136 with the GFA provided of approx. 14,528.0m^2. Please refer to Figure 1.1.1 and Appendix B for the Baseline Scheme.

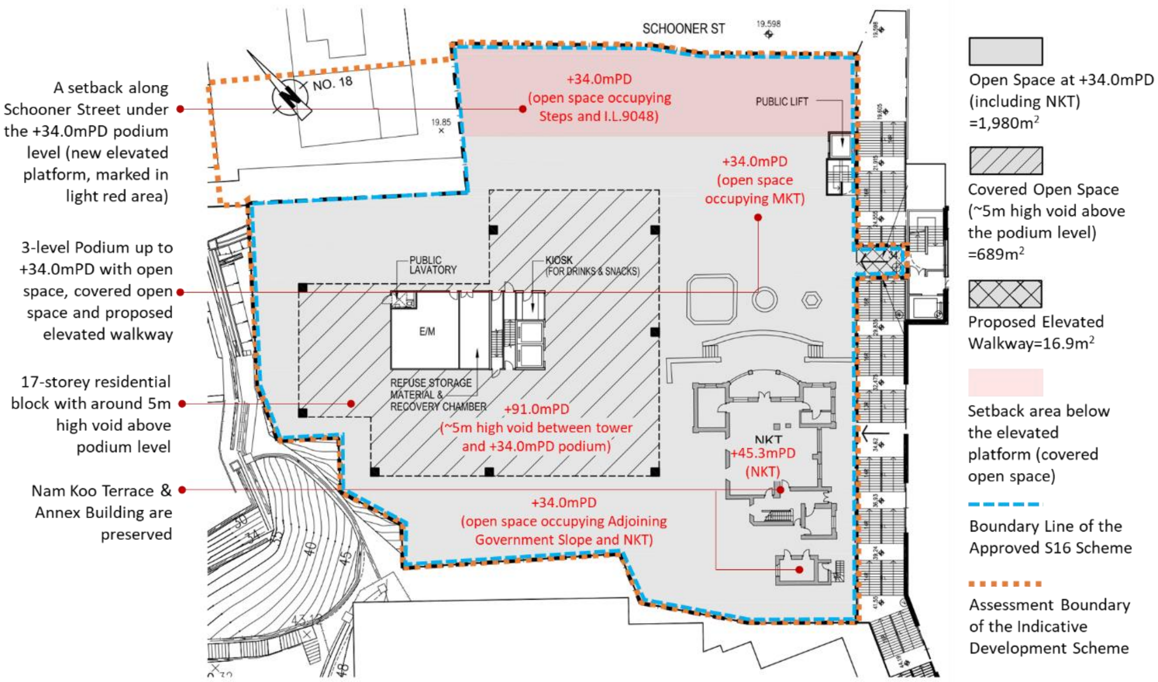


Figure 1.1.1 Baseline Scheme Plan

1.2. *Indicative Development Scheme*

The Indicative Development Scheme comprises of a 24-storey residential and commercial building over an Open Space open to public and three (3) podium levels with new design features (details refer to Appendix C). Similar to the design feature in the Baseline Scheme, a three-level podium up to +33.6mPD for open space will be built. In addition, a 24-storey residential block of +119.6mPD high which covers approx. 1,285.7m^2 covered open space will be constructed on the west of Nam Koo Terrace and on top of the podium with a ~6m high void and open space above podium level. To further enhance air permeability and ventilation environment in downstream area, the existing 6-storey residential building (No.18 Sau Wa Fong) will be demolished and developed into an at-grade open space. Moreover, a ground floor setback of approx. 3m will be provided to widen Schooner Street so as to accommodate a wider wind channel at pedestrian level of Schooner Street. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ, while its Annex Building to the south will be removed. Overall, the Indicative Development Scheme yields a total GFA of approx. 28,884.9m^2 with a total Plot Ratio of approx. 9.197. A total of approx. 3,179.9m^2 of open space open to public will be provided. Please refer to Figure 1.2.1 and Appendix C for the Indicative Development Scheme.

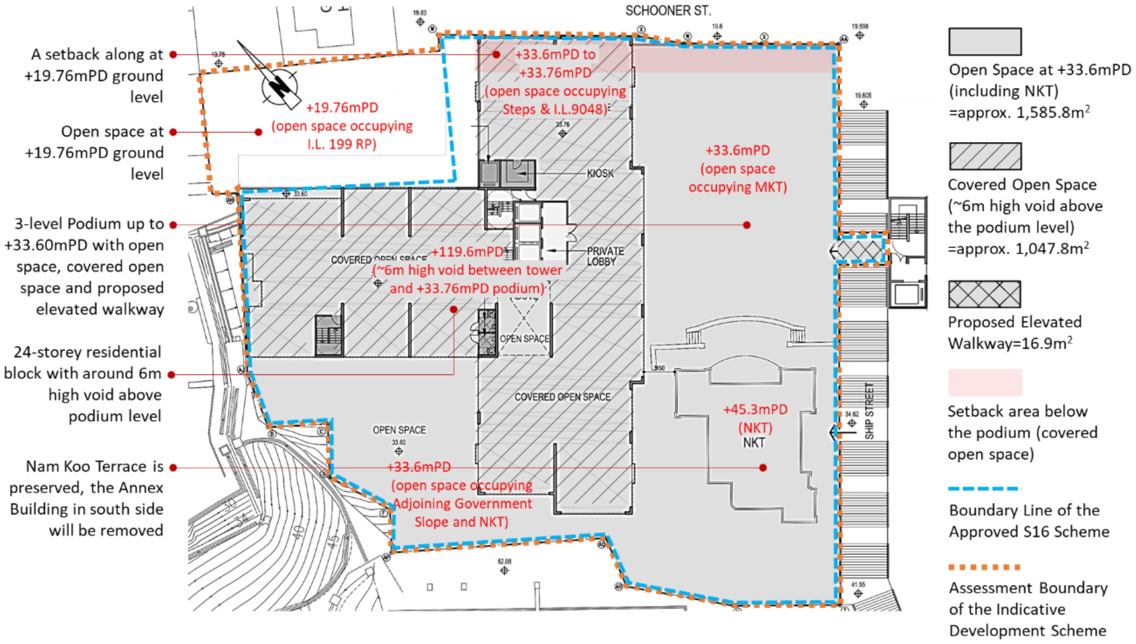


Figure 1.2.1 Indicative Development Scheme Plan

The objective of this study is to compare the Air Ventilation Assessment (AVA) based on the occurrence of wind in different directions, which should not be less than 75% of the time in a typical reference year in Wan Chai, Hong Kong. Both annual wind rose, and summer wind rose (June to August) were adopted in this AVA and supported by 3D Computational Fluid Dynamic (CFD) simulation techniques.

This report consists of the following sections:

- Site wind availability assessment in Wan Chai;
- Details of the analytical approach used in the AVA;
- Definition of pedestrian level test points for performance comparison;
- Findings on 3D CFD simulation for wind environment at pedestrian level for two development design schemes, namely Baseline Scheme and Indicative Development Scheme;
- Conclusions and recommendations.

The requirements of the methodology for carrying out AVA stated in the “Technical Guide for Air Ventilation Assessment for Developments in Hong Kong (Technical Circular No.1/06 and Annex A)” issued by Housing, Planning and Lands Bureau and Environment, Transport and Work Bureau, (the “Technical Guide” hereafter) are followed while taking due considerations on the current best CFD simulation practices in conducting this CFD analysis.

2. Surrounding Building Environment

The Rezoning Site is in the southwestern side of Queen's Road East, Wan Chai area of Hong Kong Island. As shown in Figure 2.1, the Rezoning Site is situated on the northern side of the Mount Cameron and is adjacent to Hopewell Centre which is approximately 200m high on the east side.

Based on the site inspection and desktop analysis, the major built feature around the site includes a mix of low-to-high-rise developments. Excluding the south side of the site, i.e., on the north side of Kennedy Road, the buildings are mostly placed closely to each other with a large variation in building heights. In addition, the building separation is small within the Assessment Area between Queen's Road East and Johnston Road. Furthermore, some of the building blocks in the north side of Queen's Road East are constructed alongside each other, covering an overall length of over 50m with a north to south orientation in general. After close inspection, it should be taken into consideration that there are still numerous low-to-high-rise developments in the further north side of the site. The digital elevation plan of the existing and proposed buildings within the surrounding area of the site is also provided in Figure 2.2 for reference.

The major road network with Bowen Road, Kennedy Road, Queen's Road East, Johnston Road and Hennessy Road are generally located around the Rezoning Site.

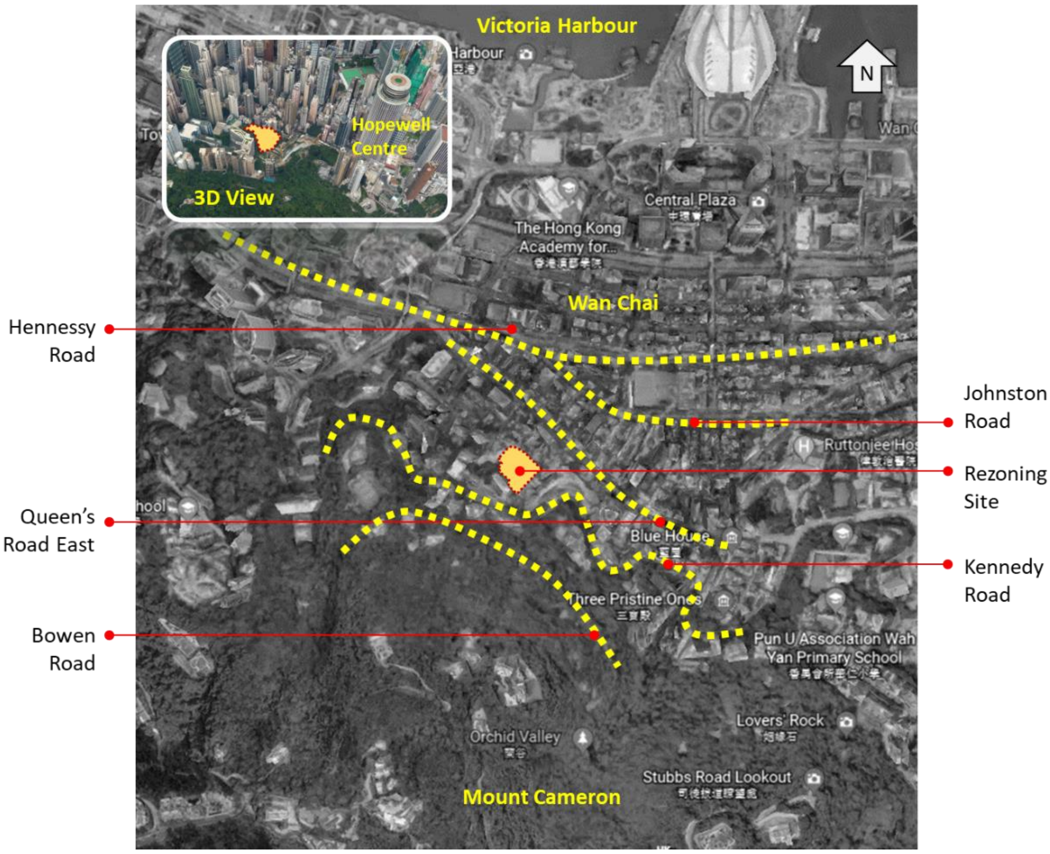


Figure 2.1 Surrounding Topography of the Site (Image Source: Google Earth)

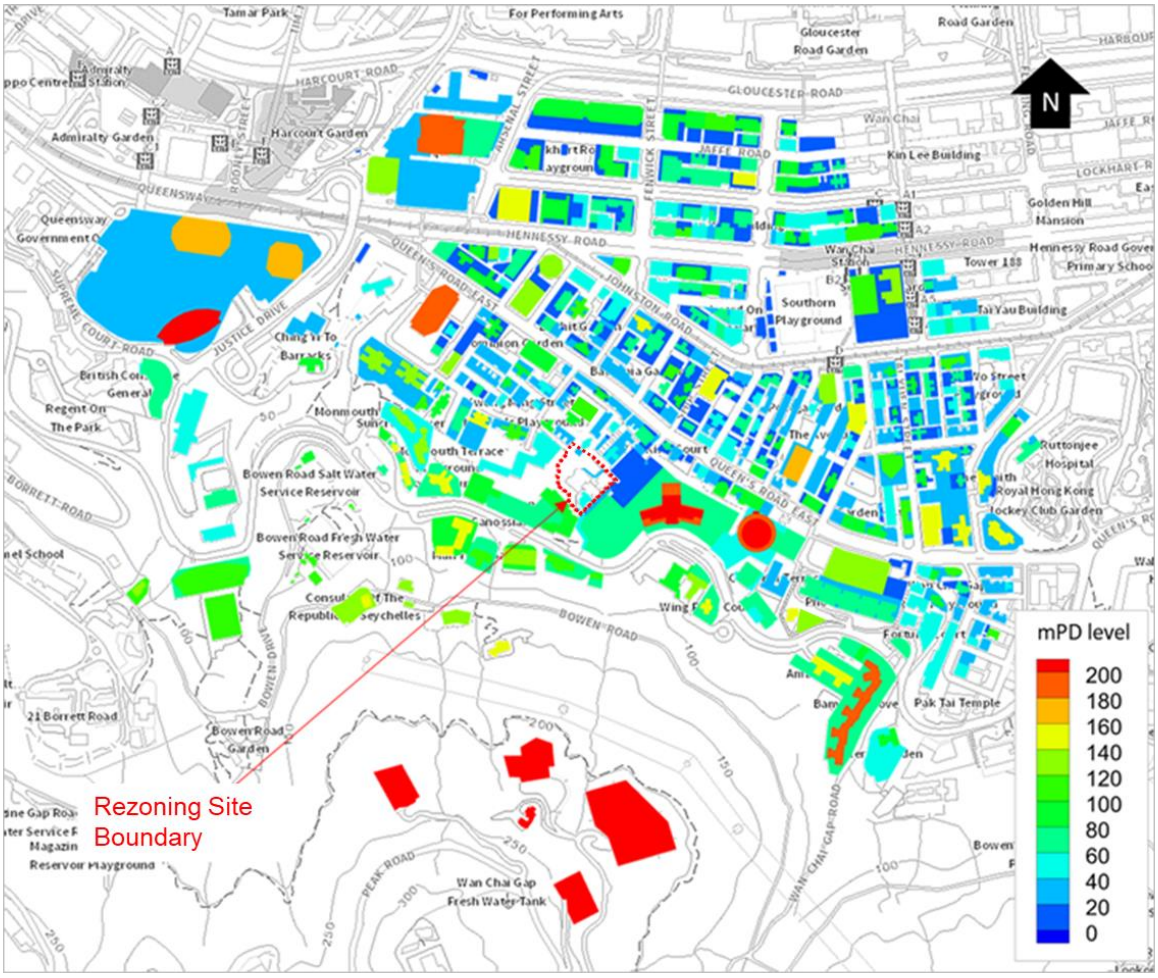


Figure 2.2 Building Height Plan around the Rezoning Site in mPD Levels

3. Site Wind Availability

3.1. *Wind Environment*

To assess the air ventilation at pedestrian level inside an urban area, the long-term characteristics of the approaching wind would need to be known in advance. For instance, the occurrence, i.e. the frequency, of a typical wind direction is the key parameter for the subsequent assessment. This is called Site Wind Availability, and the information is essential for the performance comparison of different building forms in the site.

To obtain the site wind availability in Wan Chai, several widely accepted methods will be adopted, namely mathematical models, reduced scale wind tunnel test and CFD simulations. In accordance with the AVA Technical Guide, all these methods are considered acceptable.

A study on simulated site wind availability data for Air Ventilation Assessment in Hong Kong was conducted by the City University Hong Kong and published on Planning Department's website for the public use in middle of 2015. In this Report, a meso-scale numerical model Regional Atmospheric Modelling System (RAMS) was used to simulate the site wind data including wind rose and wind profile. Based on the Site Wind Availability Data available on the PlanD's website, the Rezoning Site is located within grid X: 79 Y: 33 as shown in Figure 3.1.1 below:

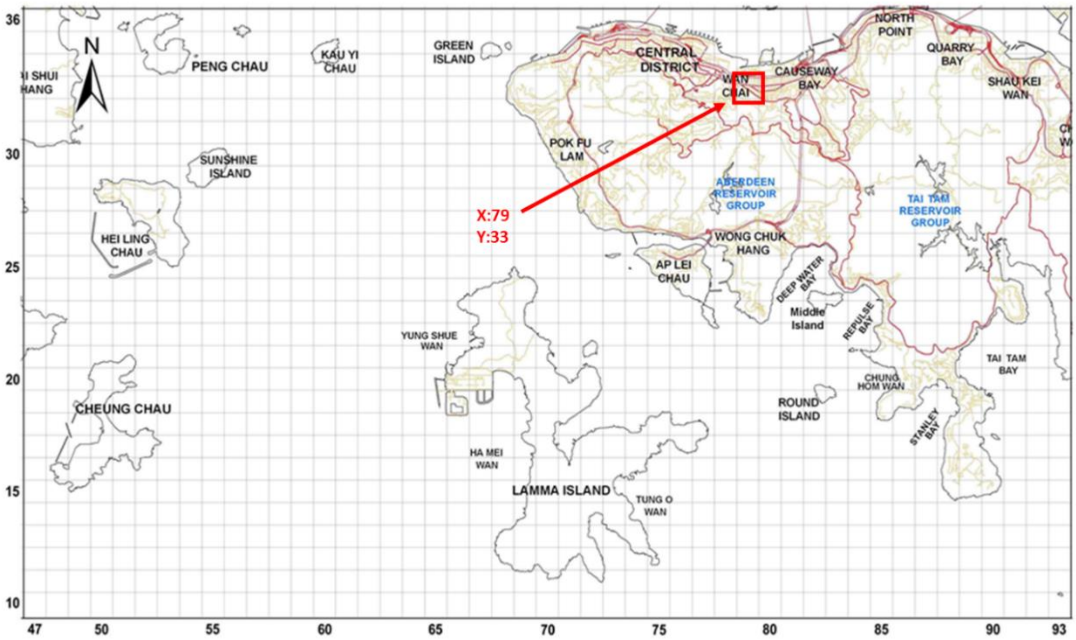


Figure 3.1.1 Site Wind Availability Data Points for Indicative Development Scheme at the Site in Wan Chai Area

The detailed site wind availability data can be found as follows:

http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/079033.html

3.2. *Wind Rose*

The wind roses for annual and summer (June to August) prevailing wind directions of a typical year are adopted as the site wind availability for this Project. Figures 3.2.1 and 3.2.2 are the wind roses for annual and summer non-typhoon winds on the Rezoning Site (corrected to 500m above ground).

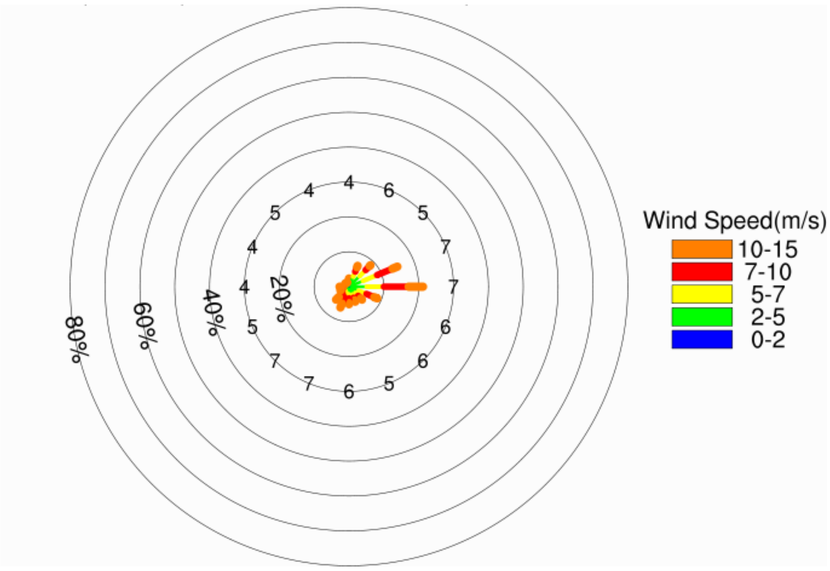


Figure 3.2.1 Annual Wind Rose for Rezoning Site (corrected to 500m)

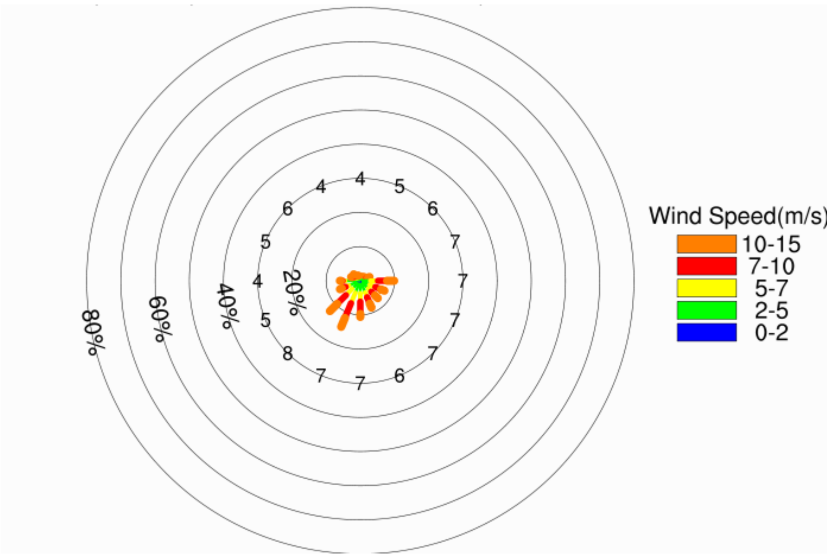


Figure 3.2.2 Summer Wind Rose for Rezoning Site (corrected to 500m)

In accordance with the requirements in the AVA Technical Guide, the reduced set of wind directions exceeding 75% of occurrence should be considered. Table 3.2.1 summarizes wind directions used in the 3D CFD simulations based on wind rose for annual and summer non-typhoon winds. The annual prevailing winds for the Rezoning Site are of 8 directions, i.e. north-north-east (NNE), north-east (NE), east-north-east (ENE), east (E), east-south-east (ESE), south-east (SE), south-south-west (SSW) and south-west (SW) which covers 78.2% of the occurrence. While, there are 8 prevailing wind directions, i.e. east (E), east-south-east (ESE), south-east (SE), south-south-east (SSE), south (S), south-south-west (SSW), south-west (SW) and west-south-west (WSW) covering 79.2% of the summer occurrence. In total, there are 11 prevailing wind directions tested in this Report, from NNE to WSW to cover all the reduced sets of wind directions mentioned above.

Table 3.2.1. Wind Directions for CFD Simulations based on Annual & Summer Wind Rose

Wind Direction	% of Annual Occurrence	% of Summer Occurrence
0° (N)	2.4	1.1
22.5° (NNE)	**6.5**	1.3
45° (NE)	**8.8**	1.6
67.5° (ENE)	**15.3**	3.2
90° (E)	**21.5**	**10.1**
112.5° (ESE)	**8.8**	**7.8**
135° (SE)	**5.4**	**7.5**
157.5° (SSE)	4.7	**8.6**
180° (S)	5.1	**10.9**
202.5° (SSW)	**6.5**	**14.9**
225° (SW)	**5.4**	**12.9**
247.5° (WSW)	2.7	**6.5**
270° (W)	2.7	6.0
292.5° (WNW)	1.4	2.9
315° (NW)	1.4	2.7
337.5° (NNW)	1.3	1.7
Reduced Set	**78.2**	**79.2**

3.3. *Wind Profile*

Under normal weather condition, wind speed varies very low near the ground due to the blockage, such as buildings, plants, etc., and gradually increases with the height. This is called atmospheric boundary layer. This wind speed variation is also called wind profile and it is one of the important boundary conditions to be used in the subsequent 3D CFD analysis. In this report, the wind profiles calculated from RAMS model from the same Planning Department website is adopted. The RAMS wind profile data for the Rezoning Site (Grid X: 79 Y: 33) are shown in Figure 3.3.1 and Table 3.3.1 which indicates the wind profile data in different directions.

Table 3.3.1 Wind Profile Data in Different Directions

Height (m)	Wind Speed (m/s)			
	22.5° - 112.4°	112.5° - 202.4°	202.5° - 292.4°	292.5° - 22.4°
20	3.75	1.88	2.07	2.72
40	3.89	2.01	2.12	2.80
60	4.04	2.10	2.17	2.82
80	4.09	2.12	2.20	2.81
100	4.00	2.13	2.21	2.72
120	3.98	2.15	2.17	2.64
140	4.12	2.20	2.19	2.60
160	4.27	2.35	2.23	2.61
180	4.36	2.49	2.38	2.63
200	4.48	2.53	2.49	2.65
250	4.75	3.34	2.71	2.66
300	5.11	3.87	3.28	2.68
350	5.72	4.36	3.66	2.99
400	6.03	4.75	3.96	3.24
450	6.54	5.02	4.28	3.51
500	6.72	5.47	4.51	3.74

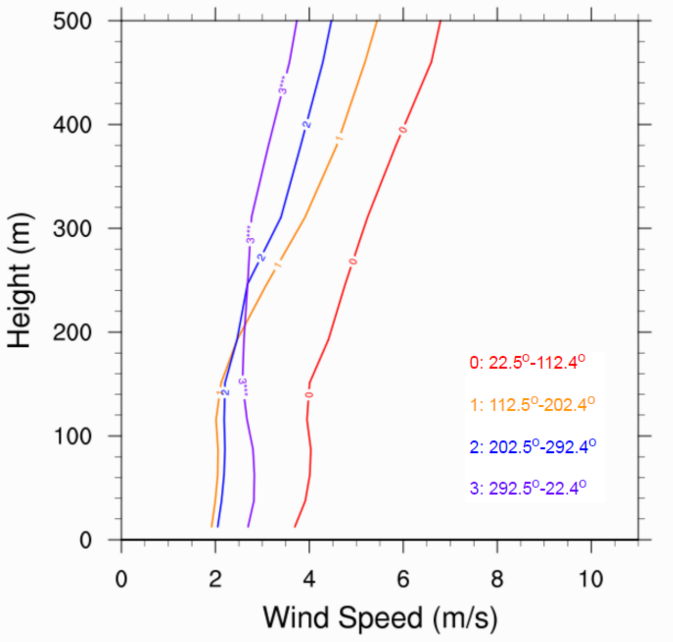


Figure 3.3.1 Simulated Wind Profile for Wanchai Region (Grid X: 79, Y: 33)

The RAMS wind profile data is from 20m to 500m. For the near ground wind profile, i.e. from ground to 20m, the Log-law profile is proposed due to the urban terrain in Wan Chai. The parameters used in the definition of the wind profile depend on site conditions, i.e. urban built-up areas.

The proposed Log-law profile is as follows:

$$V(z) = \mathrm{k}_T LN\left[\frac{z}{z_0}\right] V_{ref}$$

Where:

$V(z)$ = mean wind velocity at height z (m/s)

V_{ref} = mean wind velocity at height z_{ref} (m/s) (i.e. 20m in this Report)

z_0 = surface roughness length z_0 (m)

k_T = roughness parameters, k_T to be calculated based on z_0, V_{ref} and z_{ref} (dimensionless)

z = height (m)

The surface roughness length z_0, usually ranges from 0.3m for rough open sea to 2m for congested urban areas covered with buildings. In this Project, z_0=2m has been adopted to represent the surface roughness of urban area in Wan Chai for the calculation of the Log-law profile parameters. While for the wind from the south, which has small numbers of buildings and covered with trees, a lower surface roughness of z_0=1m has been adopted. For the wind profile above 500m height, the velocity is assumed constant.

4. Existing Wind Environment

A thorough understanding on the Rezoning Site and its surrounding is essential for the evaluation of wind environment around the site.

Based on the surrounding building environment and site wind availability information as discussed in Sections 2 and 3, the annual prevailing wind directions of the Rezoning Site is mainly from NNE, NE, ENE, E, ESE, SE, SSW and SW wind directions (8 wind directions). During summer period, the prevailing wind directions are from E, ESE, SE, SSE, S, SSW, SW and WSW wind directions (8 wind directions).

The major road networks play the important role in maintaining air ventilation around the site region. By understanding the prevailing wind directions and studying the existing wind environment around the Rezoning Site, the major wind corridors, air paths and potential problem areas are illustrated under both annual and summer prevailing winds.

4.1. *Existing Wind Environment (ENE, E, ESE, SE, SSE)*

During the annual period, the most occurrence of prevailing wind directions are generally from ENE to E directions. Figure 4.1.1 shows the existing wind environment with respect to the prevailing ENE, E, ESE, SE and SSE wind directions.

As stated in Section 2, in north of Queen’s Road East, some of the building blocks are constructed next to each other and will have an overall length of over 50m with orientations running from north to south in general. The orientation of these building blocks and streets between them (from west to east: Gresson Street, Lun Fat Street, Ship Street, Tai Wong Street East, Swatow Street and Amoy Street) will result in a strong urban canopy effect and is not favourable for these prevailing wind directions, in particularly in ENE and E, the most frequent wind directions. As such, it is anticipated that the pedestrian level ventilation around these areas will be low due to the existing building arrangement.

There are three main roads around the Rezoning Site, i.e. Kennedy Road, Queen’s Road East and Johnston Road. Both are oriented generally from east to west, generally parallel to the prevailing wind directions (i.e. E, ESE, SE). It is anticipated that the pedestrian level natural ventilation will be good comparing to the narrow perpendicular streets between Queen’s Road East and Johnston Road discussed above.

In the south side of the Rezoning Site, Bowen Road is at around +120mPD and at a distance from the site. Along Bowen Road, there are only a few low to medium rise residential building blocks. With the consideration of wind profile, the pedestrian level ventilation along Bowen Road should be good comparing to Kennedy Road, Queen’s Road East and Johnston Road.

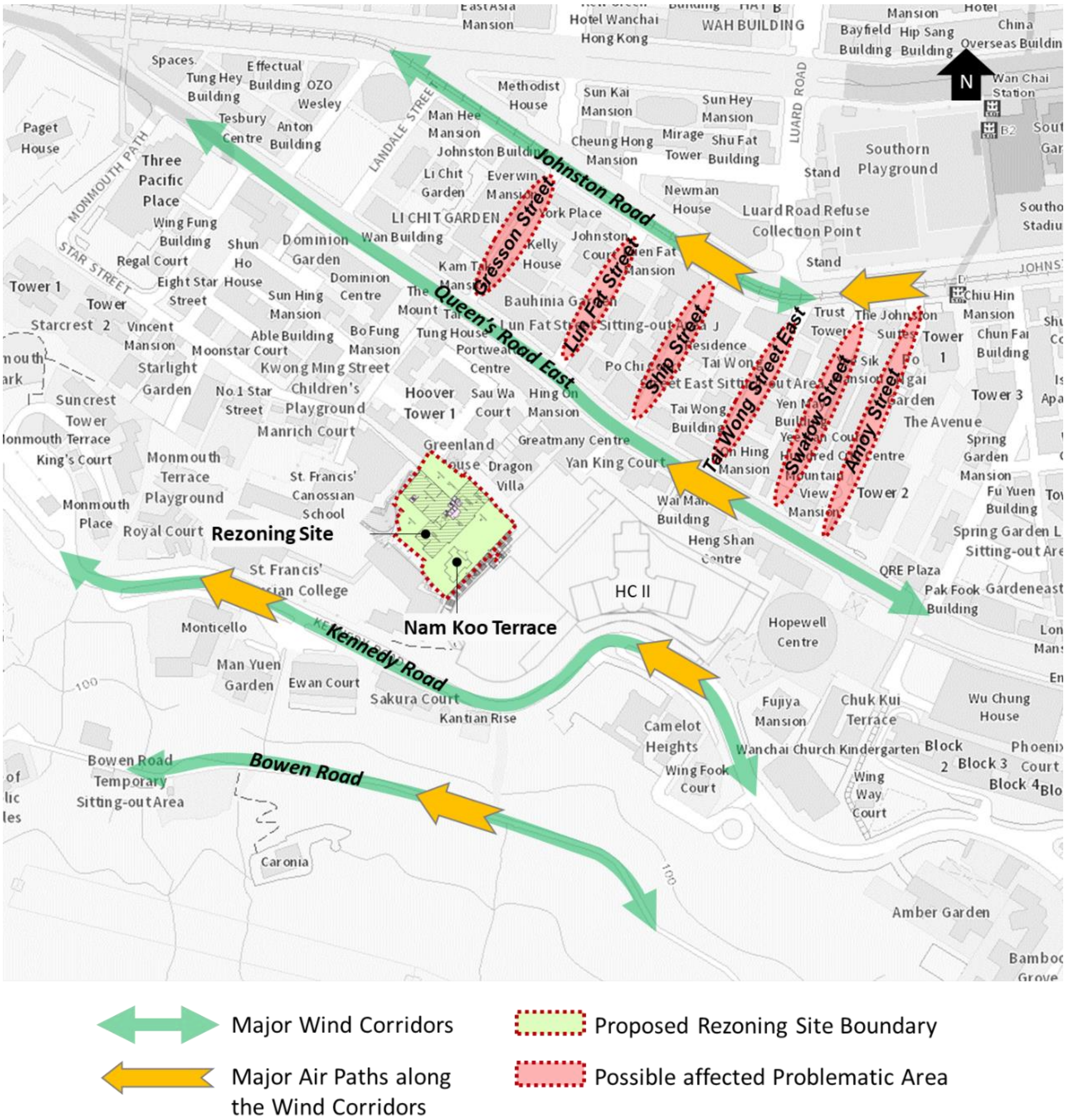


Figure 4.1.1 Existing Wind Environment in Prevailing ENE, E, ESE, SE & SSE Winds

4.2. *Existing Wind Environment (NNE, NE, S, SSW, SW, WSW)*

In summer period, the prevailing wind directions are generally from E to SSW. The most prevailing incoming wind flow is from SSW toward the congested urban area, i.e. downhill wind from hill side towards the Kennedy Road.

Figure 4.2.1 shows the existing building arrangement in this area. As the SSW wind approaches hill side from the top, most of the wind is diverted to the left and right by the existing buildings, i.e. Ewan Court with Sakura Court and Camelot Height with Wing Fook Court respectively. Some of the wind flows downhill to Kennedy Road are diverted along the 2 sides of the Kennedy Road which is considered as a ventilation corridor. Moreover, the Sakura Court and Ewan Court (which is at a higher location than the site) acts as a screen to the Rezoning Site under the SSW and SW winds.

With the low altitude and the small size of the Rezoning Site, it has a very minor influence over the wind environment under the summer scenario.

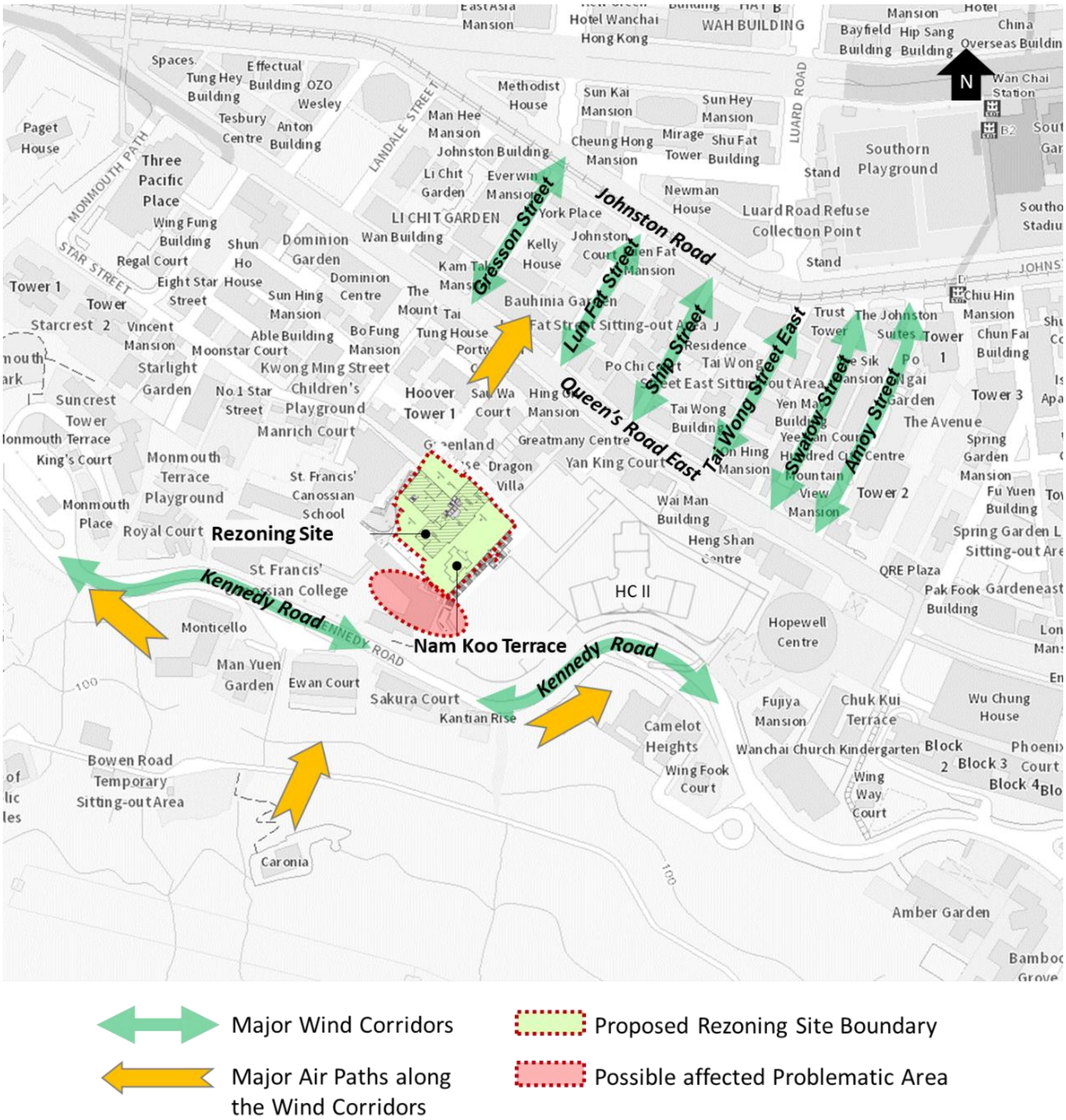


Figure 4.2.1 Existing Wind Environment in Prevailing NNE, NE, S, SSW, SW & WSW Winds

As such, it is anticipated the pedestrian level ventilation on the narrow perpendicular streets between Queen's Road East and Johnston Road (Gresson Street, Lun Fat Street, Ship Street, Tai Wong Street East, Swatow Street and Amoy Street) within the assessment area will likely be low due to the existing building configurations in this area. Comparatively, the buildings on the west side of the Rezoning Site, i.e. around St. Francis Yard and Sau Wa Fong, have a wide separation between them, and pedestrian level ventilation should be relatively better.

5. CFD Approach for AVA Study

5.1. *Assessment Areas and CFD Models*

The tallest building around this Rezoning Site is Hopewell Centre and its height is approximately 200m. As such, with the considerations of site coverage, i.e. including Project Area, Assessment Area and Surrounding Area, along with the best practice of CFD simulation analysis for environmental flow, a computational domain of over 3km wide was considered. This area coverage is considered adequate for this analysis.

Figure 5.1.1 illustrates the general arrangement of Project Area, Assessment Area and Surrounding Area for this Project as per AVA Technical Guide requirements.

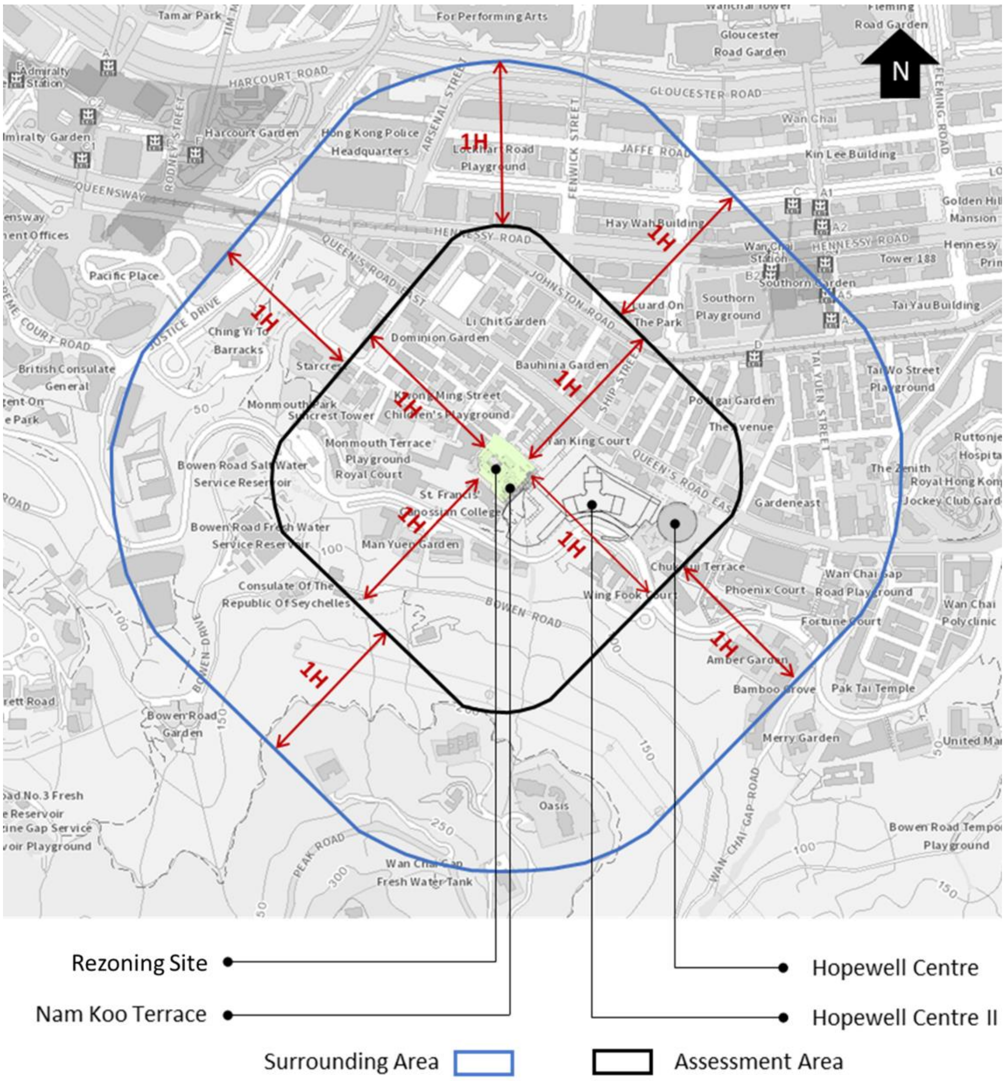


Figure 5.1.1 Coverage of Project Area, Assessment Area and Surrounding Area

Figure 5.1.2 shows the general domain configuration of the CFD analysis. The height used in the computational domain must be capable to represent the wind velocity at top of the atmospheric boundary layer, which is considered unaffected by the surface roughness, such as buildings and terrains. In this project, 2.5km has been adopted, which is more than five times the height of the hilly topography, i.e. around 400m, in the south side of the Rezoning Site.

Based on the discussion above, as well as the considerations of boundary condition settings, the computational domain is set as a cube of 2.5km height, 3.2km width and 3.2km length, respectively. The domain blockage could be kept at 3% or lower for any wind direction to reduce the influence on wind speed due to finite domain size. This computational domain has specific inlet and outlet, and with a symmetry boundary condition at the top surface, as such, mass conservation is ensured. It is a well-posed CFD setup and should result in mathematical correct numerical results.

To provide a more precise comparison regarding the pedestrian level ventilation due to the two different building forms, two different 3D models have been constructed, with the surrounding terrain and buildings remain unchanged. The information of the surrounding terrain and buildings is based on the latest open-source digital data (1:1000 3D Spatial Data) from Lands Department. This type of 3D Spatial Data is widely used in technical study and public consultation. In addition, the planned and committed developments within the Surrounding Area have been included in the 3D models (see Appendix H).

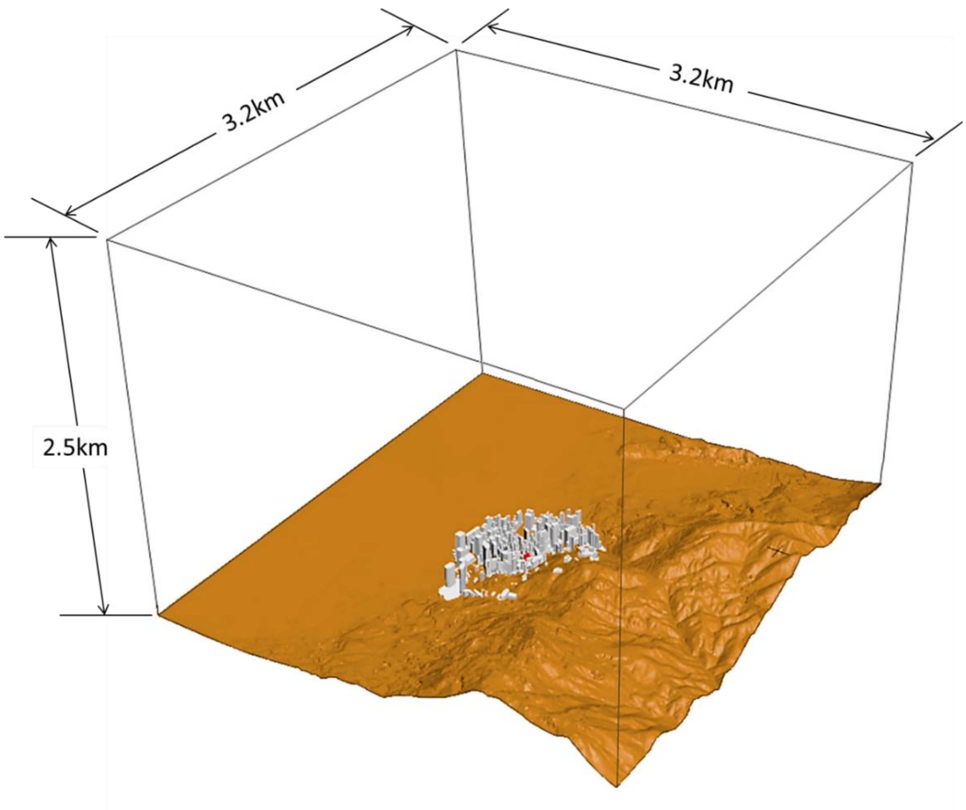


Figure 5.1.2 Computational Domain for 3D CFD Simulations (Rezoning Site in Centre)

5.1.1. Baseline Scheme

In the present AVA study, two schemes should be considered for comparison study. Sections 5.1.1 and 5.1.2 illustrate the 3D models around the Rezoning Site of Baseline Scheme and Indicative Development Scheme used for the CFD analysis. It should be noted that the only difference of the two models is the development design.

The Baseline Scheme is a S16 Approved Scheme which comprises of a 17-storey residential block above an open space open to public and a 3-storey podium. In the Baseline Scheme, the podium of Nam Koo Terrace and Hillside Terrace at approx. +34.0mPD will be extended to the northeastern side of the Site and will be used as open space, i.e. a three-level podium up to +34.0mPD for open space will be built within the existing lot boundary of Former Miu Kang Terrace. In addition, a 17-storey residential block of +91.0mPD which covers approx. 689.0m^2 open space will be constructed to the west of Nam Koo Terrace. A ~5m high void above podium level will be provided to improve the air permeability at lower portions of the proposed development. On the other hand, a podium at +34.0mPD occupying the space of both I.L.9048 and the steps in front of the Hillside Terrace (along Schooner Street) will be built. Under the podium level (new elevated platform), a setback will also be provided along Schooner Street which aims to provide a wider wind channel at the pedestrian level of Schooner Street. The existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP remains unchanged. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ. Figures 5.1.1.3 to 5.1.1.8 show the 3D CFD model of the Baseline Scheme in-cooperated with mitigation measures/good design features.

Figure 5.1.1.1 Baseline Scheme Layout Plan

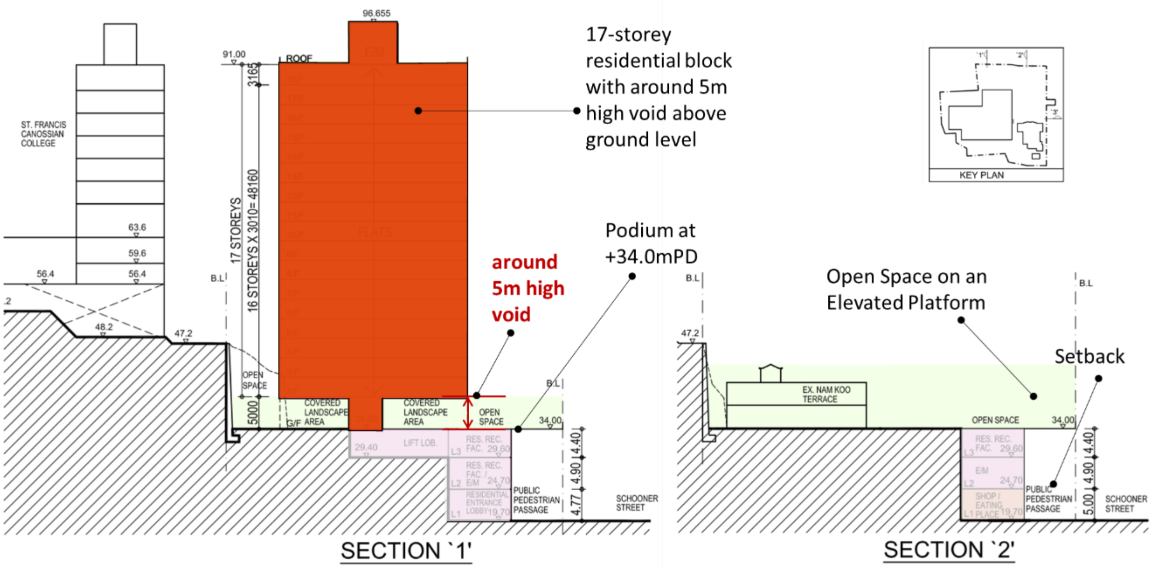


Figure 5.1.1.2 Baseline Scheme Section Plan

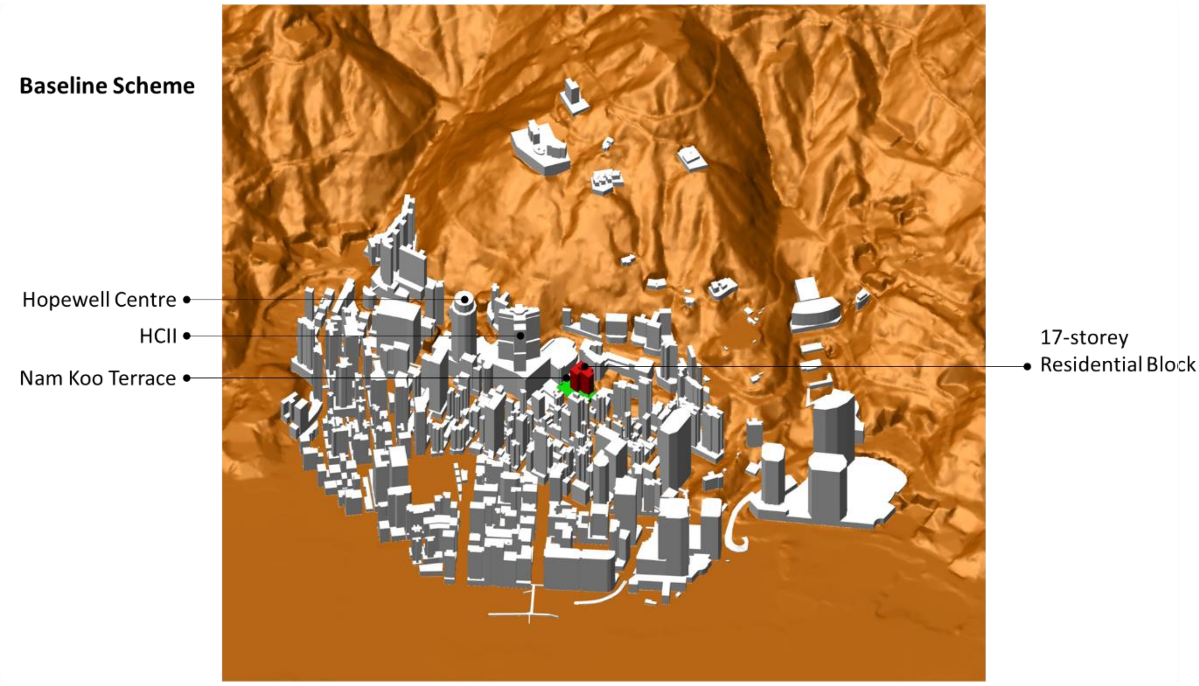


Figure 5.1.1.3 Baseline Scheme CFD Model View from North Direction

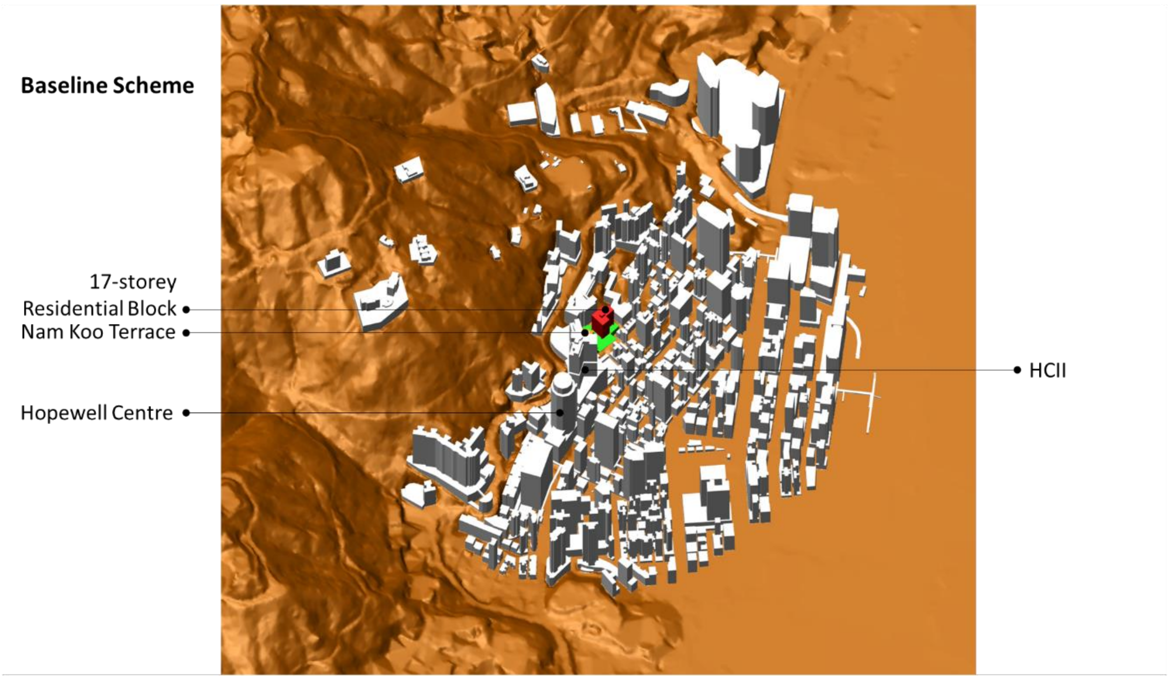


Figure 5.1.1.4 Baseline Scheme CFD Model View from East Direction

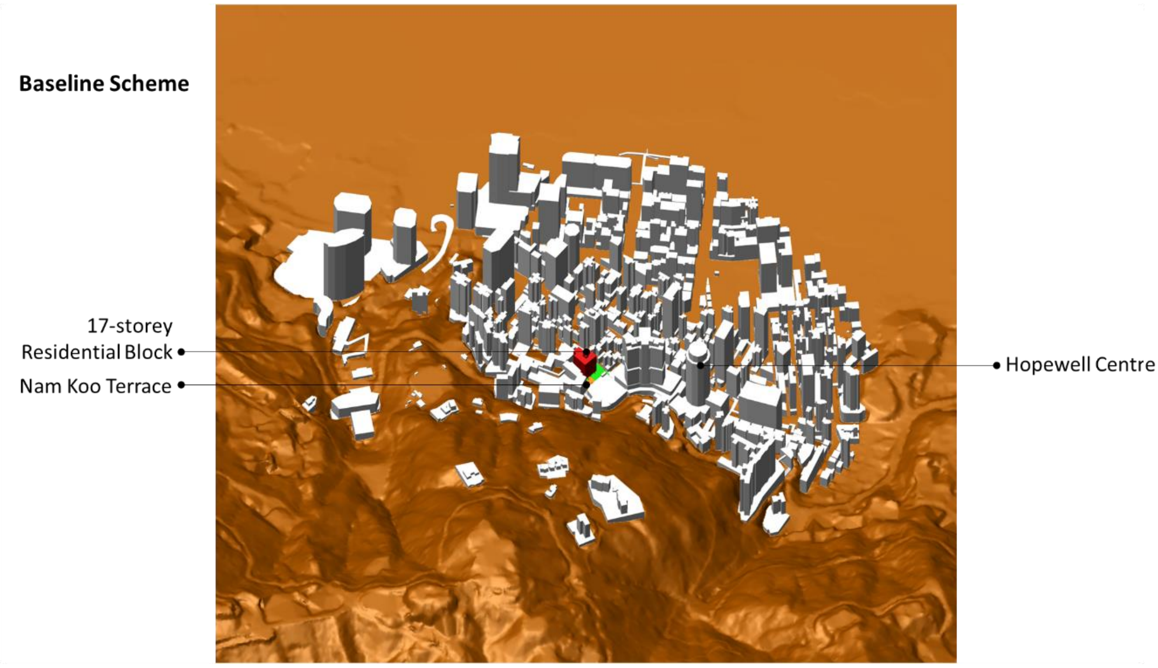


Figure 5.1.1.5 Baseline Scheme CFD Model View from South Direction

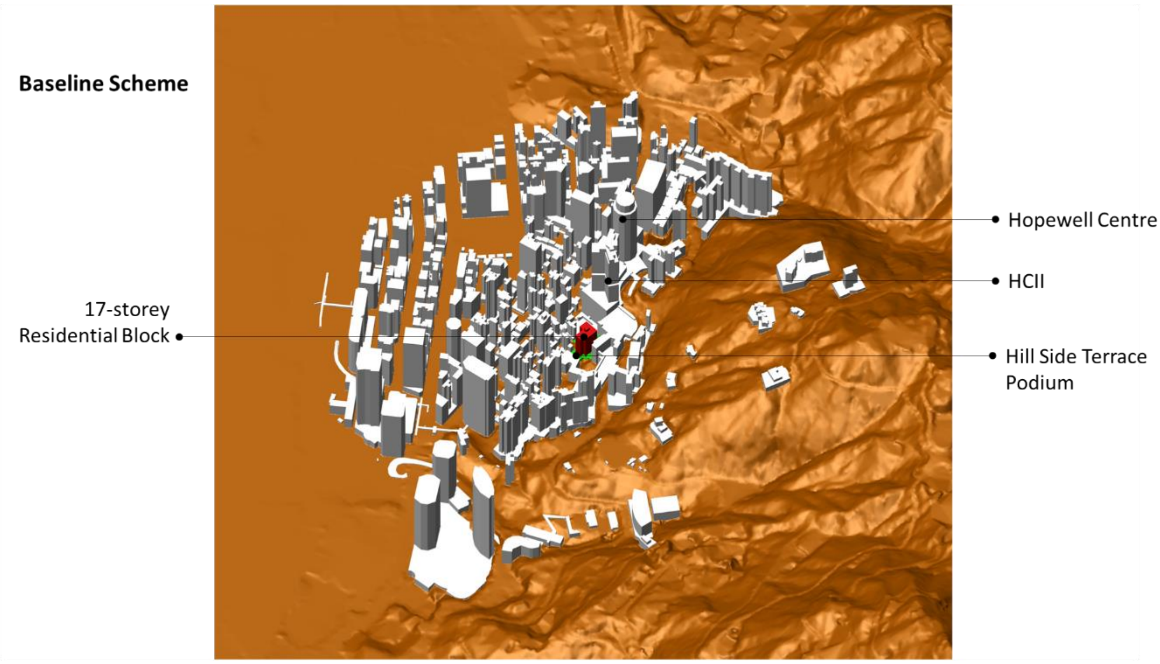


Figure 5.1.1.6 Baseline Scheme CFD Model View from West Direction

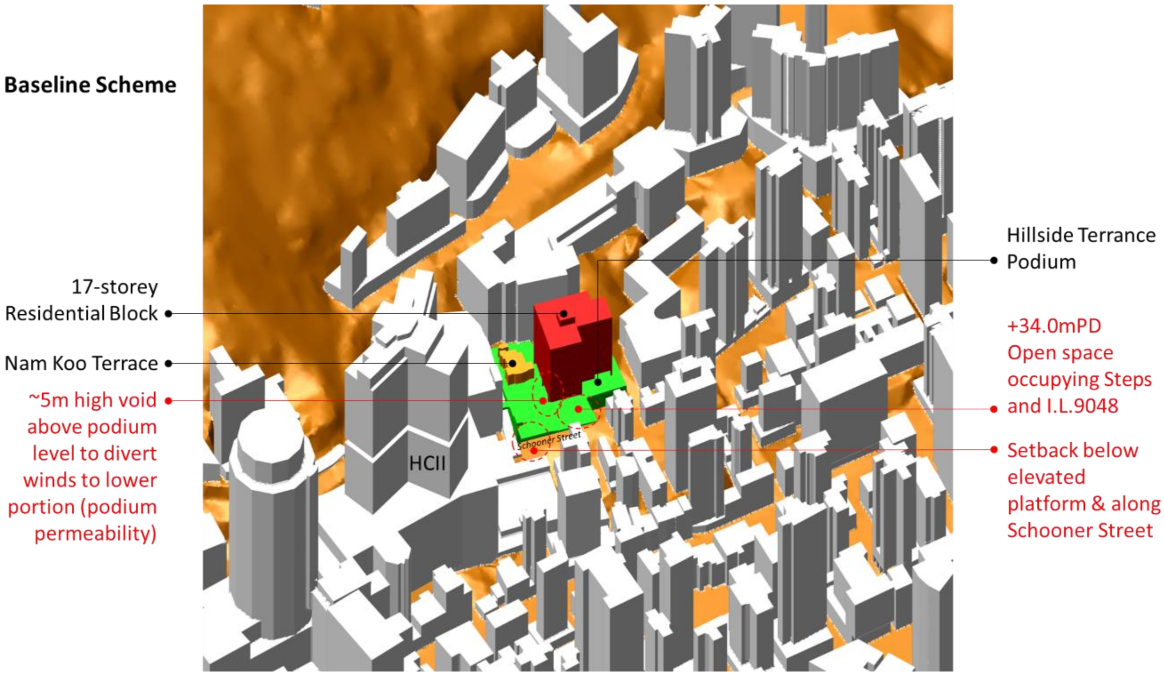


Figure 5.1.1.7 Baseline Scheme CFD Model (Zoom in View 1)

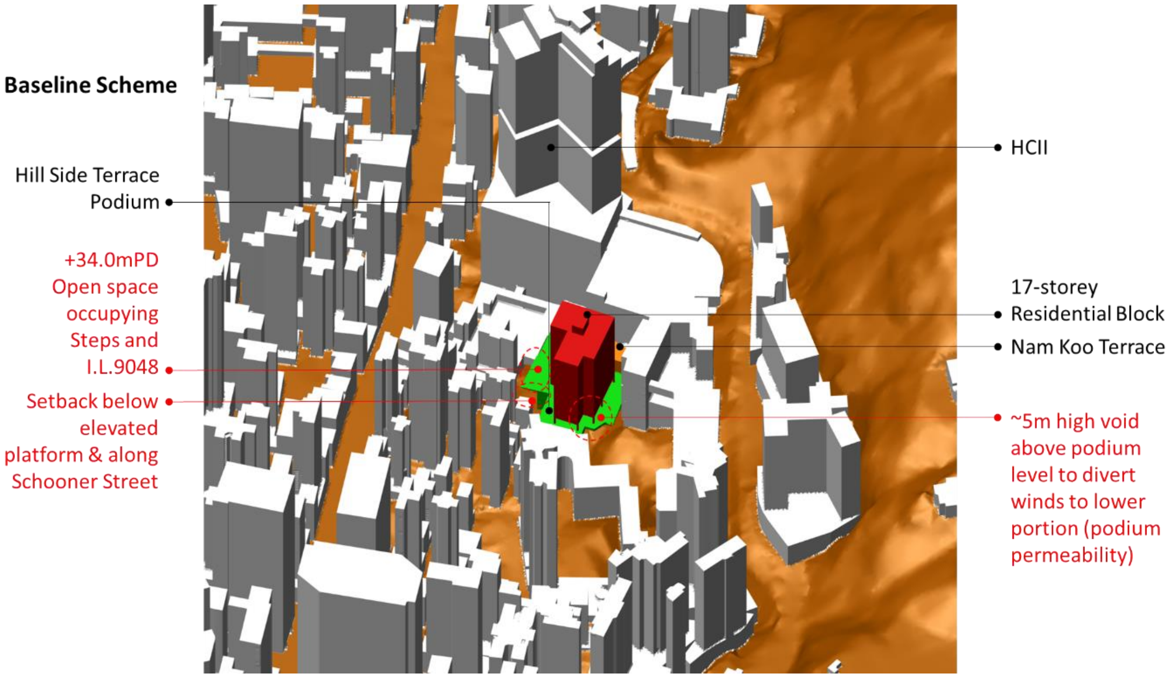


Figure 5.1.1.8 Baseline Scheme CFD Model View (Zoom in View 2)

5.1.2. Indicative Development Scheme

Figures 5.1.2.1 and 5.1.2.2 show the Indicative Development Scheme comprises of a 24-storey residential and commercial building over an Open Space open to public and three (3) podium levels with new design features. Similar to the design feature in the Baseline Scheme, a three-level podium up to +33.6mPD for open space will be built. In addition, a 24-storey residential block of +119.6mPD high which covers approx. 1,285.7m^2 covered open space will be constructed on the west of Nam Koo Terrace and on top of the podium with a ~6m high void and open space above podium level. To further enhance air permeability and ventilation environment in downstream area, the existing 6-storey residential building (No.18 Sau Wa Fong) will be demolished and developed into an at-grade open space. Moreover, a ground floor setback of approx. 3m will be provided to widen Schooner Street so as to accommodate a wider wind channel at pedestrian level of Schooner Street. Regarding the historical building at Nam Koo Terrace, it will be preserved in-situ, while its Annex Building to the south will be removed. Figures 5.1.2.3 to 5.1.2.8 show the 3D CFD model of the Indicative Development Scheme in-cooperated with mitigation measures/good design features to allow a more visual understanding of the Indicative Development Scheme.

Figure 5.1.2.1 Indicative Development Scheme Layout Plan

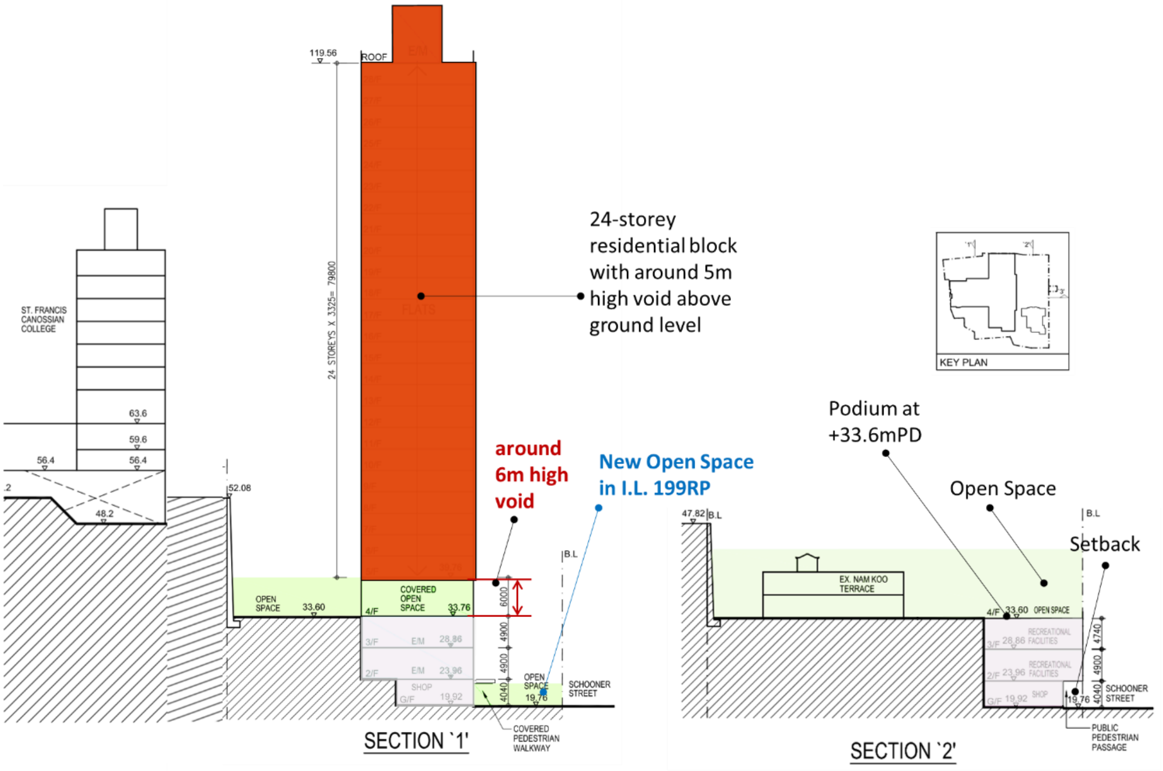


Figure 5.1.2.2 Indicative Development Scheme Section Plan

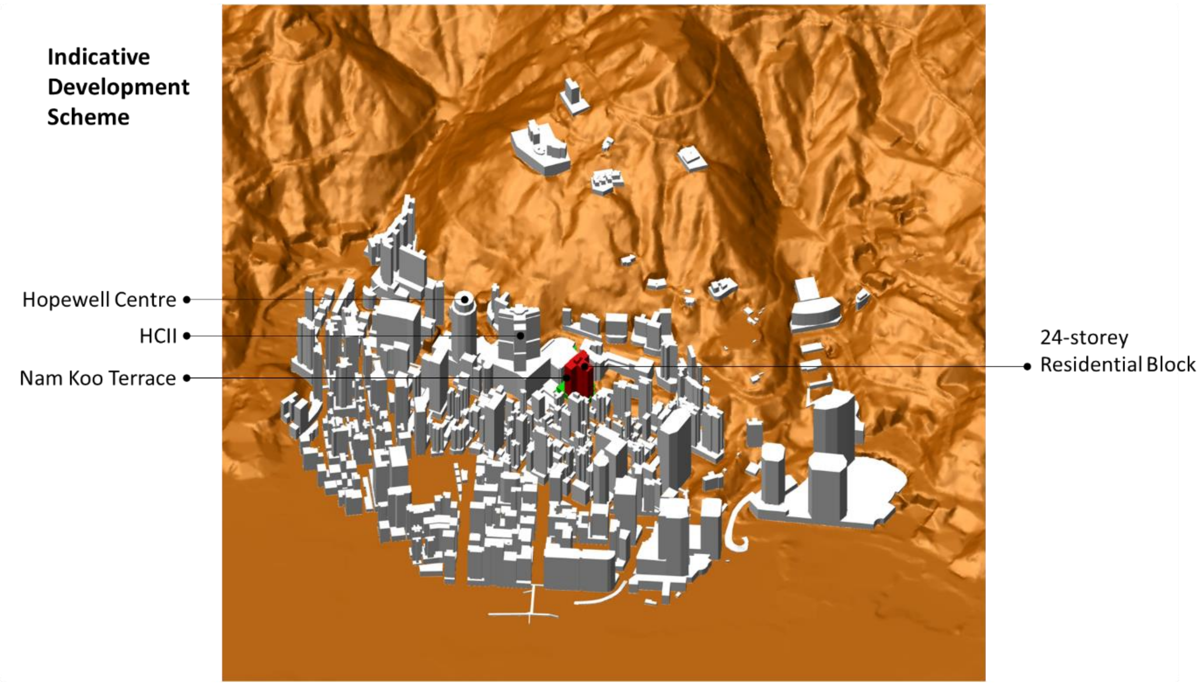


Figure 5.1.2.3 Indicative Development Scheme CFD Model View from North Direction

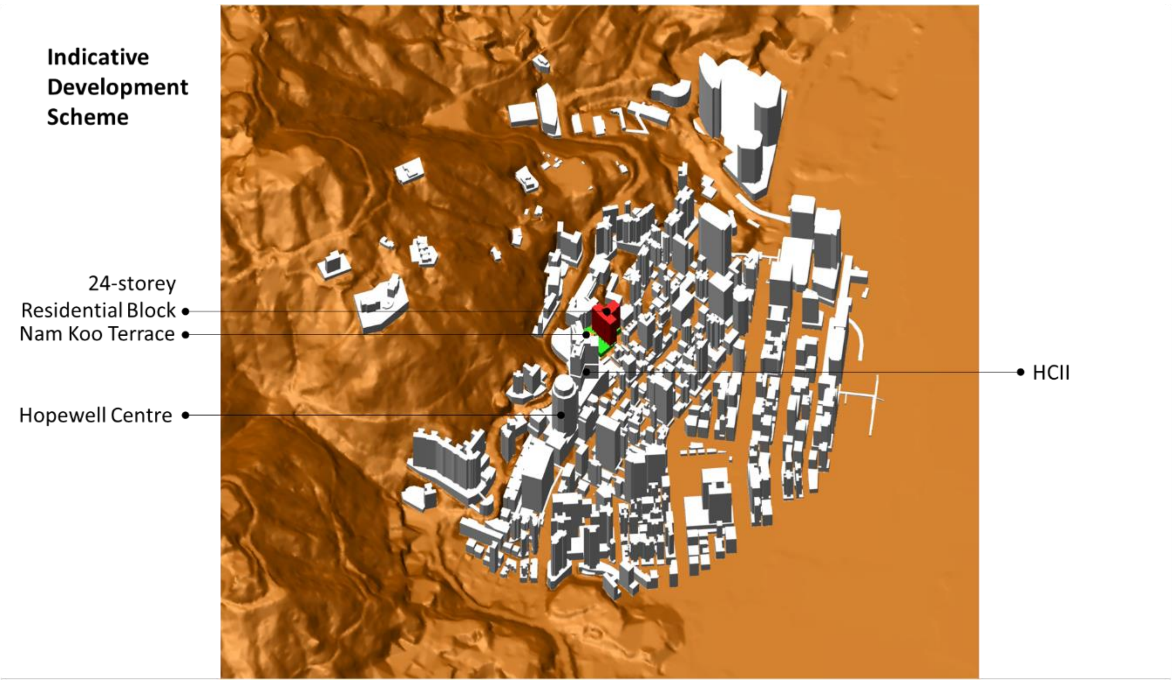


Figure 5.1.2.4 Indicative Development Scheme CFD Model View from East Direction

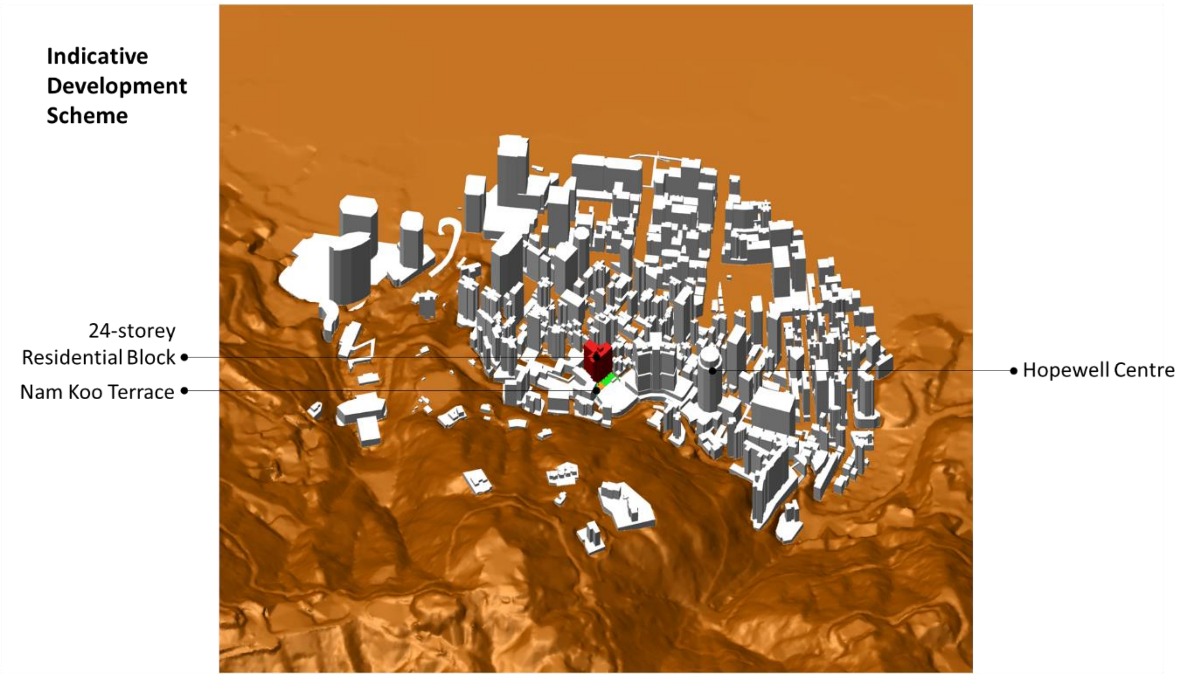


Figure 5.1.2.5 Indicative Development Scheme CFD Model View from South Direction

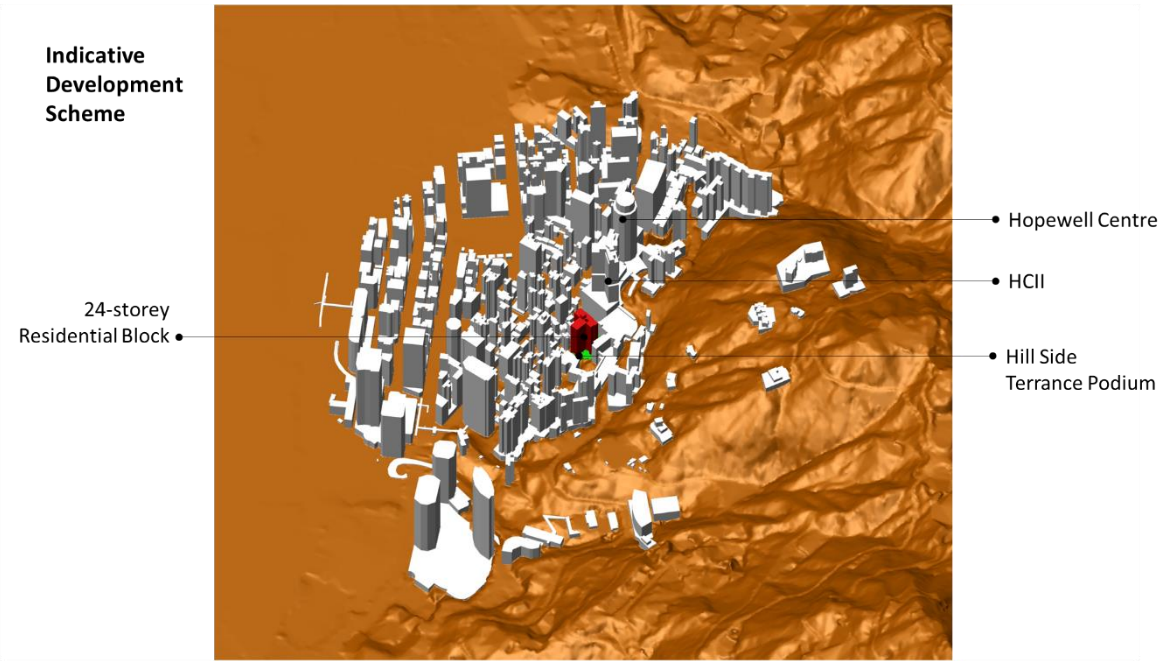


Figure 5.1.2.6 Indicative Development Scheme CFD Model View from West Direction

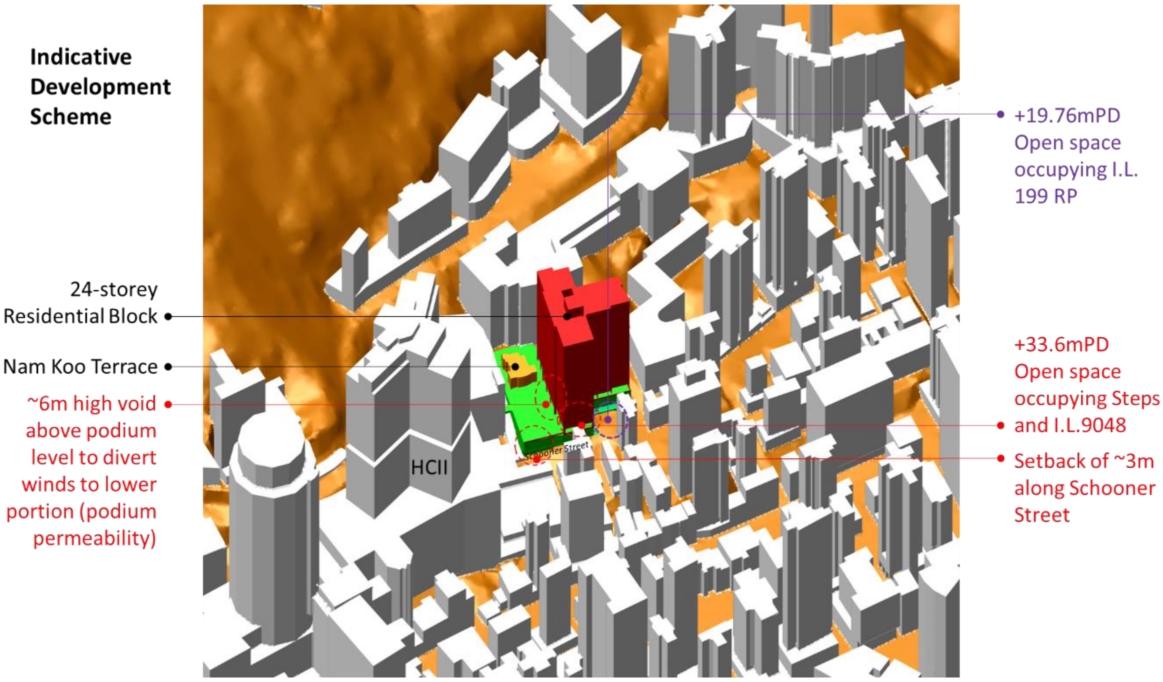


Figure 5.1.2.7 Indicative Development Scheme CFD Model (Zoom in View 1)

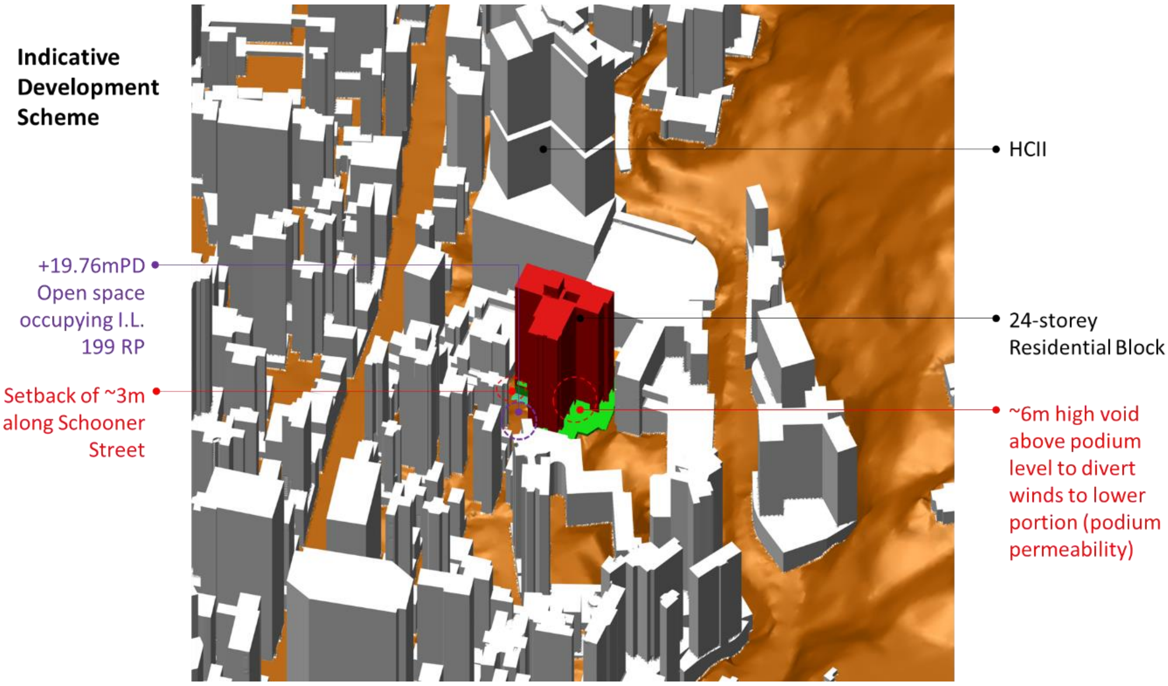


Figure 5.1.2.8 Indicative Development Scheme CFD Model View (Zoom in View 2)

5.2. *General Review on CFD Tools Suitable for AVA*

This section summarizes the details on the CFD tools, turbulence model, meshing, boundary conditions and the quality assurance approach adopted in the present CFD analysis. In general, the following are requirements for the CFD code to be used for AVA:

- Turbulence model, i.e. RNG or Realizable k-ε model in this Project;
- Parallel processing capability to simulate large CFD model;
- Accept user specified incoming wind characteristics, i.e. profile and turbulent parameters;
- Unstructured mesh to capture the geometrical details and boundary layer mesh.

The version of commercial CFD code ANSYS-FLUENT Version 2021 R1 has been adopted for the simulations in this Project as it satisfies all the above general requirements.

5.2.1. Turbulence Model

The general use for computation of turbulent flows for AVA should be the RANS approach. Apart from the standard k-ε model, two advanced k-ε models, namely Renormalization Group (RNG) k-ε model and Realizable k-ε model are commonly used in AVA today. In this Project an improved RANS turbulence model, i.e. Realizable k-ε has been adopted.

5.2.2. Computational Mesh

In this project, due to the geometrical complexity of the buildings and terrains, the meshing method, i.e. the approach to discretize the computational domain for subsequent CFD simulations, must be capable to capture adequate details. To achieve such detail, unstructured mesh is the best method for this project as it can be used to capture odd shape geometries, hence suitable for the use in AVA, where the buildings and terrains are irregular in shape.

Apart from the mesh topology, a good mesh quality will help the solution convergence and save CPU time as well. It is the key to an accurate CFD solution. To achieve and maintain mesh quality, the grid quality was closely monitored during the CFD model meshing stage. Furthermore, a highly efficient meshing package HARPOON has been used to generate the computational mesh for the CFD analysis. The generated unstructured hexagonal mesh could reduce the total number of meshes and provide a higher level of numerical accuracy than tetrahedral meshes. Layers of meshes have also been included on the ground surfaces to capture the detailed pedestrian level wind flow. The same meshing approach had also been adopted by Environmental Protection Agency (EPA) and USA for the assessment of urban scale environmental flow. Please refer to Appendix A for more details.

Figure 5.2.2.1 illustrates the general concept of hexagonal mesh and its applications in complicated geometries for typical urban environment. It clearly indicates that the geometrical details could still be maintained but the overall mesh quantity is reduced when comparing to tetrahedral mesh. And the use of hexagonal mesh would have a higher numerical accuracy than tetrahedral mesh as stated above.

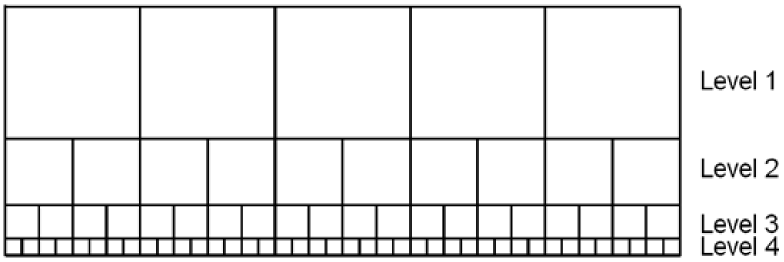


Figure 5.2.2.1 Hexagonal Mesh Concept

The length scales used for the surface mesh for the Rezoning Site (Indicative Development Scheme at Rezoning Site) is 0.5m. The ground surface within the surrounding area is also implemented at 0.5m. This short length scale is essential to capture the geometrical details for two development schemes as well as the terrain. The length scale for the rest of the buildings within the surrounding area is 1m. Outside the surrounding area, 2m surface mesh is used for the ground and buildings. The top and side length scales are all 16m. Six (6) layers of mesh with height 0.5m are used on the ground level to capture details for pedestrian level wind flow and wind profile. And the maximum grid size 32m is used for the rest of the domain. The expansion ratio is 1.2. The total mesh quantity is around 50 million. Figure 5.2.2.2 is the typical sectional mesh arrangement.

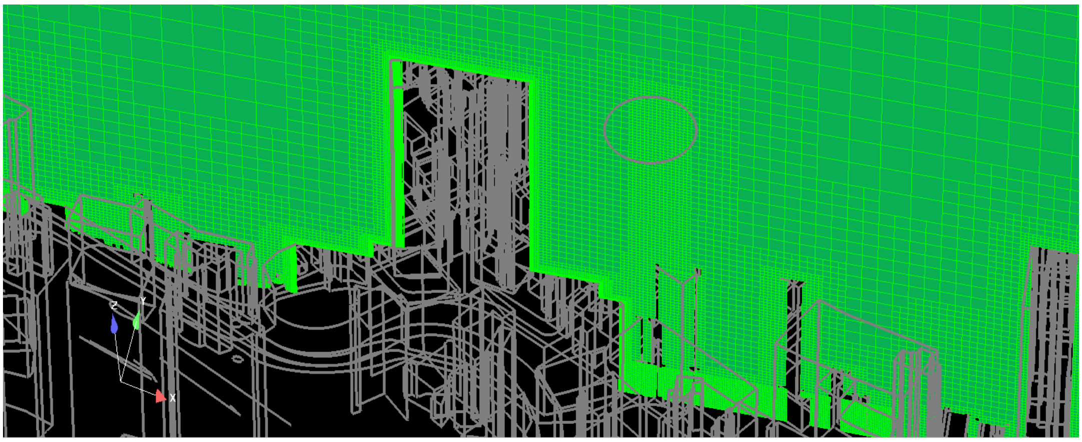


Figure 5.2.2.2 Typical Sectional Mesh Arrangement around Buildings and Ground Level

5.2.3. Boundary Condition Settings

For all CFD simulations, proper boundary condition settings are essential. For AVA, besides the geometrical models of the two development schemes, the most important boundary conditions are the approaching wind velocity and its turbulence parameters.

With the consideration of the terrain, log law is proposed for the approaching wind profile. The parameters used in the definition of the wind profile depend on site conditions. Please refer to Section 3 for more details.

Moreover, based on AVA Technical Guide, as discussed in Section 3, the wind directions used should cover over 75% of the site winds. The probabilities as tabulated in Table 3.2.1 and Table 3.3.1 in Section 3 have been adopted.

To allow the approaching winds follow the Log-law wind profile, the User Defined Functions (UDFs) in ANSYS-FLUENT have been developed to specify all these parameters for the approach wind profiles at different directions.

For the boundary condition settings, “Velocity” boundary has been used for the incoming wind profile. The outflow boundary has been defined as “Outflow” and the top domain will be defined as “Symmetry”.

5.2.4. Convergence Criteria

Maintaining the adequate convergence of solution is essential for CFD simulations. With only the residual monitoring is not enough. In additional to the typical residual monitoring used in ANSYS-FLUENT, which the residuals of the variables (velocity, pressure and turbulence parameters) should be lower than 0.001, various monitoring points inside the computation domain have been used to monitoring the solution convergence progress. Therefore, in addition to the residuals report in ANSYS-FLUENT, the velocities in the monitoring points should also indicate a converged behavior as well.

For a better convergence control, first order scheme has been used for the initial iterations and second order scheme has been used for all the variables, namely velocity, pressure and turbulent parameters.

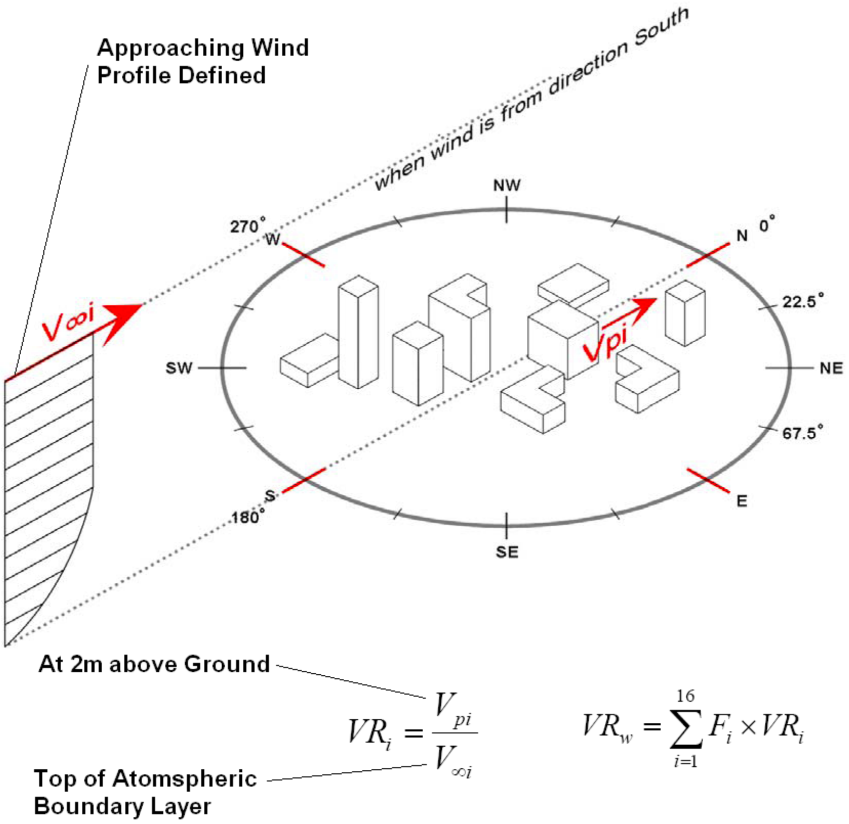
Apart from the solution convergence, an additional method has also been used to ensure the solution accuracy and consistency. Since the upstream flow pattern is away from the site, which is different with the building form, it should not be affected much due to the change in the Rezoning Site details. The flow patterns upstream from the site with the same wind direction should be compared against each other. No significant change should be observed for a correct simulation result. Otherwise, revisit the simulation model is necessary to eliminate such discrepancies.

5.3. *Test Point Locations*

As stated in Section 3, the prevailing wind directions for both annual and summer wind roses have been analyzed in detail. Once the wind directional occurrence frequencies and approaching velocity profile have been established for the Rezoning Site, the pedestrian level wind environment can be assessed quantitatively.

Based on the AVA Technical Guide, the concept of Velocity Ratio (VR) has been adopted. Figure 5.3.1 is extracted from the “Final Report of Feasibility Study for Establishment of Air Ventilation Assessment System” by PlanD 2005. It illustrates the concept of VR as well as the weighted VR, which considered the wind occurrence frequency of different directions.

For detailed performance comparison of the development schemes in terms of pedestrian level ventilation, the VR of most occurred wind directions should be compared in detail as they contribute the most to the weighted VR. In the present study, points weighted average VR for LVR (Local spatial averaged Velocity Ratio) and SVR (Site spatial averaged Velocity Ratio) for the annual and summer wind environment have been extracted for result comparison.



$$VR_i = \frac{V_{pi}}{V_{\infty i}} \qquad VR_w = \sum_{i=1}^{16} F_i \times VR_i$$

Vpi is the pedestrian wind velocity of the location when wind comes from direction i.
V∞i is the available wind velocity of the site when wind comes from direction i.
VRi is the velocity ratio of the location when wind comes from direction i.
Fi is the frequency occurrence of wind from direction i. 16 directions are considered.
VRw is the wind velocity ratio

Figure 5.3.1 Concept of VR and Weighted VR

Apart from the weighted VR, the velocity ratio of the most prevailing wind directions has also been compared and discussed in detail. As for performance comparison, the VR values at various test points should be recorded and compared in detail. The selection of test point locations is based on the recommendations as stated in Paragraphs 26 to 29 of the AVA Technical Guide.

Both main roads, such as Kennedy Road, Queen's Road East and Johnston Road, and all major accessible streets within the Assessment Area are included. Please refer to Figure 5.3.2, Figure 5.3.3 and Table 5.3.1 for all the test point locations.

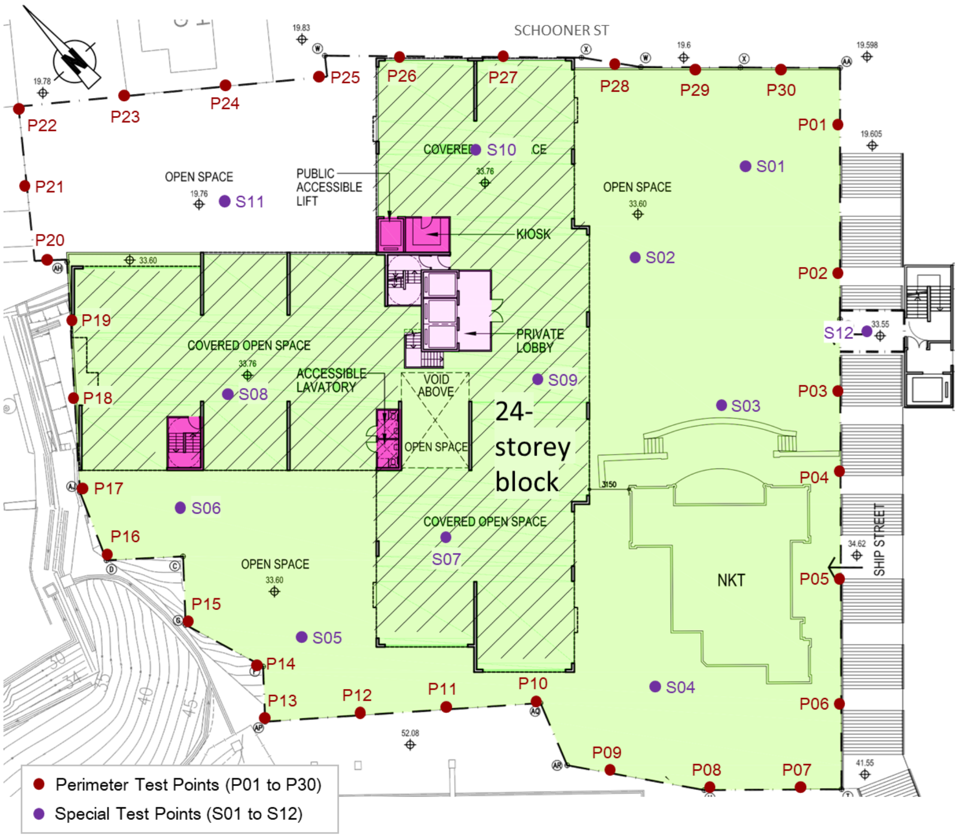


Figure 5.3.2 Perimeter Test Point and Special Test Point Locations for VR Recording

A total 177 test points have been identified for this site, 135 (T01 to T135) overall test points are located within the Assessment Area, and 30 perimeter test points (P01 to P30) are located around the Rezoning Site boundary. 6 special test points (S01 to S06) are located within the Former Miu Kang Terrace, Nam Koo Terrace, Hillside Terrace. 4 special test points (S07 to S10) are located in the podium voids. 1 special test point (S11) is located within the open area of I.L.199 RP (No.18 Sau Wa Fong), and 1 special test point (S12) is located on the proposed elevated walkway area. All these test points are located at 2m above ground level to assess the pedestrian level ventilation as per the Technical Guide requirements. They are also grouped together for easy comparison. The calculations of SVR (all perimeter test points) and LVR (all perimeter and overall test points) are based on the methodology as outlined in the AVA Technical Guide. Both annual and summer SVR and LVR have been calculated in both schemes for performance comparison.

Figure 5.3.3 Overall Test Point Locations within the Assessment Area for VR Recording

Table 5.3.1 Key Plan for Overall Test Point Locations for VR Recording

No.	Location Name	Test Points
1	Hennessey Road	T01-T03
2	Johnston Road	T04-T11
3	Thomson Road Johnston Road Junction	T12
4	Anton Street	T13-T15
5	Landale Street	T16-T18
6	Li Chit Street	T19-T20
7	Gresson Street	T21-T23
8	Lun Fat Street	T24-T26
9	Ship Street (North of Queen's Road East)	T27-T29
10	Tai Wong Street West	T30-T32
11	Tai Wong Street East	T33-T36
12	Swatow Street	T37-T39
13	Amoy Street	T40-T41
14	St. Francis' Canossian School	T42-T44
15	Queen's Road East (QRE)	T45-T59
16	Wing Fung Street	T60-T61
17	Sun Street & Moon Street	T62-T66
18	St. Francis Yard	T67-T68
19	Star Street	T69-T73
20	St. Francis Street	T74-T77
21	Sau Wa Fong	T78-T81
22	Schooner Street	T82-T84
23	Sik On Street	T85
24	Ship Street (South of Queen's Road East)	T86-T88
25	Ship Street Garden	T89-T93, T135
26	Kennedy Road	T94-T110
27	Monmouth Terrace	T111-T113
28	Back Lane on North Side of HC II Podium	T114-T116
29	Bowen Road	T117-T125
30	St. Francis Canossian College	T126
31	Lee Tung Avenue	T127-T128
32	Electric Street	T129-T130
33	Bowen Road Temporary Sitting-out Area	T131
34	Monmouth Terrace Playground	T132-T133
35	Kwong Ming Street Children's Playground	T134
36	Site Perimeter (SVR)	P01-P30
37	Special Test Points	S01-S12
Total Number of Test Points		**177**

6. Results and Discussion

In this AVA Report, two development schemes, i.e. Baseline Scheme and Indicative Development Scheme, have been analyzed in detail.

To quantify the pedestrian level ventilation, the 3D CFD simulations have been conducted based on the wind availability and methodology as stated in Sections 3 and 5, respectively. The following sections outline the findings of these two development schemes based on the 3D CFD simulation results. The detailed 3D CFD simulations have been conducted in all 11 wind directions for both schemes and the pedestrian level velocity ratios (VRs) at 2m above ground level are extracted for the performance comparison. The overall performance characteristics of the variation of building blocks can be identified by using the weighted average concept for in detailed assessment.

In general, the building should be designed to allow the best natural ventilation performance under the prevailing wind directions of both annual and summer wind roses. Based on the numerical values of weighted VR, the actual performance of the building can be evaluated quantitatively.

6.1. *Velocity Ratios (VRs) Distribution*

According to the requirement of AVA Technical Guide, frequency weighted average VR shall be used for the detailed performance comparison. This section outlines the assessment based on the frequency weighted average VR for both annual and summer wind roses.

6.1.1. Annual Weighted Average

Figure 6.1.1.1 shows the weighted VR plot at 2m above ground level for both Baseline Scheme and Indicative Development Scheme under annual prevailing winds. The No. in roads and locations are corresponding to the location No. in Table 5.3.1.

Baseline Scheme

From the annual weighted average plot, there are three major wind corridors at the pedestrian level of the adjacent main roads, i.e. Kennedy Road, Queen's Road East and Johnston Road. The high VR (better wind environment) occurs on the east side which is in line with the annual prevailing wind directions (most occurrence), i.e. from the east of Hennessey Road, Queen’s Road and Johnston Road. The wind environment at the pedestrian level in other narrow perpendicular streets between Queen’s Road East and Johnston Road (i.e. Landale Street, Li Chit Street, Gresson Street, Tai Wong Street West, Swatow Street and Amoy Street) and the streets between Queen’s Road East and Kennedy Road (in the northern to western sides of the Rezoning Site) is relatively low. This was indicated in the VR contours as the area has dense population with buildings packing in a direction perpendicular to the annual prevailing wind. Therefore, the relative wind environment along Kennedy Road, Queen's Road East and Johnston Road has better performance than the other streets within the Assessment Area.

Indicative Development Scheme

As shown in the Baseline Scheme, the three adjacent main roads as discussed above also play a major role to serve the wind around the site in the Indicative Development Scheme under annual wind directions. Since a void above podium level is constructed in both Baseline and Indicative Development Scheme, it both allows a better wind flow at the pedestrian level on the podium for the prevailing wind directions. Hence, the wind environment around the Site under both Scheme is similar. Referring to VR plots in Figure 6.1.1.1, since the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L. 199 RP is replaced as an open space in the Indicative Development Scheme, without the blockage leading to the natural ventilation at the Sau Wa Fong will be enhanced (red circle area). As a result, the Indicative Development Scheme showcases higher VR in the Sau Wa Fong when compared to the Baseline Scheme and further a slightly higher VR contours in the vicinity around this region.

The pedestrian level ventilation in other narrow perpendicular streets between Queen’s Road East and Johnston Road (i.e. Landale Street, Li Chit Street, Gresson Street, Tai Wong Street West, Swatow Street and Amoy Street) and the streets on the western side of the Rezoning Site (i.e. Wing Fung Street, Sun Street & Moon Street, St. Francis Yard, Star Street and St. Francis Street) can also be observed. In general, the Indicative Development Scheme shows a similar VR pattern as the Baseline Scheme, which means there is a relatively lower annual weighted VR when compared to the main roads results.

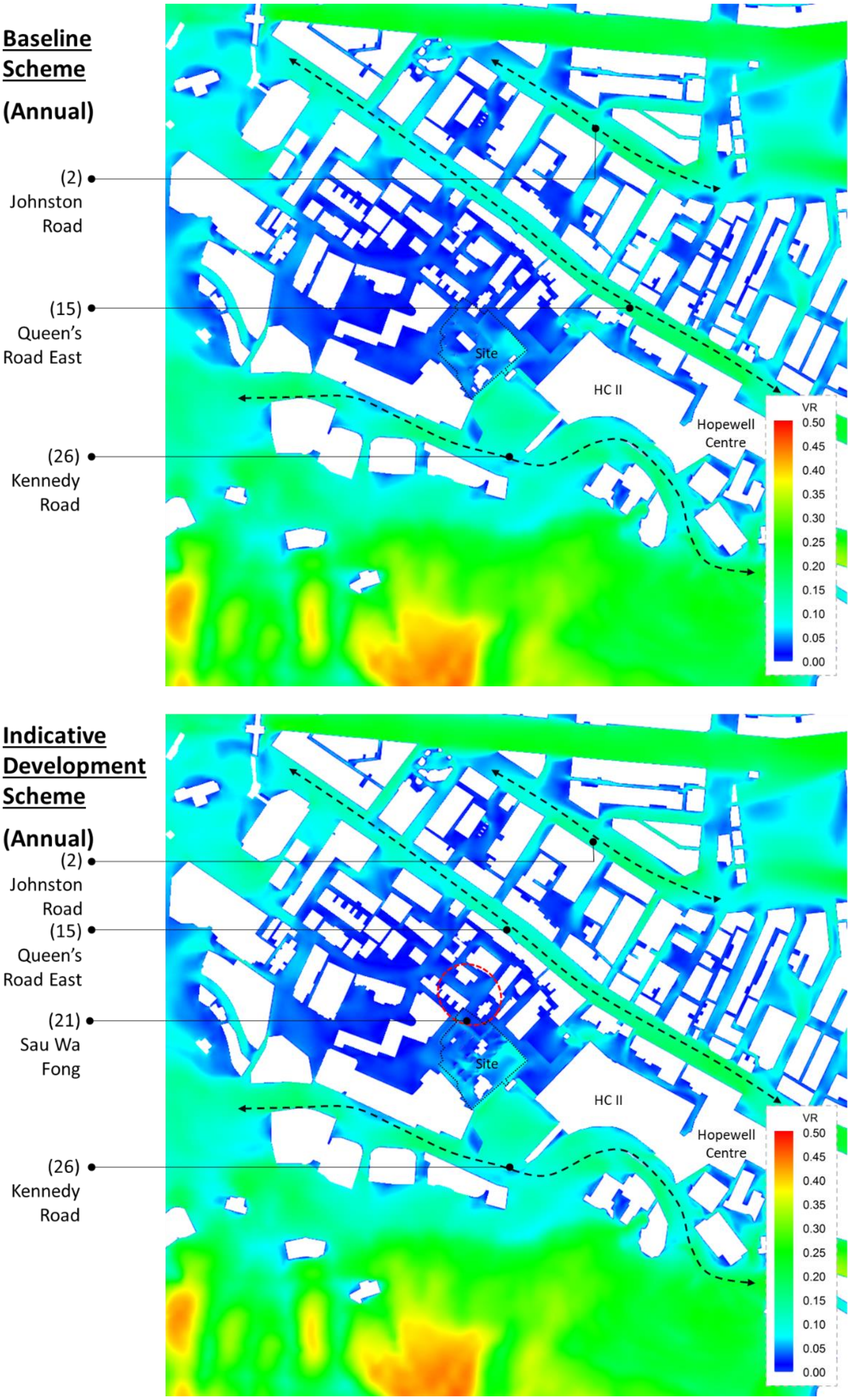


Figure 6.1.1.1 Comparison of Weighted VR Plots of Baseline & Indicative Development Schemes, Annual

6.1.2. Summer Weighted Average

Figure 6.1.2.1 shows the weighted VR plot at 2m above ground level for both Baseline Scheme and Indicative Development Scheme under annual prevailing winds. The No. in roads and locations are corresponding to the location No. in Table 5.3.1.

Baseline Scheme

From the summer weighted average VR plot, due to the difference in prevailing wind directions, the main streets Queen's Road East and Johnston Road will have a reduction in VR values. Overall, there were no stagnant zones along the main roads under summer prevailing wind directions. The area with higher VR value is located on the southern part of the Rezoning Site, which is mostly hills of higher altitude, considering that the prevailing wind (most occurrence) is the SSW wind.

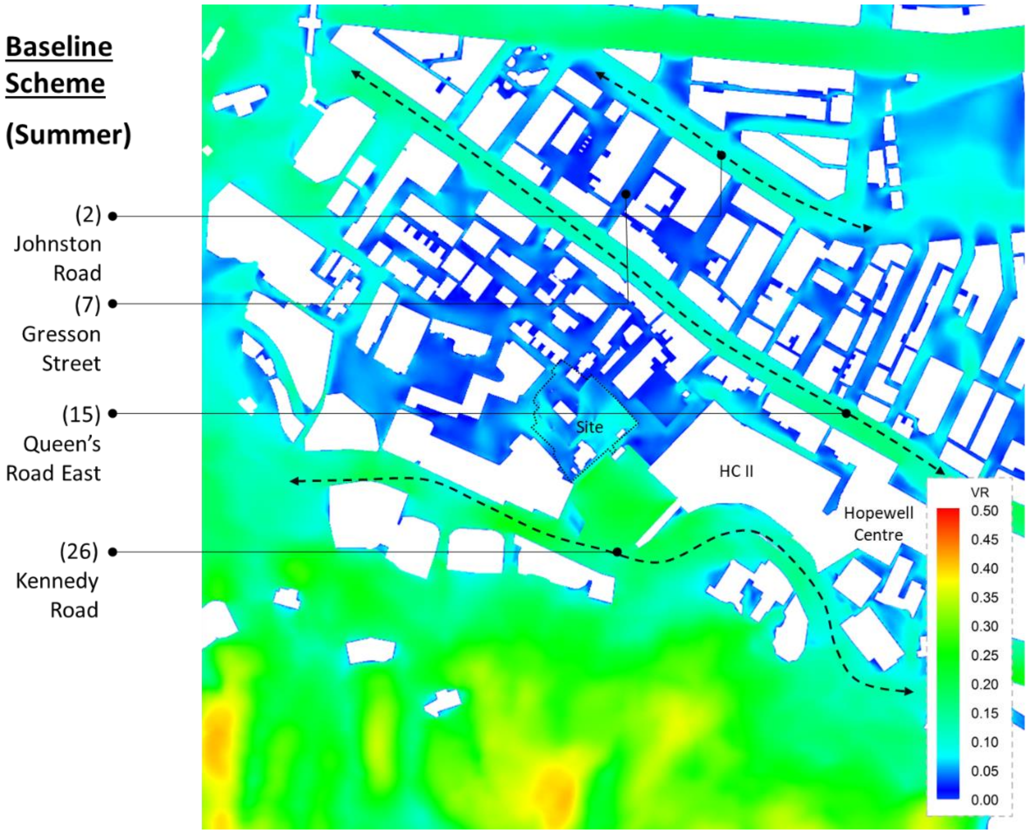
In other narrow perpendicular streets between Queen's Road East and Johnston Road (i.e. Landale Street, Li Chit Street, Gresson Street, Lun Fat Street, Ship Street, Tai Wong Street West, Swatow Street and Amoy Street) and the streets on the northern to western sides of the Rezoning Site, the VR value had a lower average at pedestrian level.

Moreover, the arrangement of a 17-storey residential block and a 3-level podium up to +34.0mPD at site area of I.L.9048 with a 5m high podium void can aid more upstream air flow from south-western side to pass through the Site and converge into the downstream area i.e. further northeast side of Schooner Street. However, the design feature with a southeast to northwest arrangement of podium setback provided under the elevated +34.0mPD platform along Schooner Street cannot bring a significant improvement to the summer wind environment at Schooner Street area for the Baseline Scheme since it is not parallel to the most occurrences summer prevailing winds, which are incoming from south to west directions of the site.

Indicative Development Scheme

Under summer prevailing wind directions, the design feature with ~3m ground floor setback along Schooner Street under the Indicative Development Scheme is similar to the Baseline Scheme that cannot enhance the summer wind environment at Schooner Street area. Moreover, the open space on the site of I.L.199 RP also cannot show a significant improvement to the wind environment at the pedestrian level under summer prevailing wind directions as the 24-storey residential block hindered part of the south-eastern wind direction to pass through.

In general, like Section 6.1.1, the pedestrian level ventilation in other narrow perpendicular streets between Queen's Road East and Johnston Road and the streets on the western side of the Rezoning Site also shows a similar VR pattern as the Baseline Scheme, with a relatively lower summer weighted VR when compared to the main roads results.



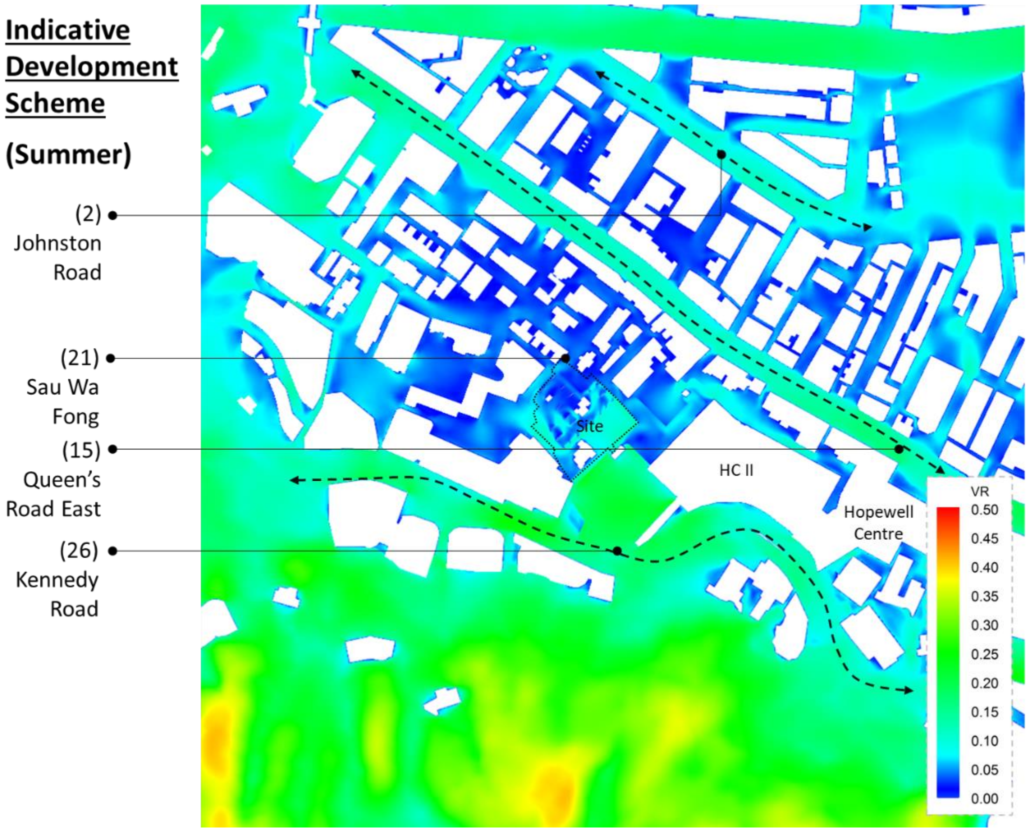


Figure 6.1.2.1 Comparison of Weighted VR Plots of Baseline & Indicative Development Schemes, Summer

6.2. *Detailed Wind Directions*

Section 6.1 outlines the general findings regarding the pedestrian level wind environment for annual and summer prevailing wind directions of both Baseline and Indicative Development Schemes. The detailed evaluation and assessment in separated wind directions are provided in the following sections.

6.2.1. Comparison for NNE Wind Direction

Figure 6.2.1.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under NNE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

In general, the Ship Street (south of Queen's Road East) and Back Lane on North Side of Hopewell Center II (HC II) Podium would be the major air paths (red arrow close to Queen's Road East) to serve the Project Site under NNE wind. Another major air path taken into consideration is (red arrow) from Kennedy Road to the podium park of HC II.

Baseline Scheme

At the northern-east side of the Baseline Scheme, part of the air flow from Ship Street (South of Queen's Road East) and Back Lane on the northern side of HCII could pass through the Hill Side Terrace podium via the extension of open space, i.e. three-level podium up to +34.0mPD within the existing area of Former Miu Kang Terrace, another part of air flow would form a recirculation area around Ship Street (South of Queen's Road East) and the Ship Street Garden. As for the air flow from Kennedy Road. Moreover, the ~5m high void above podium level under the 17-storey residential building block could enhance the air permeability at the lower portion of the development. Thus, most of incoming NNE wind could pass through the Site to its further downstream area, i.e. north side of St. Francis' Canossia College where part of the airflow may be prevented to its further north side.

Indicative Development Scheme

For the Indicative Development Scheme, the similar VR patterns surrounding the north-eastern side could be observed in comparison with the Baseline Scheme. The setback along Schooner Street (red circle area) under both Schemes can guide the wind to flow along this street to enhance the ventilation performance.

A slight improvement of ventilation could be noticed at pedestrian level in north-western side of the site considering that an open space is replaced with the existing 6-storey residential building on the site of I.L.199 RP (red circle area), where can converge the winds to improve the air flow performance. Hence, a high VR region can be observed in this area under Indicative Development Scheme.

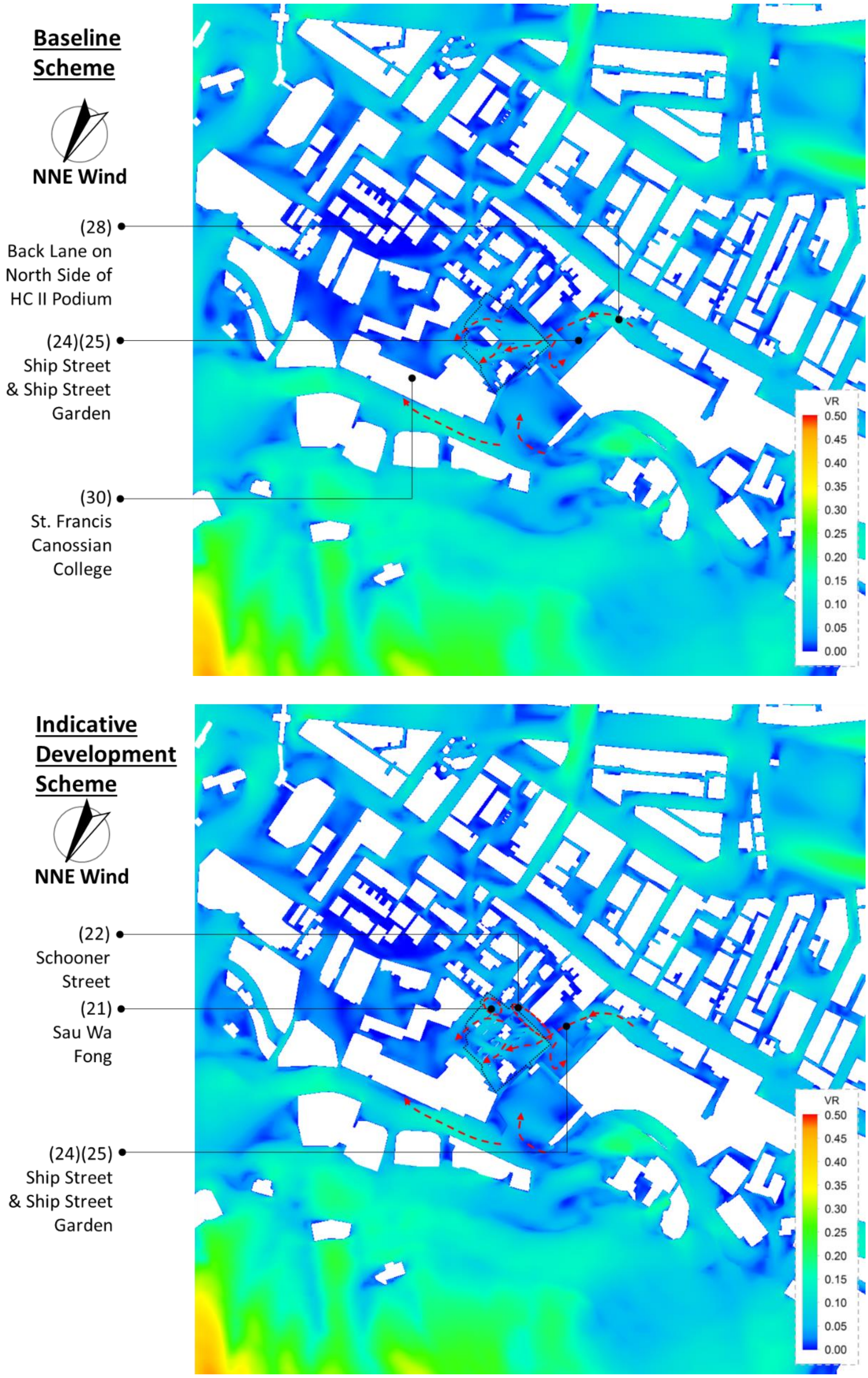


Figure 6.2.1.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, NNE Wind

6.2.2. Comparison for NE Wind Direction

Figure 6.2.2.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under NE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

Under NE wind, only Ship Street (south of Queen's Road East) plays a major air path role to enhance the air ventilation around the site. Similar to the VR patterns under NNE wind, another major air path (red arrow) from Kennedy Road through podium park of HCII could also be observed at the south side of the site.

Baseline Scheme

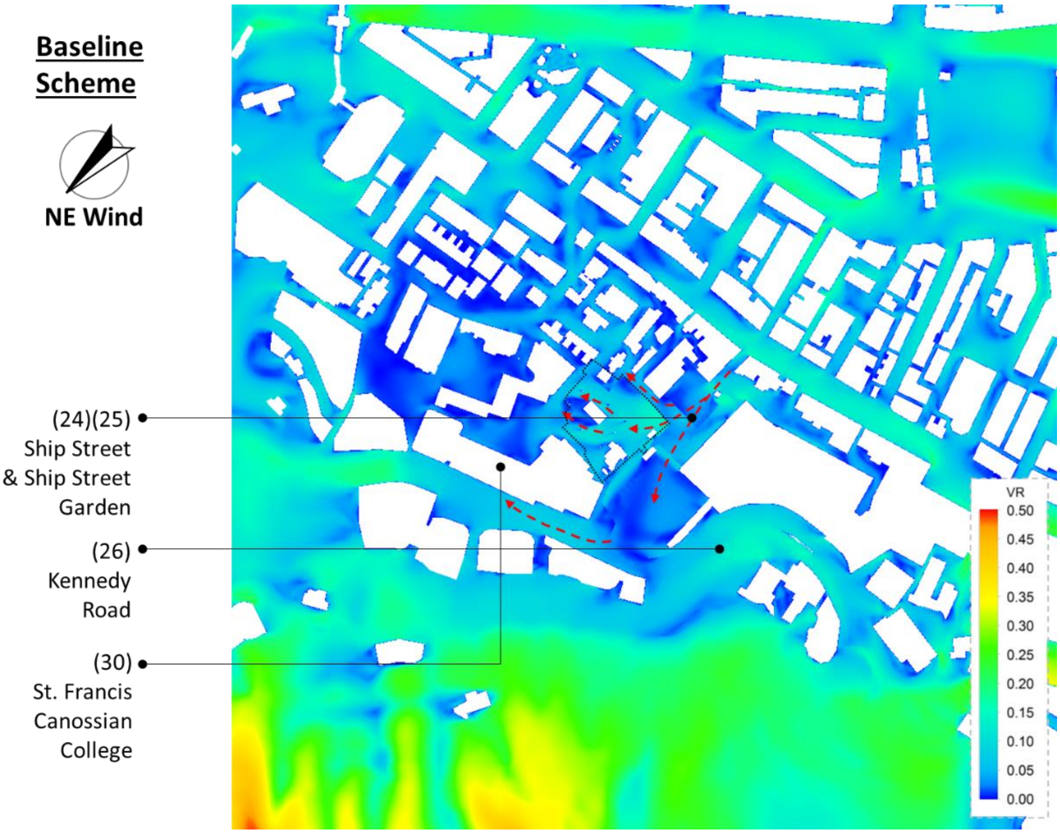
For the Baseline Scheme, the NE winds mostly incoming from Ship Street (South of Queen's Road East) to the south side directly (red arrow line). The large podium up to +34.0mPD in front of the Hillside Terrace could prevent part of air flow from Ship Street (South of Queen's Road East) to pass through and guide the air flow turn towards the west direction along Schooner Street directly. For the higher portion of the air flow, part of it is induced and diverted to the western and south-western side of the Site. The ~5m high void above podium level under the 17-storey residential building block can enhance the air permeability at the lower portion of the development and its downstream areas.

From the south side of the site, another major air flow passes the open space (+34.0mPD) at the Hillside Terrace podium smoothly. It significantly enhances the ventilation environment of the site and then dilutes its downstream areas. It also helps to divert the flow from Kennedy Road to pass through the St. Francis' Canossian College to its further downstream area, i.e. north side of the college and gives a positive impact over the wind distribution of the college.

Indicative Development Scheme

In comparison with the VR patterns of the Baseline Scheme, the Indicative Development Scheme with an open space in the north-western side of the site can allow the air flow to converge. Hence a higher VR region at pedestrian level could be observed in further downstream area of Schooner Street and Sau Wa Fong (red circle area).

Similar to the Baseline Scheme, the ~6m high void above podium level under the 24-storey residential building block can enhance the air permeability and ventilation environment in downstream areas.



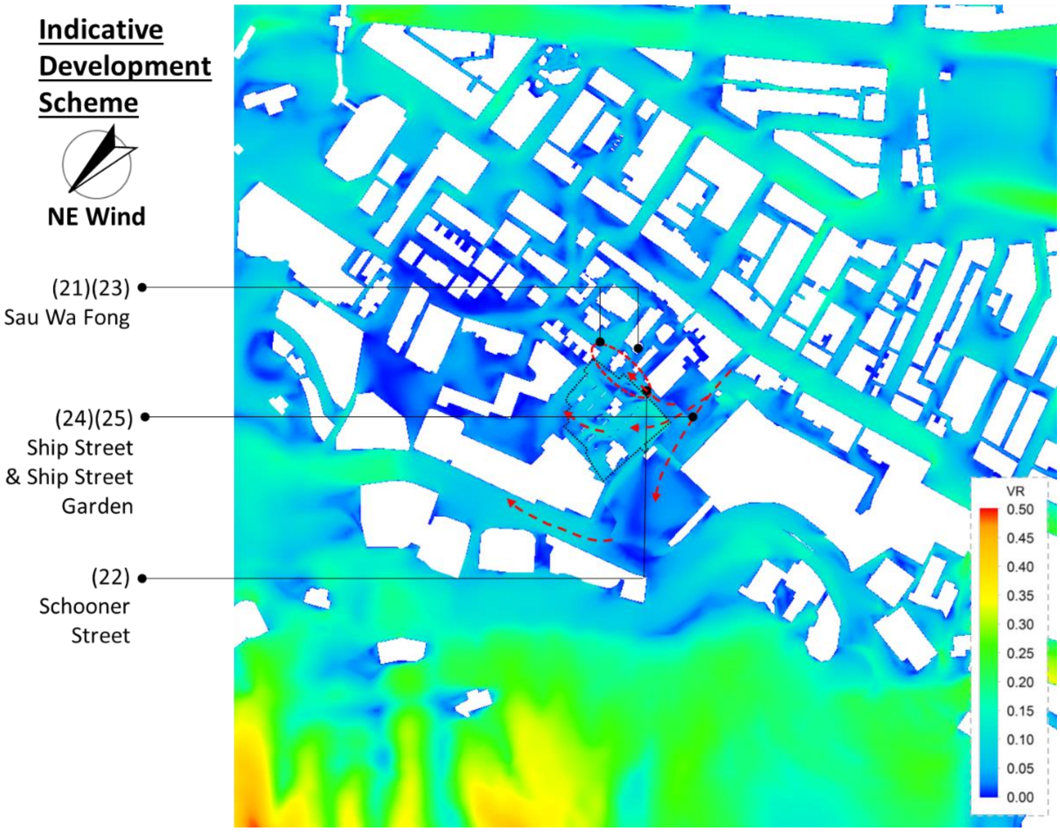


Figure 6.2.2.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, NE Wind

6.2.3. Comparison for ENE Wind Direction

Figure 6.2.3.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under ENE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

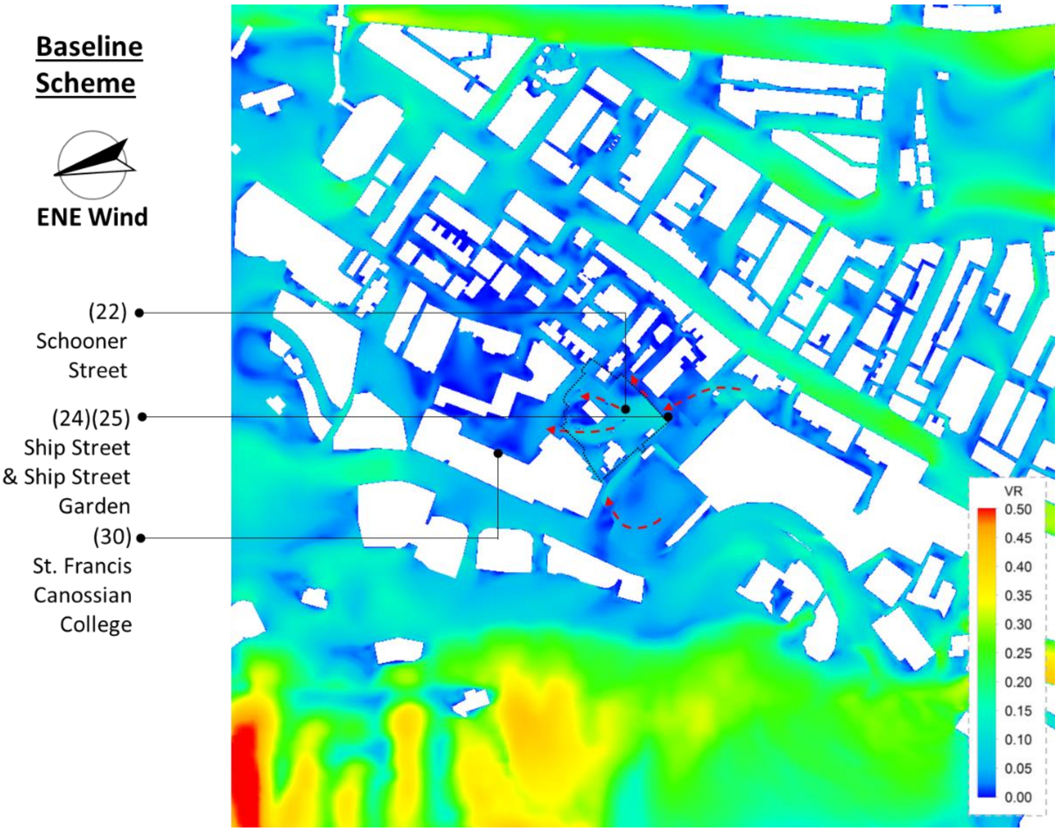
Like in NE wind condition, the Ship Street (south of Queen’s Road East) plays the major air path role to enhance the air ventilation around the site (red arrow line) under ENE wind direction.

Baseline Scheme

For the Baseline Scheme, the variations on VR mainly occur near the Project Site. Most of the incoming ENE wind from Ship Street (red arrow line) turn towards the west direction along Schooner Street. Due to the open space design of podium up to +34.0mPD at the existing area of I.L.9048, and the setback along Schooner Street under the podium level, it shows a good ventilation environment at Schooner Street and Sik On Street. The other part of air flow could pass the site and dilute towards its downstream areas, i.e. the north side of St. Francis’ Canossian College. Moreover, the rest of the air flow can travel along Ship Street and Ship Street Garden with an improvement of ventilation at these areas. For the south side of the site, the wind comes from the Kennedy Road through HCII.

Indicative Development Scheme

In general, the Indicative Development Scheme shows a similar wind environment in comparison with the Baseline Scheme. The void above podium level under the residential building block in both schemes can enhance the air permeability at the lower portion of the development and its downstream areas. The ground floor setback along Schooner Street under the podium level also helps increase the wind environment.



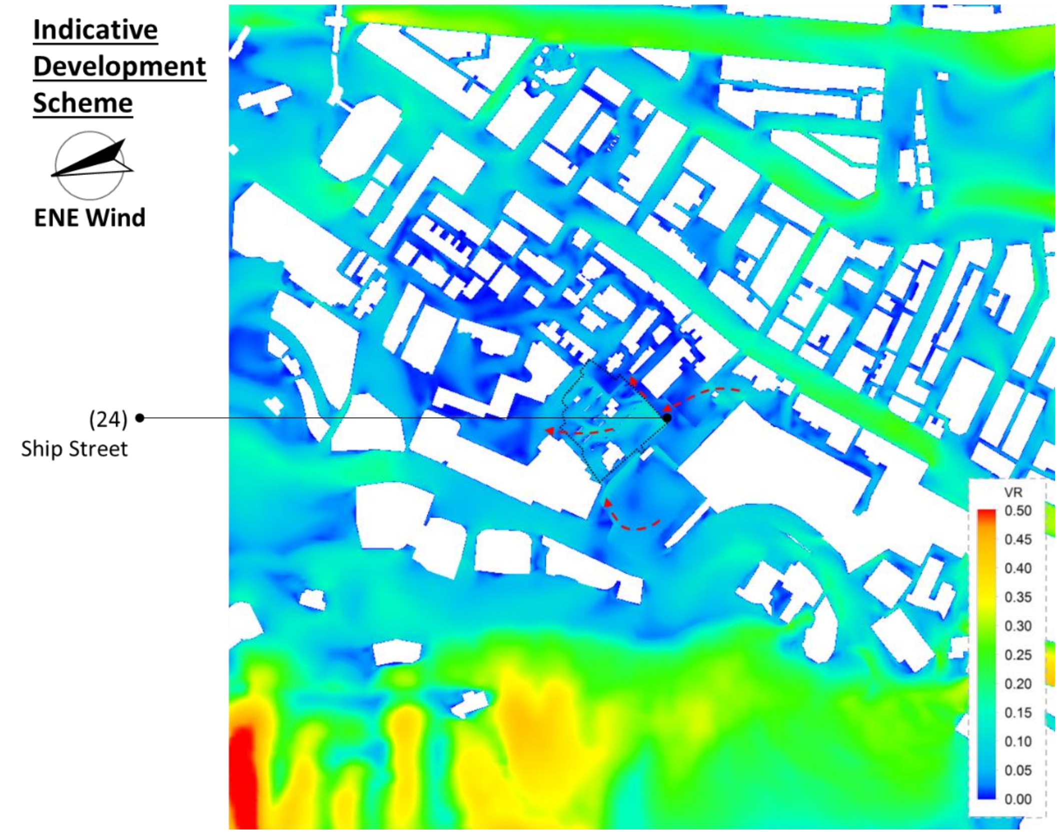


Figure 6.2.3.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, ENE Wind

6.2.4. Comparison for E Wind Direction

Figure 6.2.4.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under E wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

In the north-east side, Ship Street (south of Queen's Road East) and Back Lane at the north side of HCII Podium would be the major air paths (red arrow close to Queen's Road East) around the site. Another air path is at the south side of the site (red color arrow) from Kennedy Road through podium park of HCII.

Baseline Scheme

Under E wind, part of air flow from Ship Street (South of Queen's Road East) and Back Lane on North Side of HCII forms a recirculation area around Ship Street (South of Queen's Road East) and Ship Street Garden. Like the ENE wind condition, the rest of the air flow turn towards the west direction along Schooner Street. As the prevailing E wind is generally perpendicular to Ship Street (south of Queen's Road East), the poor wind environment at far field downstream areas can be observed in comparison with the wind environment under ENE wind. In contrast, the stronger air path route from Kennedy Road through podium park of HC II and St. Francis' Canossian College can be observed.

Indicative Development Scheme

It is noted that similar findings in the surrounding area of the site with the ENE wind are observed. Similar to the Baseline Scheme, the air flow could form a recirculation area around Ship Street (South of Queen's Road East) and Ship Street Garden. Due to the open space design with an extension of a three-level podium up to +33.6mPD, the increase of the air flow branch from Queen's Road East is observed in Ship Street (South of Queen's Road East) area. Moreover, this design feature of open space in the north-western of the site is beneficial to the air flow divert into the downstream areas. A slightly higher VR area around Sau Wa Fong (red circle area) is observed.

The Indicative Development Scheme also helps achieve a good wind environment around the south side of the site, i.e. the stronger air path routes from Kennedy Road through podium park of HC II. However, considering the large open space in the podium level, the air flow through podium park of HCII dilutes quickly inside the site and its downstream areas when in comparison with the Baseline Scheme.

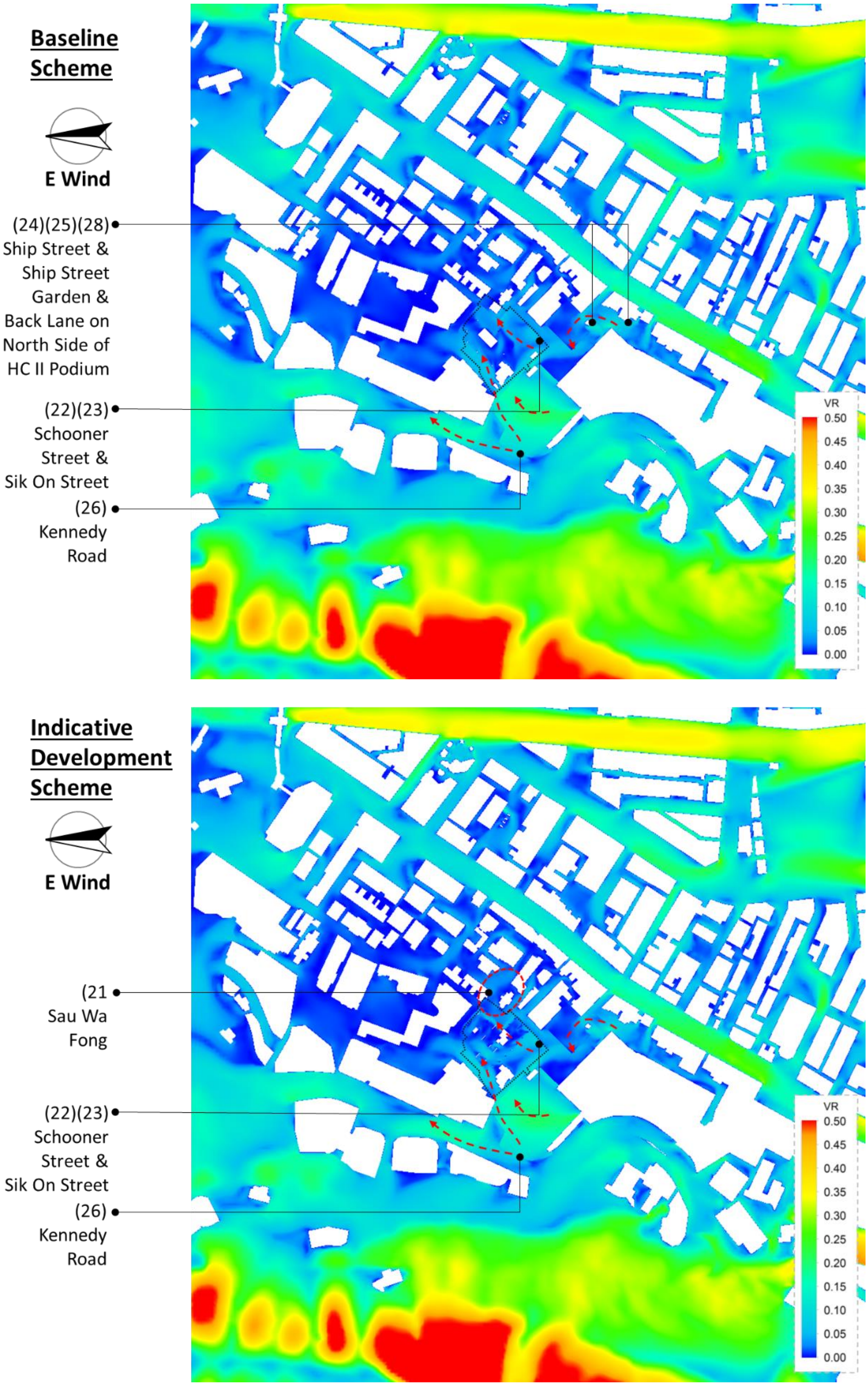


Figure 6.2.4.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, E Wind

6.2.5. Comparison for ESE Wind Direction

Figure 6.2.5.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under ESE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

Under ESE wind direction, the air path (red color arrow) from Kennedy Road through podium park of HC II would be the major air path route around the site.

Baseline Scheme

Part of the air flow from Kennedy Road pass the Hill Side Terrace podium of site via the building gap between St. Francis' Canossian College and Nam Koo Terrace for the Baseline Scheme under ESE wind. With the design feature of a ~5m high void between the 17-storey residential building block and the podium, the air flow from Kennedy Road is driven to the southwest side of the site towards the downstream area. It leads to a good ventilation area within the southwest area of the site. While, another part of air flow turns towards the northeast side of the site, i.e. along Ship Street (South of Queen's Road East) direction to its downstream area.

Indicative Development Scheme

For the Indicative Development Scheme, most of air is driven along the Kennedy Road and towards northwest side of the site and whilst the rest air is driven towards the northeast side of site. Similar to the Baseline Scheme, the ~6m high void above +33.6mPD podium level allows more air flow from Kennedy Road through HC II podium park passes through the site to the further downstream area of the site. The design feature of open space at the north-western side of the site following the setback along the Schooner Street under the podium level can help to converge the prevailing wind to then reach the downstream area. Hence, the VR around this open space (red circle area) has slightly improvement in comparison with the Baseline Scheme.

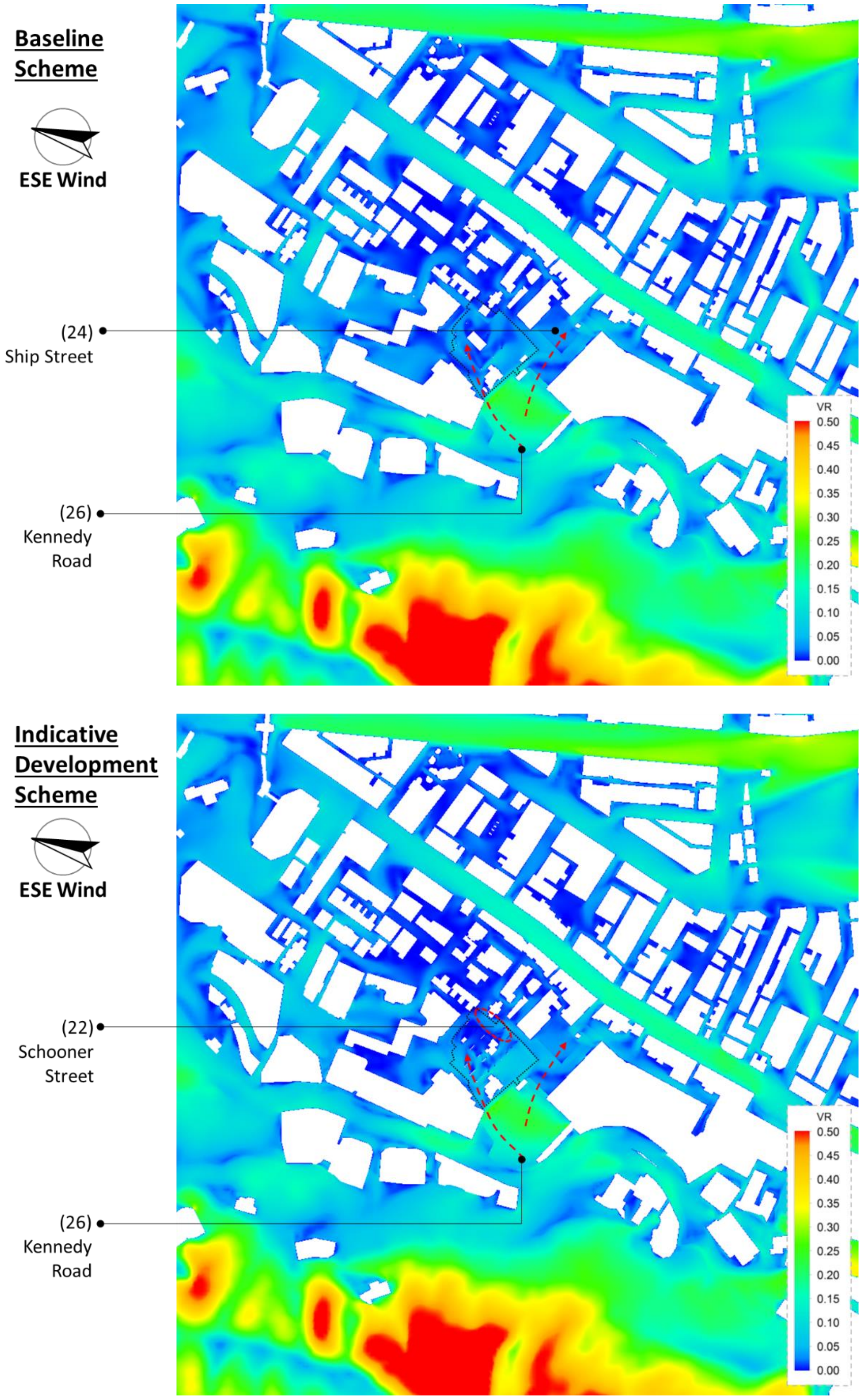


Figure 6.2.5.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, ESE Wind

6.2.6. Comparison for SE Wind Direction

Figure 6.2.6.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under SE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

Same as which showed in Section 6.2.5, the major air path is also from Kennedy Road through podium park of HCII (red arrow line) under SE wind direction.

Baseline Scheme

For the Baseline Scheme, the incoming air flow from Kennedy Road through podium park of HCII will be diverted into two parts by the Nam Koo Terrace. One part of the wind will flow to the south-western side of the site, and then pass through the ~5m high void above +34.0mPD podium level to reach the north-western part of the site. Hence, the ventilation performance around the areas of Sau Wa Fong will be higher. Another portion of the incoming winds will flow to the north-eastern open space of the site. This up to +34.0mPD three-level podium open space is beneficial to converge the wind and the flow to the downstream areas (i.e. Ship Street). Hence, a higher VR can be observed on this open space.

Indicative Development Scheme

For the Indicative Development Scheme under SE wind, similar wind pattern to the Baseline Scheme can be observed that the incoming SE wind will be also diverted into two parts. As the proposed residential building block under Indicative Development Scheme is higher than the Baseline Scheme, the downwash effect of the upper portion of incoming wind induced by the building block on the open space will be stronger resulting in a higher VR area (red circle area).

In the north-eastern side of the Site, similar ventilation performance can be observed for both Baseline and Indicative Development Scheme. A high VR is performed on the up to +33.6mPD three-level podium open space as well as the downstream areas (i.e. Ship Street). Moreover, the design feature of setback along Schooner Street is beneficial to the ventilation performance at pedestrian level of Schooner Street.

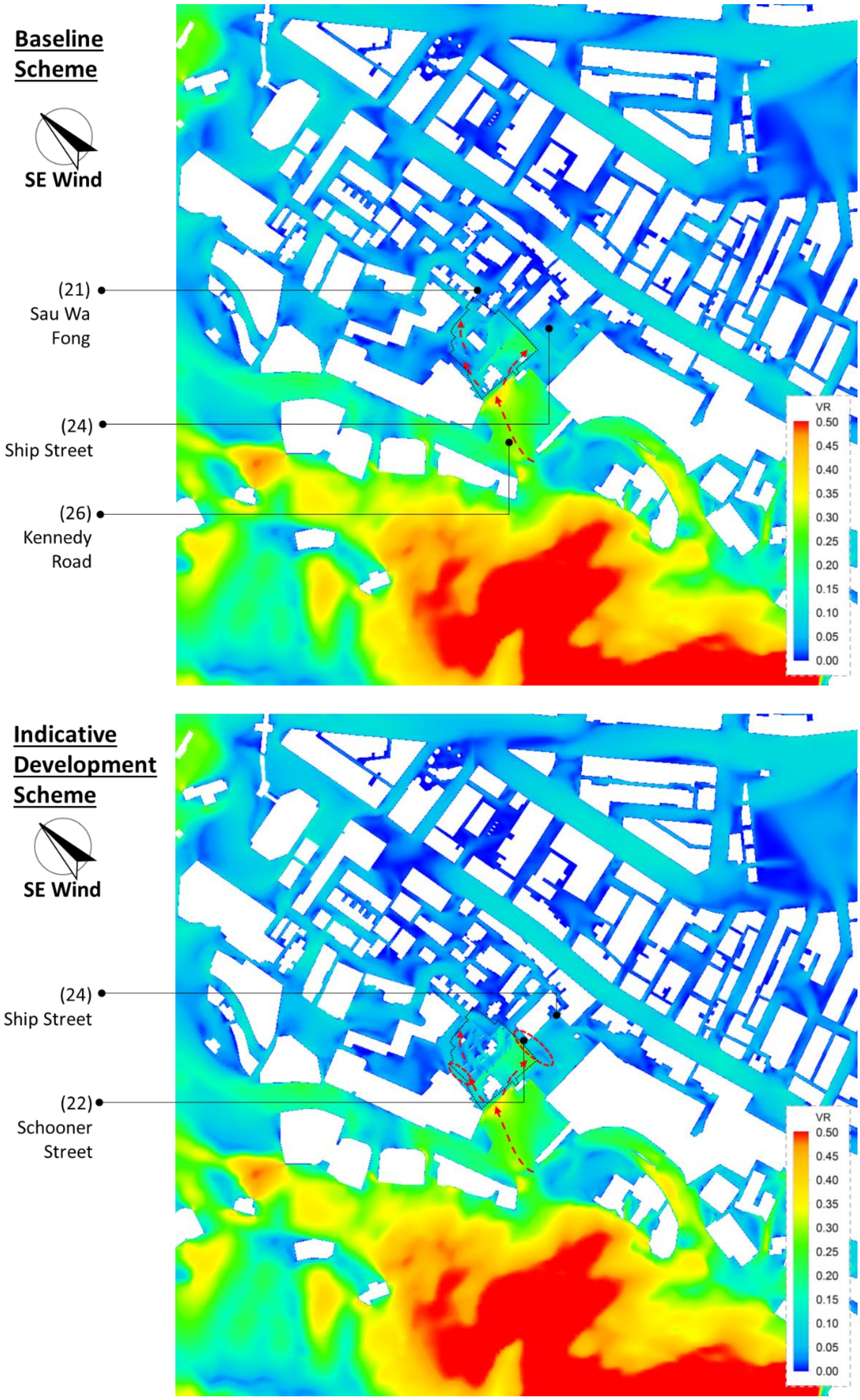


Figure 6.2.6.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, SE Wind

6.2.7. Comparison for SSE Wind Direction

Figure 6.2.7.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under SSE wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

In general, the major air path in south side of the site is from Kennedy Road through podium park of HC II (red arrow line) under SSE wind direction.

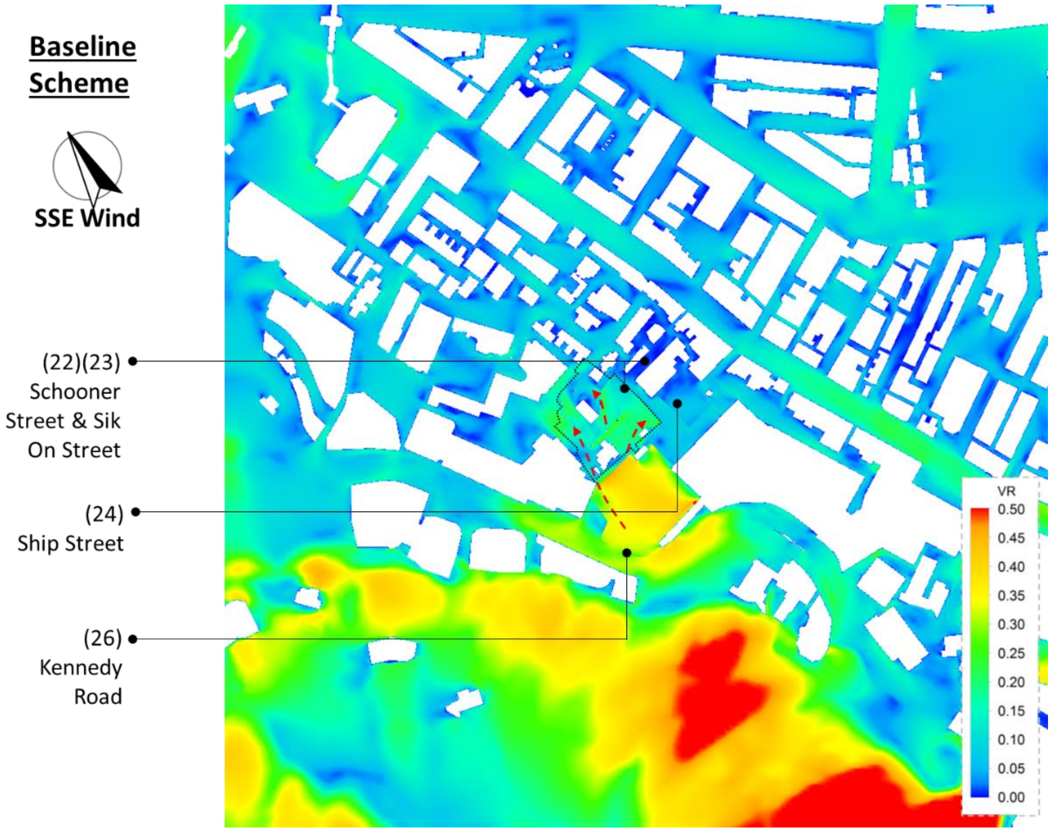
Baseline Scheme

Under SSE wind, the air flow from Kennedy Road can pass through the podium park of HCII and reach the site smoothly. The incoming wind can enter the site through the building gap between the Nam Koo Terrace and St. Francis Canossian College. The design feature of the ~5m high void above +34.0mPD podium level can enhance the air permeability for the wind to penetrate the site and flow to the downstream areas. Hence, a high VR can be observed on the podium and the downstream areas (i.e. Sau Wa Fong). For the north-eastern side of the site, the three-level podium up to +34.0mPD for open space can allow the incoming wind to flow smoothly to the downstream areas (i.e. Ship Street).

Indicative Development Scheme

In general, the surrounding wind environment for both schemes are similar. Like the air path routes under SE wind, the higher proposed residential building block under Indicative Development Scheme in comparison with Baseline Scheme can induce the downwash effect of the upper portion of incoming wind on the open space above the podium level, resulting in a higher VR area (red circle area). Moreover, the design feature of replacing the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP into an open space can be beneficial to the incoming wind to converge in this area. Hence, a high VR for this local area can be observed (red circle area). Besides, a higher ventilation performance can be observed at Sik On Street (red circle area) in comparison with the Baseline Scheme. The reason of it may be due to the longer frontage of the proposed residential block can drive the upper level incoming wind to reach this downstream areas.

For the north-eastern part of the site, the ventilation performance on the up to +33.6mPD three-level podium open space is similar to the Baseline Scheme that has a high VR in this area. And the design feature of setback along Schooner Street can also increase the ventilation performance at pedestrian level of Schooner Street.



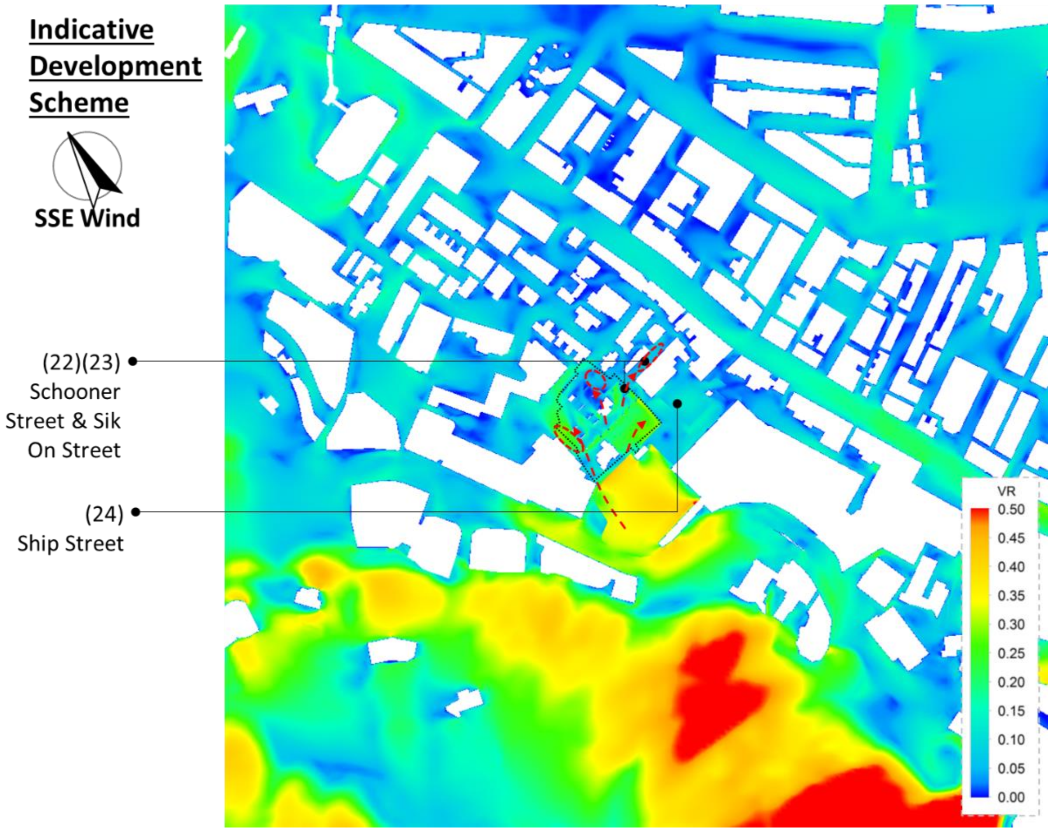


Figure 6.2.7.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, SSE Wind

6.2.8. Comparison for S Wind Direction

Figure 6.2.8.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under S wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

In the south side, the major air path to the site area is from Kennedy Road through podium park of HC II (red arrow line) under S wind direction.

Baseline Scheme

Under S wind, the air flow from Kennedy Road is separated to three major air paths. One air path turns towards the west direction along Kennedy Road. The second air path passes through the podium park of HC II to the site area via the building gap between St. Francis' Canossian College and Nam Koo Terrace. Lastly, the last air flow branch turns towards the Ship Street Garden.

The design feature of ~5m high void above podium level allows the incoming wind to pass through the site and reach the downstream areas at the north-western side of the site. Another part of air flow will recirculate around the St. Francis' Canossian College area at the south-western side of the site. The three-level podium up to +34.0mPD for open space can help to converge the incoming wind to enter the downstream areas.

Indicative Development Scheme

For the Indicative Development Scheme, similar air flow pattern to the Baseline Scheme can be observed that the incoming winds is separated into three major air paths. In comparison with the Baseline Scheme, a large portion of the air path flowing to the north-eastern side of the site can be observed. A slightly higher VR than Baseline Scheme can be observed at the Schooner Street and Ship Street (red circle area), while the downstream areas at the north-western part (i.e. Sau Wa Fong) has a weaker wind performance (black circle area).

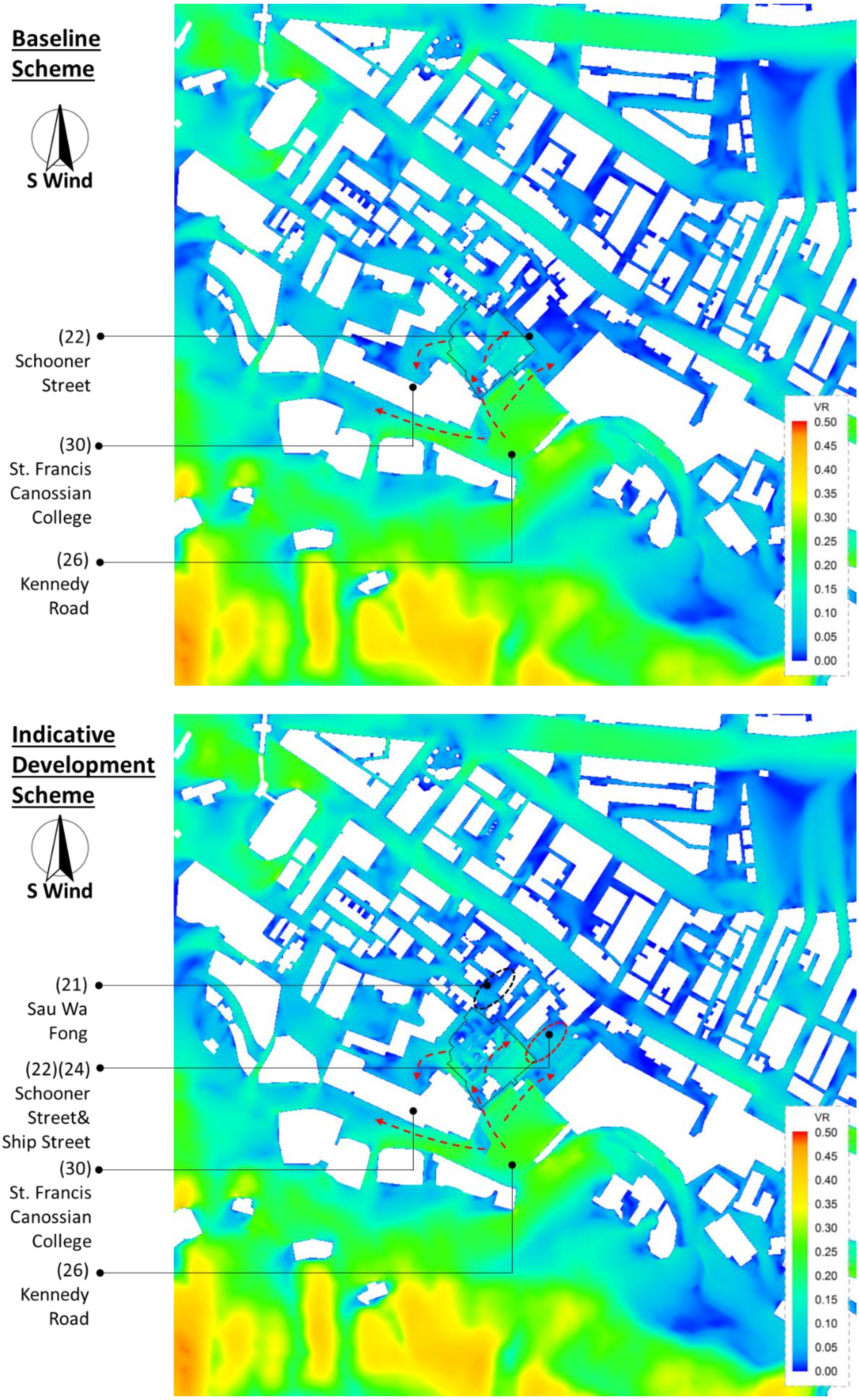


Figure 6.2.8.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, S Wind

6.2.9. Comparison for SSW Wind Direction

Figure 6.2.9.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under SSW wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

The SSW wind is the dominant wind in the summer prevailing wind. In the south side of the site, the major air path is along the Kennedy Road under SSW wind direction.

Baseline Scheme

Referring to the velocity vector distribution (Appendixes D and E) around the site, the air flow (red arrow line) is generally in an opposite direction against the SSW wind direction, i.e. part of the air flow enter the site from the south-eastern side from the Kennedy Road. The reason of it is due to the fact that the uneven hilly terrain features at the south part of the site will redirect the incoming SSW winds direction.

The design feature of ~5m high void above podium level allow the incoming wind to pass through the site and flow to the downstream areas at the north-western side of the site. Part of air flow at the western side of the site will be recirculated around the St. Francis' Canossian school due to the fact that a stronger downwash effect induced by the building block. Another part of the wind will flow to the north-eastern part of the site and reach the downstream areas (i.e. Ship Street).

Indicative Development Scheme

For the Indicative Development Scheme, the major incoming air flow are also coming from the Kennedy Road at the south-eastern side of the site. Similar air flow pattern to the Baseline Scheme can be observed. The design feature of three-level podium up to +33.6mPD open space can help to converge the winds to improve the air flow performance at the downstream areas. A slightly weak ventilation performance can be observed in the downstream area at Sik On Street (black circle area) in comparison with the Baseline Scheme.

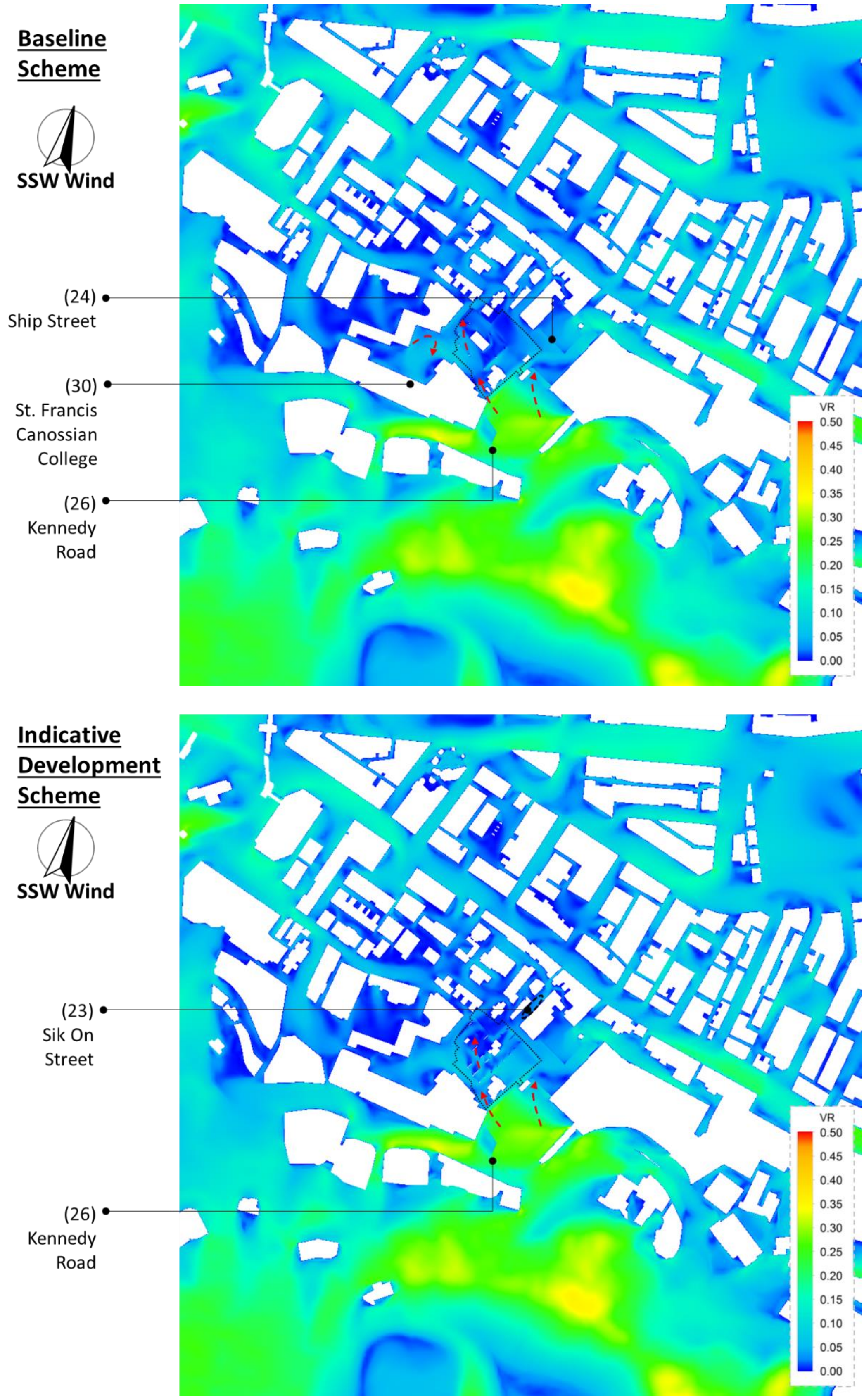


Figure 6.2.9.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, SSW Wind

6.2.10. Comparison for SW Wind Direction

Figure 6.2.10.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under SW wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

The major air path is along Queen’s Road East, Star Street and Kennedy Road in the northern, north-western and southern side of the site respectively under SW wind direction.

Baseline Scheme

Under SW wind, the major incoming winds to the site are coming from the Queen’s Road East and Star Street. The +34.0mPD podium divert the incoming wind from Star Street into two parts. One part of the wind will flow towards the south-western direction and reach St. Francis Canossian College. The air flow will be recirculated in this area resulting in a higher VR. Another part of the wind will flow along the Schooner Street where the design feature of setback is beneficial to enhance the wind performance at the pedestrian level. Moreover, some of the air flow will penetrate the design feature of ~5m high void above podium level and then pass through the building gap between the Nam Koo Terrace and St. Francis Canossian College to enter the downstream major road (Kennedy Road).

Indicative Development Scheme

For the Indicative Development Scheme, the air flow pattern around the site is similar to the Baseline Scheme. The open space of replacing the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199P has the similar VR in comparison with the Baseline Scheme. The incoming wind will pass through the ~6m high void above podium level and reach the downstream areas. And other wind flowing through the site is coming from the Ship Street at the north-eastern part of the site. In general, there is no much difference of the surrounding area ventilation environment can be observed between the Baseline Scheme and the Indicative Development Scheme.

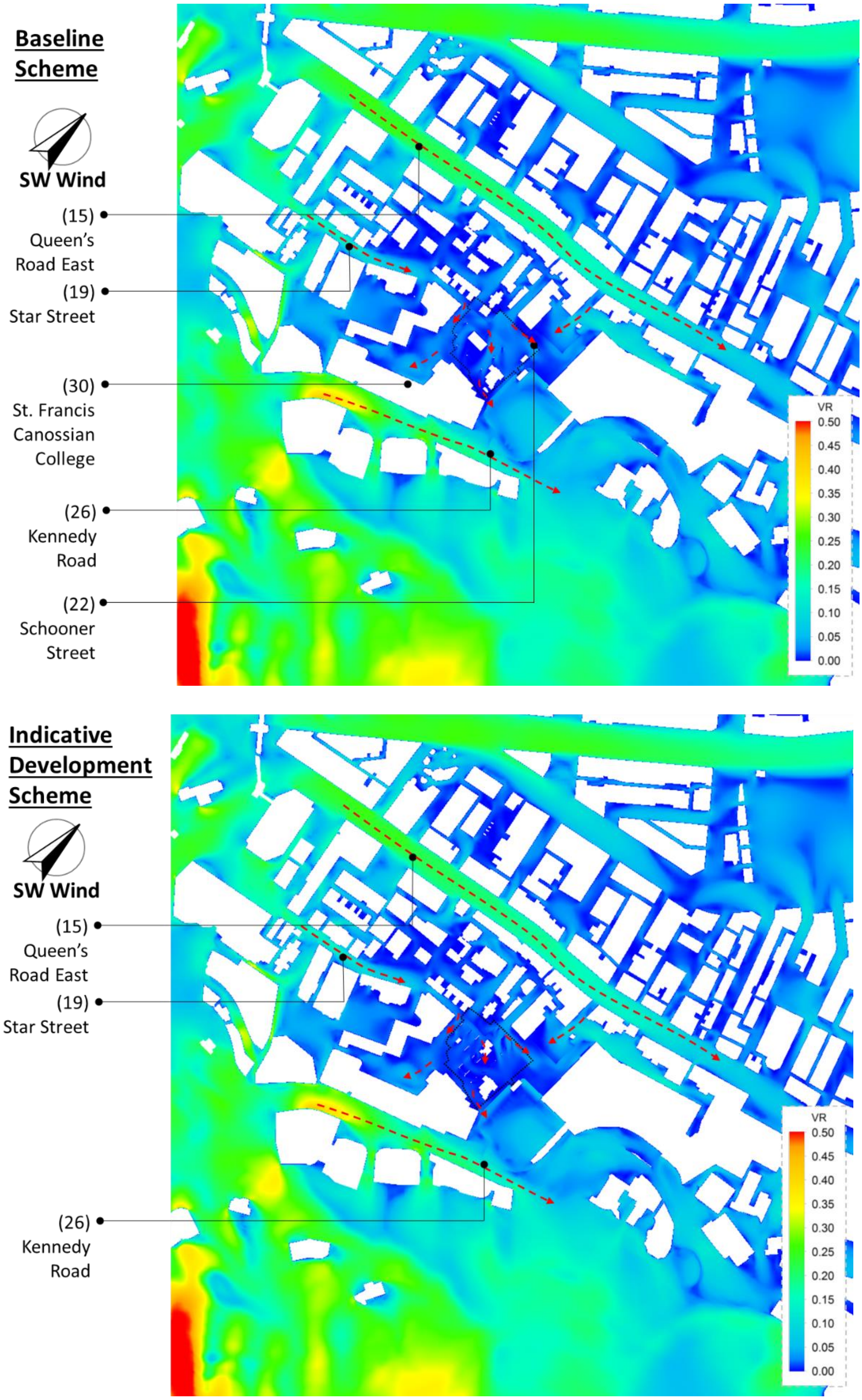


Figure 6.2.10.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, SW Wind

6.2.11. Comparison for WSW Wind Direction

Figure 6.2.11.1 shows the comparison of the VR contours at 2m above ground level for the Baseline and Indicative Development Schemes under WSW wind. The zoom in VR contours and velocity vectors are also shown in Appendix D (Baseline Scheme) and Appendix E (Indicative Development Scheme) for reference.

Under WSW wind direction, it is similar to SW wind direction that the major air path is along Queen's Road East and Kennedy Road in the northern and southern side of the site respectively under WSW wind direction.

Baseline Scheme

For the Baseline Scheme, the incoming air flow comes from the north-western side of the site. Part of the wind will turn towards to the south-western direction and enter the St. Francis Canossian College. The downwash effect induced by the St. Francis Canossian College will ventilate the pedestrian level. The design feature of setback along Schooner Street can enhance the ventilation performance at the pedestrian level of Schooner Street. Moreover, the ~5m high void above podium level can enhance the air permeability to allow the incoming wind to pass through the site. The air flow will penetrate the building gap between the Nam Koo Terrace and St. Francis Canossian College and then reach the downstream areas.

Indicative Development Scheme

For the Indicative Development Scheme, the design feature of replacement of the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199P to an open space (red circle area) has a higher VR in comparison with the Baseline Scheme as there is no blockage to hinder the air flow. In general, the air flow pattern for the Indicative Development Scheme is similar to the Baseline Scheme as both of them has the design feature of a void above podium level to enhance the air permeability for the incoming wind to pass through.

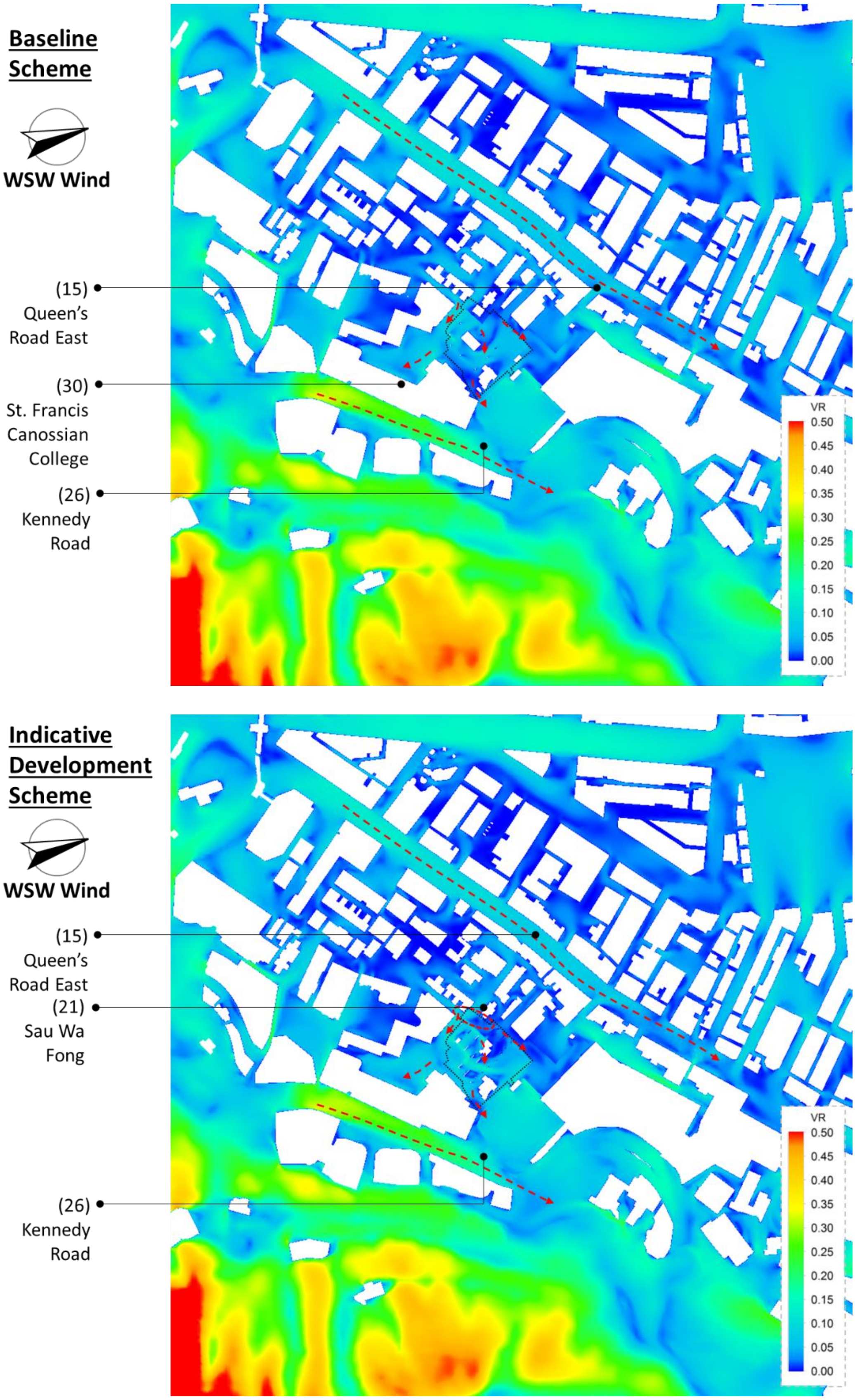


Figure 6.2.11.1 Comparison of VR Contour of Baseline & Indicative Development Schemes, WSW Wind

6.2.12. Summary of VR Test Points

For a comprehensive comparison of the variation in pedestrian level ventilation on the areas of interest, the Velocity Ratio (VR) values under annual and summer wind roses are provided for easy reference. Two parameters are used to characterize the pedestrian level natural ventilation, namely SVR (Site spatial averaged Velocity Ratio) and LVR (Local spatial averaged Velocity Ratio). A higher value than the other indicates a better ventilation performance.

Table 6.2.12.1 shows the comparison of VR test points for Baseline and Indicative Development Schemes. It is observed similar local spatial wind environments (LVR) at the pedestrian level for both the Baseline Scheme and the Indicative Development Scheme under either annual or summer prevailing wind directions. But it has a slight improvement of site spatial wind environment (SVR) in the Indicative Development Scheme under both annual and summer prevailing winds.

Table 6.2.12.1 SVR and LVR Comparison for Baseline Scheme and Indicative Development Scheme

Scheme	Annual		Summer	
	Baseline	Indicative Development	Baseline	Indicative Development
SVR	0.04	0.05	0.06	0.07
LVR	0.08	0.08	0.08	0.08

Table 6.2.12.2 summarizes the weighted average VR of both schemes for each location (refer to Table 5.3.1 and Figures 5.3.2 to 5.3.3). As indicated in the weighted average VR, the Indicative Development Scheme has a similar wind environment at pedestrian level with the Baseline Scheme from areas adjacent to the site.

The good design feature with a void above podium level configuration of both Schemes plays an important role in giving a positive impact. The proposed void can enhance the air permeability to allow more air flow passing through the building block and reach the downstream areas at the pedestrian level. Moreover, the setback along Schooner Street can widen the wind channel at pedestrian level of Schooner Street (Overall Test Points T82 to T84) to enhance the ventilation performance. For the Indicative Development Scheme, the replacement of the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP to an open space can help to converge the air flow and then ventilate the downstream areas. All these design features can improve the wind environment and distribution over the area of site as well as some of the surroundings. However, due to the smaller influenced zone of the site, such an improvement is not that as one can anticipate.

Moreover, all eleven (11) wind directions of these locations are outlined in Appendix F together with full details of the raw data of individual test point values for each scheme under different wind directions.

Table 6.2.12.2 Annual and Summer Weighted Average VR Test Points

No.	Location Name	Test Points	Annual		Summer	
			Baseline	Indicative Development	Baseline	Indicative Development
1	Hennessey Road	T01-T03	0.22	0.22	0.16	0.16
2	Johnston Road	T04-T11	0.11	0.11	0.09	0.09
3	Thomson Rd Johnston Rd Junction	T12	0.11	0.11	0.07	0.07
4	Anton Street	T13-T15	0.12	0.12	0.09	0.09
5	Landale Street	T16-T18	0.07	0.07	0.07	0.07
6	Li Chit Street	T19-T20	0.04	0.04	0.04	0.04
7	Gresson Street	T21-T23	0.07	0.07	0.04	0.04
8	Lun Fat Street	T24-T26	0.05	0.05	0.04	0.03
9	Ship Street (North of QRE)	T27-T29	0.09	0.09	0.05	0.05
10	Tai Wong Street West	T30-T32	0.08	0.07	0.05	0.05
11	Tai Wong Street East	T33-T36	0.06	0.06	0.05	0.04
12	Swatow Street	T37-T39	0.06	0.06	0.04	0.05
13	Amoy Street	T40-T41	0.05	0.05	0.06	0.06
14	St. Francis' Canossian School	T42-T44	0.02	0.02	0.03	0.03
15	Queen's Road East (QRE)	T45-T59	0.12	0.13	0.12	0.12
16	Wing Fung Street	T60-T61	0.07	0.07	0.09	0.09
17	Sun Street & Moon Street	T62-T66	0.04	0.04	0.05	0.06
18	St. Francis Yard	T67-T68	0.02	0.02	0.03	0.02
19	Star Street	T69-T73	0.05	0.05	0.08	0.08
20	St. Francis Street	T74-T77	0.03	0.03	0.04	0.04
21	Sau Wa Fong	T78-T81	0.03	0.04	0.04	0.04
22	Schooner Street	T82-T84	0.02	0.03	0.02	0.03
23	Sik On Street	T85	0.02	0.03	0.03	0.04
24	Ship Street (South of QRE)	T86-T88	0.03	0.03	0.03	0.03
25	Ship Street Garden	T89-T93, T135	0.03	0.03	0.03	0.03
26	Kennedy Road	T94-T110	0.10	0.10	0.13	0.13
27	Monmouth Terrace	T111-T113	0.07	0.06	0.08	0.08
28	Back Lane on North Side of HC II Podium	T114-T116	0.05	0.05	0.07	0.07
29	Bowen Road	T117-T125	0.20	0.20	0.23	0.23
30	St. Francis Canossian College	T126	0.02	0.02	0.04	0.04
31	Lee Tung Avenue	T127-T128	0.07	0.07	0.06	0.06

No.	Location Name	Test Points	Annual		Summer	
			Baseline	Indicative Development	Baseline	Indicative Development
32	Electric Street	T129-T130	0.05	0.05	0.08	0.08
33	Bowen Road Temporary Sitting-out Area	T131	0.12	0.12	0.18	0.18
34	Monmouth Terrace Playground	T132-T133	0.03	0.03	0.05	0.06
35	Kwong Ming Street Children’s Playground	T134	0.02	0.02	0.04	0.04
36	Site Perimeter (SVR)	P01-P30	0.04	0.05	0.06	0.07
37	Special Test Points	S01-S12	0.05	0.05	0.06	0.07

7. Recommendation of Mitigation Measures

As demonstrated in the assessment above, some locations will have a good ventilation performance for certain wind directions but may perform worse at other wind directions. The comparisons above also illustrate that the changes in development scheme will mainly affect the VR in its proximity.

As discussed in above Sections, the Indicative Development Scheme would adopt the arrangement of a three-level podium up to +33.6mPD for open space. It provides the design with a ~6m high void above podium level under the proposed 24-storey residential block. Under the podium level, a ~3m building ground floor along Schooner Street is provided to widen the wind channel to enhance ventilation performance at the pedestrian level. Moreover, the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP is replaced to an open space to enhance the local ventilation environment as well as the downstream area.

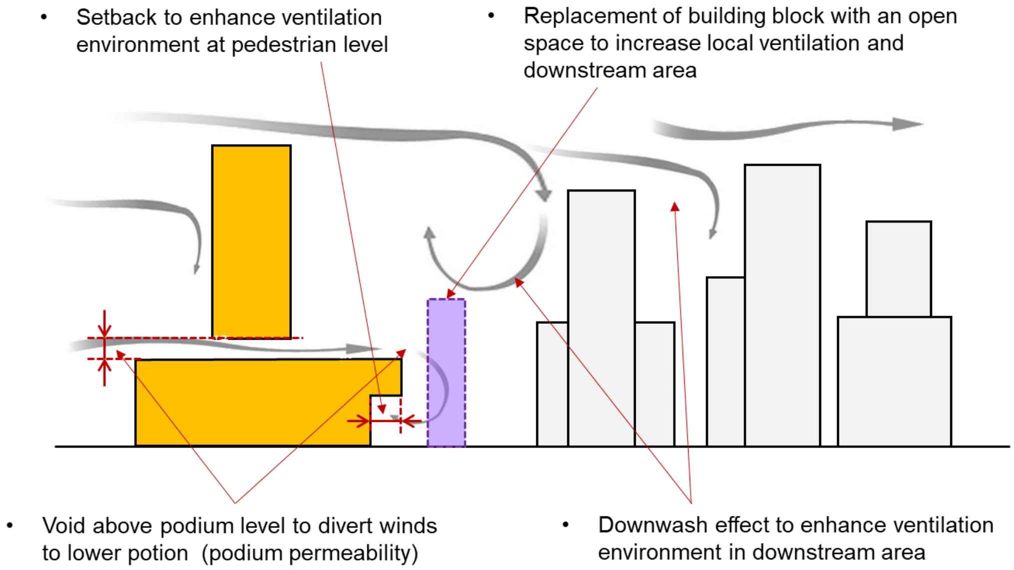


Figure 7.1 Illustration of Mitigation Measures

These mitigation measures are essential in ensuring the Indicative Development Scheme will enhance the wind permeability at its podium level as well as the wind capturing potential of the site and the wake area around it (refer to the schematic diagram in Figure 7.1). Moreover, considering the height of a 24-storey residential block, the downwash winds converging into downstream areas of the site also help to improve the ventilation environment. Thus, the wind environment of the Rezoning Site and its surrounding neighborhood is slightly improved. Therefore, it is recommended to ensure these mitigation measures be implemented at detailed design stages.

8. Conclusions

Detailed 3D CFD simulations have been conducted for comparing the Baseline Scheme (a S16 approved scheme with the comprehensive development) and Indicative Development Scheme. Based on the methodology outlined in AVA Technical Guide, the pedestrian level wind environments are compared in detail with the consideration of annual and summer prevailing wind directions in Wan Chai. In general, the Indicative Development Scheme will result in a similar local spatial ventilation environment (LVR) with the Baseline Scheme under both annual and summer prevailing wind directions. It has a slight improvement of site spatial wind environment (SVR) in the Indicative Development Scheme under annual and summer prevailing winds. However, due to the small site coverage compared to the total assessment area coverage, the improvement indicated in the SVR is relatively minor.

With a detailed examination on the annual and summer weighted VR contour plots for these two schemes, it is noted that there were no stagnant zones on the pedestrian level along Kennedy Road, Queen's Road East and Johnston Road for both schemes within the assessment area.

Low pedestrian level natural ventilation is observed along most perpendicular narrow streets between Queen's Road East and Johnston Road on the northern side of the site. This is because the existing buildings along these streets are all located near each other and some of them are arranged in an unfavorable direction, i.e. the narrow streets between Queen's Road East and Johnston Road running from north to south. The existing building layout results in a strong urban canopy effect which prevents good air circulation at the pedestrian level even under a windy condition with a prevailing E wind.

To the west of the site, the wind environment at pedestrian level is also relatively less ideal for the similar reasons stated above. The area does not have many connections to the existing buildings along Queen’s Road East. With the lack of street as ventilation corridor, the wind movement in this area is likely to be less.

Areas of the southern side of Kennedy Road are located at the high hilly terrain and the wind speed will be higher than the areas of Queen's Road East and Johnston Road. With the consideration of the annual and summer prevailing wind directions, the weighted VR around those buildings on the southern side of Kennedy Road is considered good under both schemes. The wind environment at hilly terrain is relatively better and is not affected by the site at the lower terrain. There should not be any adverse impact to the buildings due to the Indicative Development Scheme design.

With the configuration of the site in the Indicative Development Scheme, the wind environment adjacent to the site is slightly improved under annual prevailing winds. Most likely, this improvement is due to the arrangement of 24-storey residential block with three-level podium up to +33.6mPD at I.L.9048, together with the ~6m high void above podium level under the residential block. The large open space and the ~6m high void provide a ventilation pathway under the building. It diverts winds to the downstream area and brings a better wind environment to the lower portion of the site.

Moreover, under the podium level, a mitigation design with a setback along Schooner Street is also provided which aims to enhance the local ventilation environment at pedestrian level and its surroundings. Besides, the existing 6-storey residential building (No.18 Sau Wa Fong) on the site of I.L.199 RP is replaced to an open space to enhance the local ventilation environment as well as the downstream area.

Based on the findings and comparison of all two development schemes, it is concluded that the Indicative Development Scheme has a similar overall natural ventilation to the surrounding area with the Baseline Scheme.

Appendix A

The Use of FLUENT and Harpoon by US EPA

Not in Use

Appendix A - The Use of FLUENT and Harpoon by US EPA

Pollution Dispersion in Urban Landscapes

By Alan Huber, *National Oceanic and Atmospheric Administration, ASMD*, in partnership with *US Environmental Protection Agency, National Exposure Research Laboratory*, Research Triangle Park, North Carolina, USA; Matthew Freeman and Richard Spencer, *US EPA Environmental Modeling and Visualization Laboratory, Lockheed-Martin Operations Support*, Research Triangle Park, North Carolina, USA; Walter Schwarz, Brian Bell, and Karl Kuehlert, *Fluent Inc.*

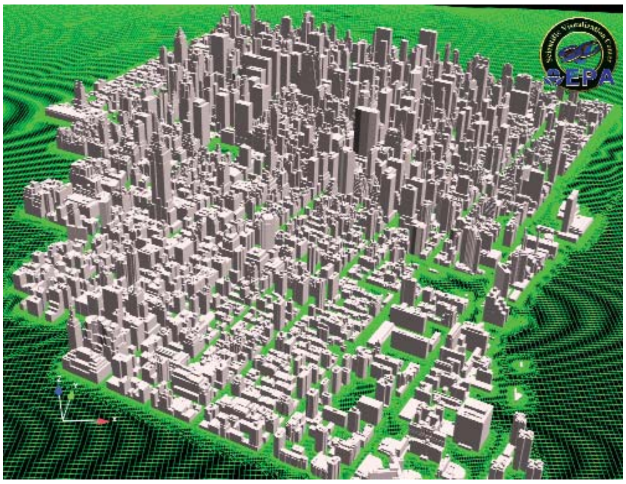
Understanding the pathways of toxic air pollutants from their source through the air humans breathe in urban areas is of critical interest to governmental agencies that have a responsibility to protect the public health and welfare. Rapid assessments of risk, such as the migration of toxic gases related to major fires or chemical spills, are vital to first responders, local officials, federal officials, and the public. The scientific shortcomings are especially serious for incidents that occur in an urban center where the airflow around large buildings is very complex and poorly understood.

High-resolution, high-fidelity CFD simulations have long been used in the aerospace and automotive industries to evaluate the detailed airflow associated with the design and operation of airplanes and cars. CFD techniques also have the potential to be used to describe, for example, the flow of pollutants from accidental explosions, fires, or routine emissions from human activities such as driving motor vehicles; or the release of biological agents associated with an accident or terrorist event.

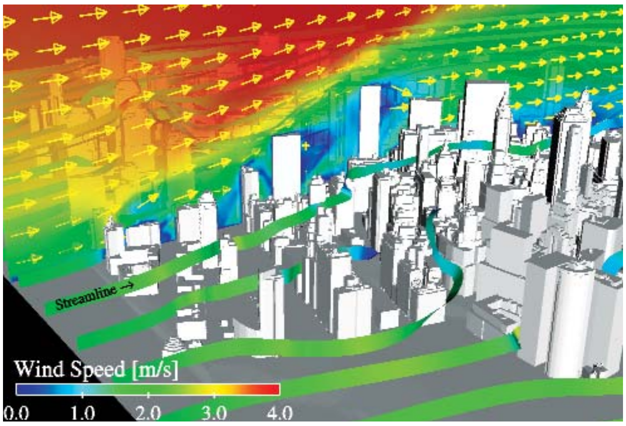
In recent years, CFD modeling has emerged as a promising technology for such assessments. Already in use by early-adopters, CFD has demonstrated the potential to yield accurate solutions because it is based on fundamental physics, on the effects of detailed three-dimensional geometry, and on local environmental conditions. However, today's CFD tools are not well evaluated for environmental modeling. Best-practice methodologies have not been established. Furthermore, today's CFD tools are not tailored to the specific needs and nomenclature of environmental scientists. All of these factors limit the ability of this group of researchers to benefit from CFD as a routine assessment technique.

Through a Cooperative Research and Development Agreement (CRADA), Fluent Inc. and the US Environmental Protection Agency (EPA) have worked towards the evaluation and demonstration of CFD for large-scale environmental applications. Efforts are being made to demonstrate best practices for using CFD as a tool for estimating potential human exposures to local sources of toxic air contaminants in geometrically complex environments.

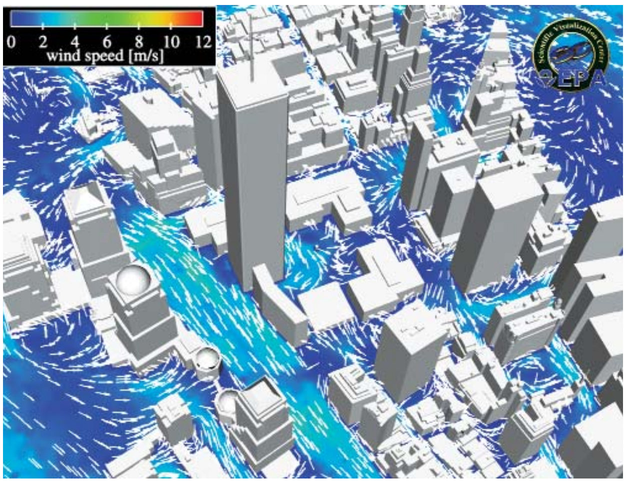
In addition to this general goal,



An example of the detailed building geometry for Manhattan, presented with a surface mesh on the ground; the mesh was created using Harpoon from CEI



A simulation of the complex wind patterns between the buildings of Manhattan, shown using vectors, pathlines, and contours of velocity on a vertical slice



Near surface winds from a CFD solution for lower Manhattan; while the solution has a 1-3m resolution near the ground only about 10% of the vectors are plotted; the winds are from the Northwest (upper left corner)

Fluent has been supporting the US EPA in developing simulations for large sections of Manhattan, which may be one of the most complex building environments worldwide. While it has been a challenging exercise to set up working CFD models that describe the detailed building environment for Manhattan, there have been many lessons learned that are making it easier to set up similarly complex urban environments for future studies. To date the project has focused on steady-state solutions using the widely used k-ε turbulence models. Ongoing developments are being extended to include unsteady solutions and higher order turbulence models as well.

Modeling large numbers of unique buildings typical of major urban areas presents special challenges in developing an applicable computational mesh. The digital geometries of many of the buildings in large cities have already been obtained and are being updated by government agencies and commercial vendors. While the typical building geometries from these sources easily support visual models, minor flaws that may not be visible lead to difficulties for CFD modeling. A great deal of development work has gone into improving and streamlining the clean-up procedures for flawed geometries of buildings and for other objects in general, such as manufactured equipment.

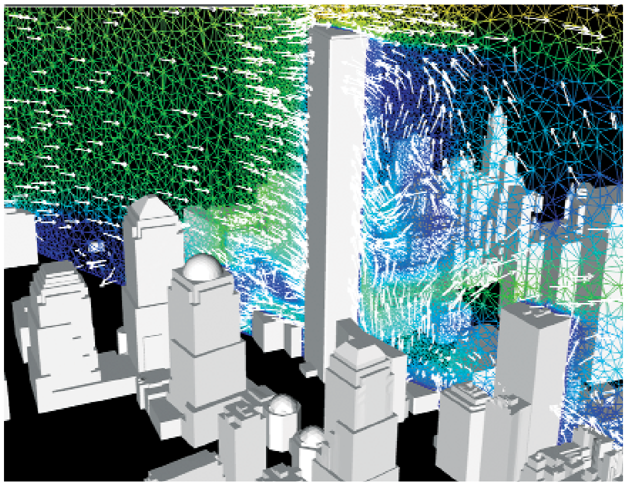
Once the geometry meets certain requirements, it is used for the creation of a surface mesh and subsequently, a volume mesh. For the steady-state simulations of urban areas performed to date, a mesh with computational cells one to two meters in size near the building surfaces has proven sufficient. This results in models with no more than 50 million cells overall, which can be handled by the computing resources available for the project. For future work the present methods are scalable to larger sized models.

One recent EPA study involved the dispersion of pollutants emanating from Ground Zero following the collapse of the World Trade Center (WTC), and this case has provided a unique opportunity to develop and demonstrate the capabilities of CFD for environmental analysis. Winds in urban micro-environments are very complex because of blockages and aerodynamic influences from the built environment. Visualizations of the flow on vertical slices through city streets or horizontal slices near ground level illustrate the complexity in the wind patterns. Even if only 10 percent of the solution vectors are plotted in a typical display, the pattern of downward airflow on the windward side of a building and upward flow on the leeward side is clear.

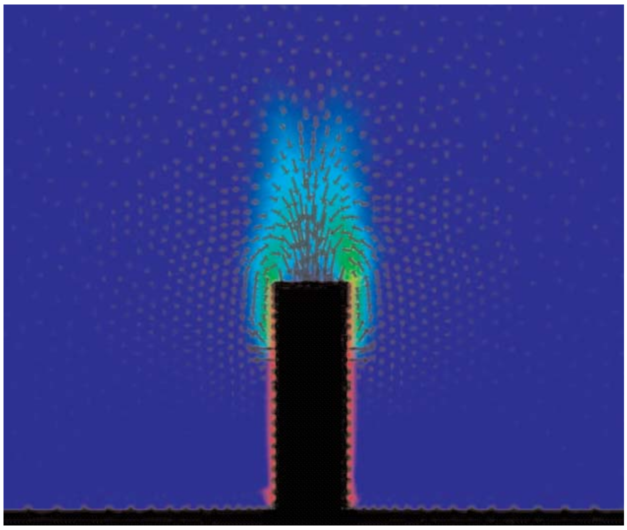
Before the collapse of the WTC, the buildings stored a great deal of potential energy, owing to their extreme height above the ground. During the collapse, this potential energy was converted to kinetic energy, and a large amount of momentum was generated. Each falling building entrained air into the volume previously occupied by the building, forming large circulation currents and strong local winds. In addition to the motion of the tower, the airflow in the vicinity of the WTC during the collapse was governed by the local built landscape and the air and smoke that squeezed out of the building and discharged into the surroundings as individual floors collapsed.

To simulate the fall of the tower, the dynamic mesh model in FLUENT was used. This capability allows the arbitrary motions of walls to be defined. By considering only the deformation of the outer shape of the building, the collapsing tower was essentially modeled as a piston approaching the ground surface. Approximately 90 to 95% of the volume of the WTC was assumed to be air and smoke; the remaining volume contained solid material.

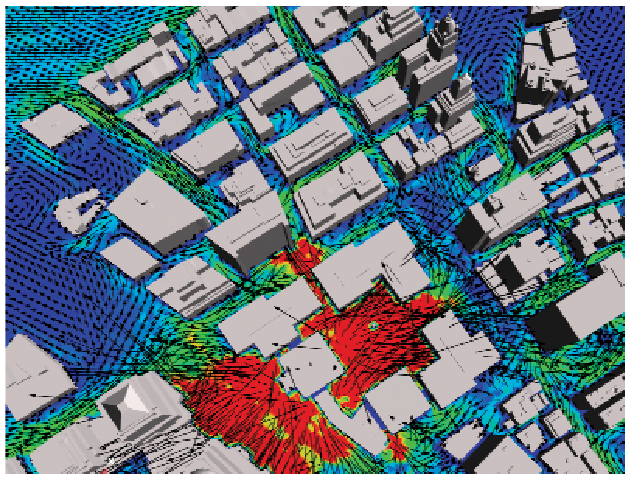
The collapse of the tower takes about 15 seconds. The CFD results indicate that the collapsing tower creates vortex structures in the surrounding air, which transport gaseous constituents and particulate matter radially outward from the base of the buildings. Particles of different size are injected into the airflow from each collapsed floor. The dispersion of the particles is directly controlled by the airflow and turbulence field. The smallest particles remain suspended within the displaced volume of the collapsing building, while the larger particles fall to the ground. The radial impulse created by the collapsed tower, with velocities of up to 30 to 40 m/s, is short- lived however, and soon the material is transported by the prevailing winds through lower



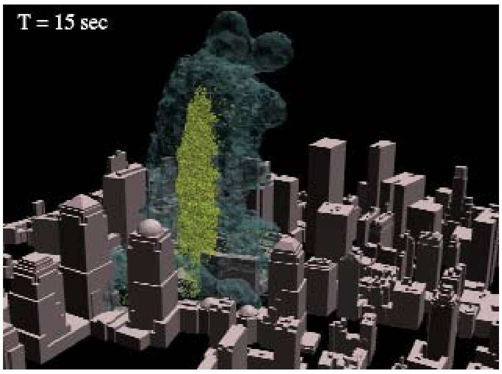
Winds from the northwest and the resulting airflow on a vertical plane in lower Manhattan

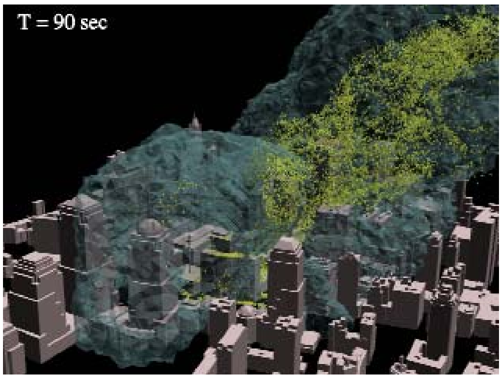


CFD simulation of a collapsing building showing air entrainment into the collapsed volume



Surface winds, 5m above the ground, immediately following the initiation of the building collapse





The outer boundaries of smoke (gray) and a particle cloud (yellow) 15 (top) and 90 (bottom) seconds after the start of the building collapse

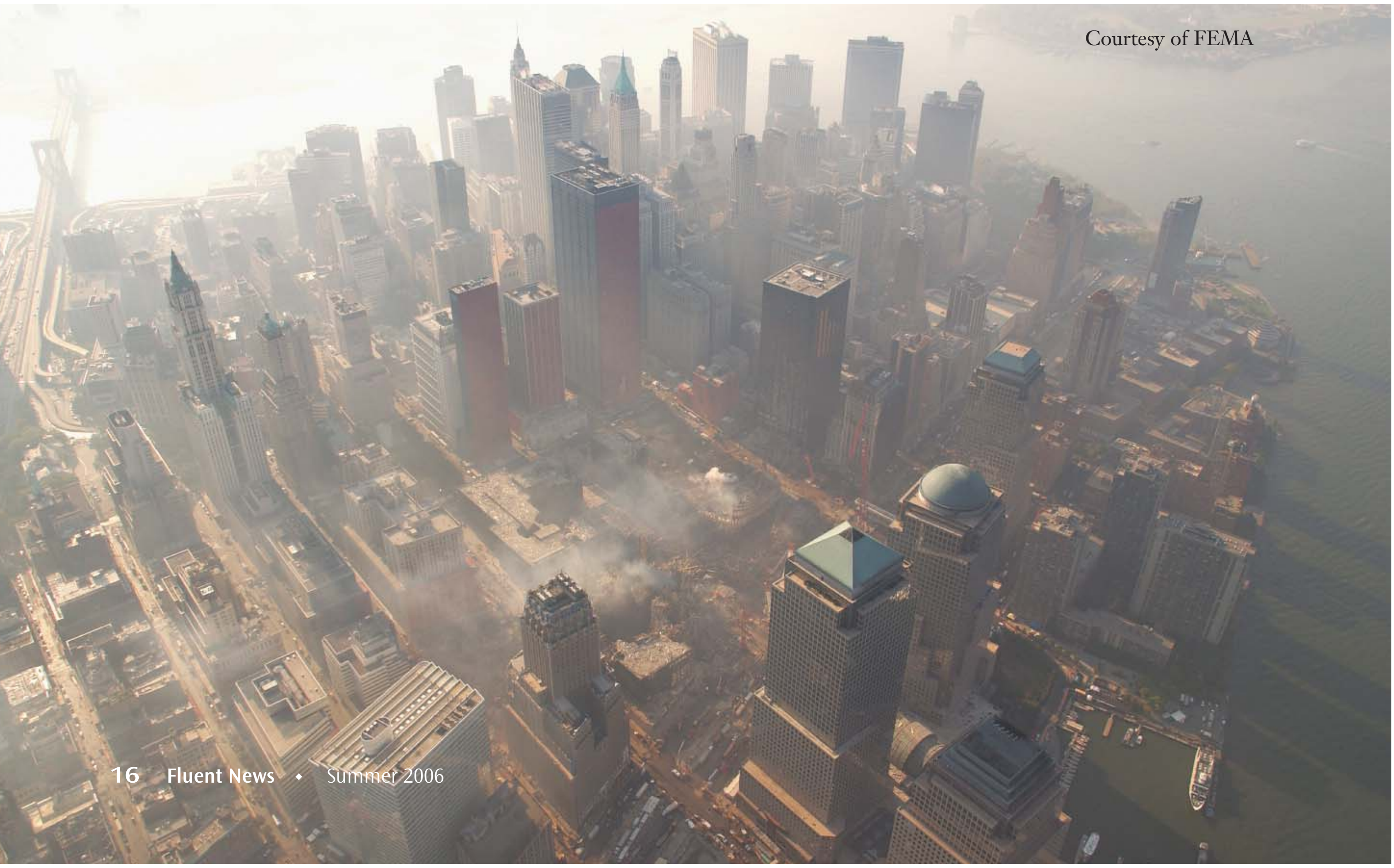
Manhattan and into the surrounding metropolitan area.

The CFD results are being compared to data recorded in an EPA wind tunnel model using post 9/11 conditions with westerly or south-westerly winds. Generally good comparison has been found at several measurement points, particularly in vertical profiles of wind speed. Other variables such as wind direction and turbulent kinetic energy have also been compared. Overall, these results support the CFD methodology.

The application of CFD simulations may evolve for routine environmental use following further demonstrated evaluations with wind tunnel models and field measurements. Measurements alone will rarely be sufficient for accurate planning or understanding what may have happened during an event. Ongoing developments and demonstrations of the reliability and accuracy of CFD simulations will lead to its broad future application for urban air quality and homeland security studies. As has happened for the aerospace and automotive industries, continued evaluation work will make CFD simulations increasingly trusted by environmental engineers for applications such as this. ■

Disclaimer: Although this work has been reviewed by EPA and NOAA and approved for publication, it does not necessarily reflect their policies or views.

Acknowledgement: Scientific visualization and high performance computing were provided through support from the US EPA's National Environmental Computing Center.

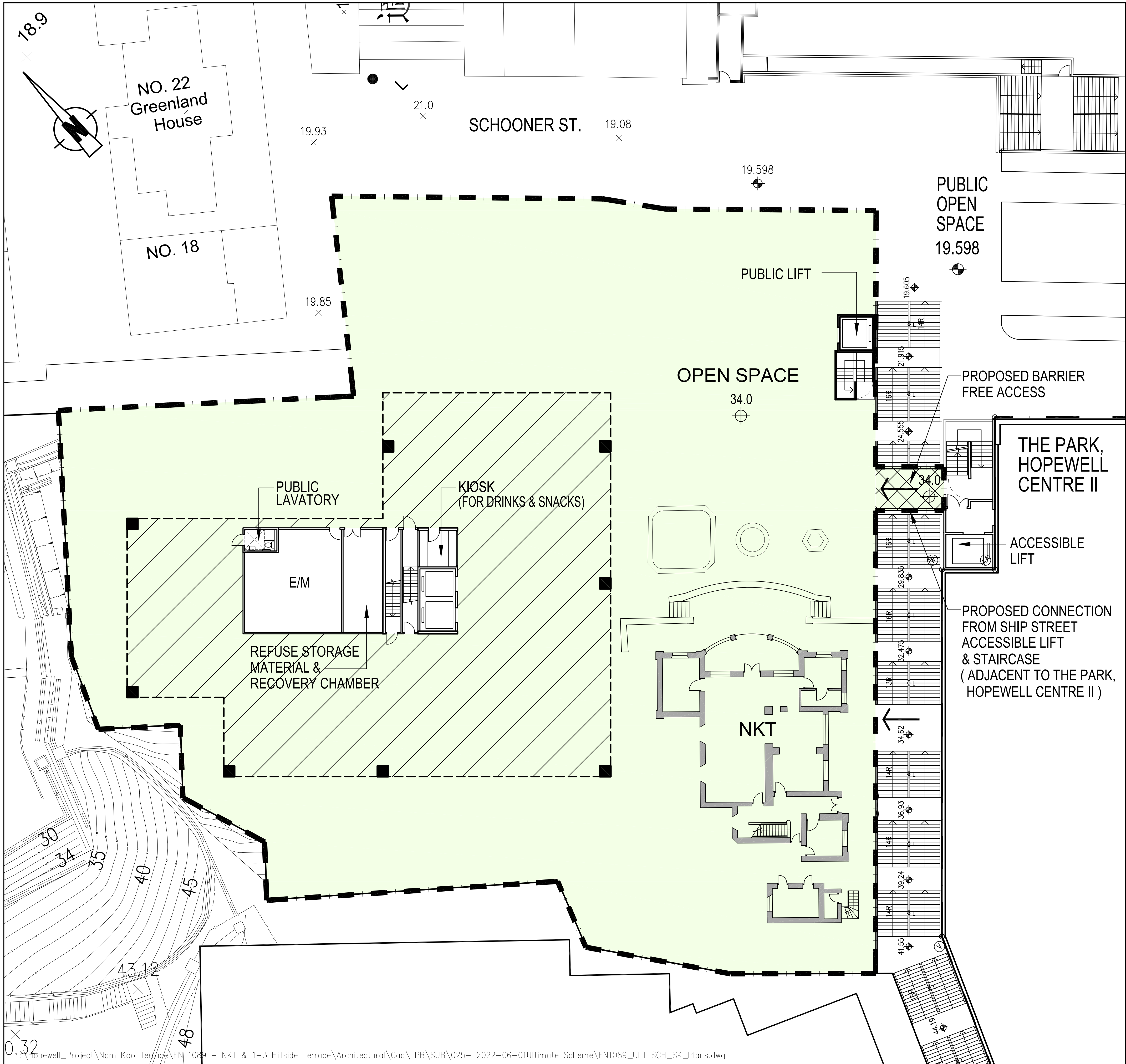


Courtesy of FEMA

Appendix B

Master Layout Plan for Baseline Scheme

Not in Use



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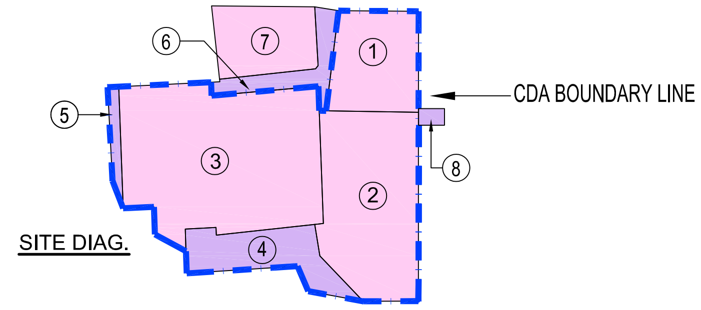


APPLICATION SITE

	SITE	SITE AREA (m^2)
1 - 7	DEVELOPMENT SITE	2,828.8 (APPROX.)
8	PROPOSED BFA	16.9
	TOTAL	2,845.7 (APPROX.)

DEVELOPMENT SITE

	SITE		SITE AREA (m^2)	
1	MIU KANG TER. (MKT)	CDA	342.0	2428.8 (APPROX.)
2	NAM KOO TER. (NKT)		685.0	
3	HILLSIDE TER. (HST)		1,100.9	
4	SLOPE		256.9 (APPROX.)	
5	SLOPE		44.0 (APPROX.)	
6	STEPS		130.0 (APPROX.)	
7	I.L. 9048		270.0	
	TOTAL		2,828.8 (APPROX.) SUBJECT TO DETAILED TOPOGRAPHICAL SURVEY	

OPEN SPACE PROVIDED (m^2)				
UNCOVERED			1,980.0	2,669.0
COVERED			689.0	
SITE COVERAGE ABOVE 15 m = 830 m (29.34%)				
(MEAN STREET LEVEL = (41.55 + 19.598) / 2 = 30.574 mPD.)				
NAM KOO TER. (NKT)	2 STOREYS X 192.0	=	384.0 APP.	384.0 APP.
FLATS	17 STOREYS X 812.3	=	13,809.1	14,144.0
G/F	DOMESTIC : 28.5 NON-DOMESTIC : 31.2	=	59.7	
L3/F	DOMESTIC : N.A. NON-DOMESTIC : 7.8	=	7.8	
L2/F	DOMESTIC : N.A. NON-DOMESTIC : 7.8	=	7.8	
L1/F	DOMESTIC : 67.6 NON-DOMESTIC : 192.0	=	259.6	
			TOTAL	14,528.0

14,528.0 / 2,828.8 = PLOT RATIO 5.136
14,144.0 / 2,828.8 = PLOT RATIO 5.0 (EXCLUDING NKT)

RESIDENTIAL RECREATIONAL FACILITIES
(G.F.A EXEMPTED) = 689.0 m^2

OPEN SPACE (INCLUDING NKT HISTORICAL BLDG.)	= 1,980.0 m^2
COVERED LANDSCAPE AREA	= 689.0 m^2
PROPOSED BARRIER FREE ACCESS (BFA)	
BOUNDARY LINE OF APPLICATION SITE	

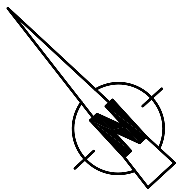
PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

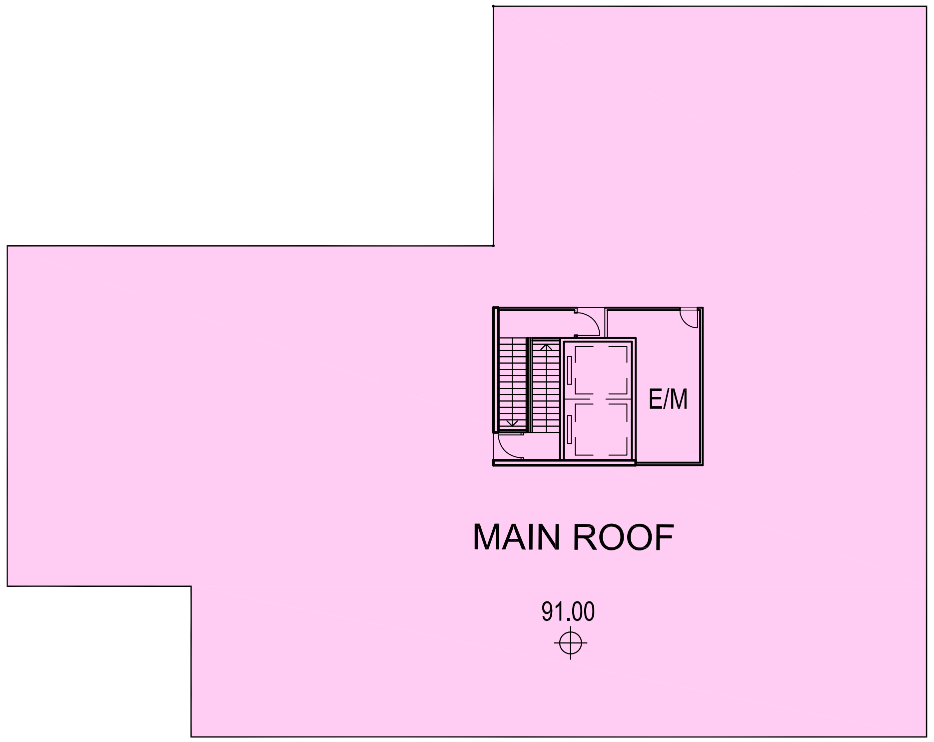
OVERALL LAYOUT PLAN

0 5 10m
SCALE : 1:300 @A3

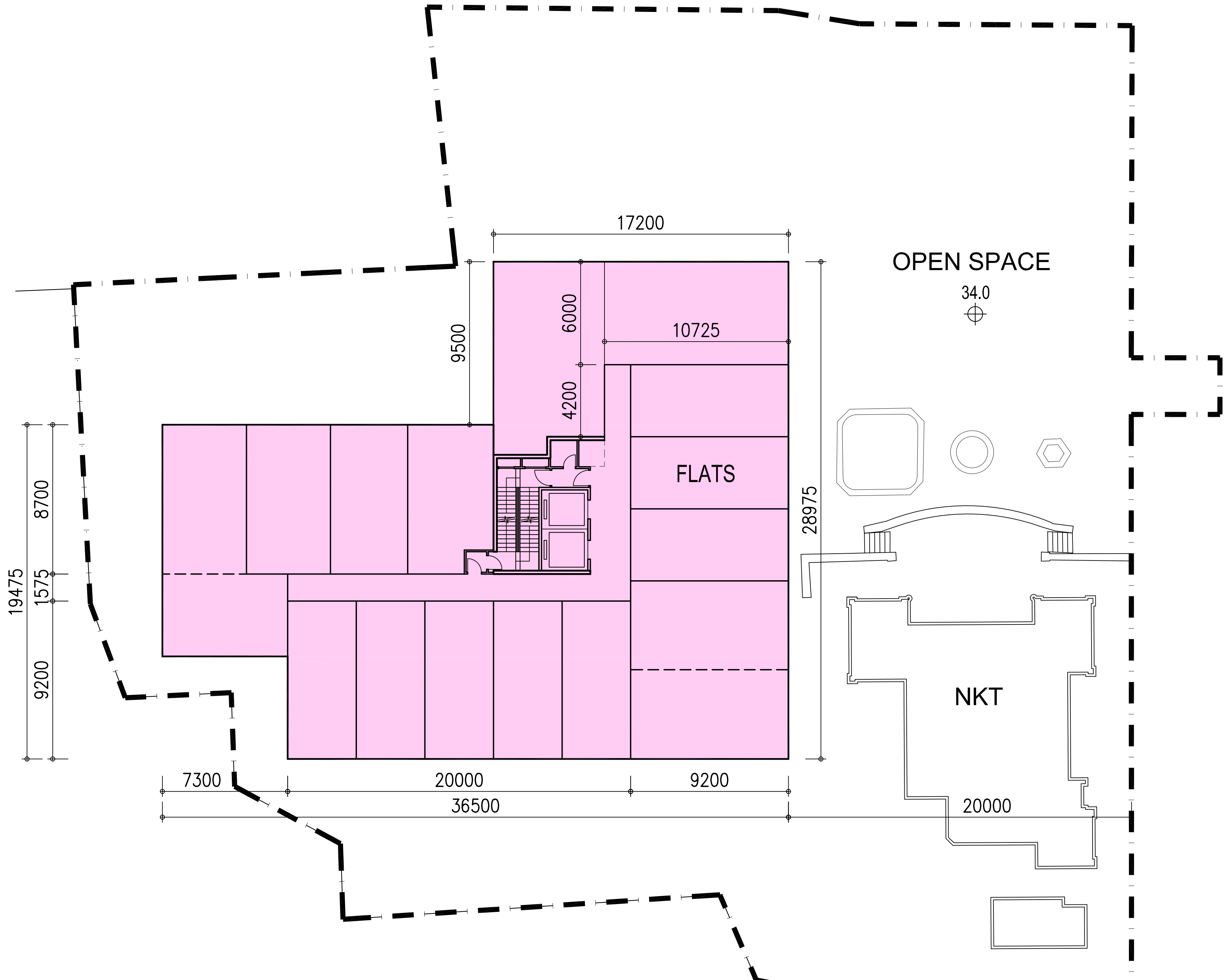
DWG. NO : TPB - 001
DATE : 01/06/2022

HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司





ROOF PLAN



2/F - 18/F PLAN

NO. OF UNITS / FL.

= 15 NOS.

TOTAL NO. OF UNITS

= 17 STOREYS X 15 NOS.

= 255 NOS.

LEGEND:

BOUNDARY LINE OF APPLICATION SITE

NOTE :
FLOOR NO. 1/F IS NOT APPLICABLE IN THIS DEVELOPMENT.

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PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

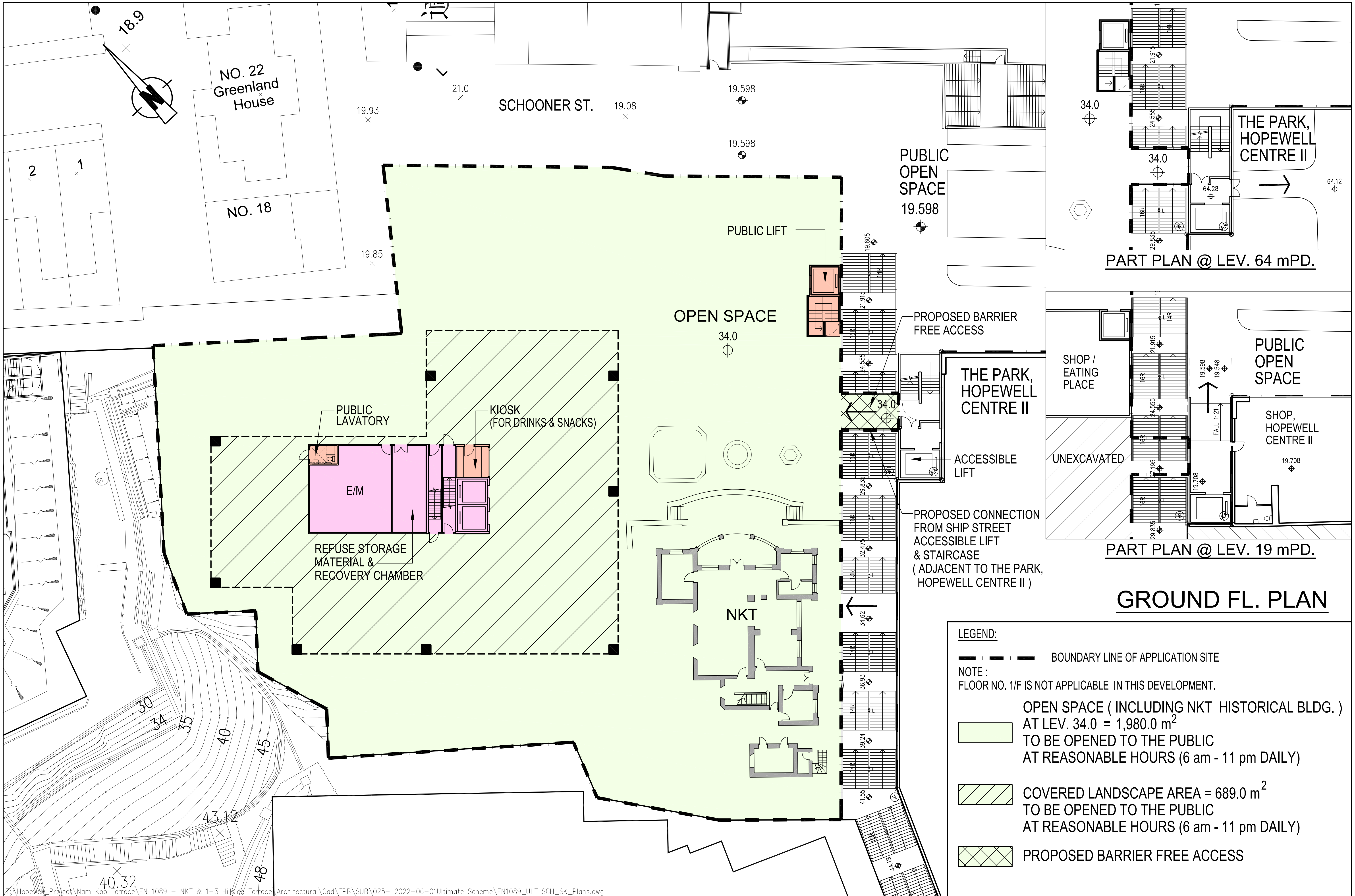
0 5 10m

SCALE : 1:300@A3

DWG. NO : TPB - 002

DATE : 01/06/2022

HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司



LEGEND:

BOUNDARY LINE OF APPLICATION SITE

NOTE :
FLOOR NO. 1/F IS NOT APPLICABLE IN THIS DEVELOPMENT.

OPEN SPACE (INCLUDING NKT HISTORICAL BLDG.) AT LEV. 34.0 = 1,980.0 m^2 TO BE OPENED TO THE PUBLIC AT REASONABLE HOURS (6 am - 11 pm DAILY)

COVERED LANDSCAPE AREA = 689.0 m^2 TO BE OPENED TO THE PUBLIC AT REASONABLE HOURS (6 am - 11 pm DAILY)

PROPOSED BARRIER FREE ACCESS

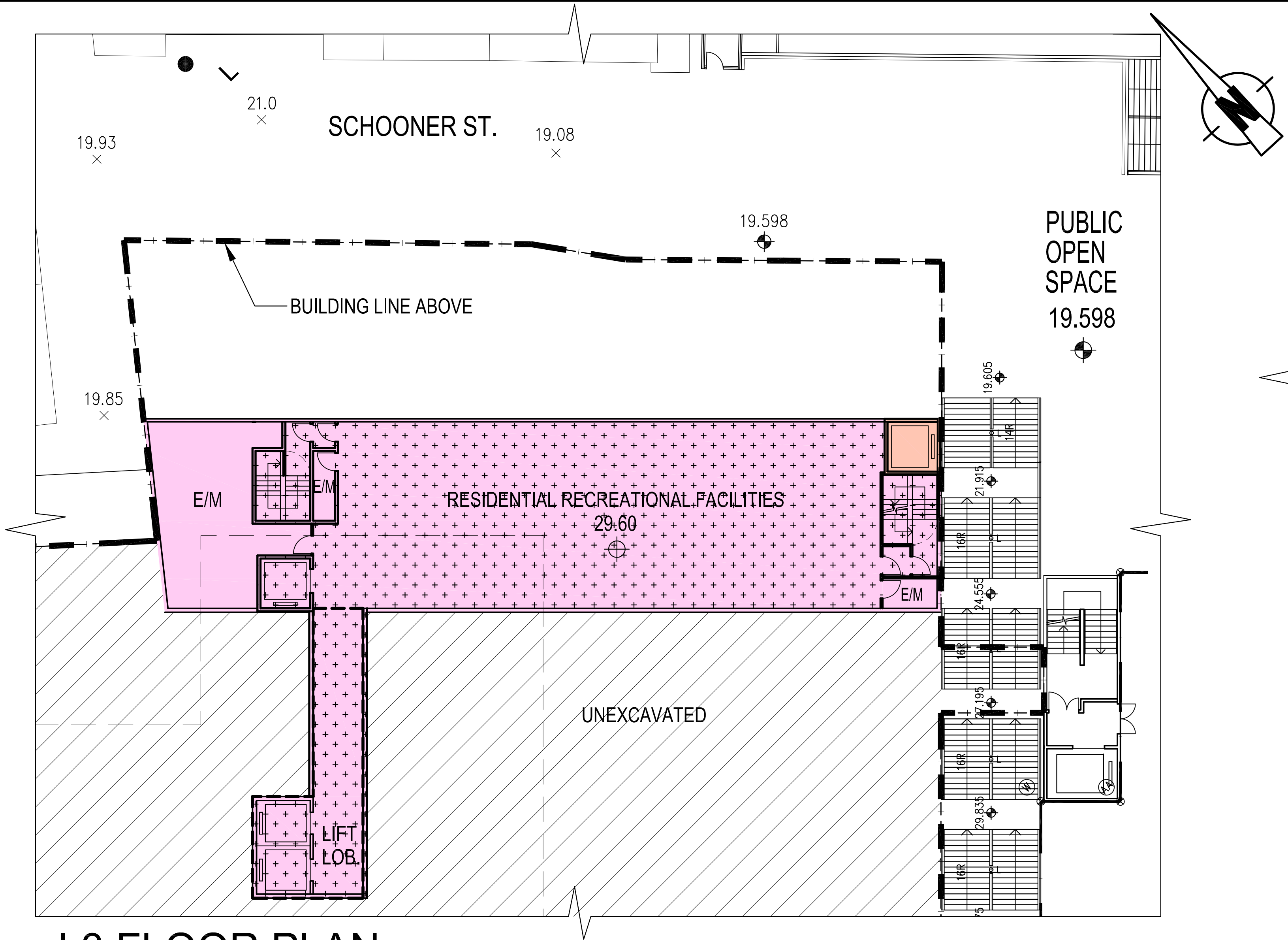
PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

SCALE : 1:300 @A3

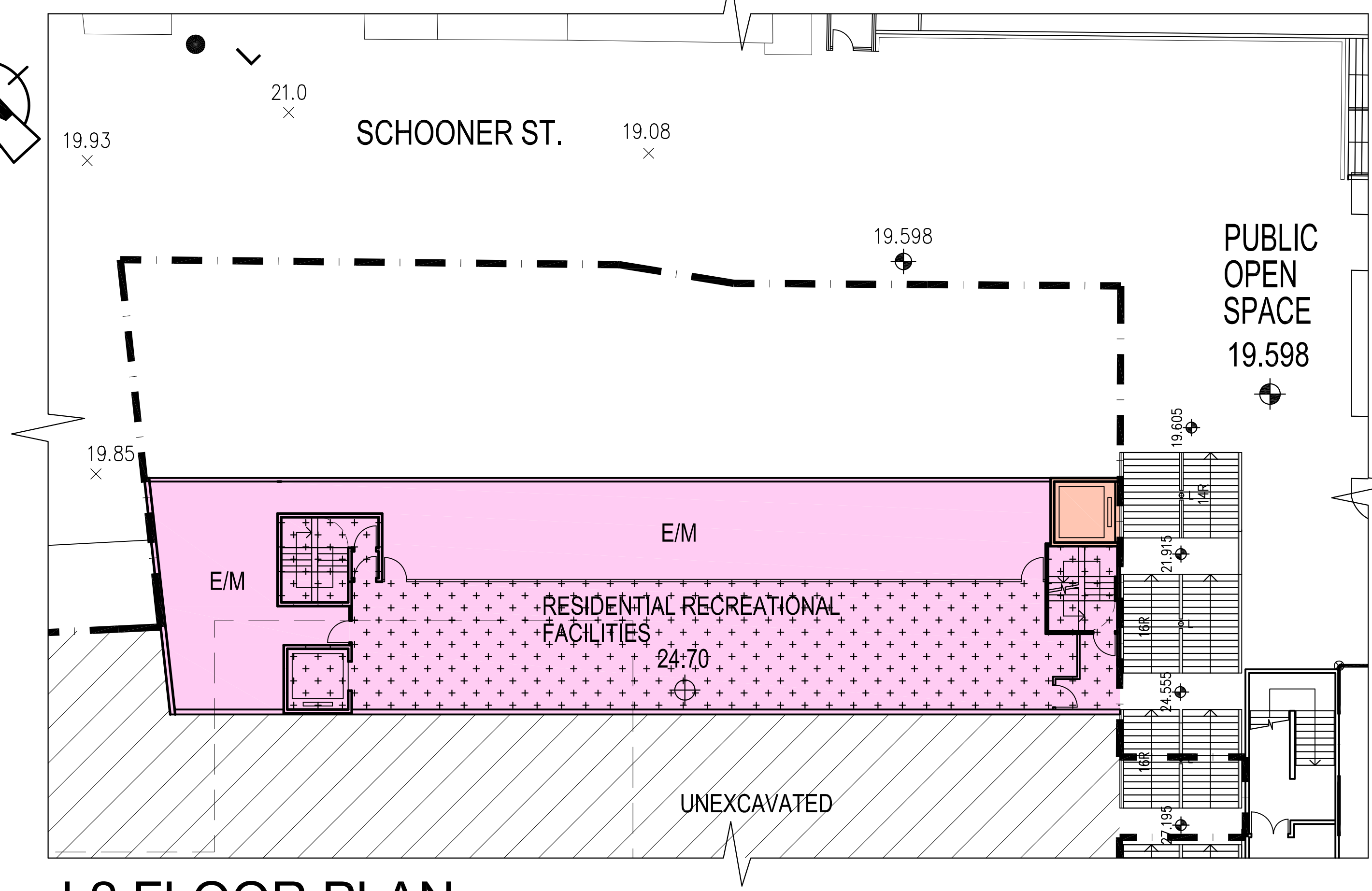
DWG. NO : TPB - 003

DATE : 01/06/2022

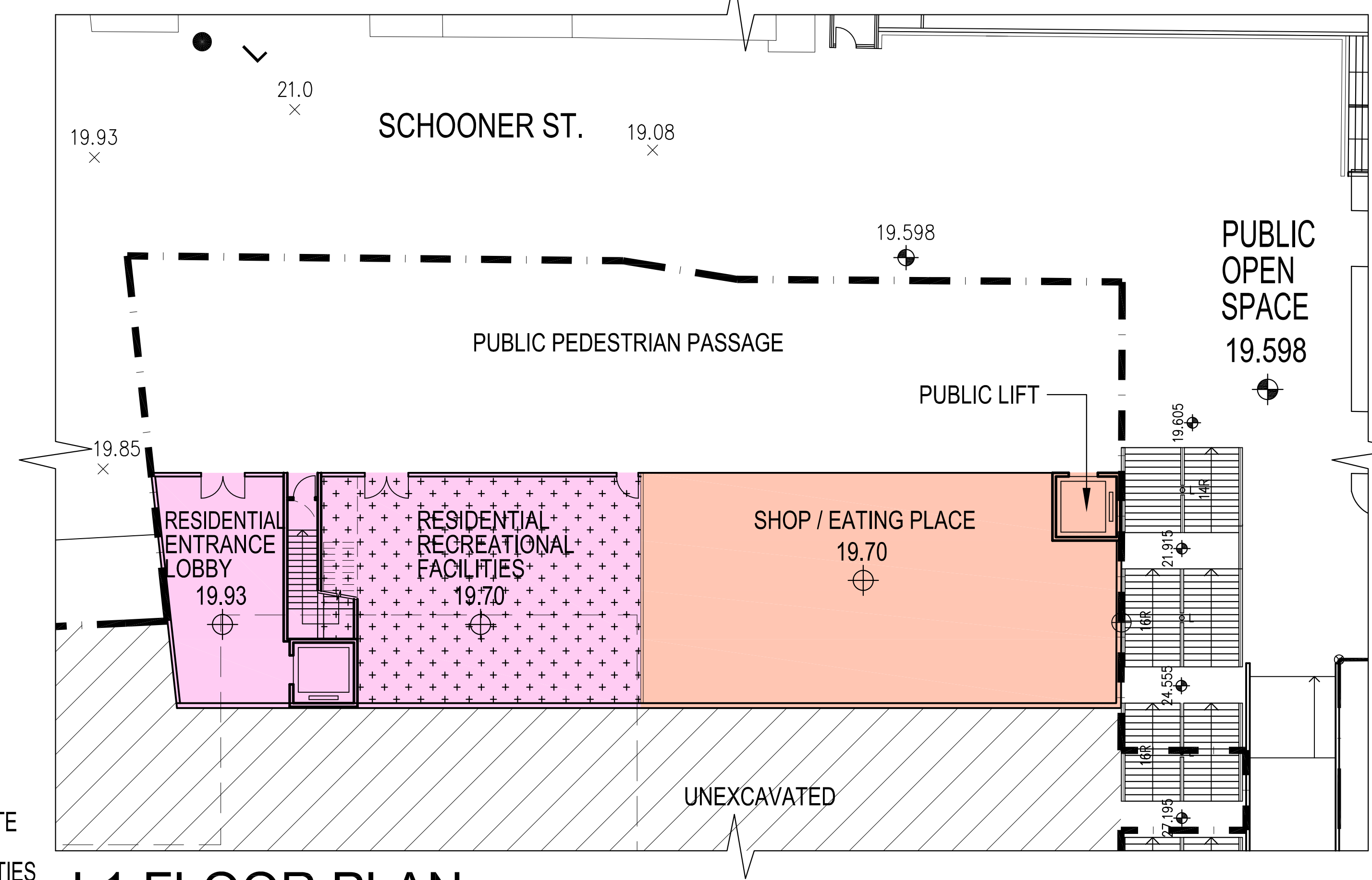
HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司



L3 FLOOR PLAN



L2 FLOOR PLAN



L1 FLOOR PLAN

SCHEDULE OF AREAS (m^2)

FLOOR	COVERED AREA	*E/M	*RES. REC-REATION	GFA	
				DOMESTIC	NON-DOMESTIC
L3	440.6	63.6	369.2	-	7.8
L2	383.7	173.9	202.0	-	7.8
L1	383.7	-	124.1	67.6	192.0
TOTAL	1,208.0	237.5	695.3	67.6	207.6

*** GFA EXEMPTED UNDER BUILDINGS ORDINANCE**

LEGEND:

- BOUNDARY LINE OF APPLICATION SITE
- RESIDENTIAL RECREATIONAL FACILITIES

NOTE :
FLOOR NO. 1/F IS NOT APPLICABLE IN THIS DEVELOPMENT.

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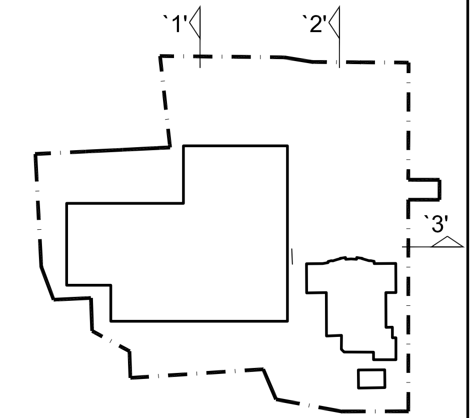
PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

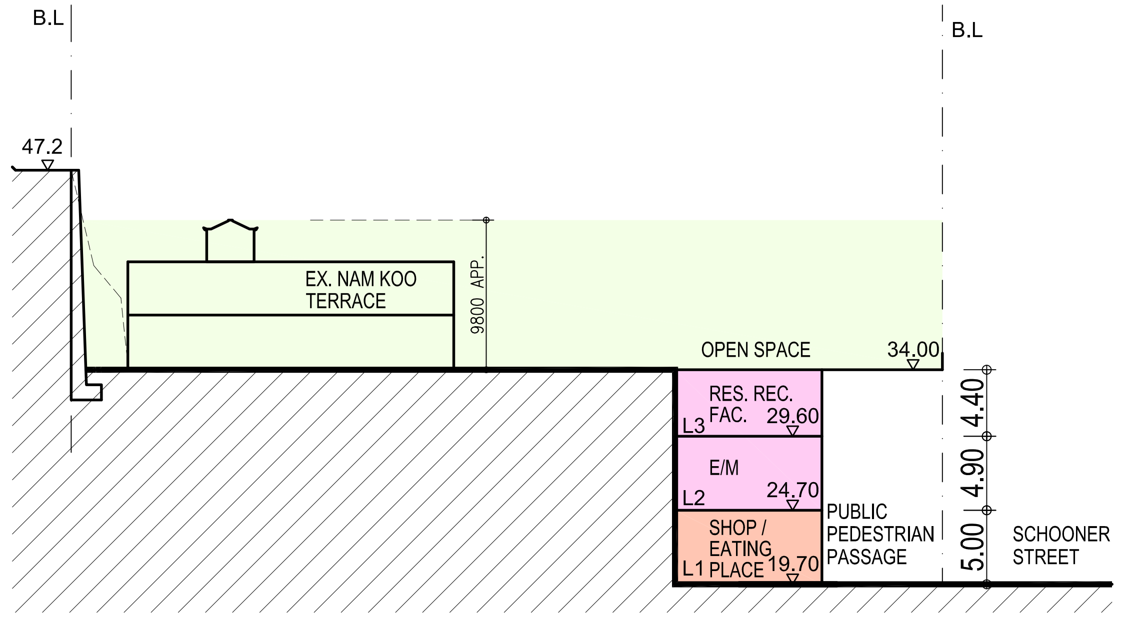
0 5 10m
SCALE : 1:300 @A3

DWG. NO : TPB - 004
DATE : 01/06/2022

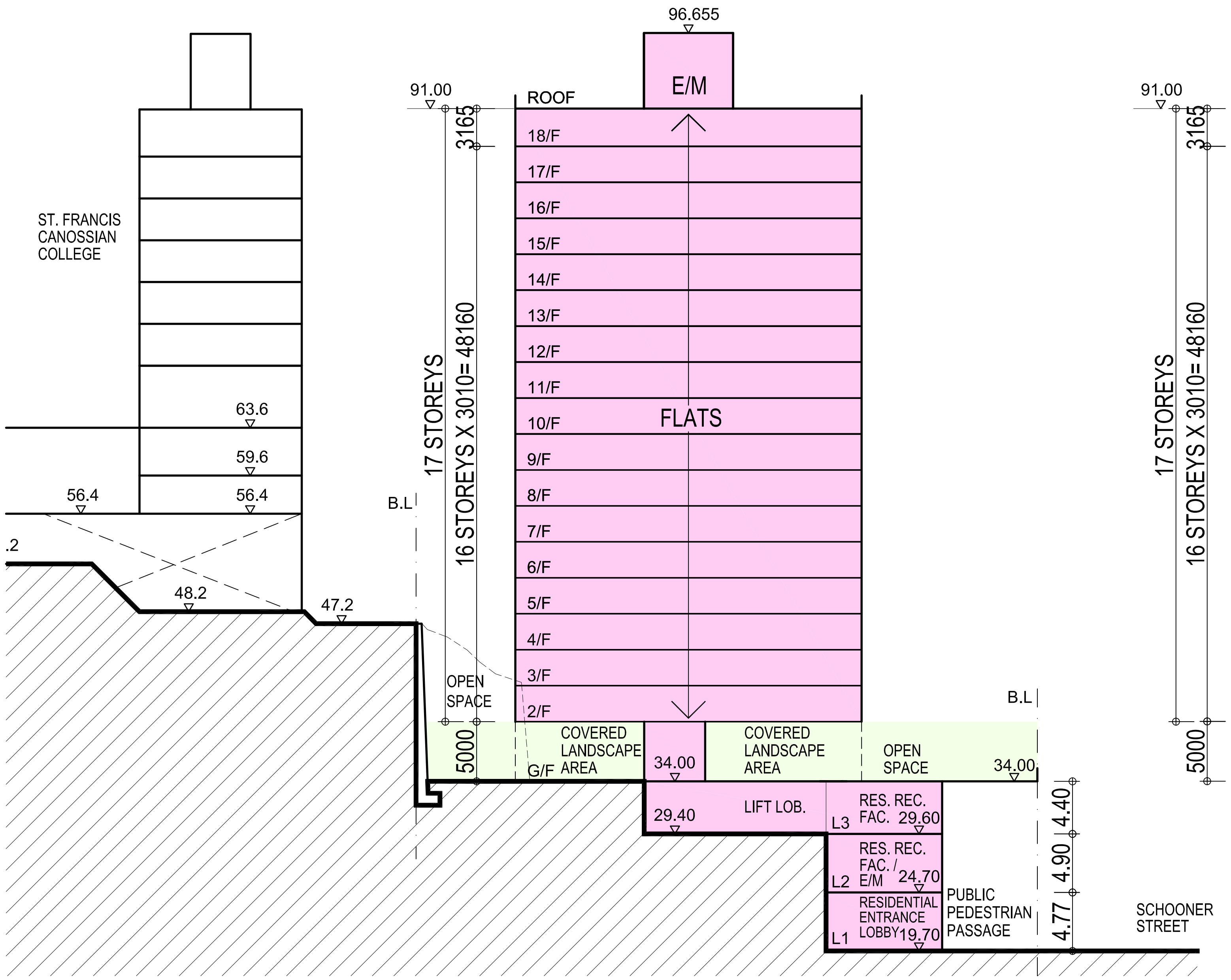
HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司



KEY PLAN

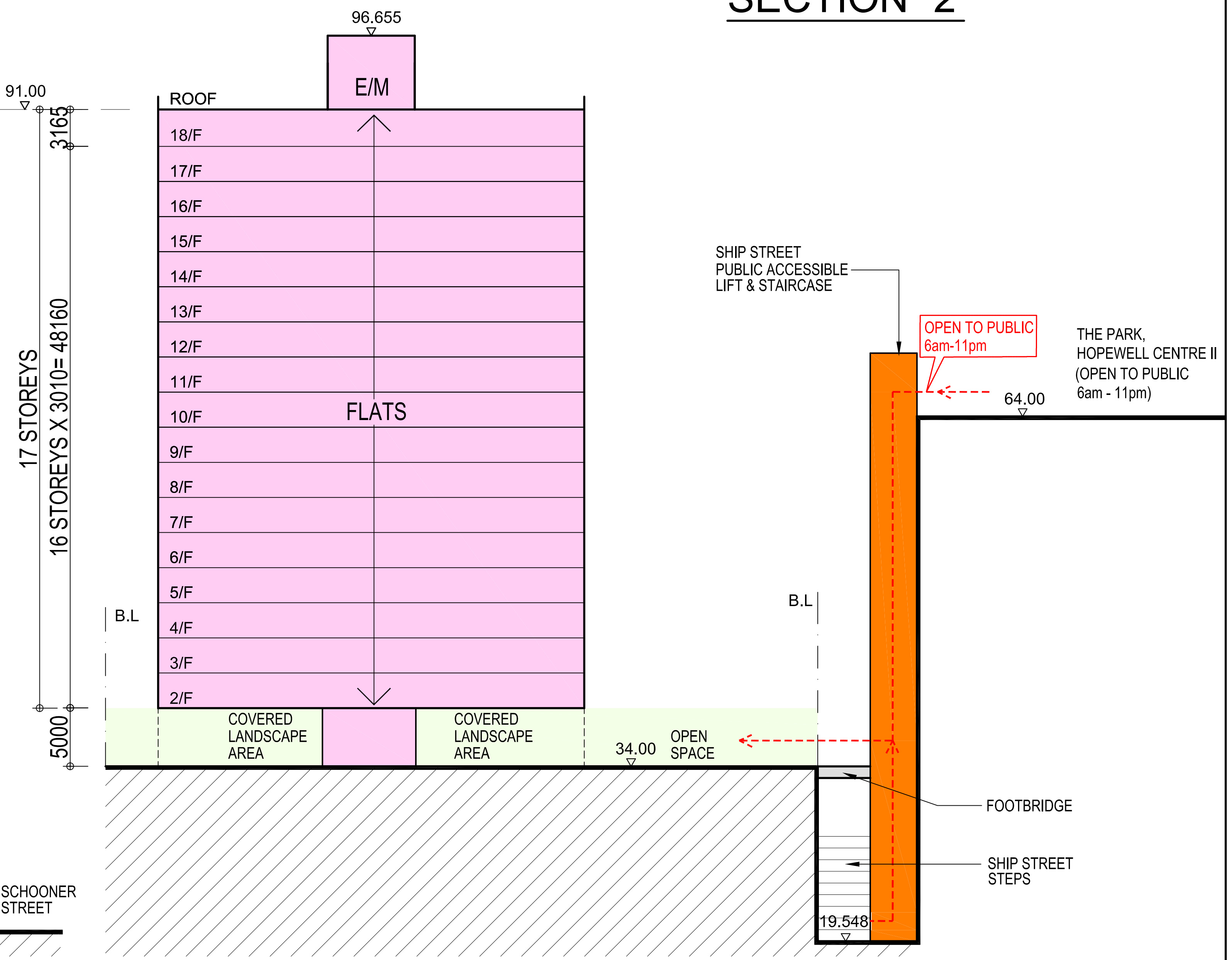


SECTION `2'



NOTE :
FLOOR NO. 1/F IS NOT APPLICABLE IN THIS DEVELOPMENT.

SECTION `1'



SECTION `3'

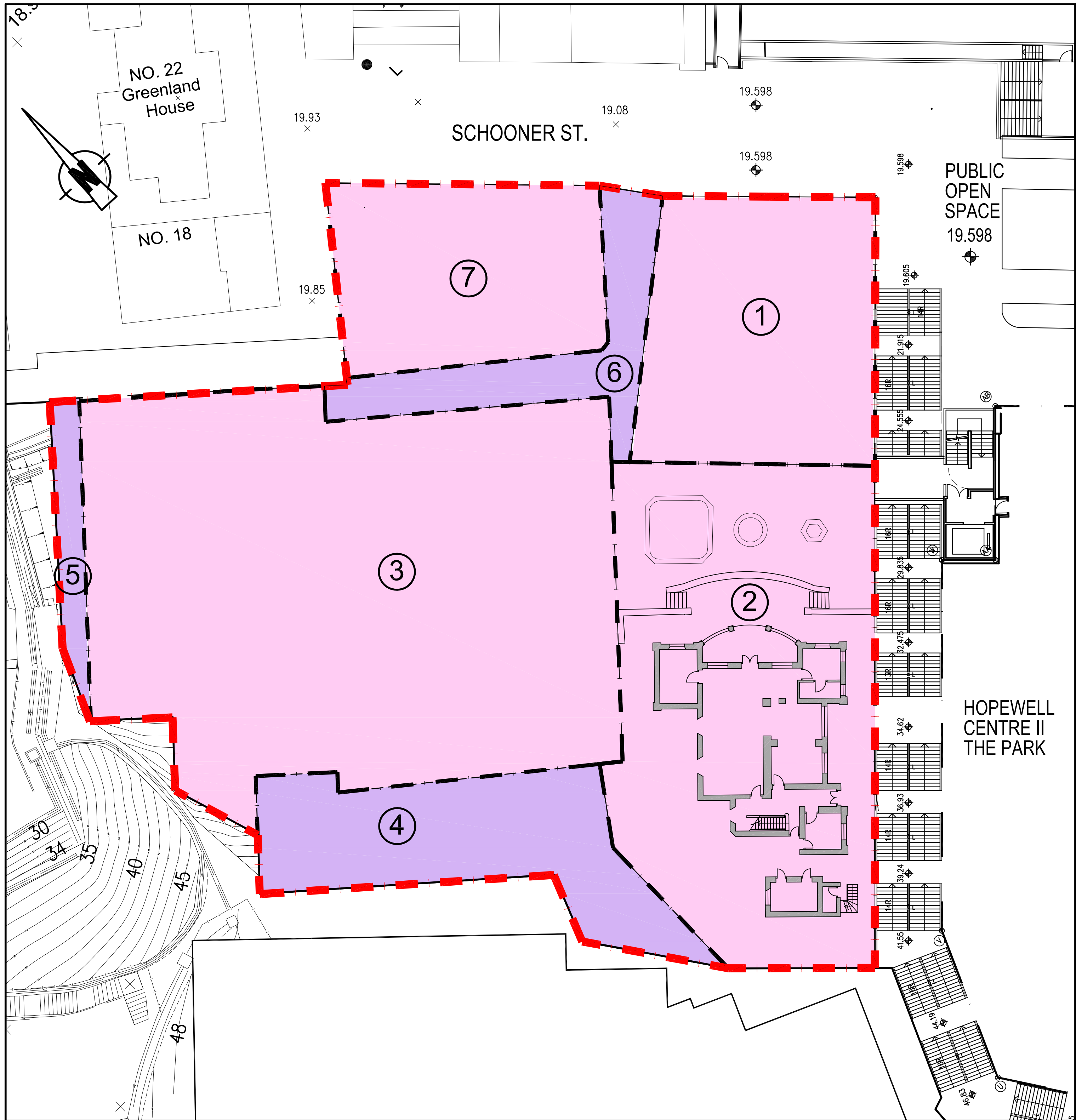
T:\Hopewell_Project\Nam Koo Terrace\EN 1089 – NKT & 1-3 Hillside Terrace\Architectural\Cad\TPB\SUB\025– 2022-06-01Ultimate Scheme\EN1089_ULT SCH_ Sub_Section.dwg

PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

0 5 10 15m
SCALE 1:500 @A3

DWG. NO : TPB - 005
DATE : 01/06/2022

HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司



DEVELOPMENT SITE

LEGEND

DEVELOPMENT SITE BOUNDARY

LAND LOT BOUNDARY

T:\Hopewell_Project\Nam Koo Terrace\EN 1089 - NKT & 1-3 Hillside Terrace\Architectural\Cad\TPB\SUB\025- 2022-06-01Ultimate Scheme\EN1089_Site Plans.dwg

Site Details

There are a total of 7 plots within the proposed `SITE'

	Land Lot	Site Area (m^2)	Current Site Use	Zoning Before 1994	OZP S/H5/8 10 Jun 1994	Draft OZP S/H5/28 04 May 2018	S12A APPROVAL 01 March 2020	Ownership	Acq'd Date
1	Miu Kang Terrace (MKT)	342	6 - storeys residential cum-shops	R (B)	R (C)	R (C)	CDA	HHL	2014
2	Nam Koo Terrace (NKT)	685	2 - storeys Grade 1 historical building	R (B) & GIC	O & GIC	O & GIC	CDA	HHL	1988
3	Hill Side Terrace (HST)	1,100.9	4 - storeys vacant school	R (B)	O	O	CDA	HHL	1981
4	South Slopes (Gov't)	256.9	N.A.	R (B) & GIC	O & GIC	O & GIC	CDA	Gov't	N.A.
5	West Slopes (Gov't)	44	N.A.	R (B)	O	O	CDA	Gov't	N.A.
6	Steps (Rt of way to HST)	130	N.A.	R (B)	R (C)	Road	Road	Gov't	N.A.
7	I.L. 9048 (Schooner Street)	270	Vacant and designated for residential use	R (B)	R (C)	R (C)	R (C)	HHL	2014
Total		2,828.8							

PROPOSED COMPREHENSIVE DEVELOPMENT AT HILLSIDE & NAM KOO TERRACE, WAN CHAI, HONG KONG.

0 5 10m

SCALE : 1:300 @A3

DWG. NO : TPB-06

DATE : 01/06/2022

HOPEWELL CONSTRUCTION COMPANY LIMITED
合和建築有限公司

Appendix C

Master Layout Plan for Indicative Development Scheme

Please refer to Appendix 1 of the Supplementary Planning Statement

Not in Use

Appendix D

Summary of Velocity Ratio and Velocity Vector Plots for Baseline Scheme

Not in Use

Velocity Ratio (VR) Plots

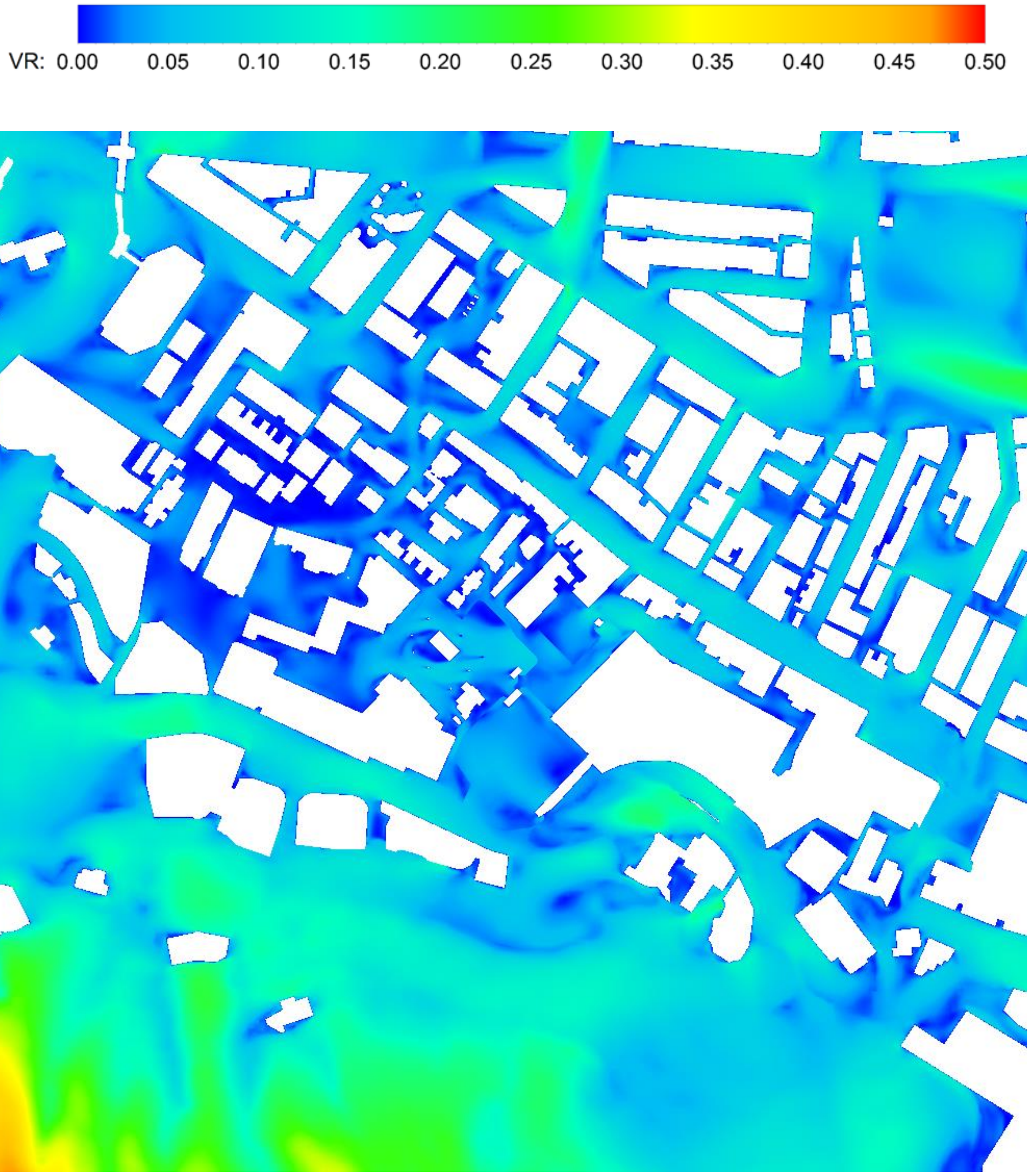


Figure D1. VR Plot at 2m above Ground Level under NNE wind (Baseline Scheme)

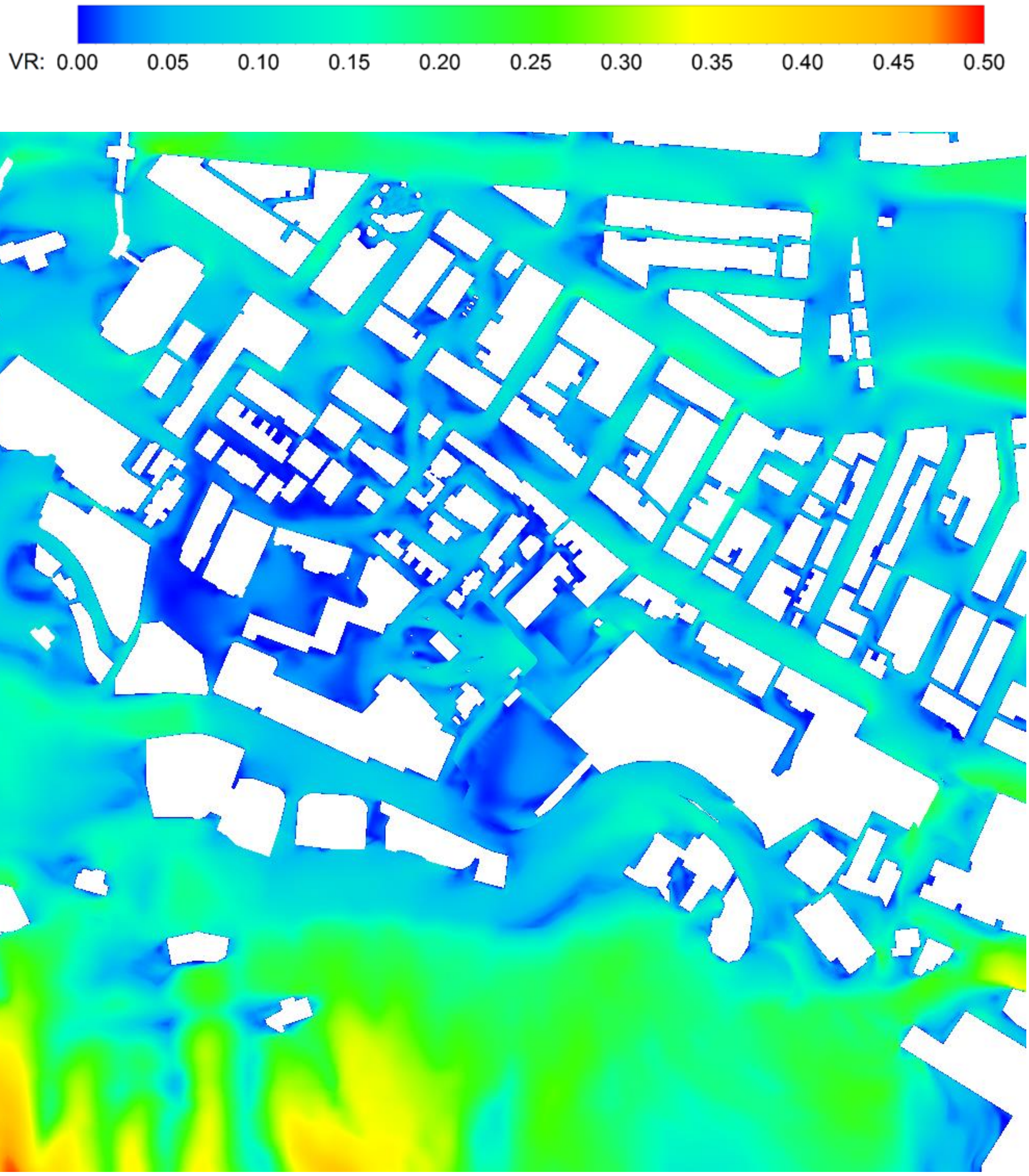


Figure D2. VR Plot at 2m above Ground Level under NE wind (Baseline Scheme)

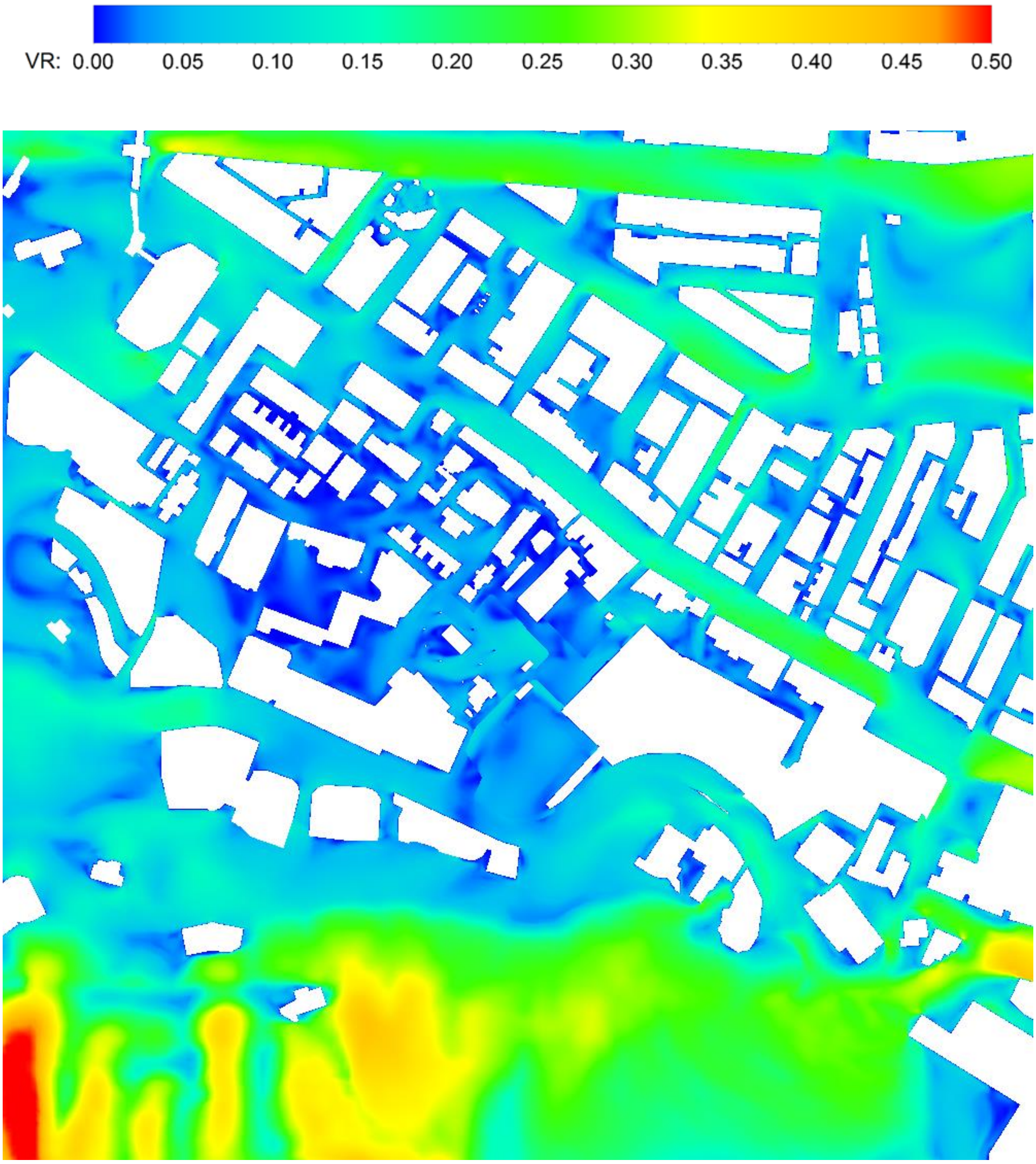


Figure D3. VR Plot at 2m above Ground Level under ENE wind (Baseline Scheme)

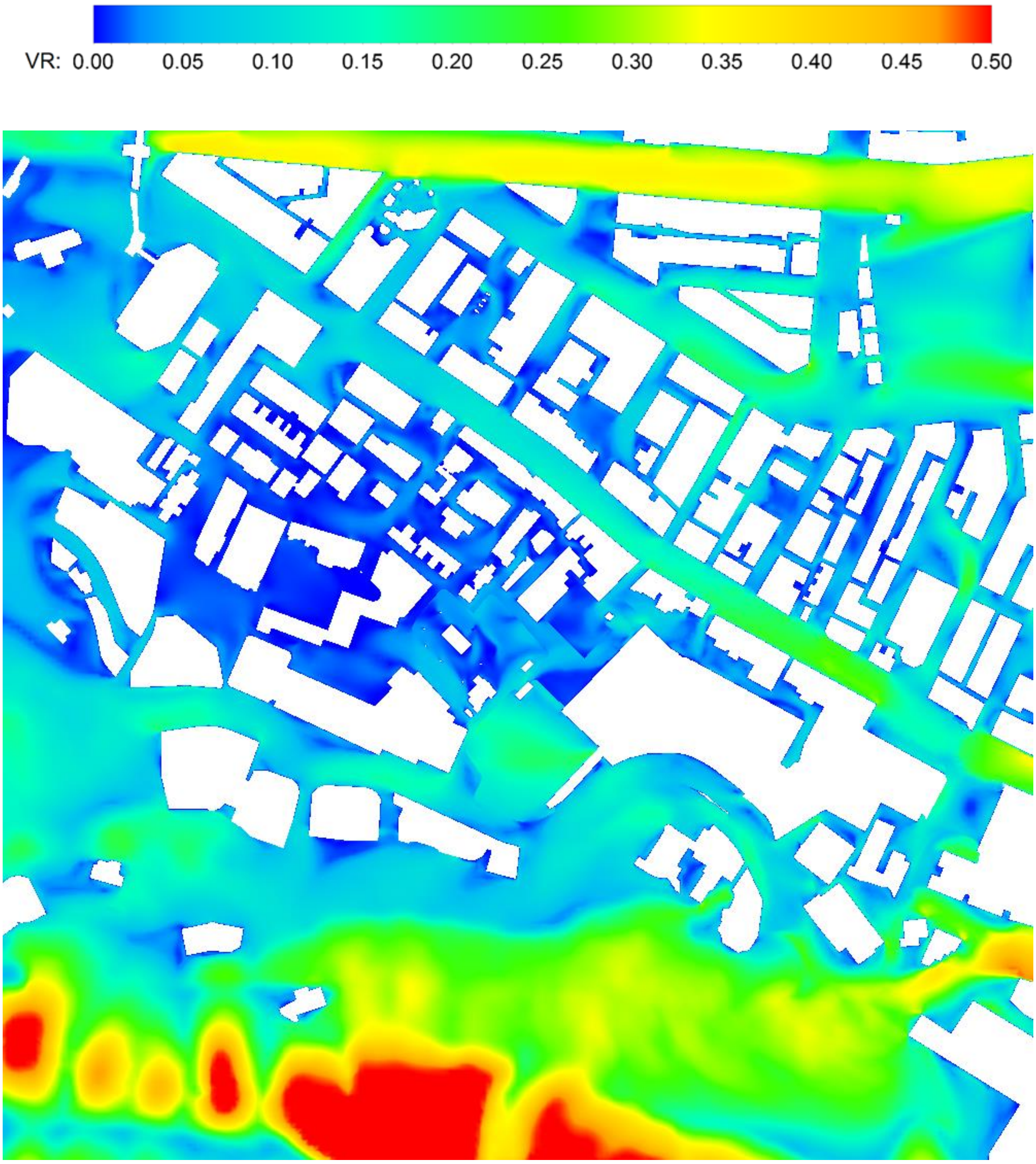


Figure D4. VR Plot at 2m above Ground Level under E wind (Baseline Scheme)

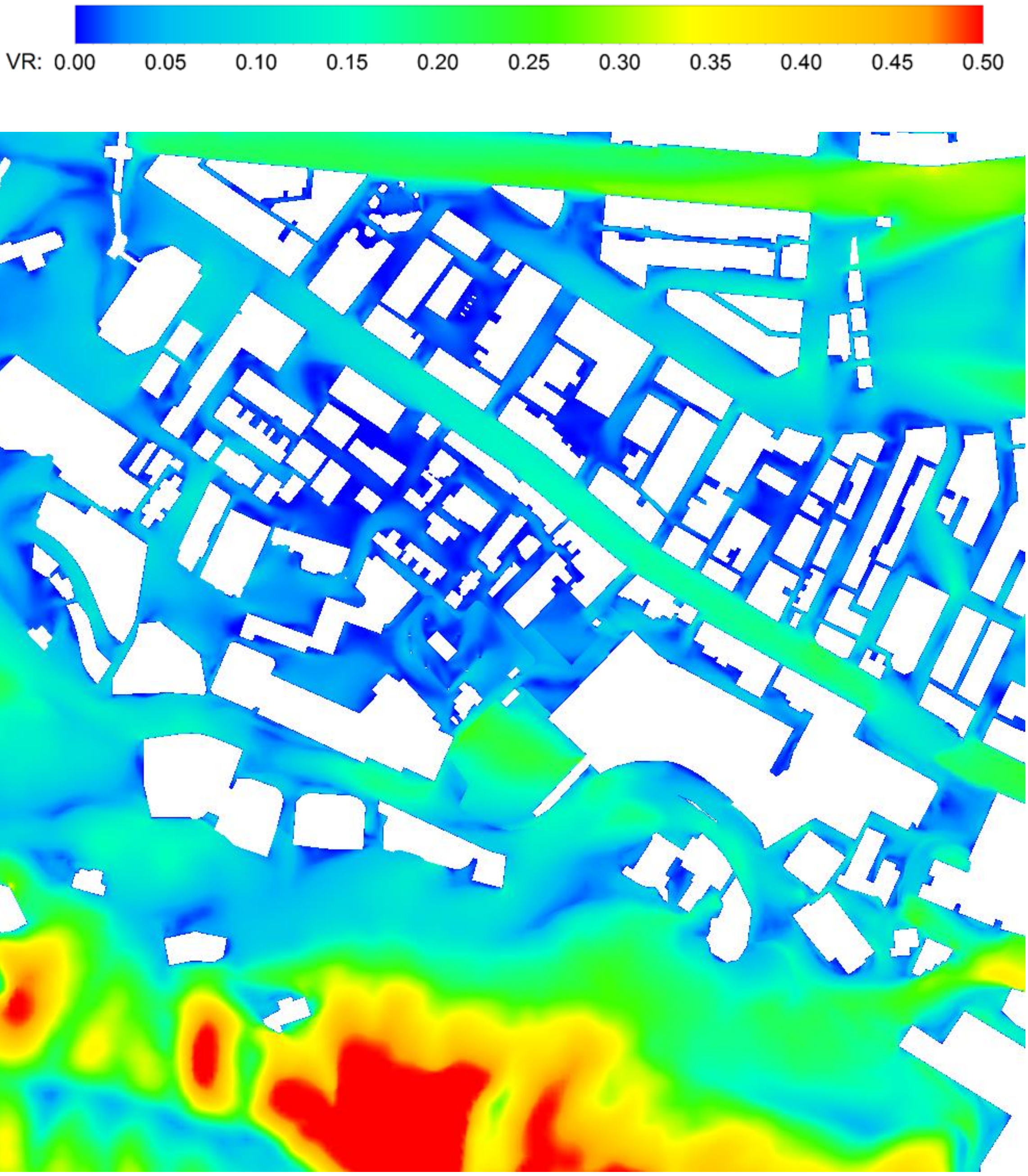


Figure D5. VR Plot at 2m above Ground Level under ESE wind (Baseline Scheme)

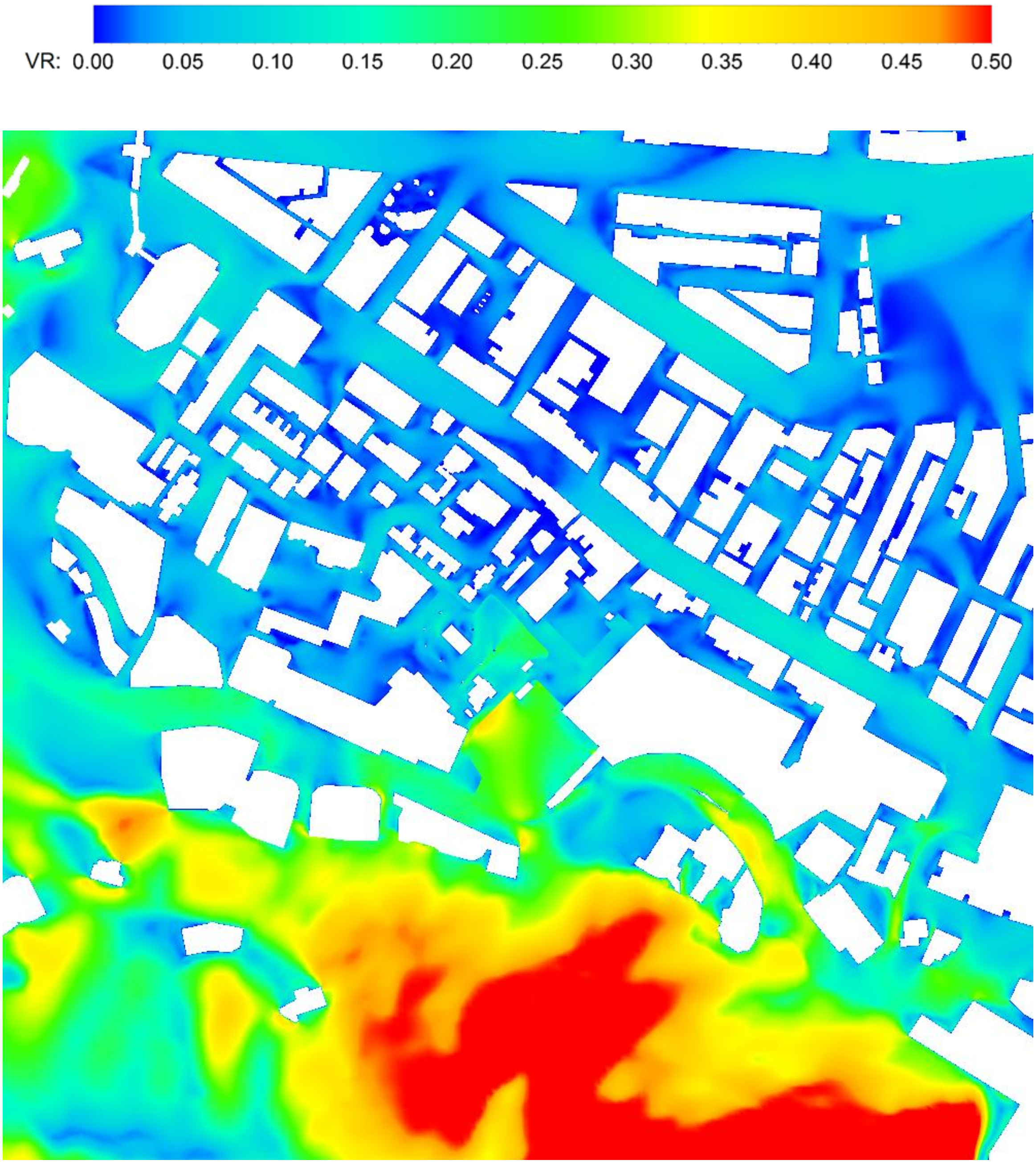


Figure D6. VR Plot at 2m above Ground Level under SE wind (Baseline Scheme)

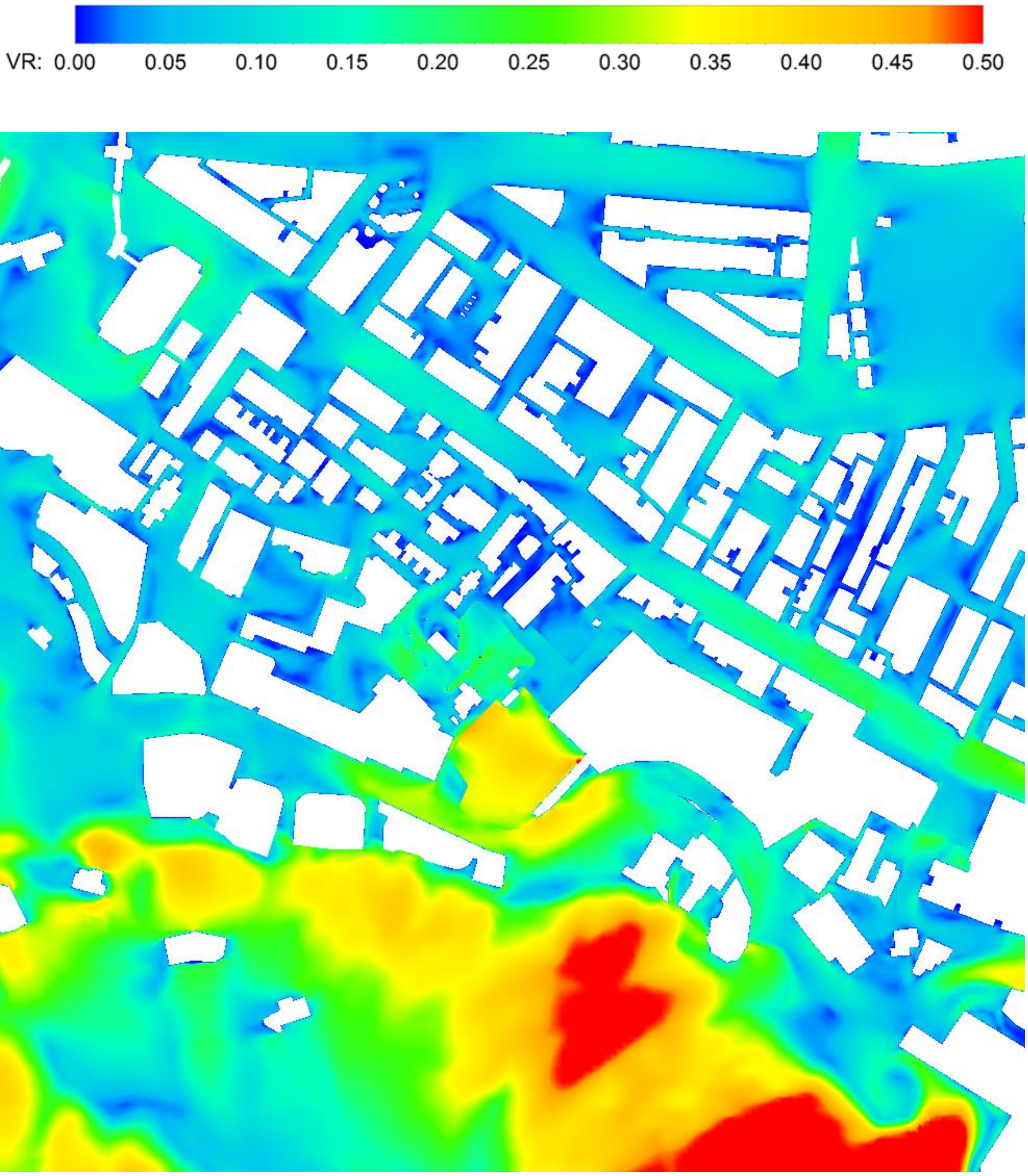


Figure D7. VR Plot at 2m above Ground Level under SSE wind (Baseline Scheme)

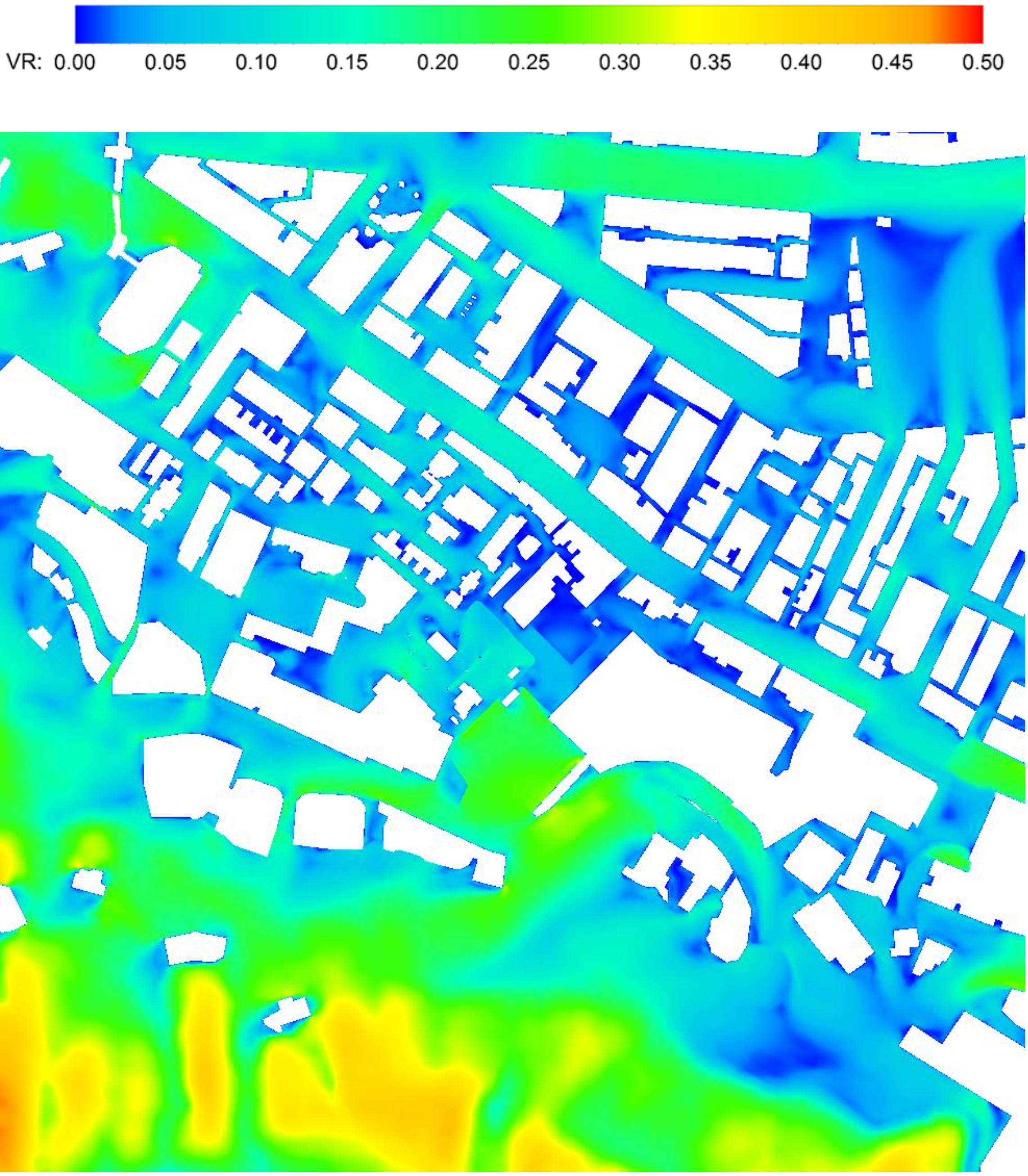


Figure D8. VR Plot at 2m above Ground Level under S wind (Baseline Scheme)

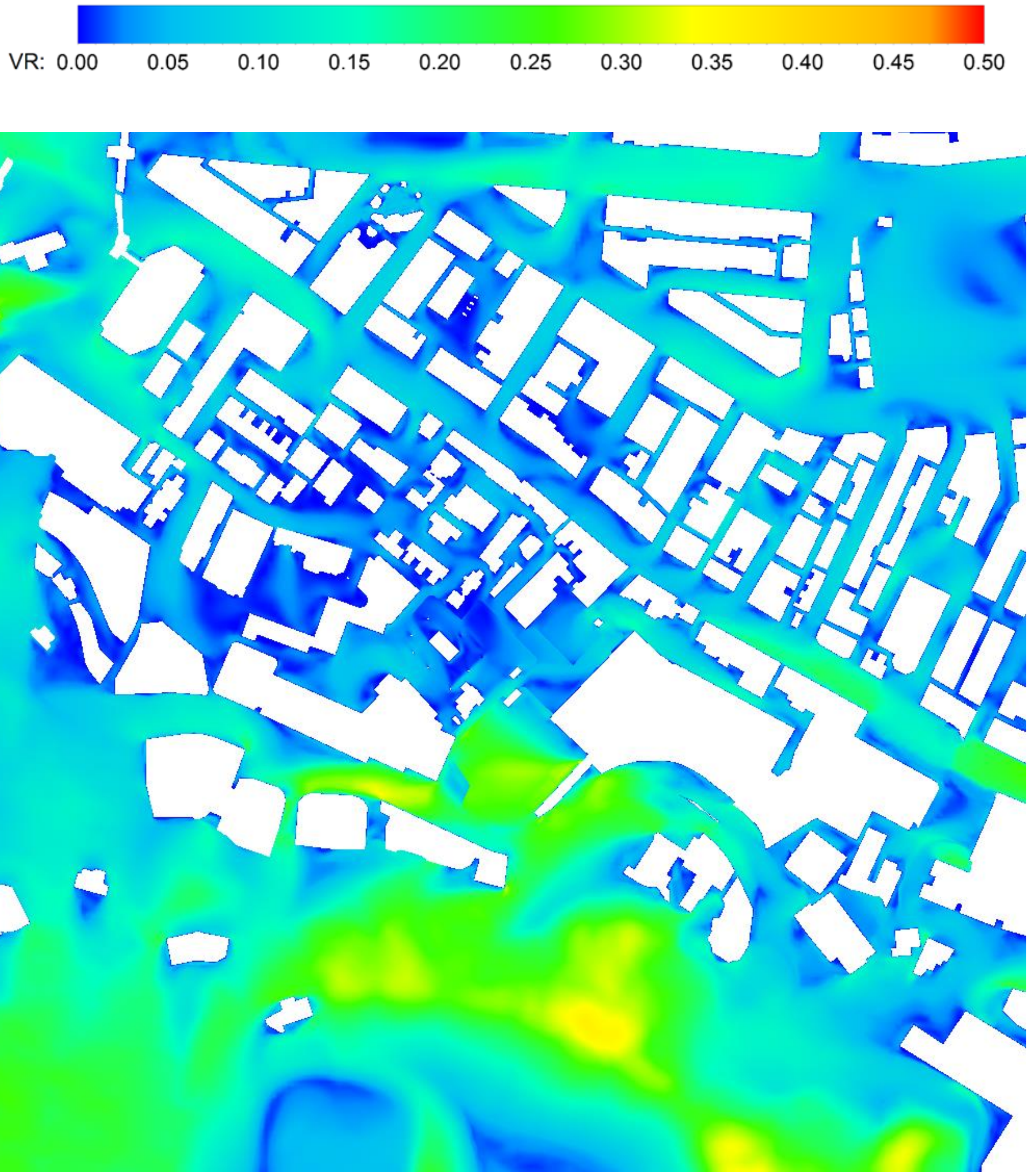


Figure D9. VR Plot at 2m above Ground Level under SSW wind (Baseline Scheme)

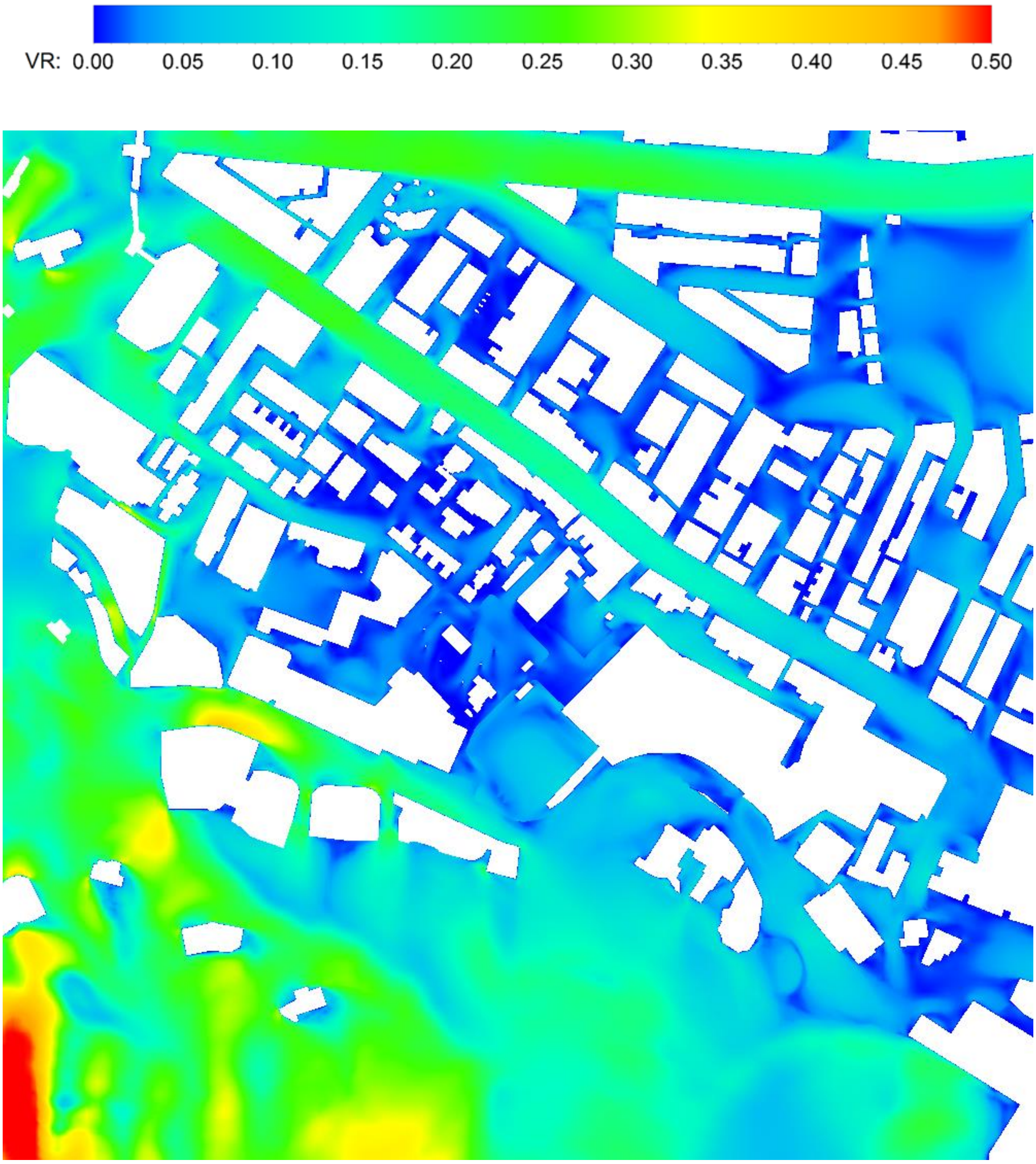


Figure D10. VR Plot at 2m above Ground Level under SW wind (Baseline Scheme)

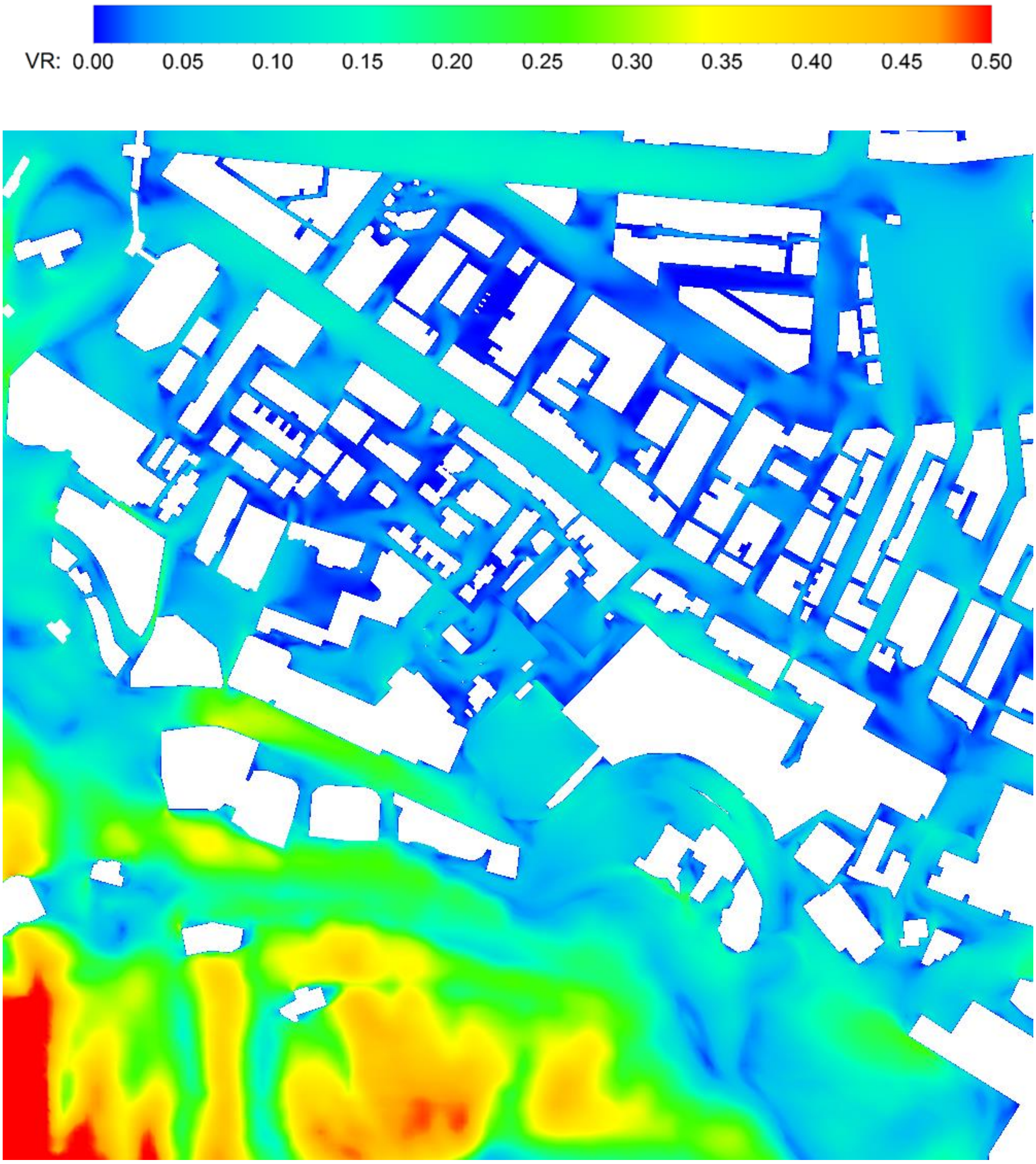


Figure D11. VR Plot at 2m above Ground Level under WSW wind (Baseline Scheme)

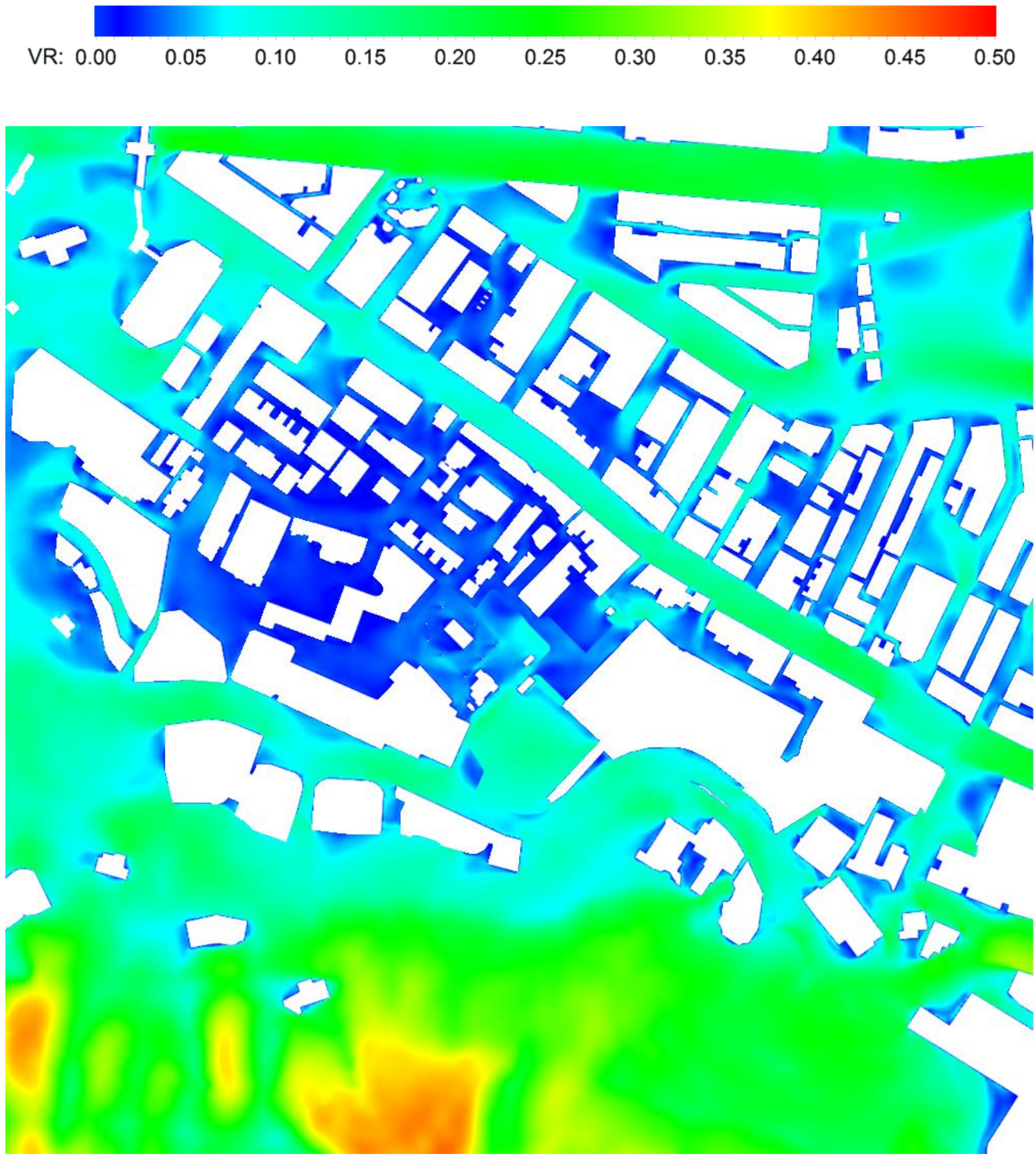


Figure D12. Annual Weighted VR Plot at 2m above Ground Level (Baseline Scheme)

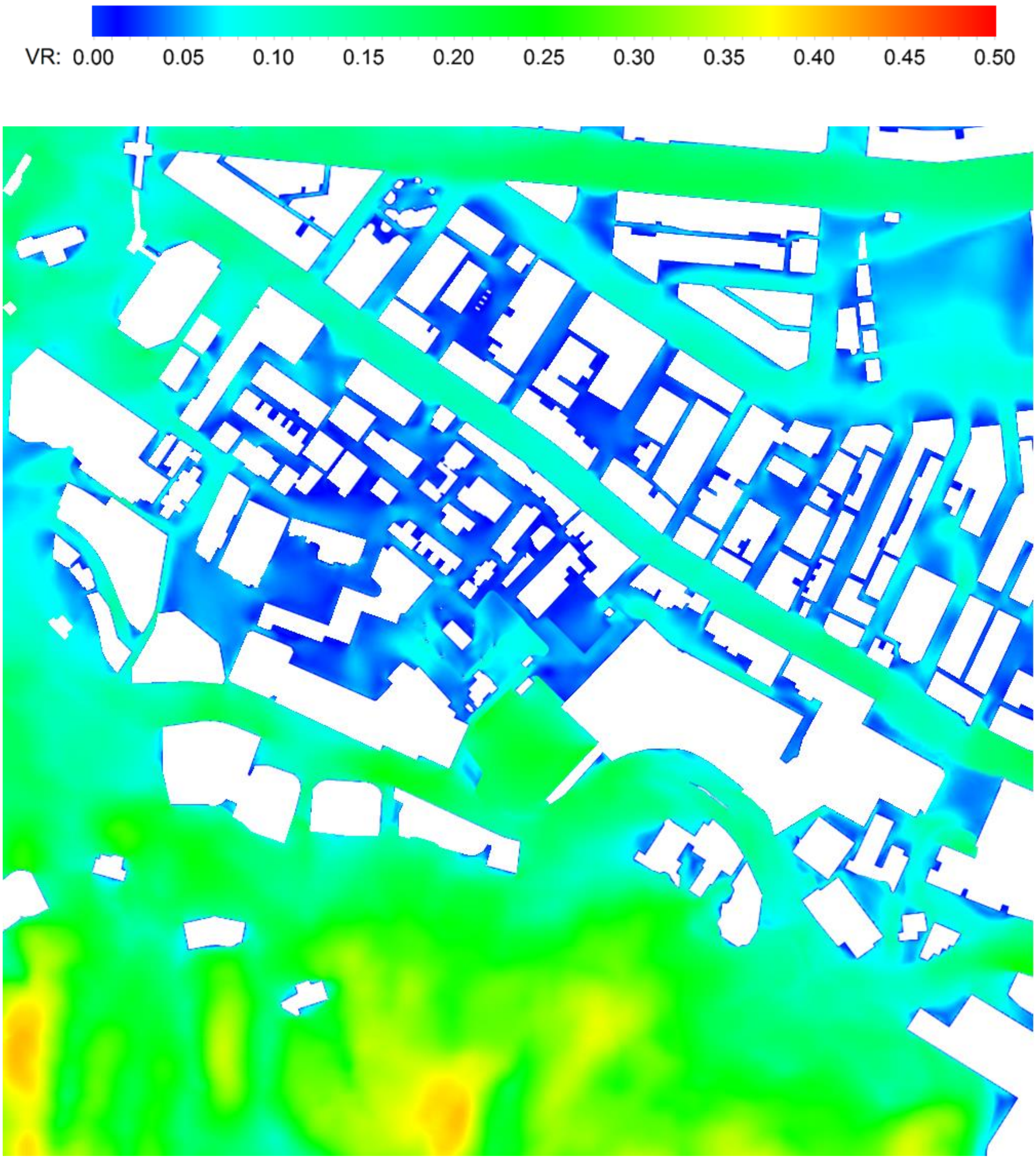


Figure D13. Summer Weighted VR Plot at 2m above Ground Level (Baseline Scheme)

Velocity Vector (VR) Plots

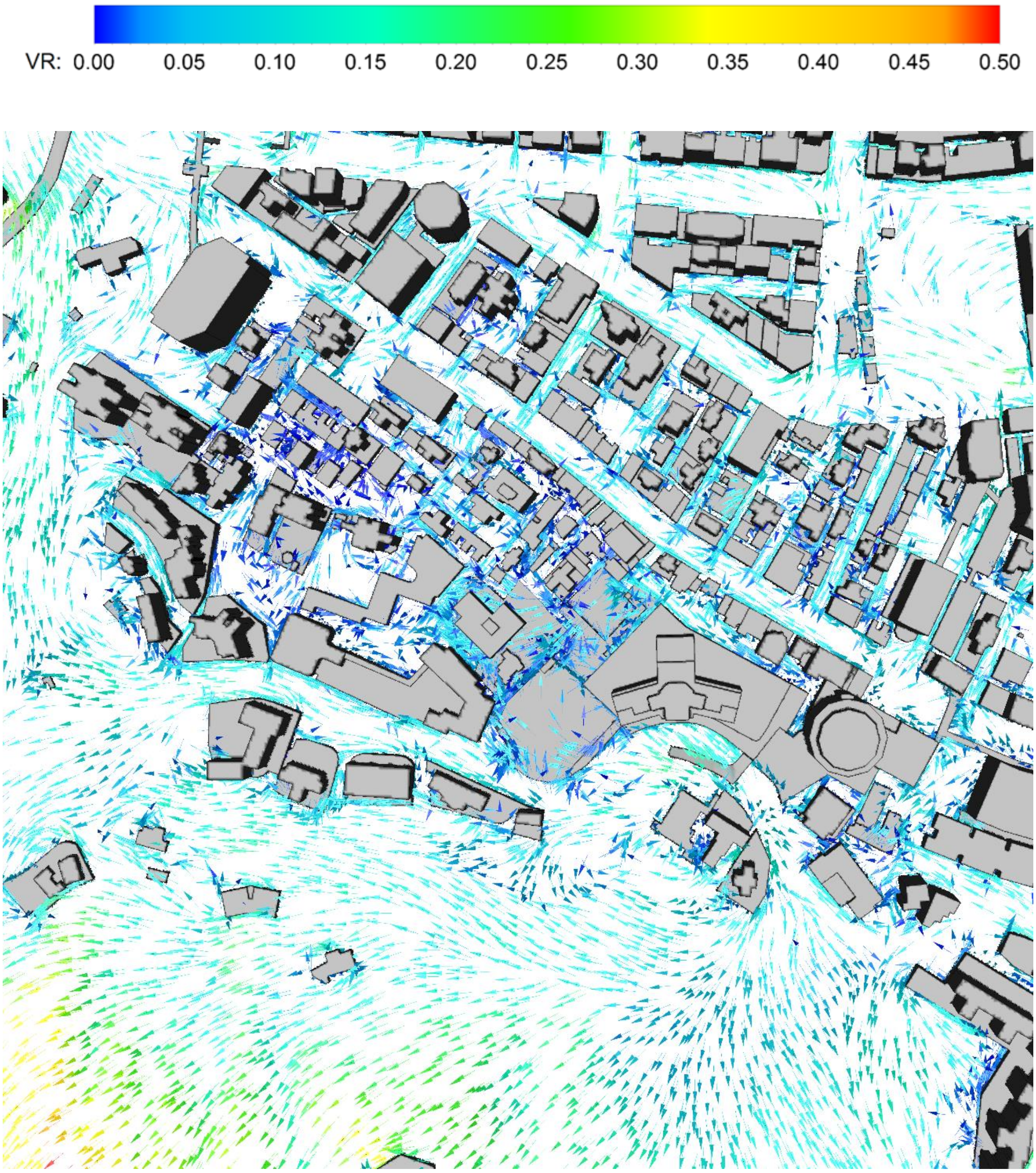


Figure D14. Vector Plot at 2m above Ground Level under NNE wind (Baseline Scheme)

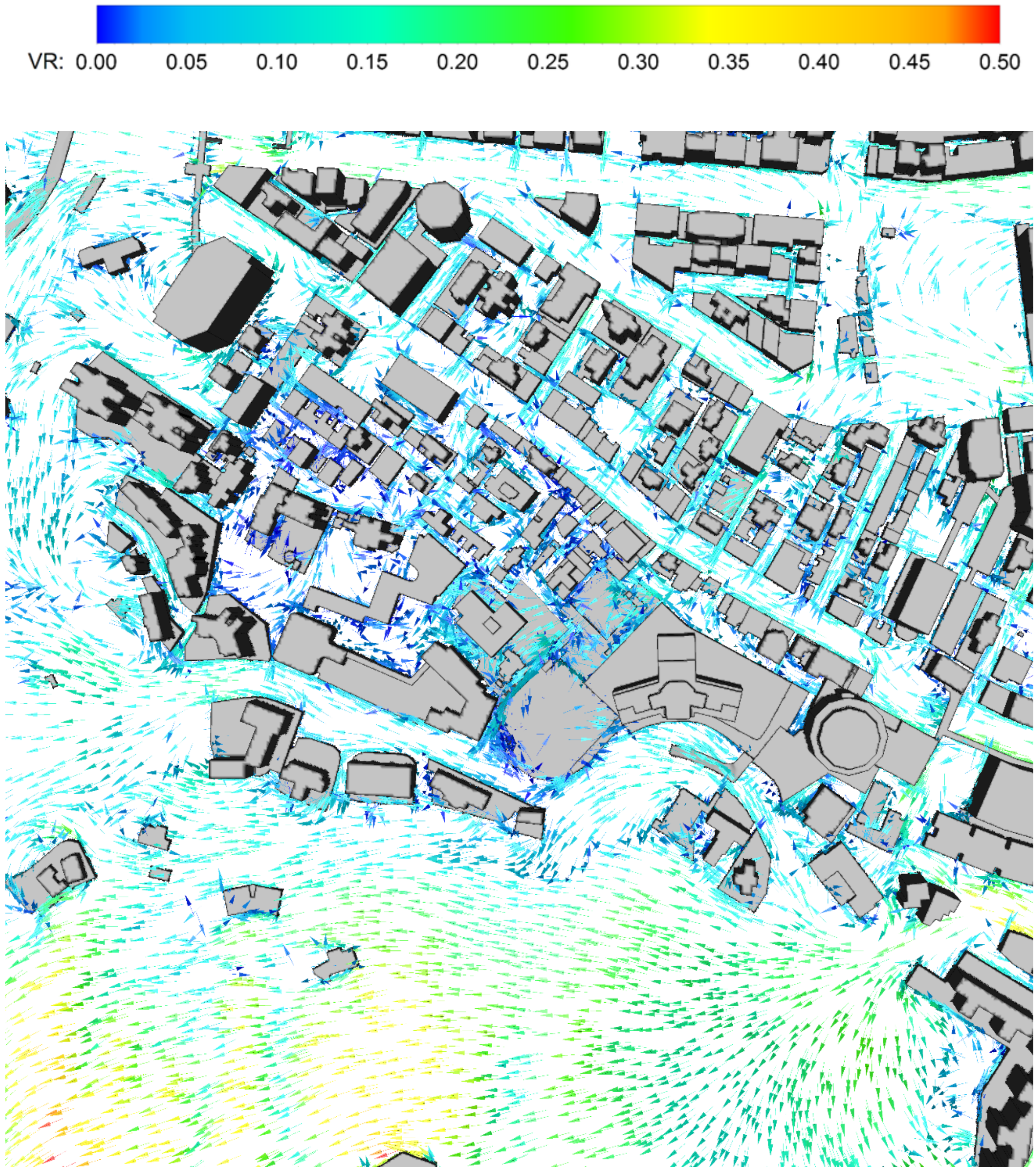


Figure D15. Vector Plot at 2m above Ground Level under NE wind (Baseline Scheme)

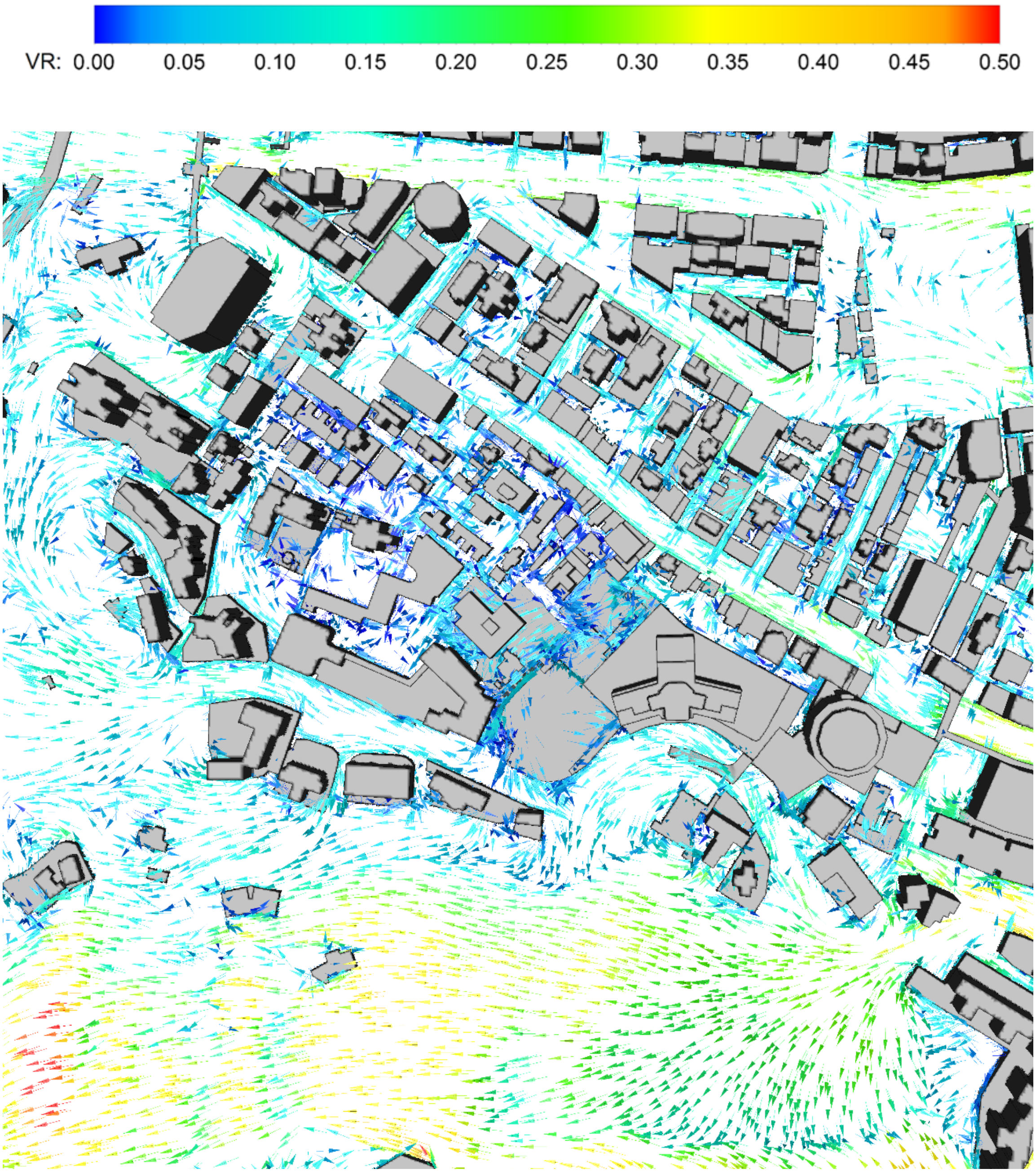


Figure D16. Vector Plot at 2m above Ground Level under ENE wind (Baseline Scheme)

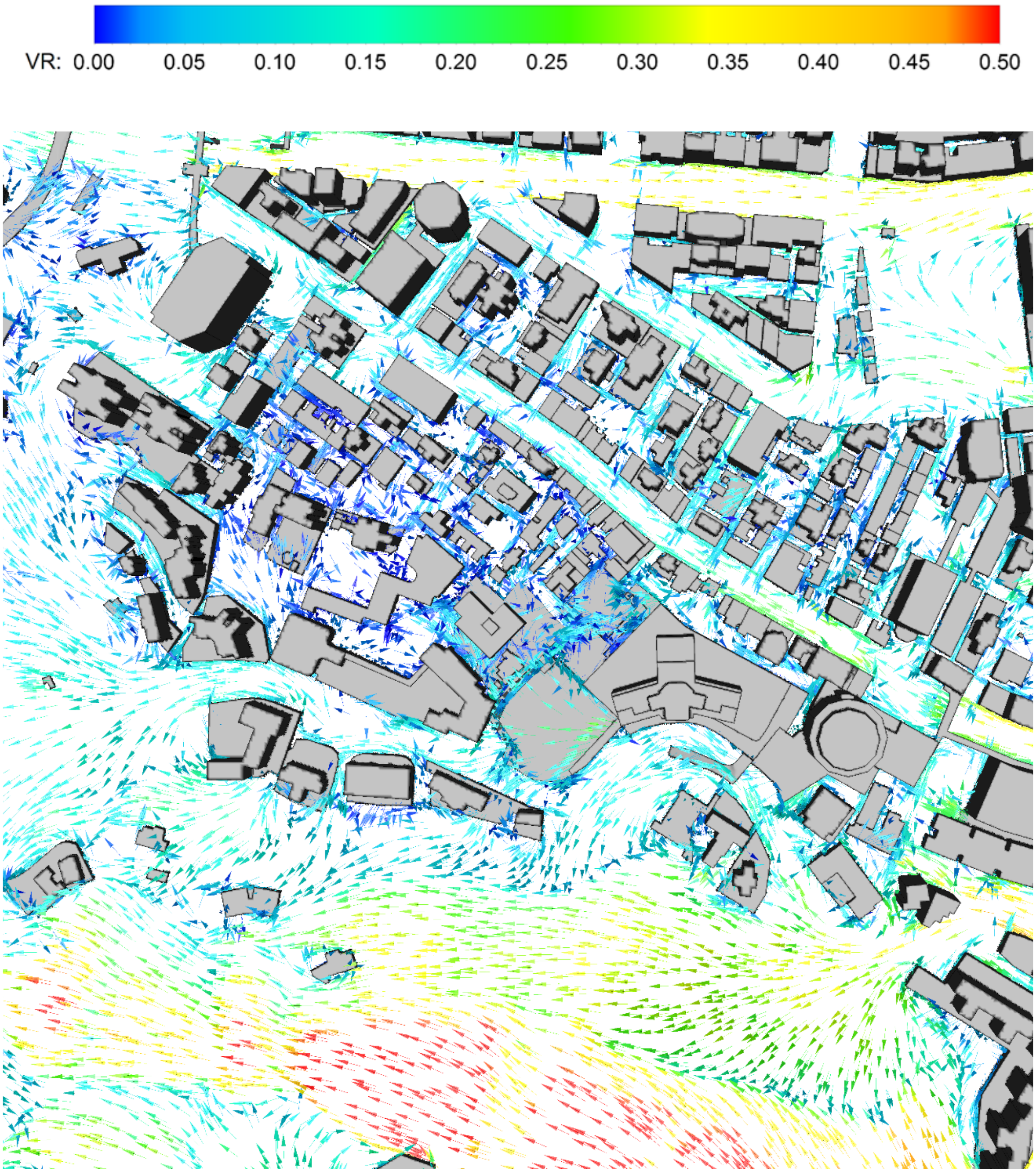


Figure D17. Vector Plot at 2m above Ground Level under E wind (Baseline Scheme)

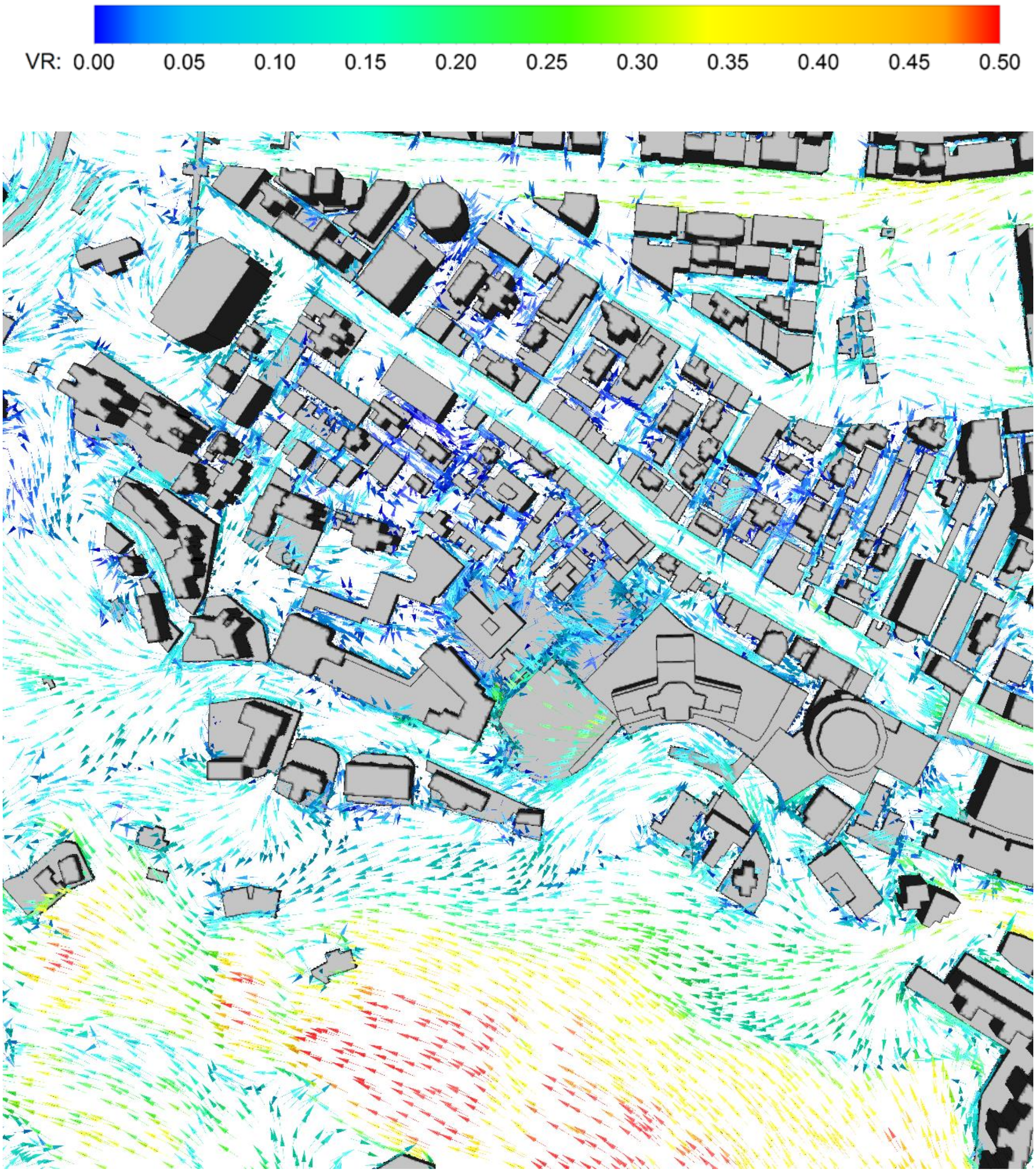


Figure D18. Vector Plot at 2m above Ground Level under ESE wind (Baseline Scheme)

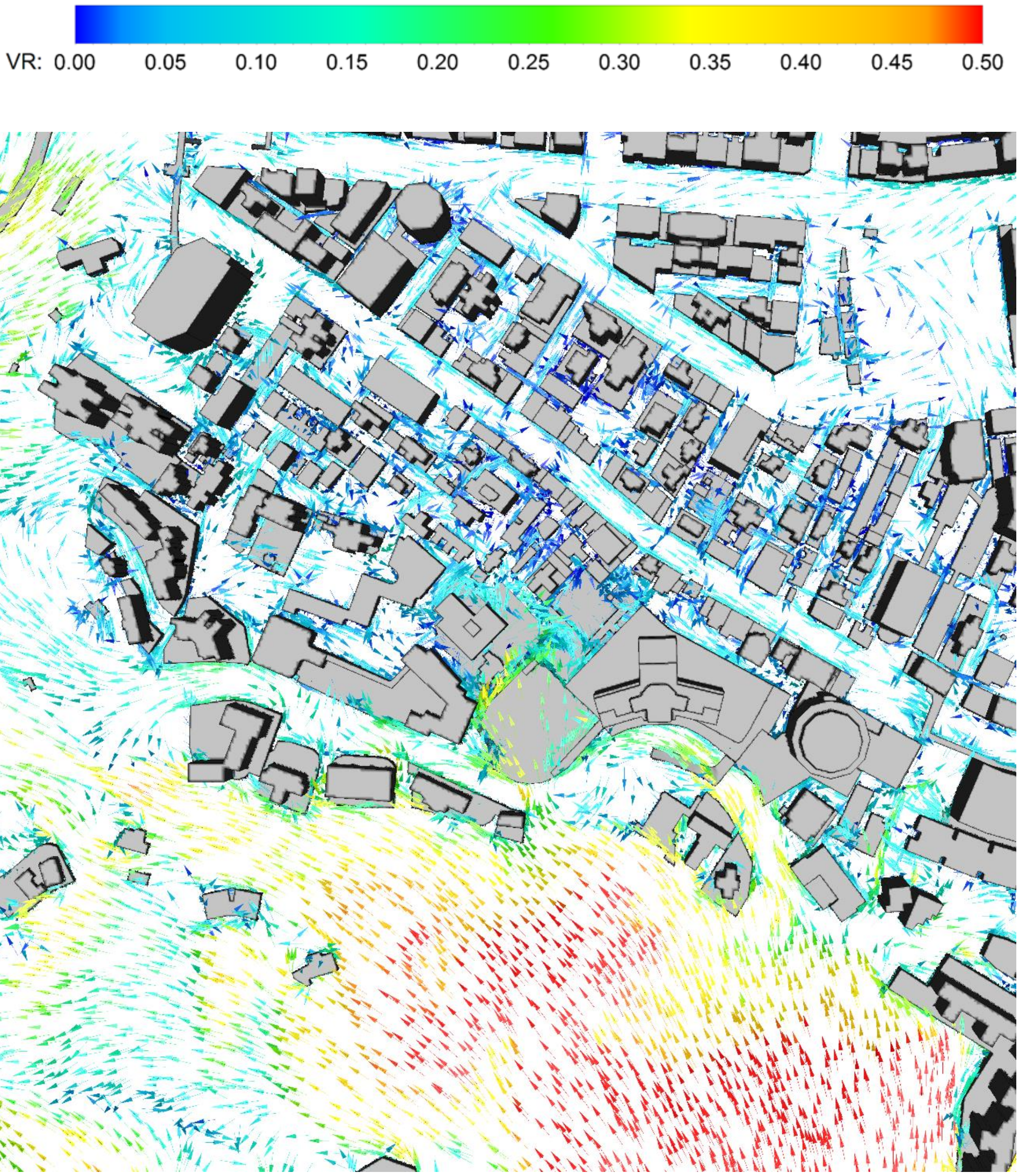


Figure D19. Vector Plot at 2m above Ground Level under SE wind (Baseline Scheme)

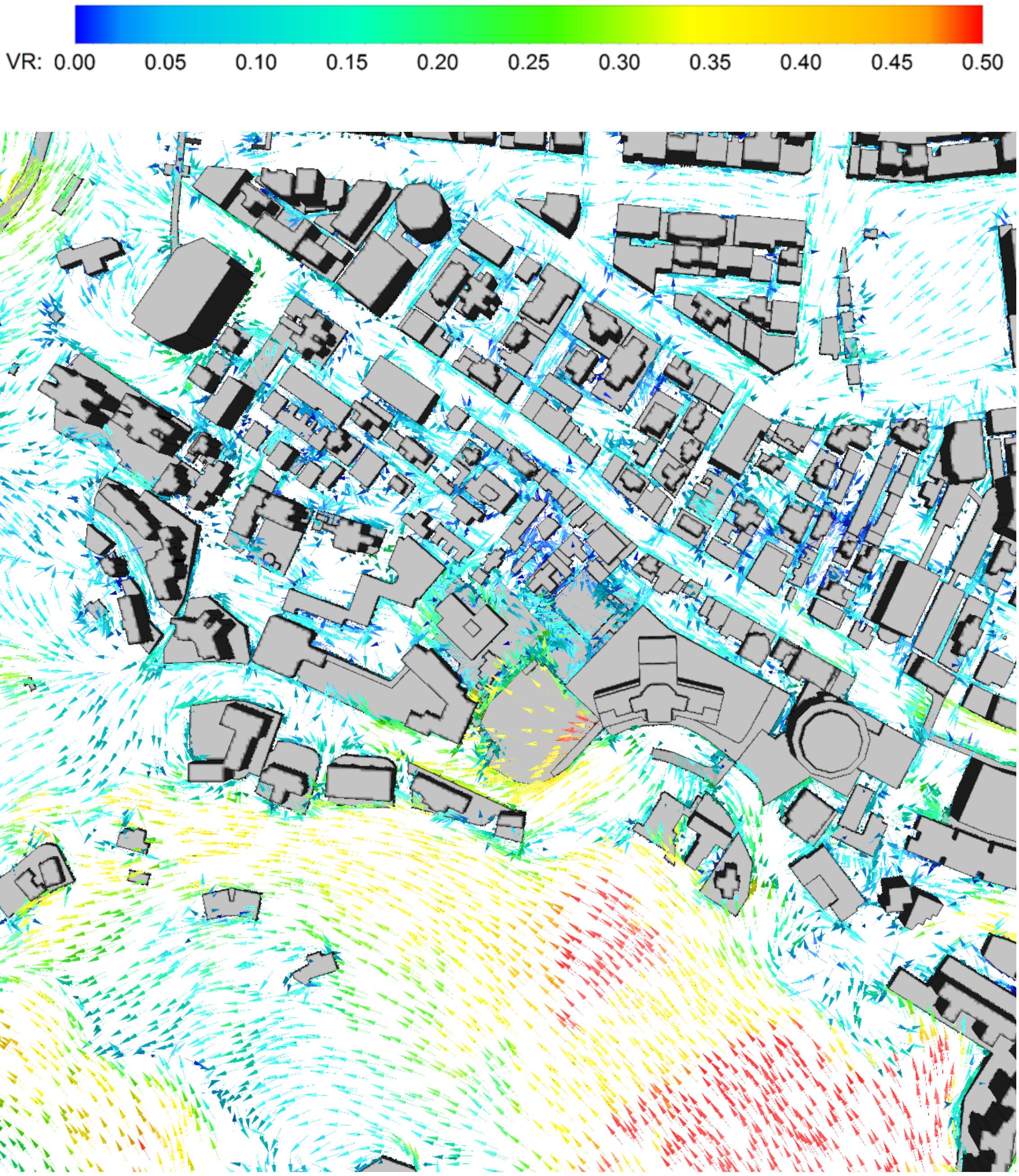


Figure D20. Vector Plot at 2m above Ground Level under SSE wind (Baseline Scheme)

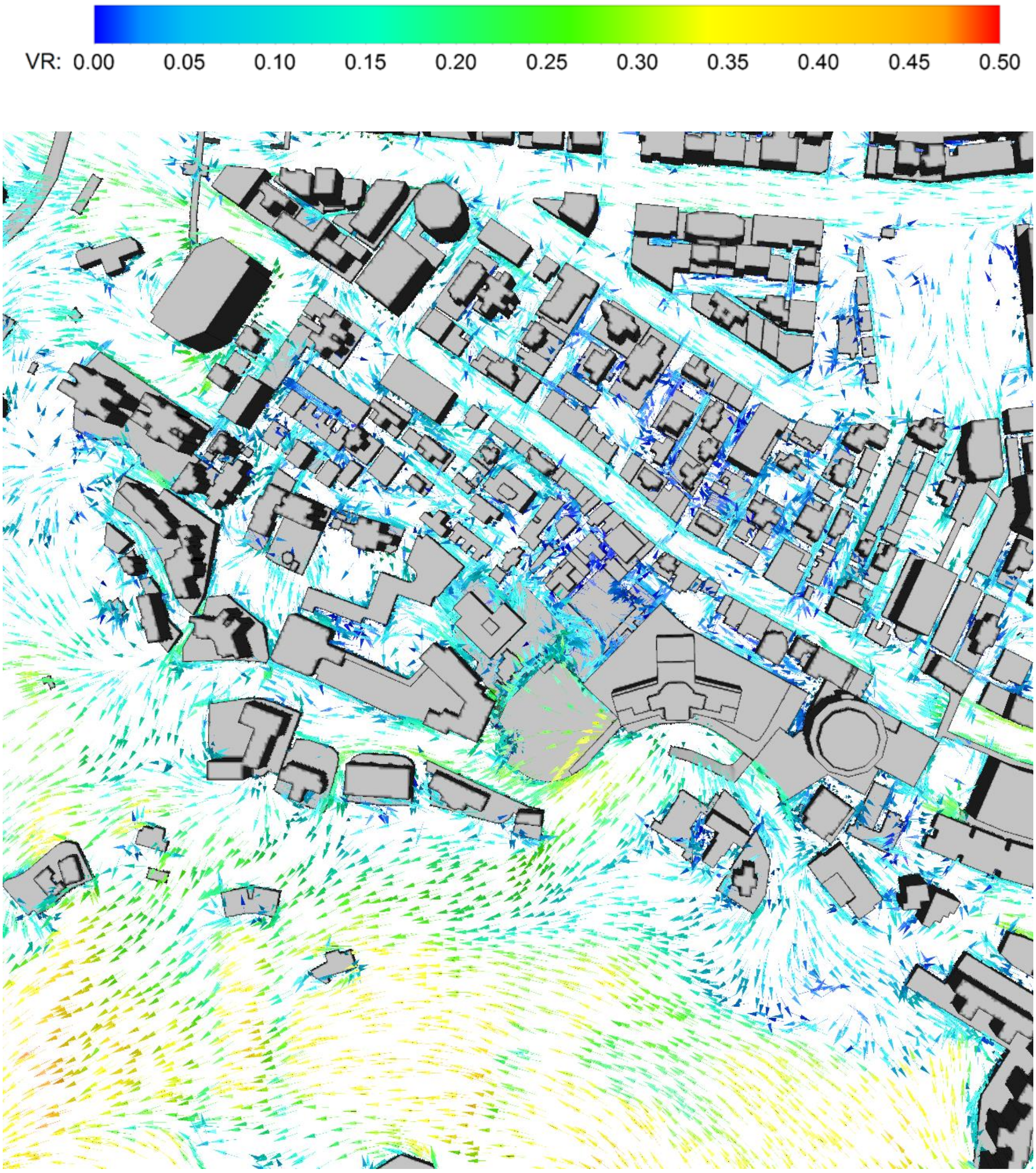


Figure D21. Vector Plot at 2m above Ground Level under S wind (Baseline Scheme)

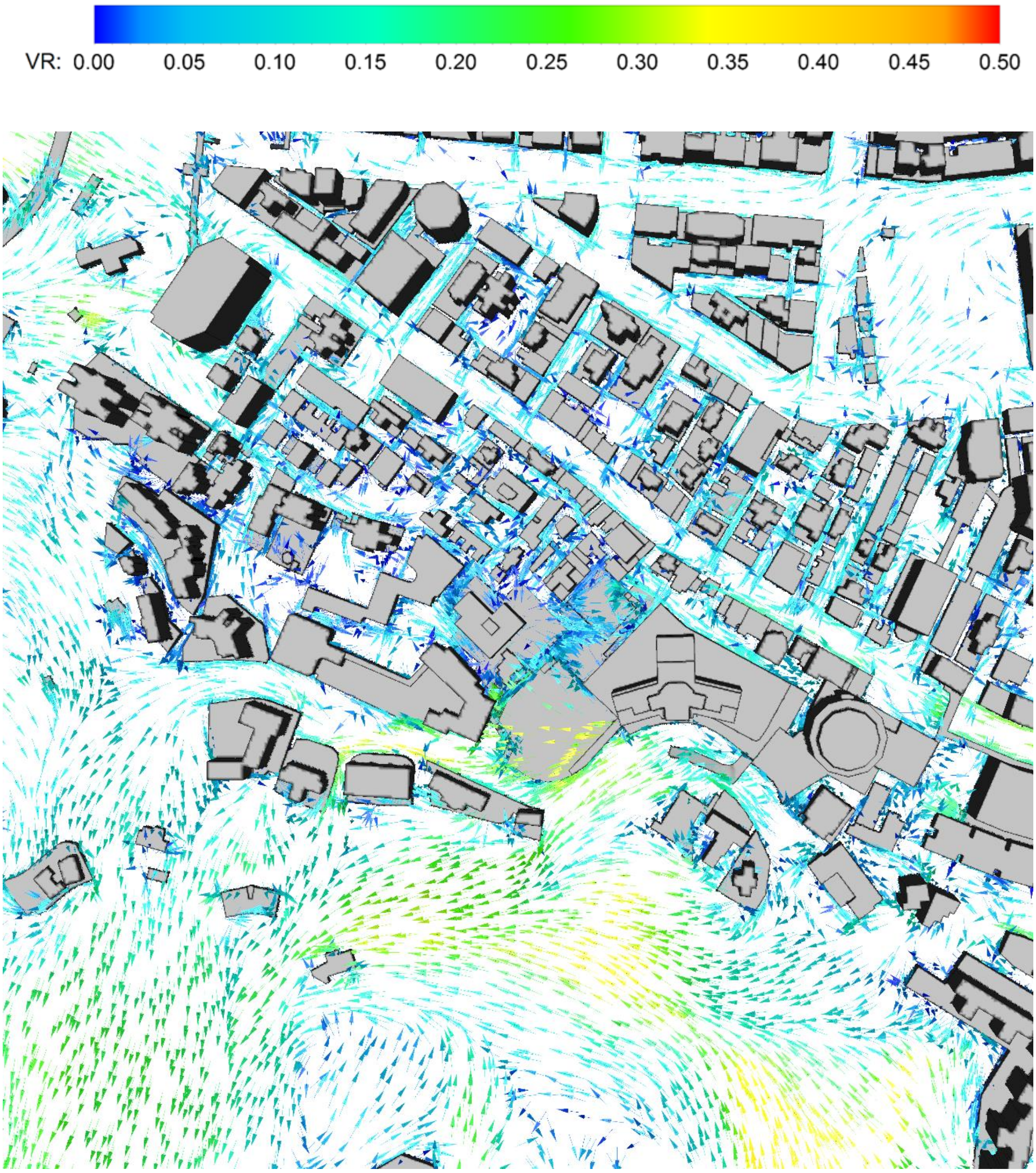


Figure D22. Vector Plot at 2m above Ground Level under SSW wind (Baseline Scheme)

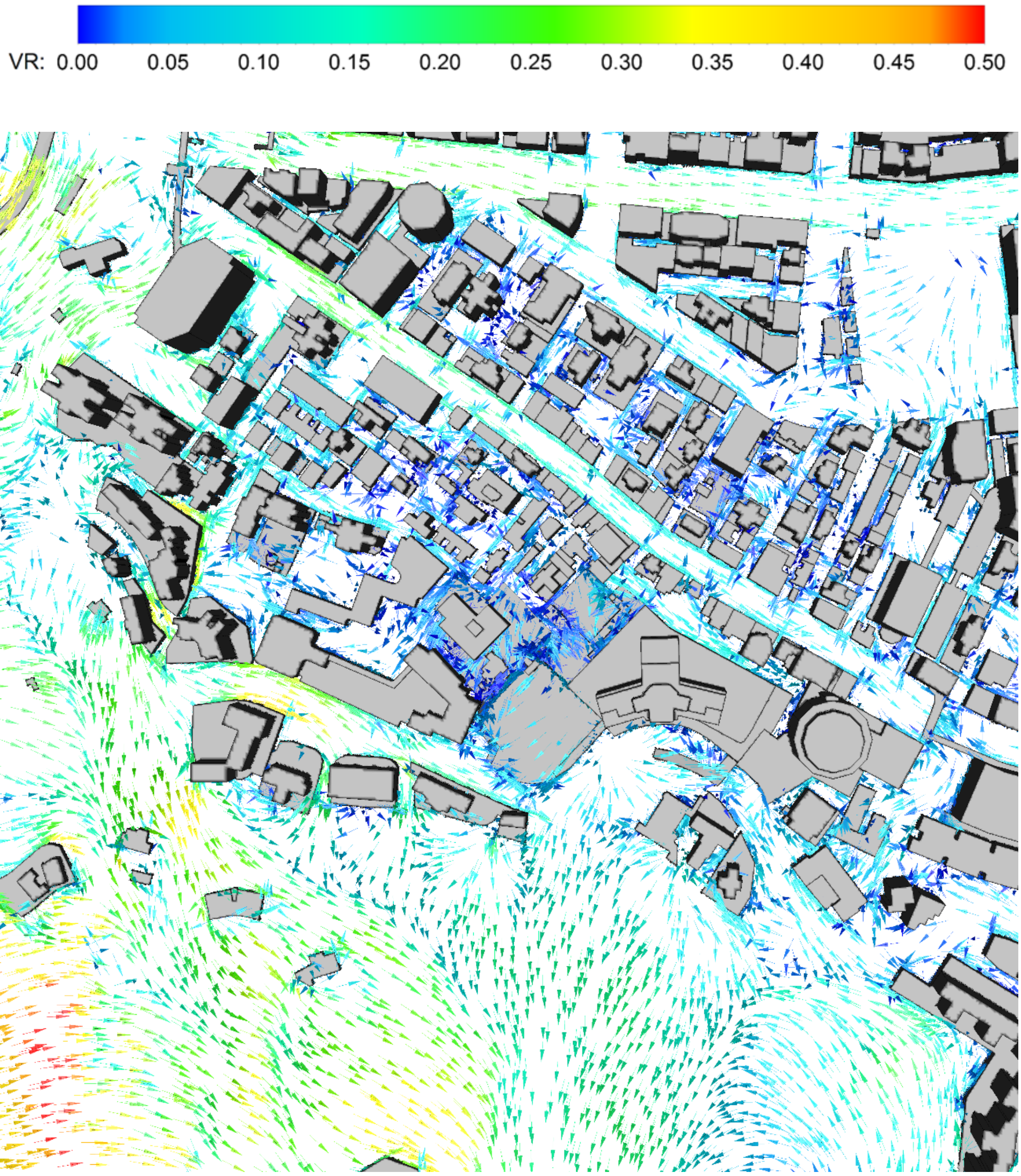


Figure D23. Vector Plot at 2m above Ground Level under SW wind (Baseline Scheme)

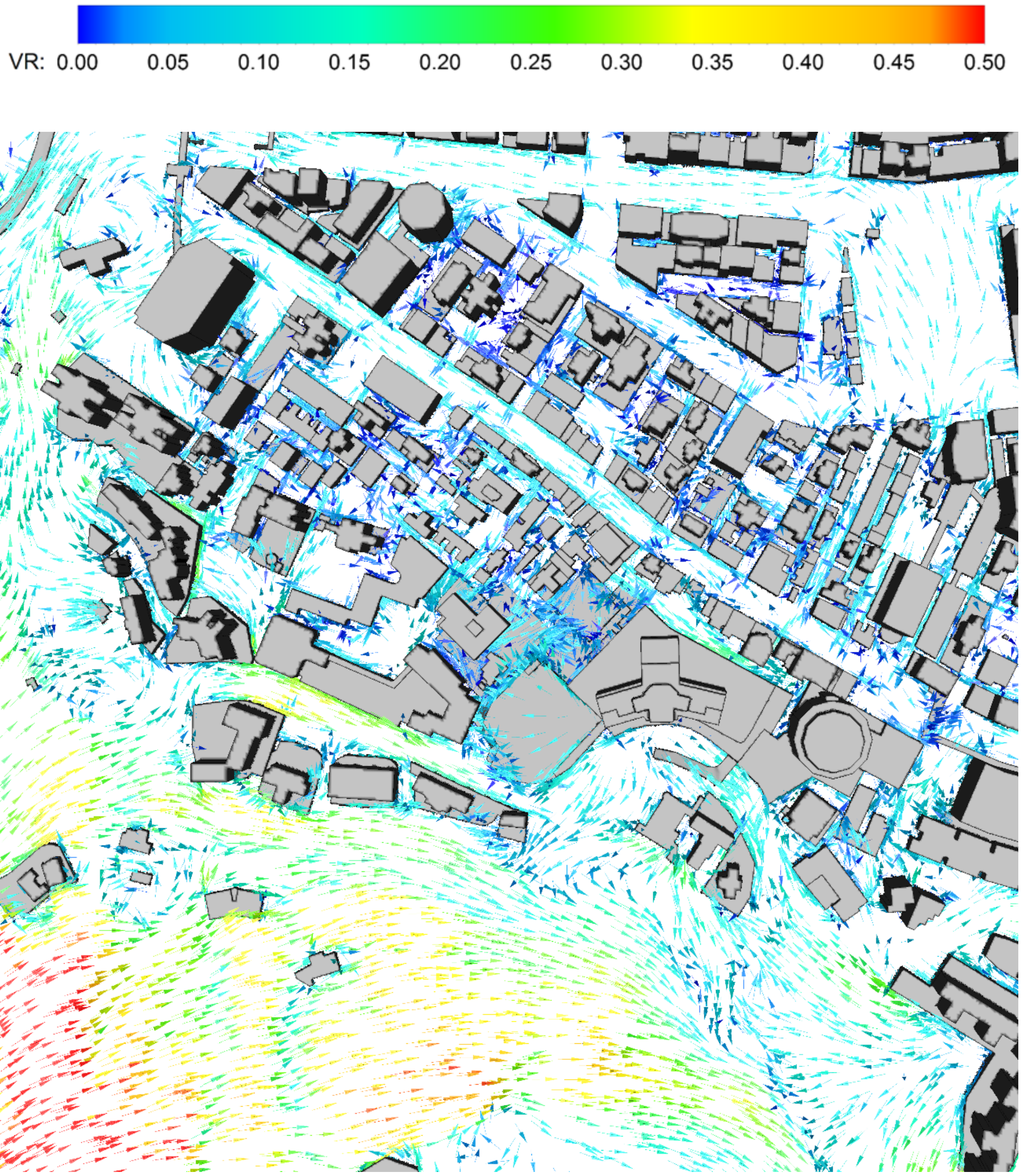


Figure D24. Vector Plot at 2m above Ground Level under WSW wind (Baseline Scheme)

Appendix E

Summary of Velocity Ratio and Velocity Vector Plots for Indicative Development Scheme

Not in Use

Velocity Ratio (VR) Plots

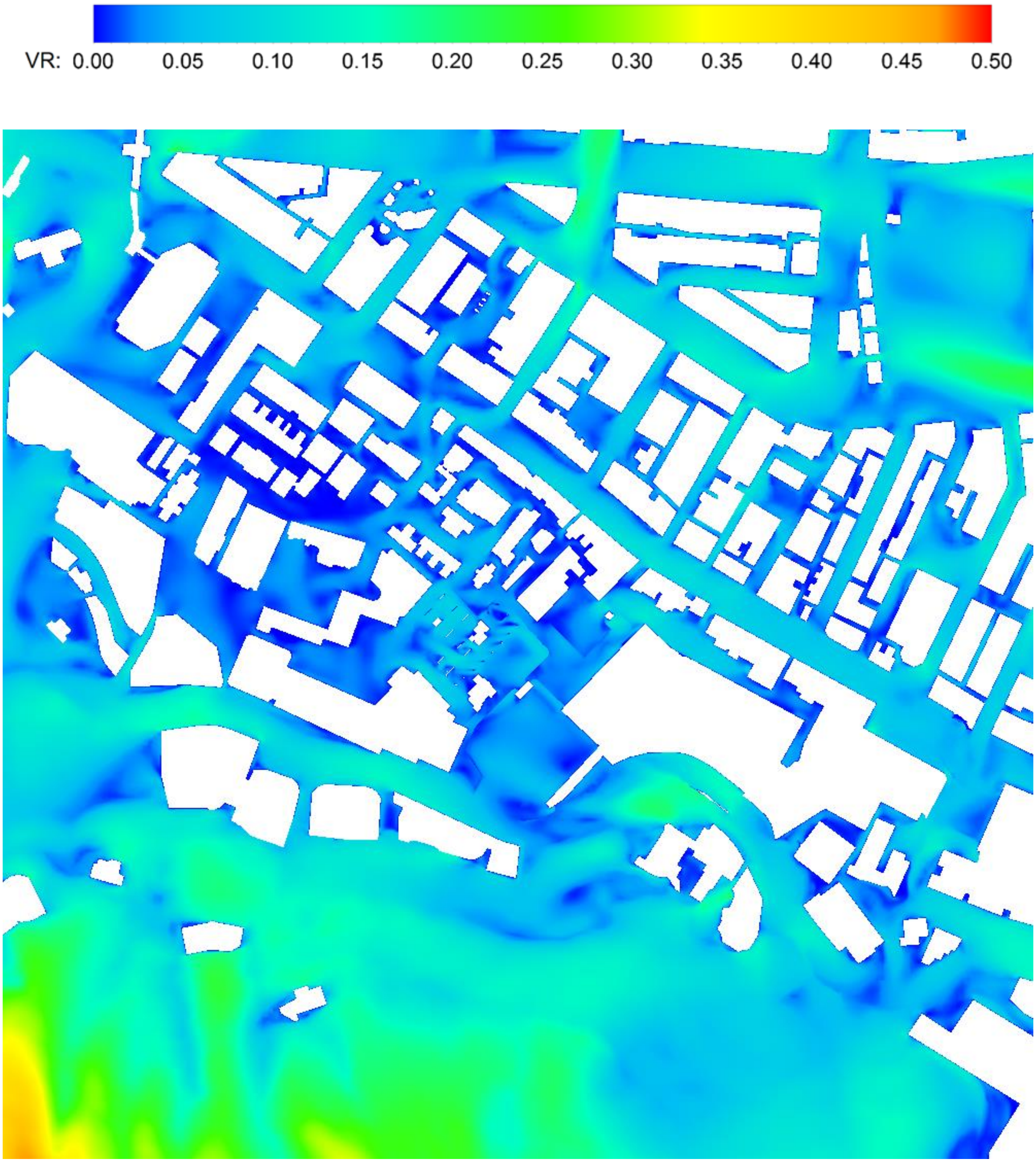


Figure E1. VR Plot at 2m above Ground Level under NNE wind (Indicative Development Scheme)

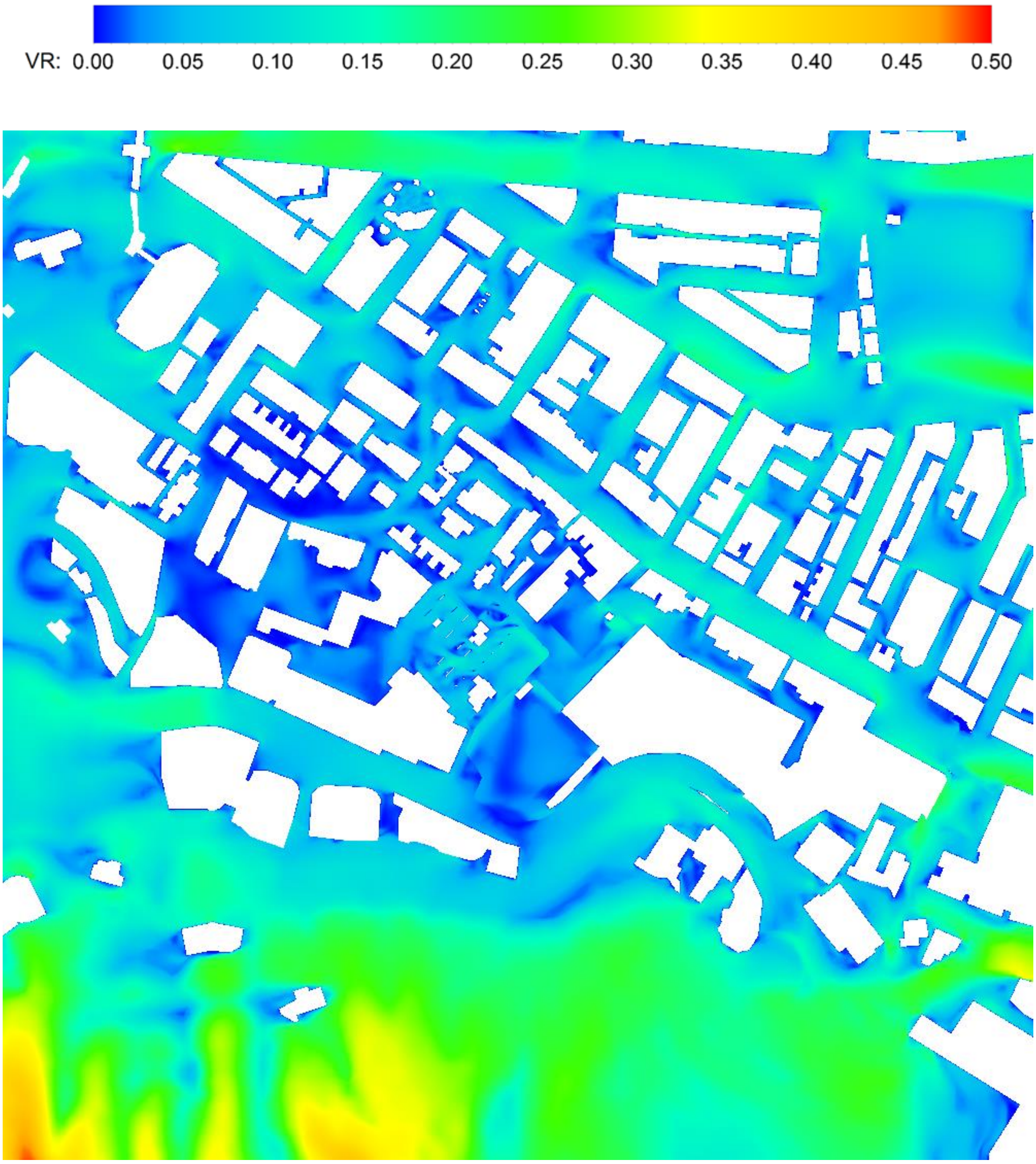


Figure E2. VR Plot at 2m above Ground Level under NE wind (Indicative Development Scheme)

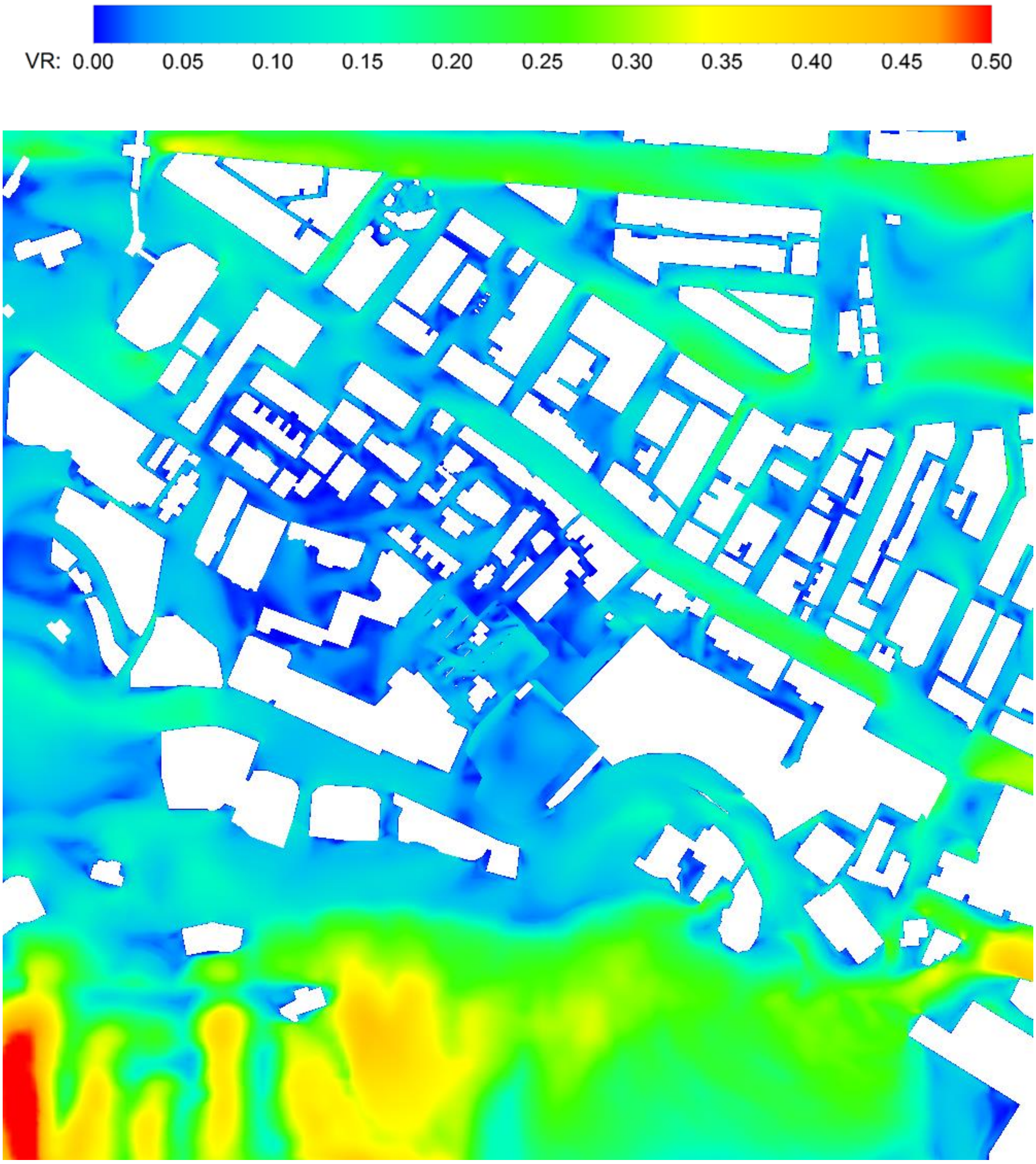


Figure E3. VR Plot at 2m above Ground Level under ENE wind (Indicative Development Scheme)

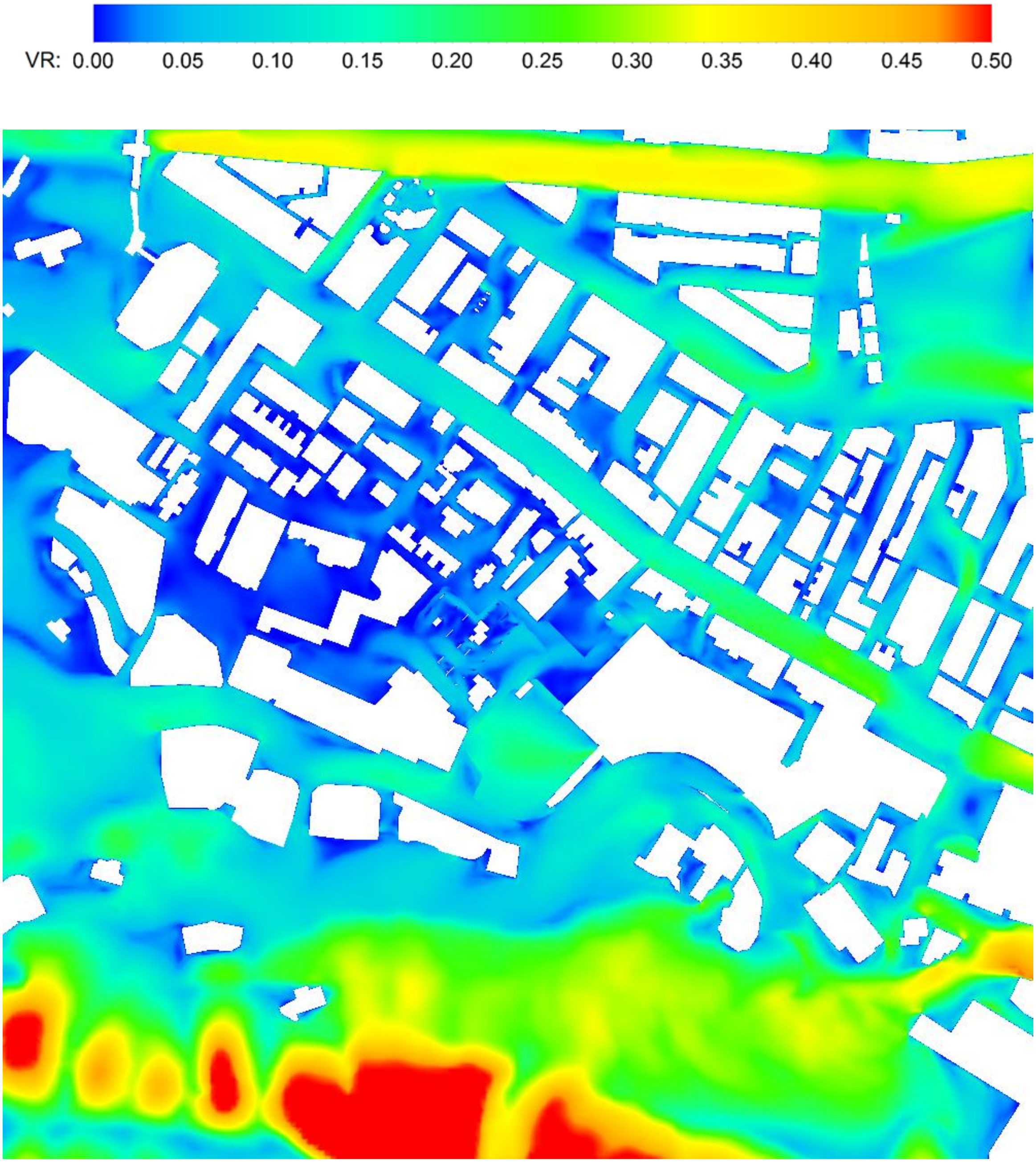


Figure E4. VR Plot at 2m above Ground Level under E wind (Indicative Development Scheme)

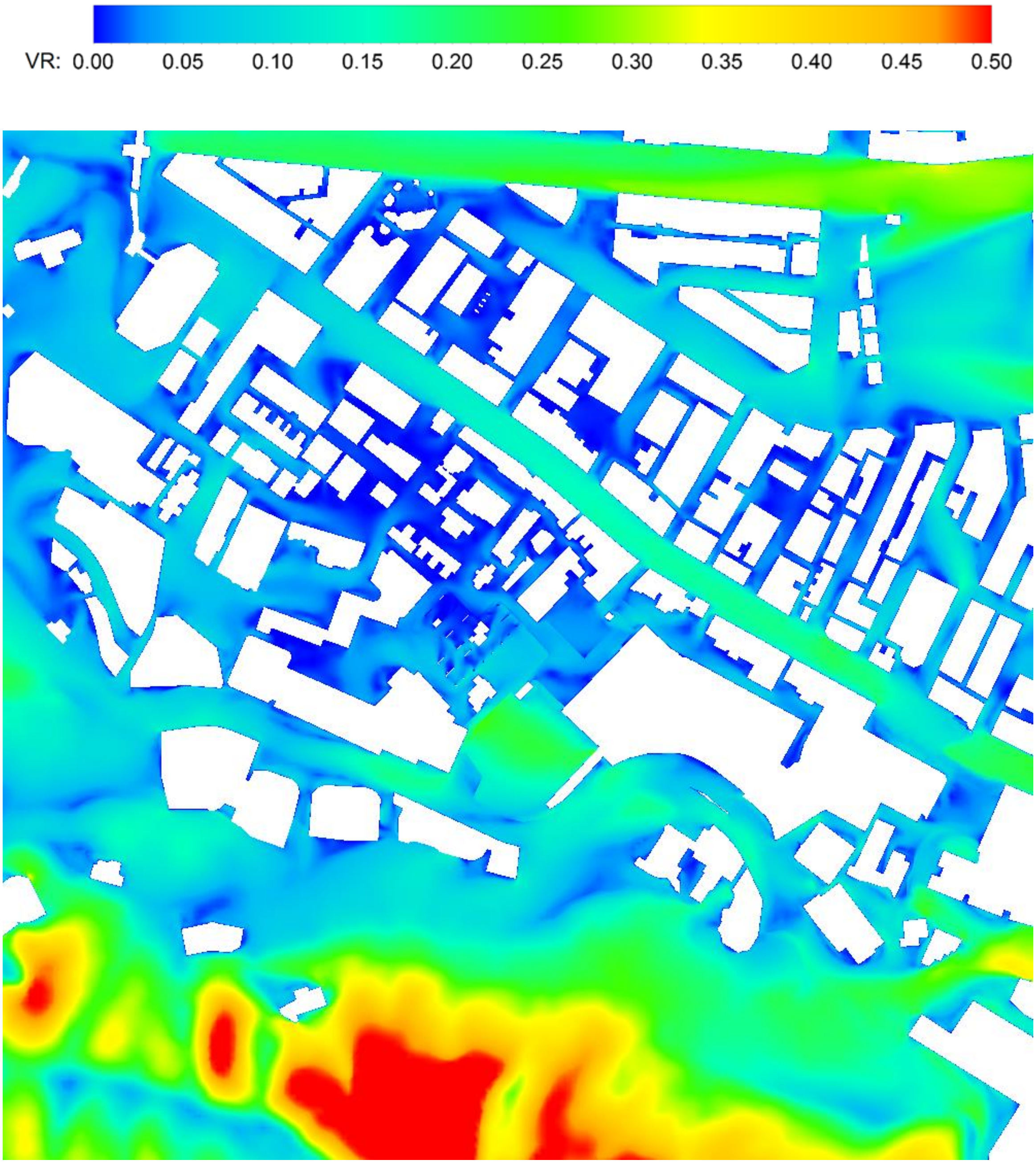


Figure E5. VR Plot at 2m above Ground Level under ESE wind (Indicative Development Scheme)

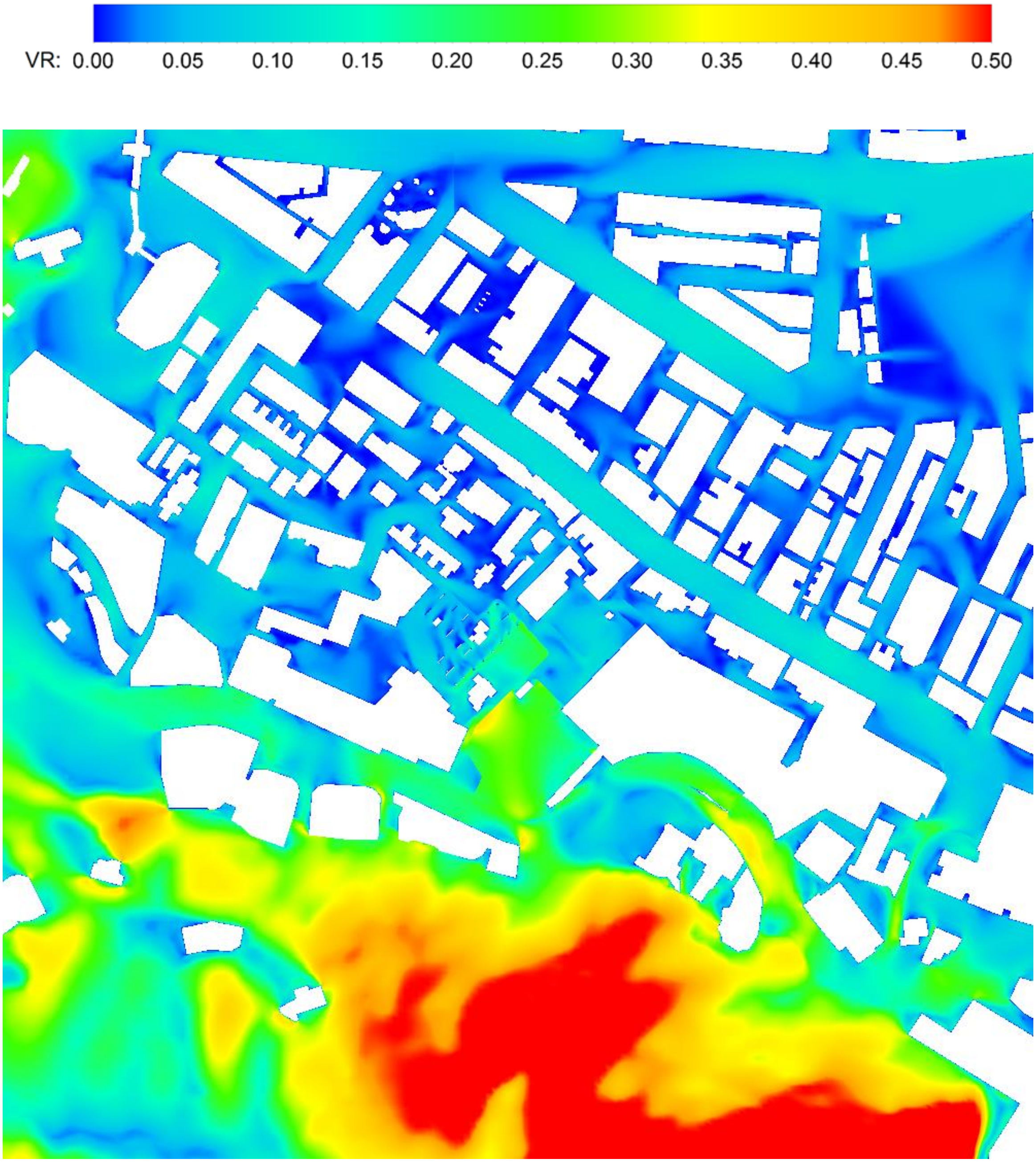


Figure E6. VR Plot at 2m above Ground Level under SE wind (Indicative Development Scheme)

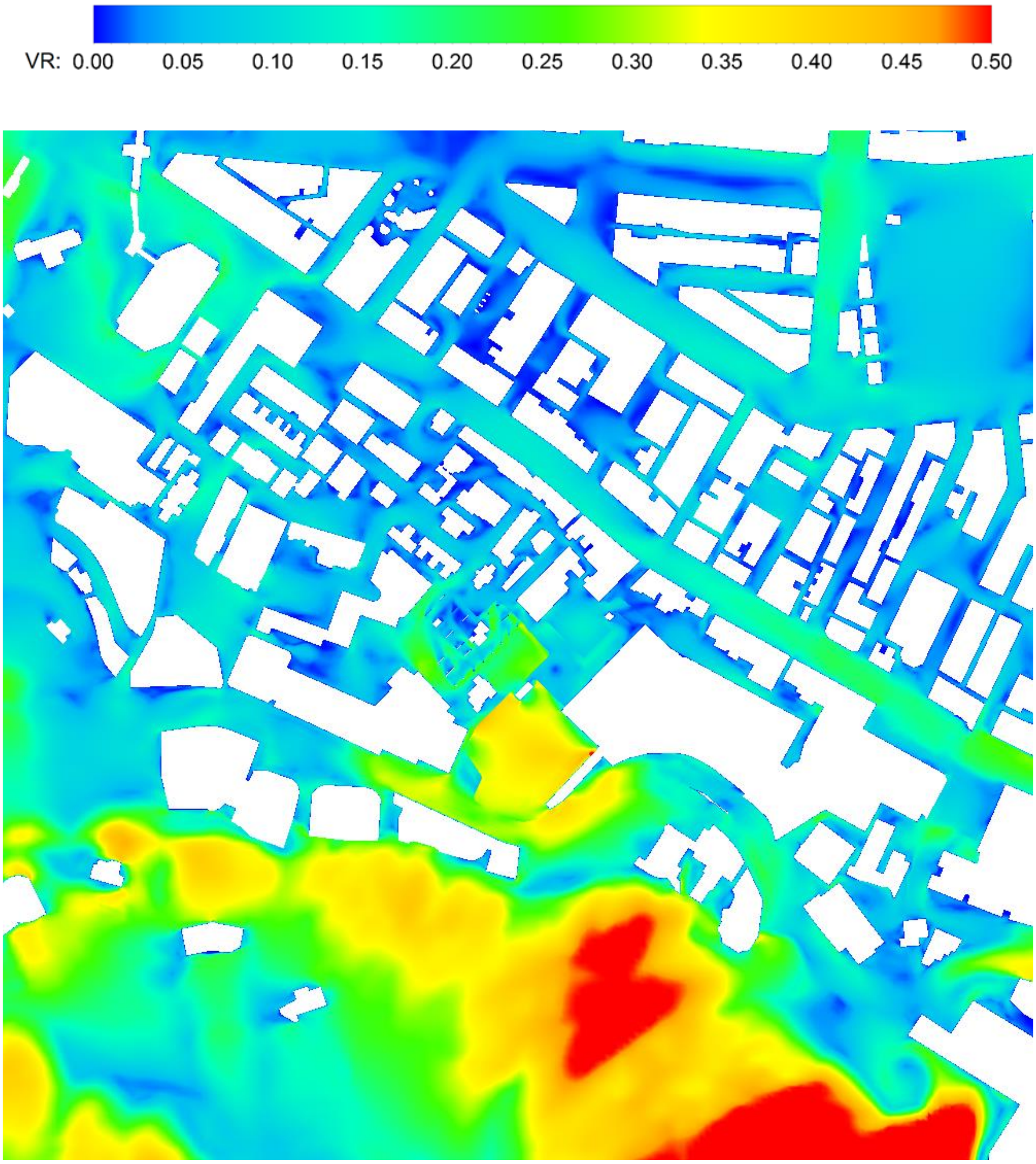


Figure E7. VR Plot at 2m above Ground Level under SSE wind (Indicative Development Scheme)

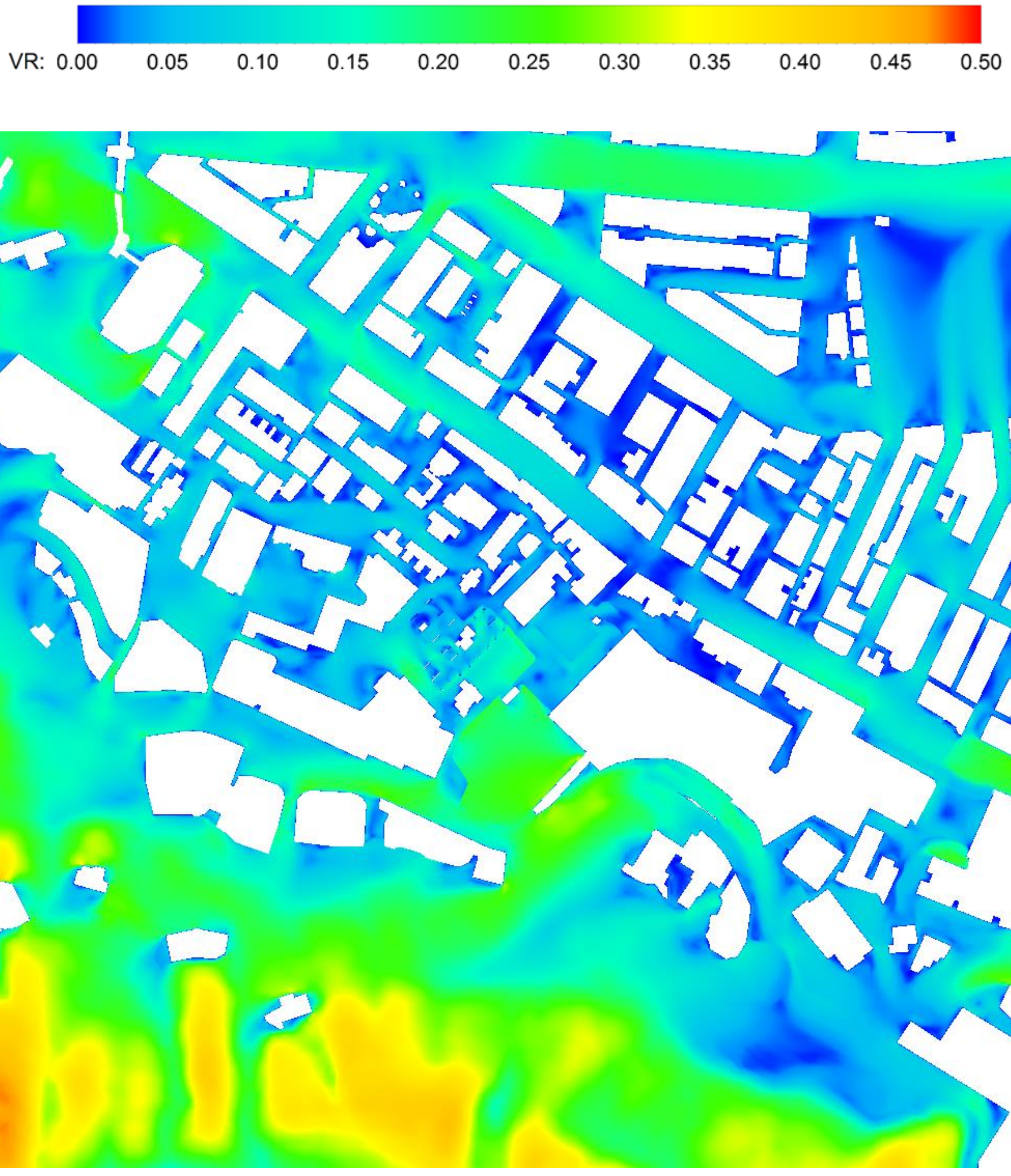


Figure E8. VR Plot at 2m above Ground Level under S wind (Indicative Development Scheme)

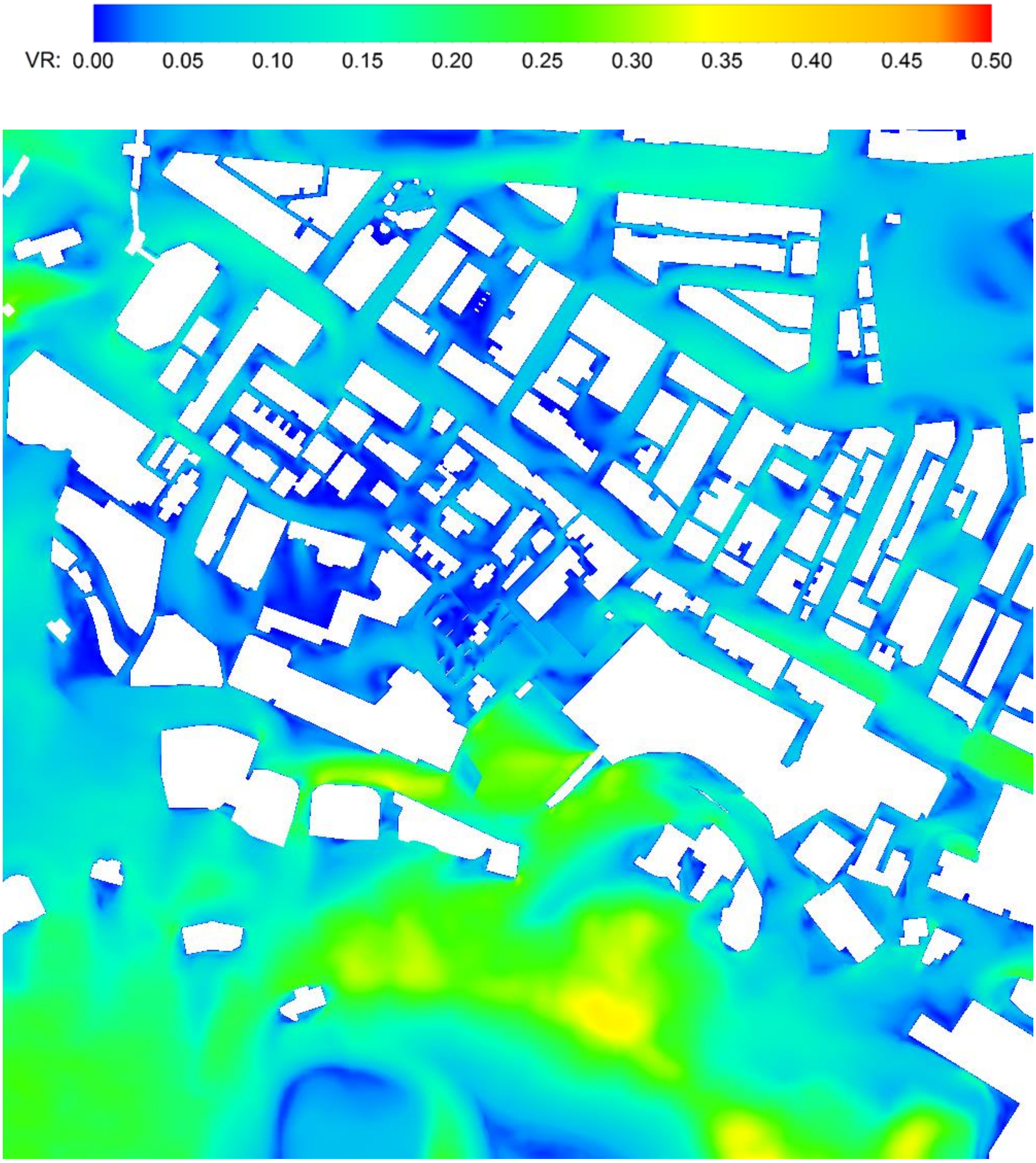


Figure E9. VR Plot at 2m above Ground Level under SSW wind (Indicative Development Scheme)

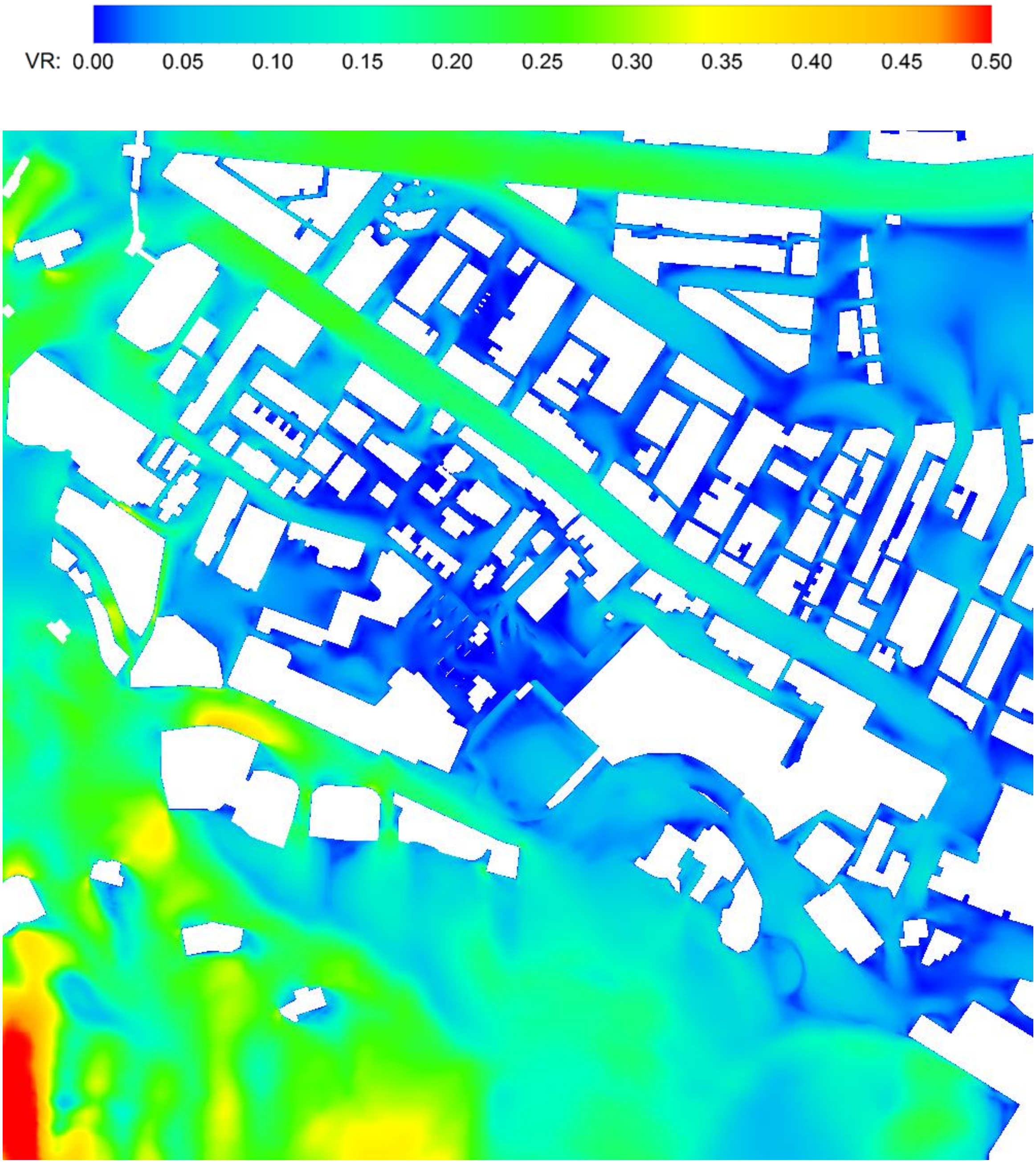


Figure E10. VR Plot at 2m above Ground Level under SW wind (Indicative Development Scheme)

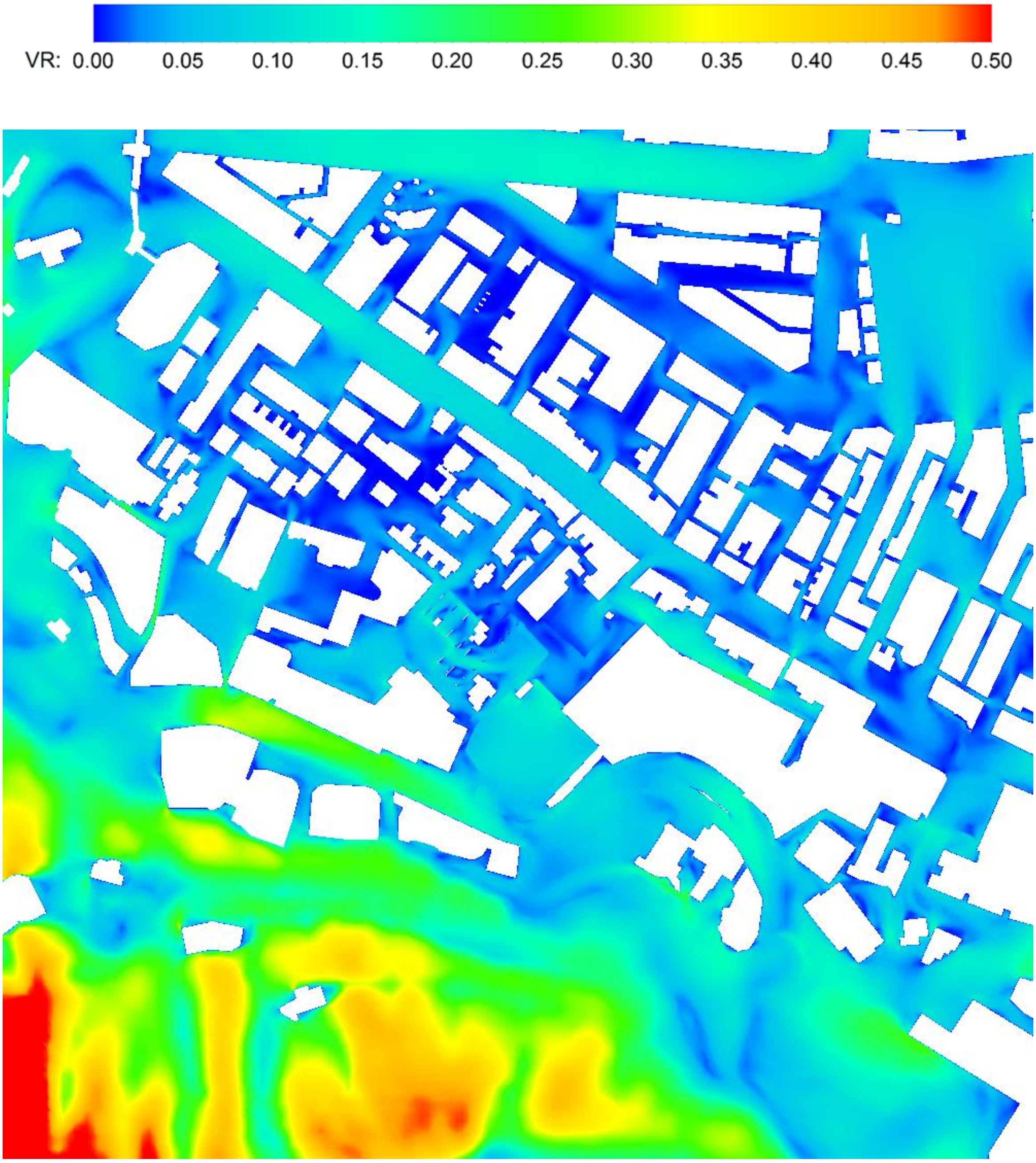


Figure E11. VR Plot at 2m above Ground Level under WSW wind (Indicative Development Scheme)

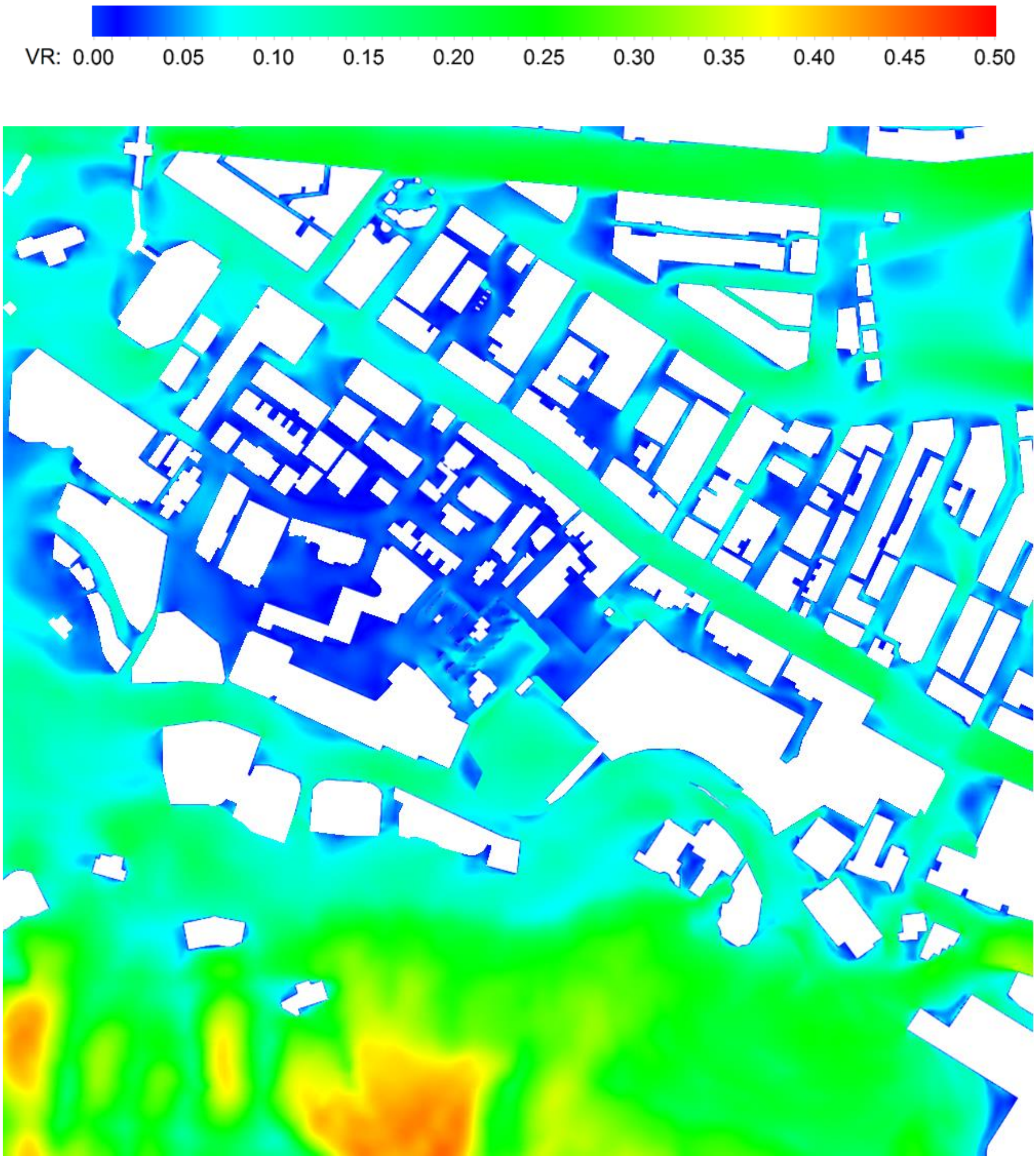


Figure E12. Annual Weighted VR Plot at 2m above Ground Level (Indicative Development Scheme)

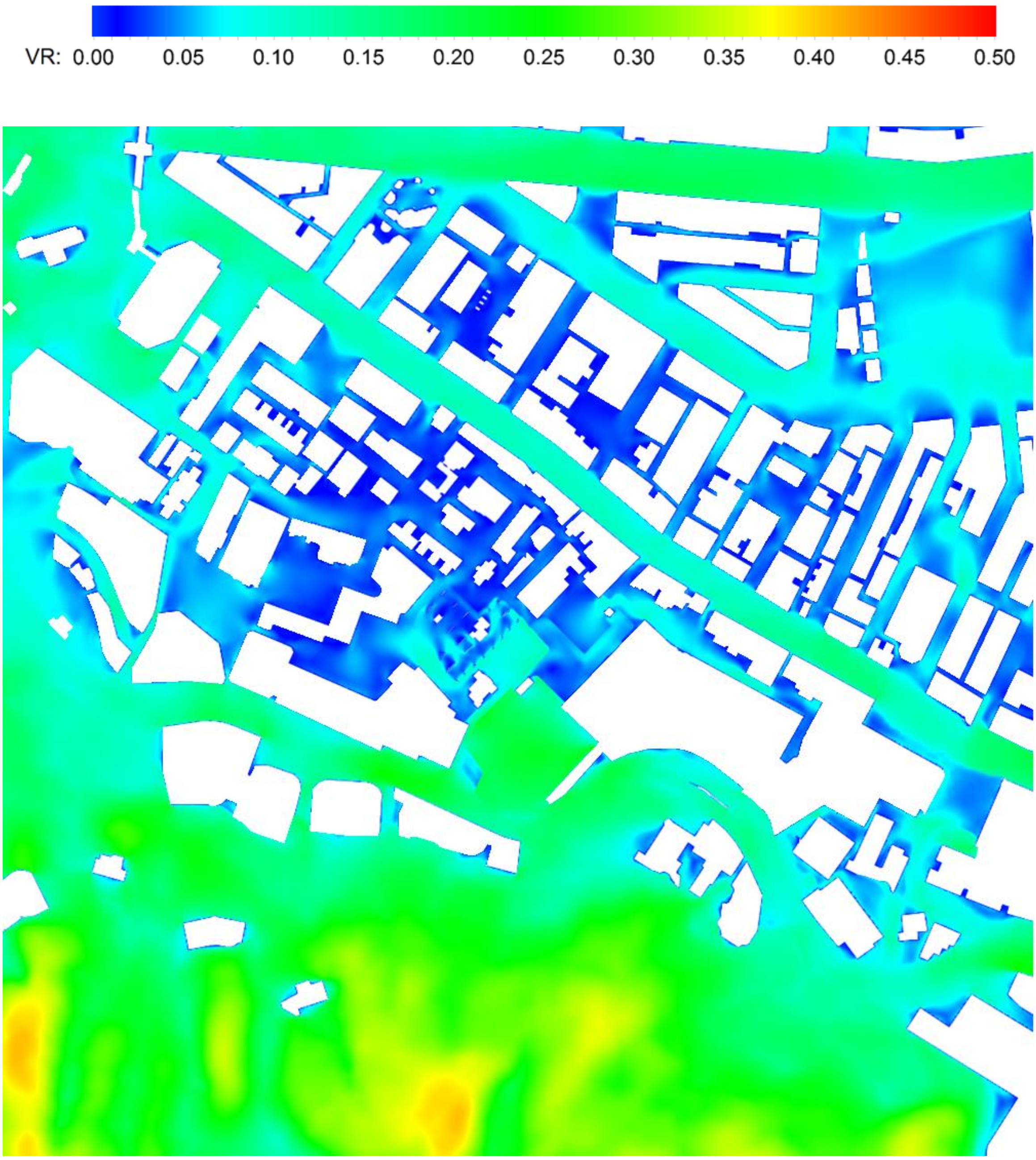


Figure E13. Summer Weighted VR Plot at 2m above Ground Level (Indicative Development Scheme)

Velocity Vector (VR) Plots

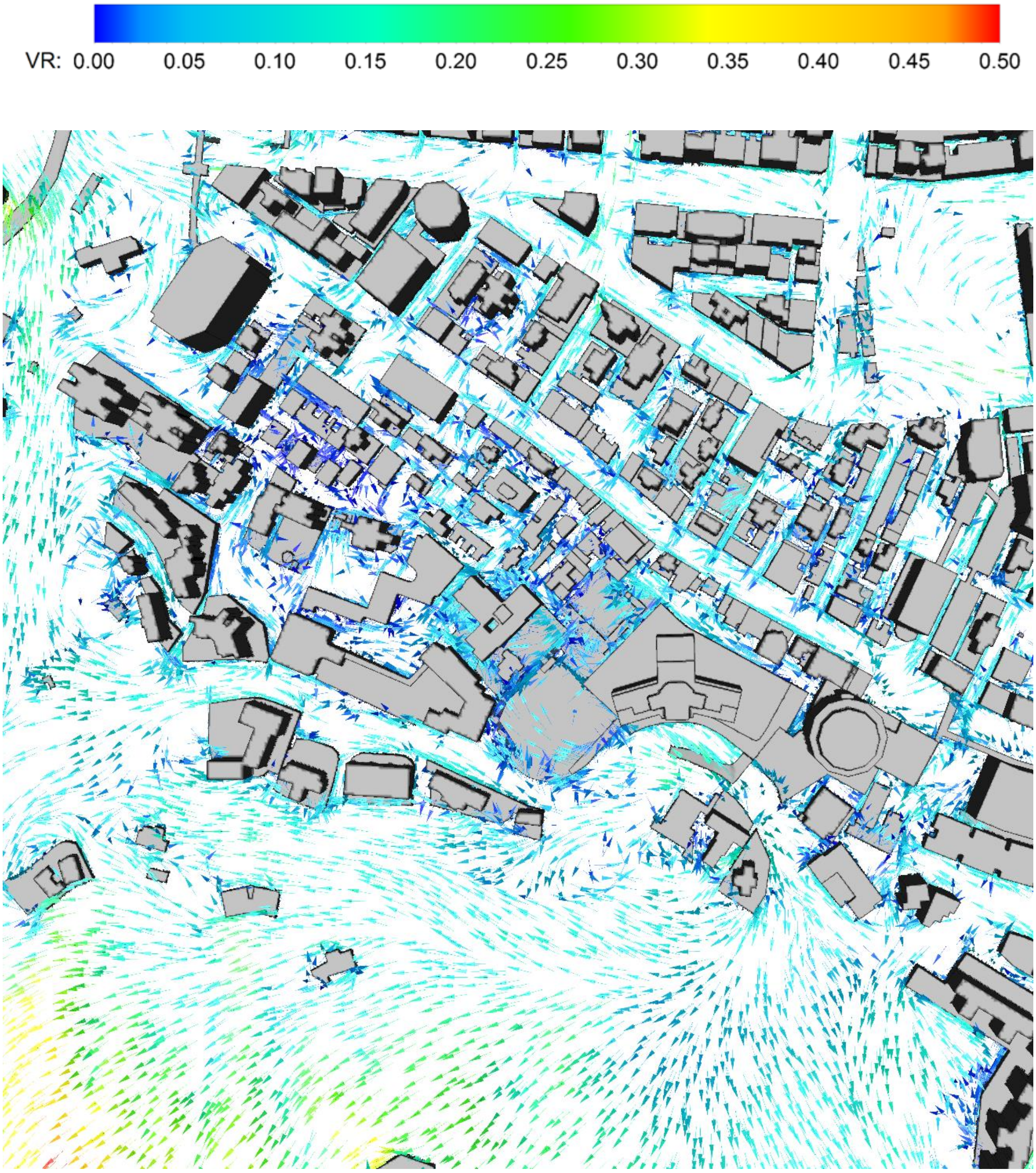


Figure E14. Vector Plot at 2m above Ground Level under NNE wind (Indicative Development Scheme)

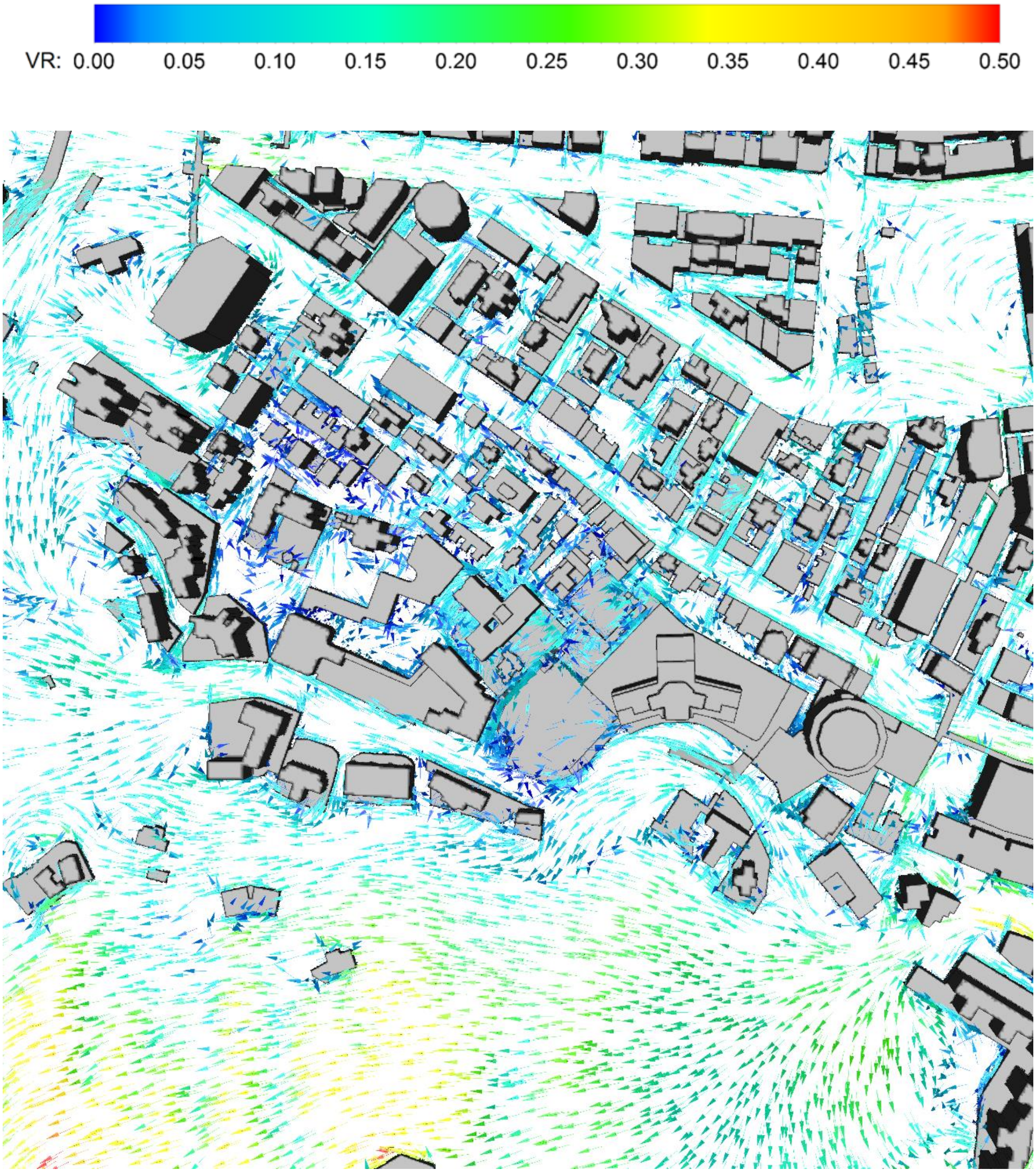


Figure E15. Vector Plot at 2m above Ground Level under NE wind (Indicative Development Scheme)

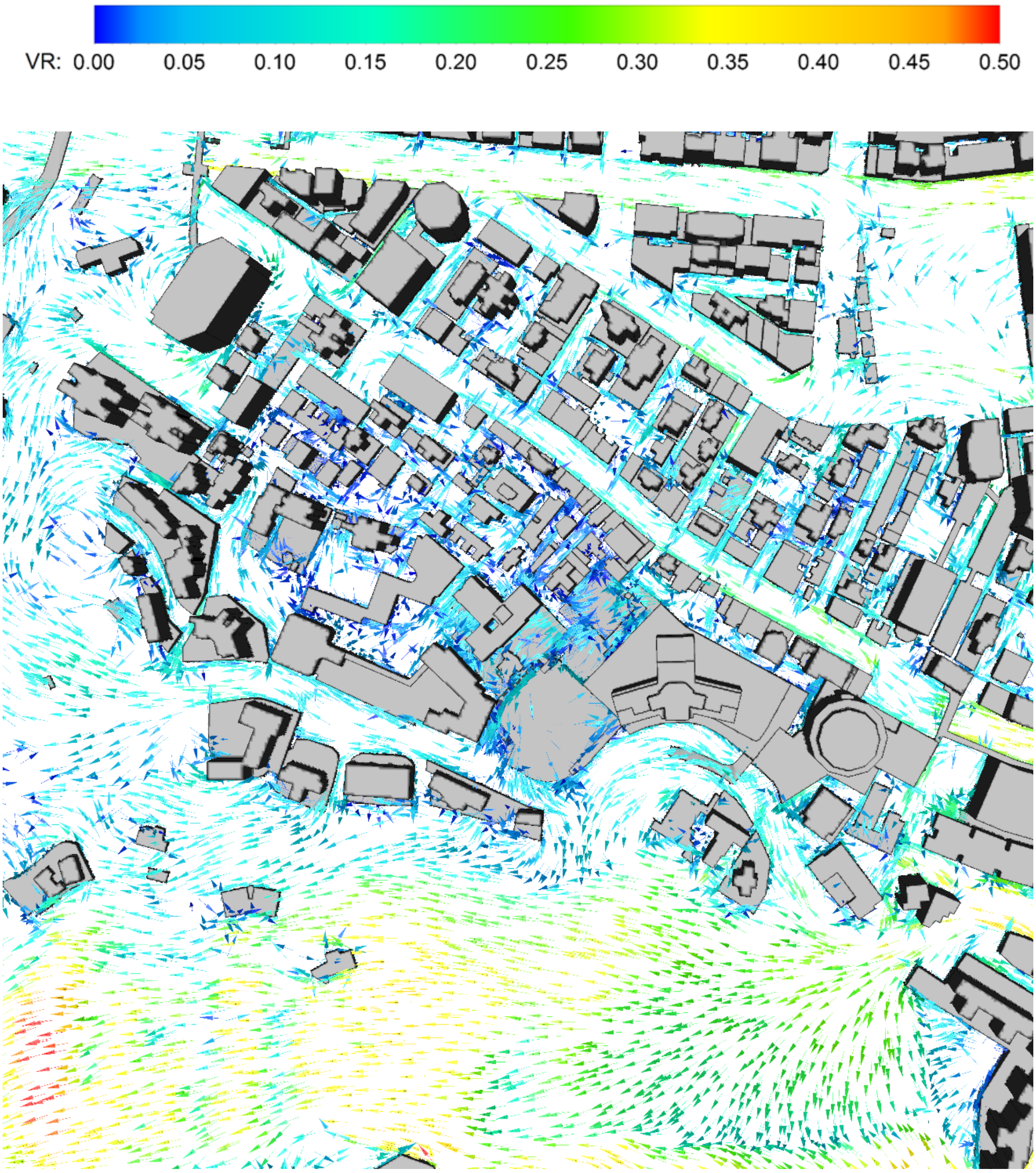


Figure E16. Vector Plot at 2m above Ground Level under ENE wind (Indicative Development Scheme)

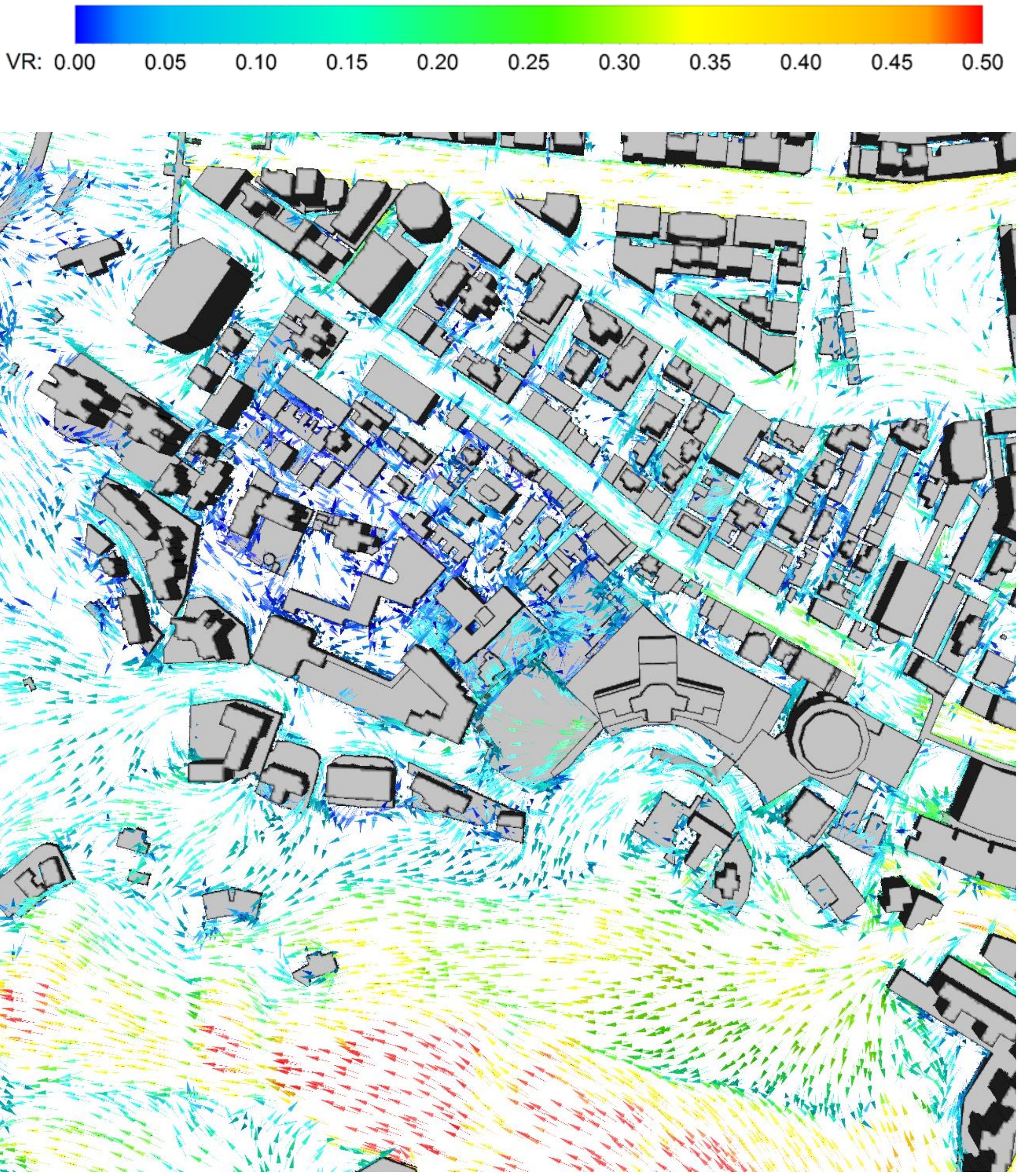


Figure E17. Vector Plot at 2m above Ground Level under E wind (Indicative Development Scheme)

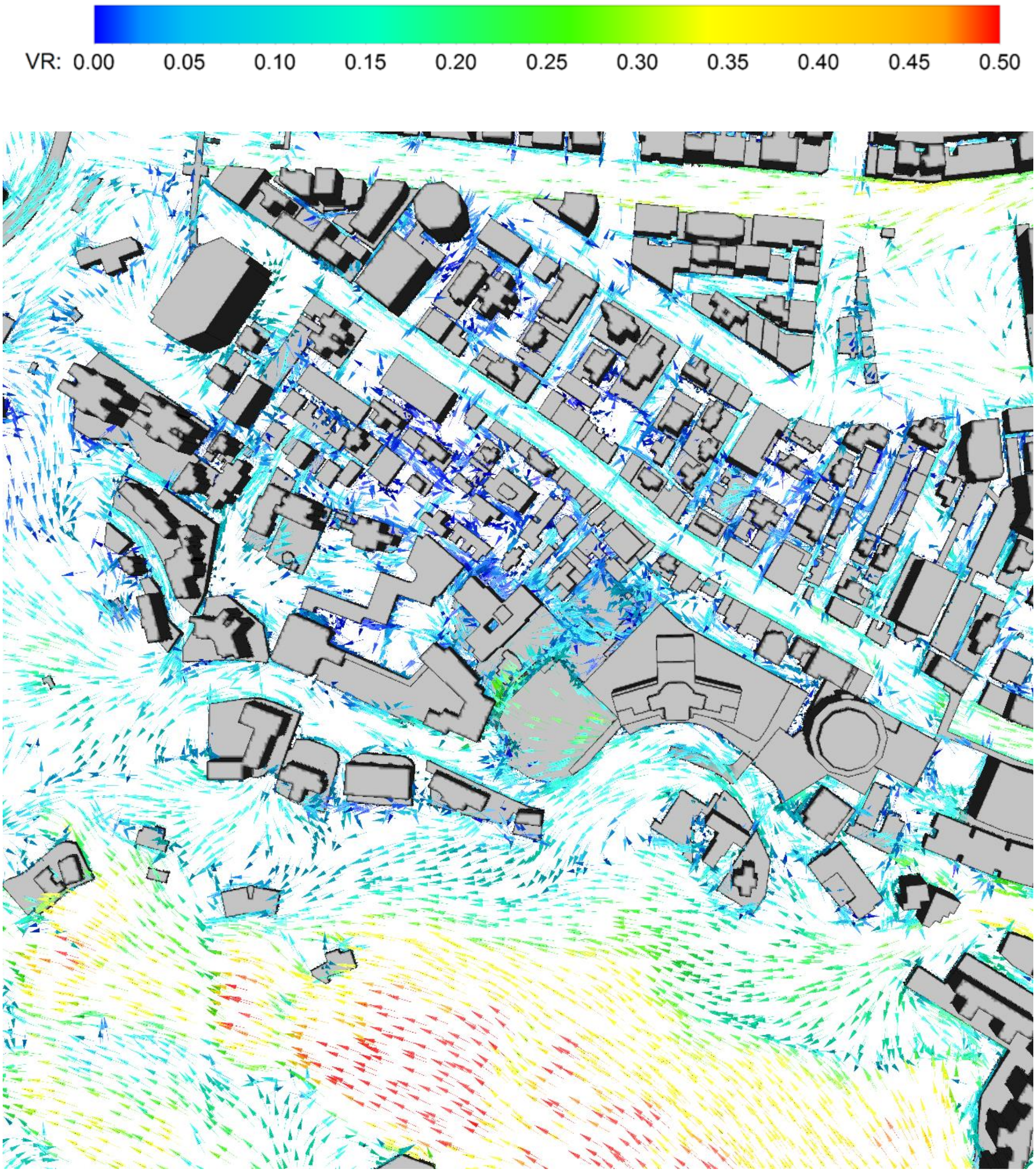


Figure E18. Vector Plot at 2m above Ground Level under ESE wind (Indicative Development Scheme)

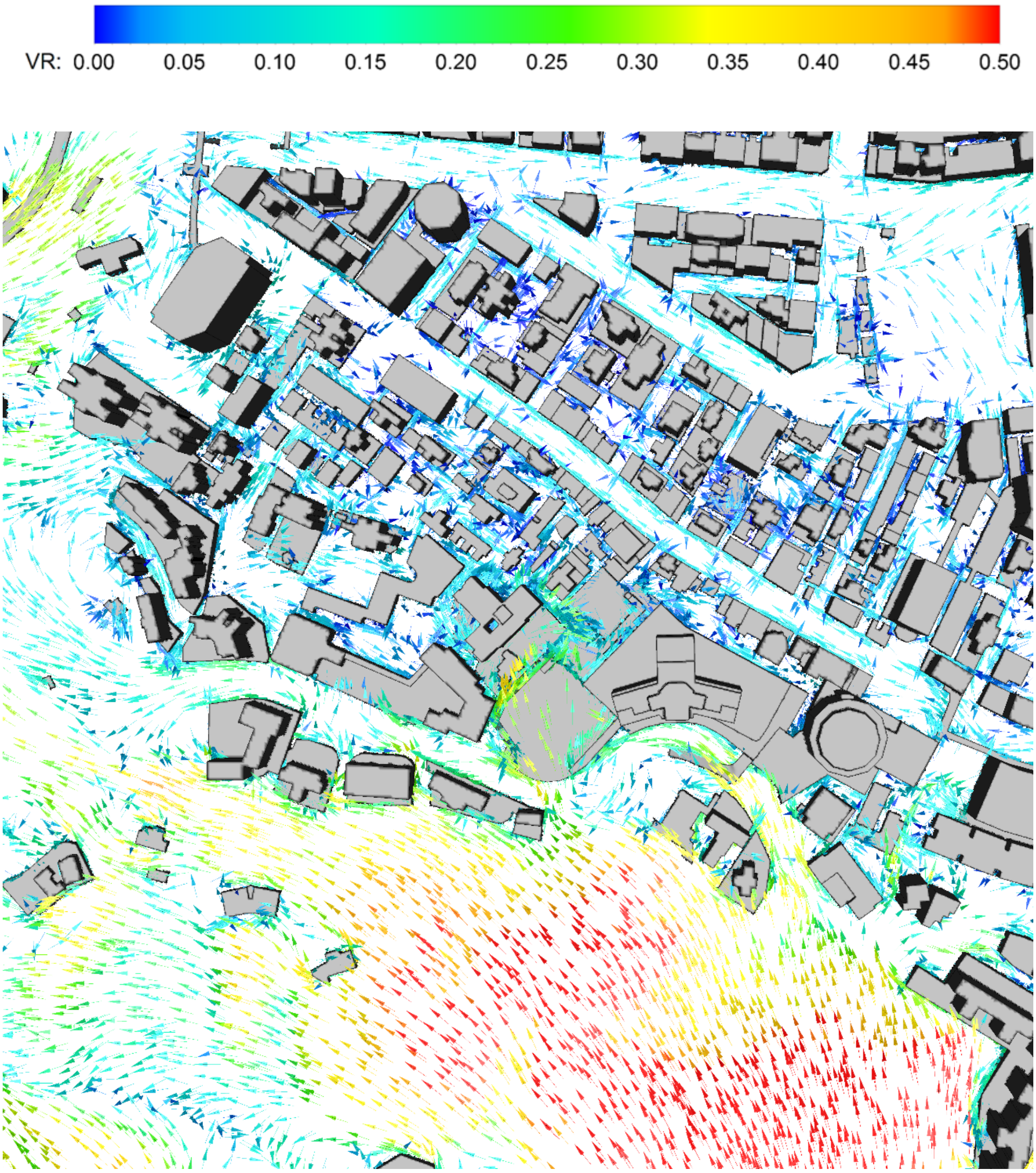


Figure E19. Vector Plot at 2m above Ground Level under SE wind (Indicative Development Scheme)

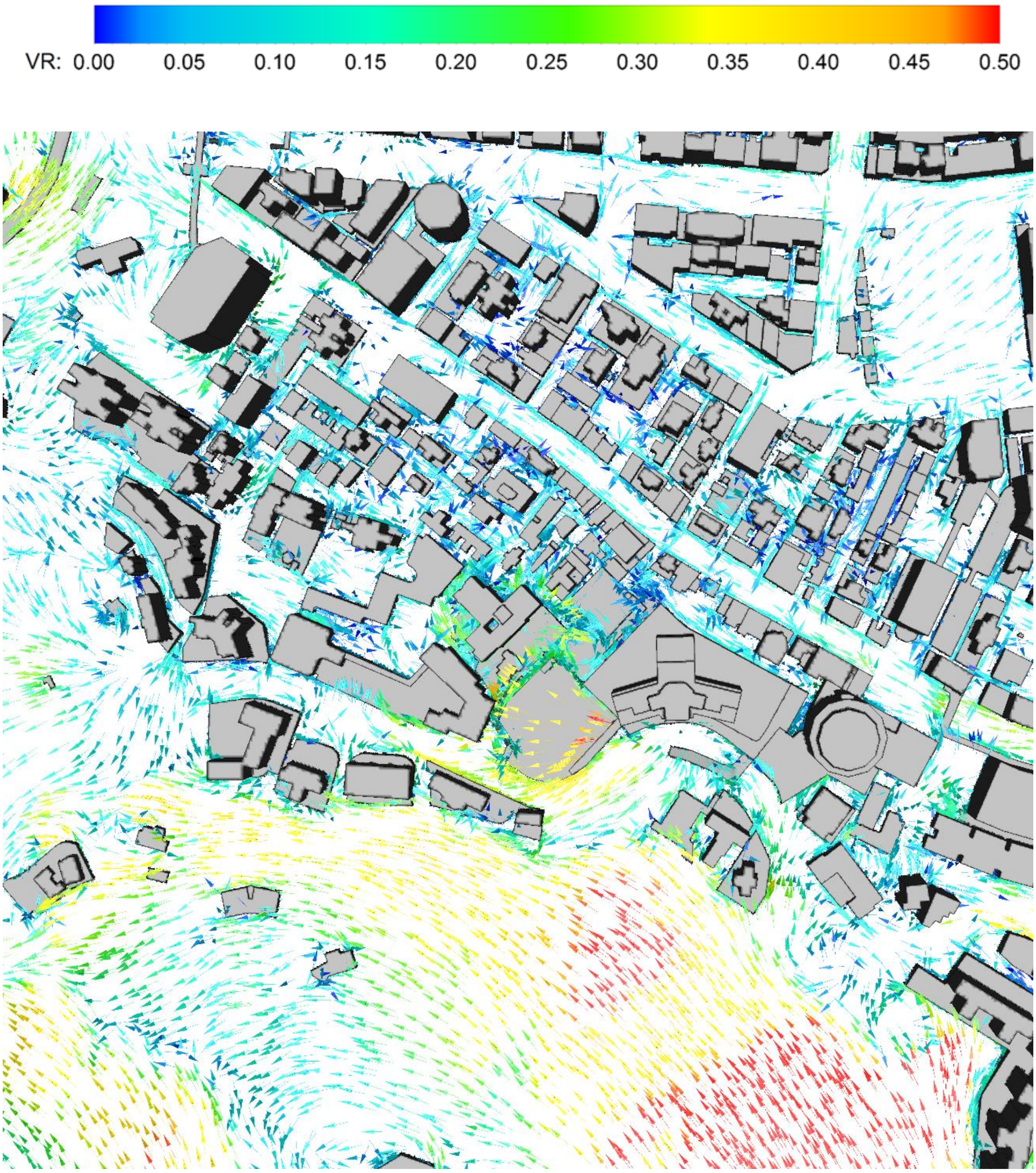


Figure E20. Vector Plot at 2m above Ground Level under SSE wind (Indicative Development Scheme)

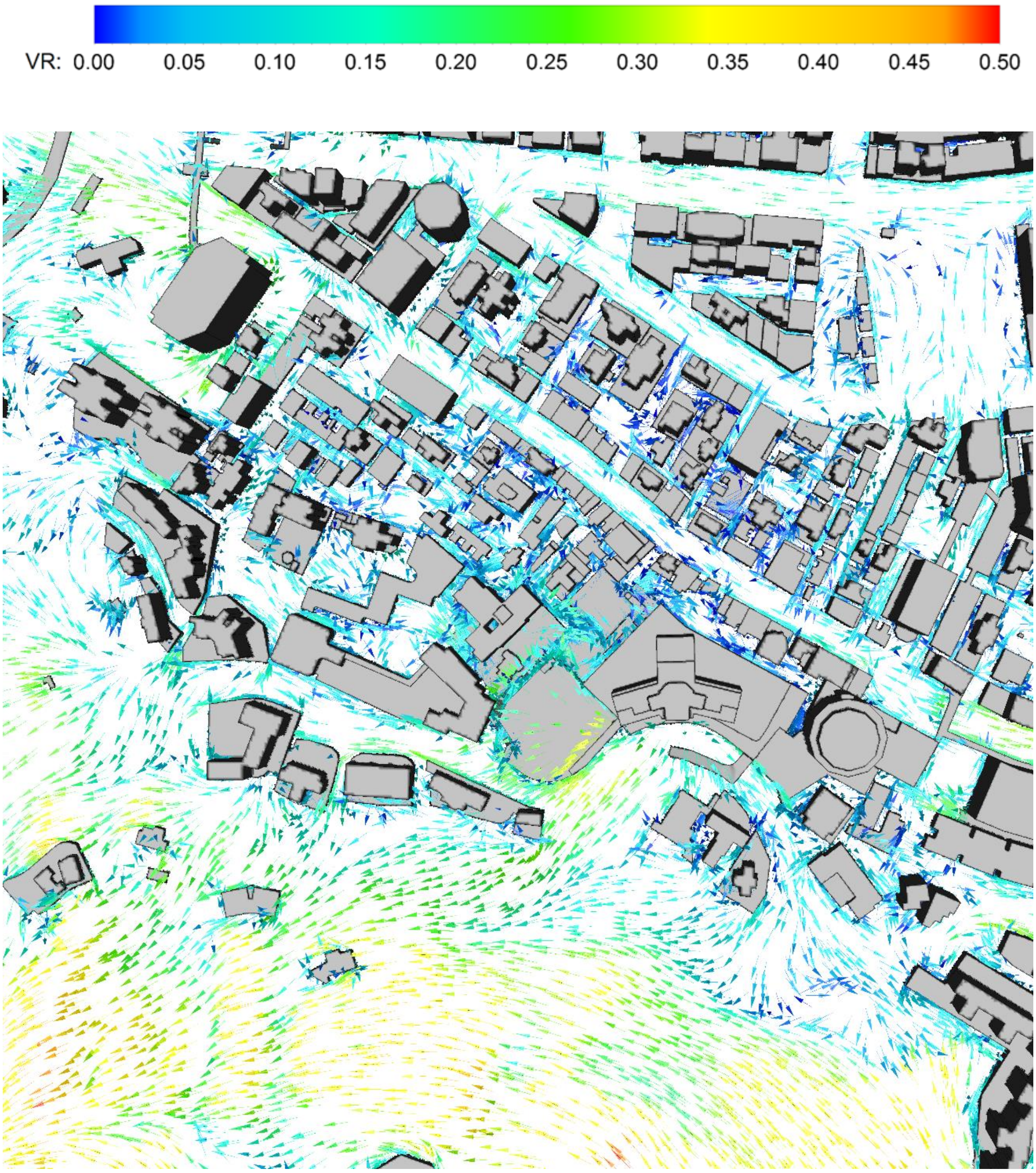


Figure E21. Vector Plot at 2m above Ground Level under S wind (Indicative Development Scheme)

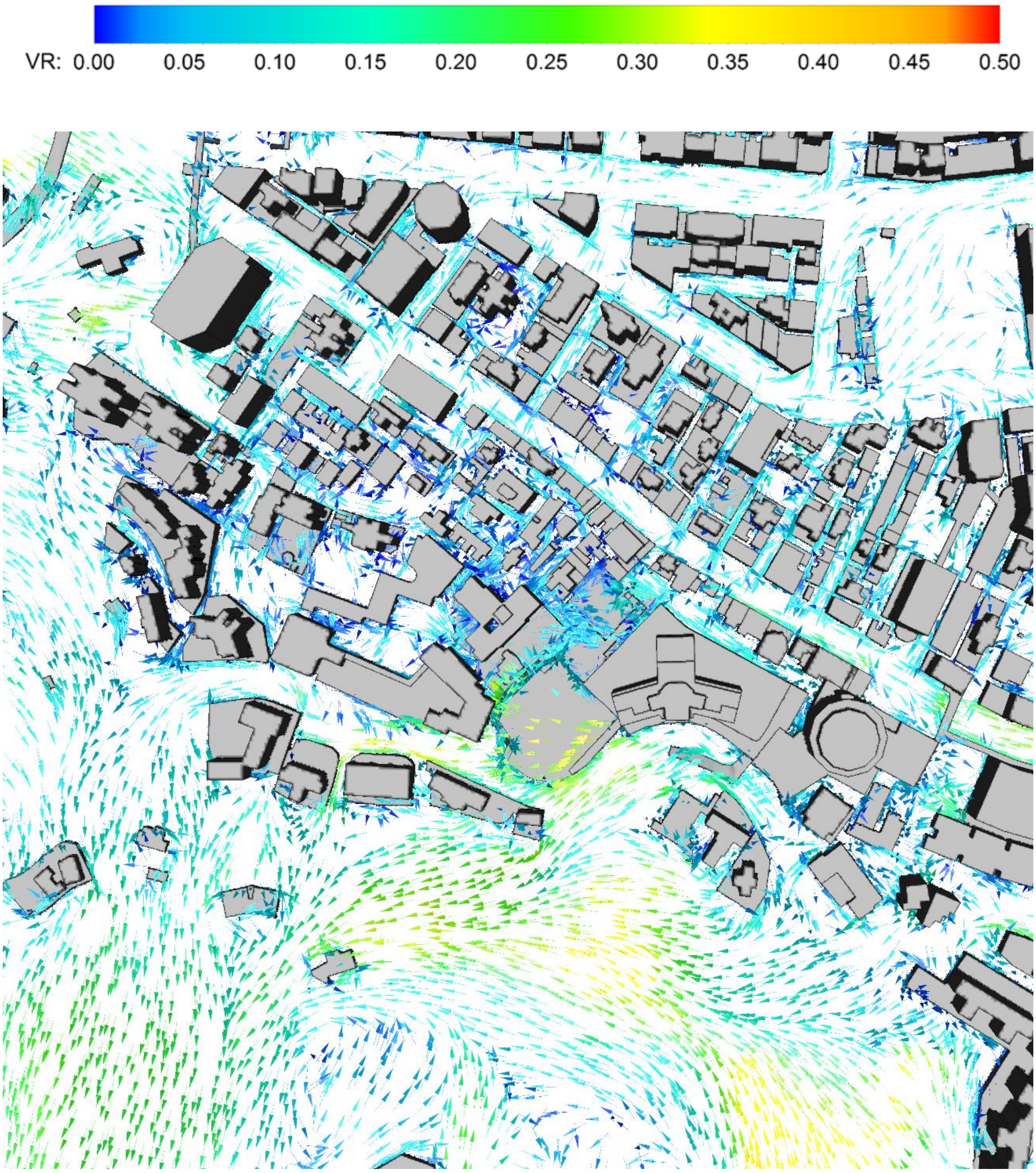


Figure E22. Vector Plot at 2m above Ground Level under SSW wind (Indicative Development Scheme)

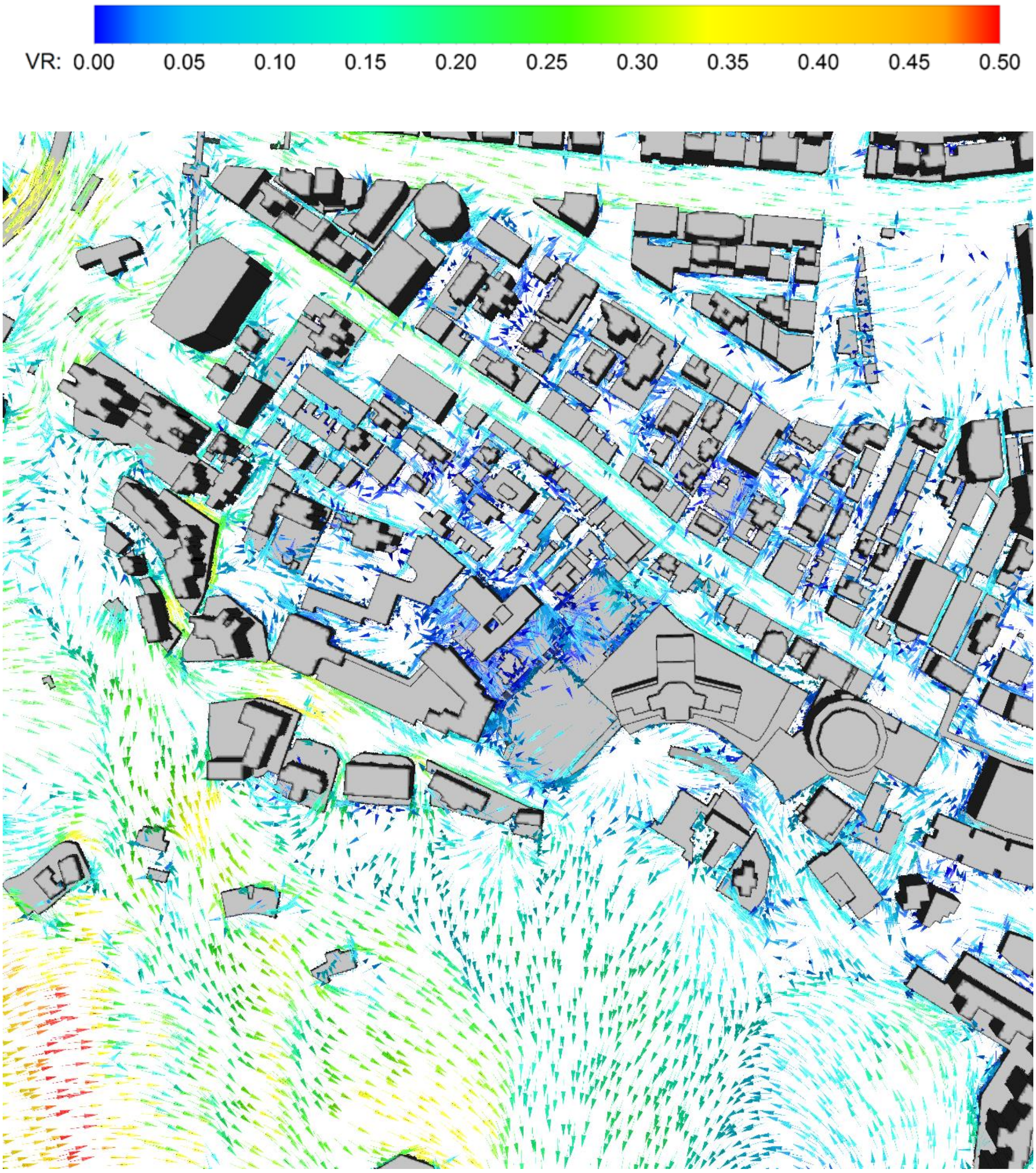


Figure E23. Vector Plot at 2m above Ground Level under SW wind (Indicative Development Scheme)

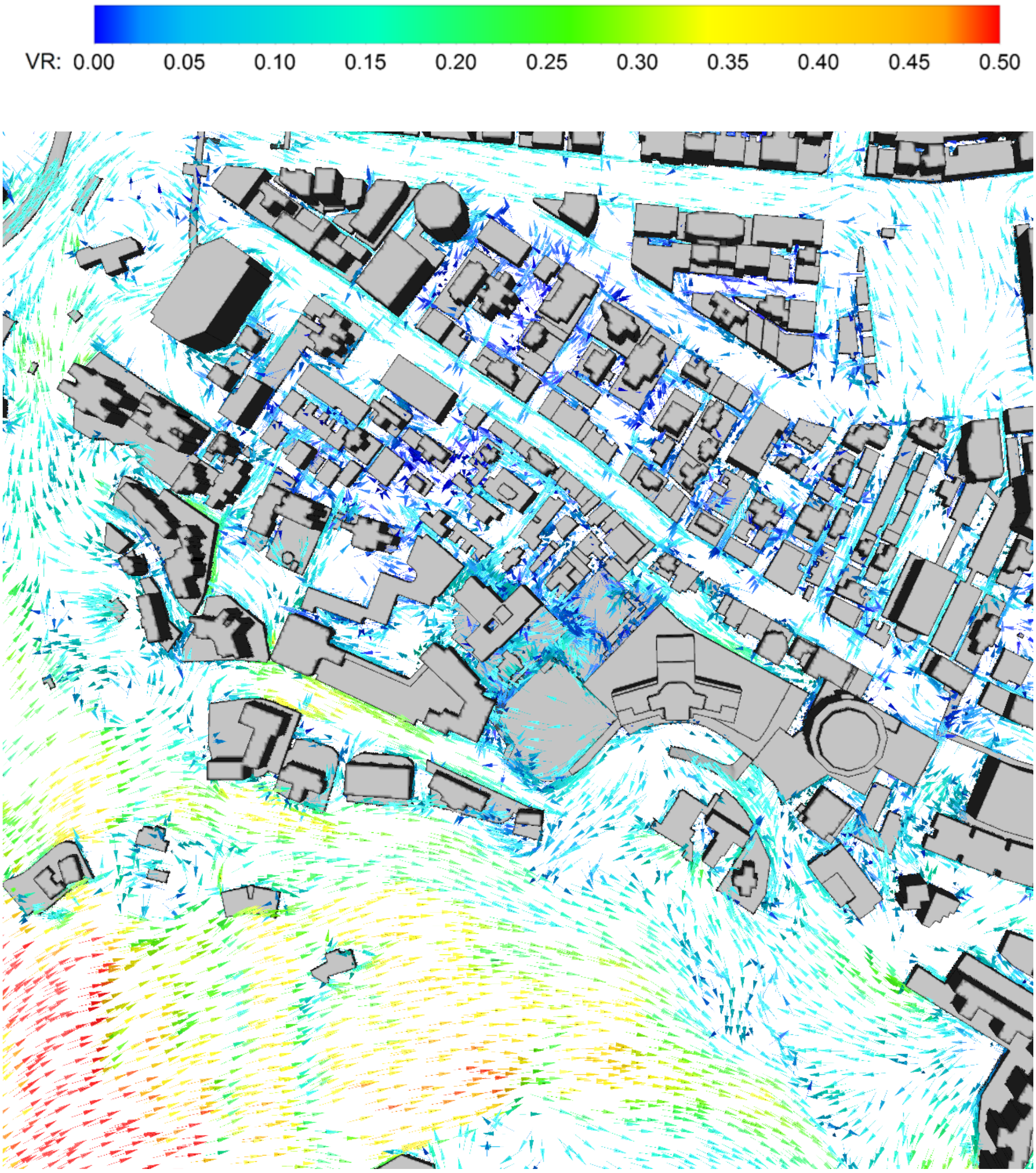


Figure E24. Vector Plot at 2m above Ground Level under WSW wind (Indicative Development Scheme)

Appendix F

Numerical Values and Graphical Presentation of the VR for SVR and LVR

Not in Use

Table F1 Comparisons of Location VR Values for Baseline Scheme (B) and Indicative Development Scheme (ID) at Wind Directions of NNE, NE, and ENE

No.	Location Name	Test Points	NNE (A-6.5%) (S-not use)		NE (A-8.8%) (S-not use)		ENE (A-15.3%) (S-not use)	
			B	ID	B	ID	B	ID
1	Hennessey Road	T01-T03	0.05	0.05	0.18	0.18	0.24	0.24
2	Johnston Road	T04-T11	0.09	0.09	0.13	0.13	0.15	0.15
3	Thomson Rd Johnston Rd Junction	T12	0.09	0.09	0.12	0.12	0.13	0.13
4	Anton Street	T13-T15	0.09	0.09	0.13	0.13	0.17	0.17
5	Landale Street	T16-T18	0.08	0.08	0.08	0.08	0.09	0.09
6	Li Chit Street	T19-T20	0.04	0.04	0.06	0.06	0.06	0.06
7	Gresson Street	T21-T23	0.12	0.12	0.12	0.12	0.09	0.09
8	Lun Fat Street	T24-T26	0.06	0.06	0.09	0.09	0.06	0.06
9	Ship Street (North of QRE)	T27-T29	0.07	0.07	0.11	0.11	0.13	0.13
10	Tai Wong Street West	T30-T32	0.08	0.08	0.11	0.11	0.10	0.10
11	Tai Wong Street East	T33-T36	0.05	0.05	0.08	0.08	0.08	0.08
12	Swatow Street	T37-T39	0.08	0.08	0.10	0.10	0.08	0.08
13	Amoy Street	T40-T41	0.04	0.04	0.05	0.05	0.06	0.06
14	St. Francis' Canossian School	T42-T44	0.02	0.02	0.02	0.03	0.02	0.02
15	Queen's Road East (QRE)	T45-T59	0.07	0.07	0.09	0.09	0.14	0.14
16	Wing Fung Street	T60-T61	0.02	0.02	0.05	0.05	0.10	0.09
17	Sun Street & Moon Street	T62-T66	0.03	0.03	0.04	0.04	0.03	0.03
18	St. Francis Yard	T67-T68	0.02	0.02	0.03	0.04	0.02	0.03
19	Star Street	T69-T73	0.02	0.02	0.05	0.04	0.04	0.04
20	St. Francis Street	T74-T77	0.03	0.04	0.05	0.05	0.03	0.03
21	Sau Wa Fong	T78-T81	0.04	0.05	0.06	0.07	0.04	0.04
22	Schooner Street	T82-T84	0.02	0.03	0.03	0.04	0.01	0.01
23	Sik On Street	T85	0.01	0.02	0.02	0.03	0.01	0.02
24	Ship Street (South of QRE)	T86-T88	0.02	0.01	0.02	0.02	0.03	0.03
25	Ship Street Garden	T89-T93, T135	0.03	0.03	0.04	0.04	0.03	0.03
26	Kennedy Road	T94-T110	0.09	0.08	0.08	0.08	0.08	0.08
27	Monmouth Terrace	T111-T113	0.06	0.06	0.07	0.07	0.06	0.06
28	Back Lane on North Side of HC II Podium	T114-T116	0.04	0.04	0.04	0.04	0.03	0.04
29	Bowen Road	T117-T125	0.13	0.13	0.18	0.18	0.21	0.21
30	St. Francis Canossian College	T126	0.02	0.02	0.02	0.02	0.02	0.01
31	Lee Tung Avenue	T127-T128	0.07	0.07	0.03	0.03	0.08	0.08

No.	**Location Name**	**Test Points**	**NNE (A-6.5%) (S-not use)**		**NE (A-8.8%) (S-not use)**		**ENE (A-15.3%) (S-not use)**	
			B	**ID**	**B**	**ID**	**B**	**ID**
32	Electric Street	T129-T130	0.03	0.04	0.02	0.03	0.07	0.07
33	Bowen Road Temporary Sitting-out Area	T131	0.08	0.07	0.14	0.14	0.10	0.10
34	Monmouth Terrace Playground	T132-T133	0.02	0.02	0.02	0.02	0.05	0.05
35	Kwong Ming Street Children's Playground	T134	0.01	0.01	0.03	0.02	0.01	0.02
36	Site Perimeter (SVR)	P01-P30	0.04	0.05	0.05	0.05	0.04	0.04
37	Special Test Points	S01-S12	0.04	0.05	0.07	0.07	0.05	0.05

Table F2 Comparisons of Location VR Values for Baseline Scheme (B) and Indicative Development Scheme (ID) at Wind Directions of E, ESE and SE

No.	Location Name	Test Points	E (A-21.5%) (S-10.1%)		ESE (A-8.8%) (S-7.8%)		SE (A-5.4%) (S-7.5%)	
			B	ID	B	ID	B	ID
1	Hennessey Road	T01-T03	0.34	0.34	0.21	0.21	0.05	0.04
2	Johnston Road	T04-T11	0.13	0.13	0.07	0.07	0.08	0.09
3	Thomson Rd Johnston Rd Junction	T12	0.13	0.13	0.10	0.10	0.03	0.03
4	Anton Street	T13-T15	0.17	0.17	0.03	0.03	0.05	0.05
5	Landale Street	T16-T18	0.08	0.08	0.02	0.02	0.05	0.05
6	Li Chit Street	T19-T20	0.04	0.04	0.02	0.02	0.03	0.02
7	Gresson Street	T21-T23	0.05	0.05	0.03	0.03	0.03	0.02
8	Lun Fat Street	T24-T26	0.05	0.05	0.03	0.03	0.03	0.02
9	Ship Street (North of QRE)	T27-T29	0.11	0.11	0.04	0.04	0.02	0.01
10	Tai Wong Street West	T30-T32	0.08	0.08	0.03	0.03	0.05	0.03
11	Tai Wong Street East	T33-T36	0.07	0.06	0.03	0.03	0.04	0.03
12	Swatow Street	T37-T39	0.03	0.03	0.04	0.04	0.02	0.04
13	Amoy Street	T40-T41	0.05	0.05	0.06	0.06	0.04	0.04
14	St. Francis' Canossian School	T42-T44	0.01	0.02	0.03	0.03	0.03	0.03
15	Queen's Road East (QRE)	T45-T59	0.15	0.16	0.15	0.15	0.08	0.09
16	Wing Fung Street	T60-T61	0.07	0.07	0.07	0.07	0.08	0.08
17	Sun Street & Moon Street	T62-T66	0.03	0.03	0.04	0.04	0.06	0.06
18	St. Francis Yard	T67-T68	0.02	0.02	0.01	0.01	0.04	0.02
19	Star Street	T69-T73	0.03	0.03	0.05	0.06	0.07	0.08
20	St. Francis Street	T74-T77	0.02	0.03	0.02	0.02	0.06	0.05
21	Sau Wa Fong	T78-T81	0.02	0.03	0.02	0.02	0.03	0.04
22	Schooner Street	T82-T84	0.03	0.03	0.02	0.03	0.04	0.03
23	Sik On Street	T85	0.03	0.05	0.02	0.03	0.02	0.05
24	Ship Street (South of QRE)	T86-T88	0.04	0.04	0.04	0.03	0.04	0.04
25	Ship Street Garden	T89-T93, T135	0.03	0.02	0.03	0.03	0.04	0.04
26	Kennedy Road	T94-T110	0.09	0.09	0.09	0.09	0.17	0.17
27	Monmouth Terrace	T111-T113	0.06	0.06	0.06	0.06	0.06	0.06
28	Back Lane on North Side of HC II Podium	T114-T116	0.03	0.03	0.05	0.05	0.05	0.04
29	Bowen Road	T117-T125	0.20	0.20	0.14	0.14	0.41	0.41
30	St. Francis Canossian College	T126	0.01	0.02	0.04	0.03	0.03	0.03
31	Lee Tung Avenue	T127-T128	0.11	0.11	0.07	0.07	0.03	0.03

No.	Location Name	Test Points	E (A-21.5%) (S-10.1%)		ESE (A-8.8%) (S-7.8%)		SE (A-5.4%) (S-7.5%)	
			B	ID	B	ID	B	ID
32	Electric Street	T129-T130	0.02	0.01	0.10	0.10	0.07	0.09
33	Bowen Road Temporary Sitting-out Area	T131	0.10	0.10	0.07	0.07	0.11	0.11
34	Monmouth Terrace Playground	T132-T133	0.02	0.02	0.04	0.05	0.05	0.05
35	Kwong Ming Street Children's Playground	T134	0.02	0.02	0.01	0.01	0.02	0.02
36	Site Perimeter (SVR)	P01-P30	0.05	0.05	0.04	0.05	0.08	0.09
37	Special Test Points	S01-S12	0.04	0.05	0.04	0.05	0.11	0.11

Table F3 Comparisons of Location VR Values for Baseline Scheme (B) and Indicative Development Scheme (ID) at Wind Directions of SSE, S and SSW

No.	Location Name	Test Points	SSE (A-not used) (S-8.6%)		S (A-not used) (S-10.9%)		SSW (A-6.5%) (S-14.9%)	
			B	ID	B	ID	B	ID
1	Hennessey Road	T01-T03	0.07	0.03	0.10	0.12	0.10	0.10
2	Johnston Road	T04-T11	0.10	0.09	0.13	0.13	0.09	0.09
3	Thomson Rd Johnston Rd Junction	T12	0.06	0.06	0.05	0.05	0.10	0.10
4	Anton Street	T13-T15	0.09	0.09	0.13	0.13	0.07	0.08
5	Landale Street	T16-T18	0.09	0.10	0.12	0.12	0.09	0.09
6	Li Chit Street	T19-T20	0.04	0.04	0.09	0.10	0.03	0.03
7	Gresson Street	T21-T23	0.04	0.02	0.03	0.03	0.08	0.08
8	Lun Fat Street	T24-T26	0.06	0.05	0.03	0.02	0.04	0.04
9	Ship Street (North of QRE)	T27-T29	0.08	0.09	0.02	0.04	0.06	0.06
10	Tai Wong Street West	T30-T32	0.08	0.08	0.04	0.03	0.10	0.10
11	Tai Wong Street East	T33-T36	0.07	0.07	0.05	0.03	0.06	0.06
12	Swatow Street	T37-T39	0.03	0.04	0.06	0.06	0.08	0.08
13	Amoy Street	T40-T41	0.06	0.05	0.10	0.09	0.08	0.07
14	St. Francis' Canossian School	T42-T44	0.03	0.04	0.04	0.04	0.02	0.02
15	Queen's Road East (QRE)	T45-T59	0.13	0.13	0.11	0.11	0.09	0.09
16	Wing Fung Street	T60-T61	0.11	0.13	0.12	0.14	0.07	0.07
17	Sun Street & Moon Street	T62-T66	0.07	0.09	0.04	0.08	0.05	0.05
18	St. Francis Yard	T67-T68	0.06	0.04	0.05	0.05	0.02	0.02
19	Star Street	T69-T73	0.09	0.11	0.09	0.08	0.08	0.08
20	St. Francis Street	T74-T77	0.08	0.06	0.09	0.06	0.03	0.03
21	Sau Wa Fong	T78-T81	0.08	0.07	0.07	0.04	0.04	0.03
22	Schooner Street	T82-T84	0.04	0.06	0.02	0.04	0.02	0.02
23	Sik On Street	T85	0.01	0.06	0.02	0.05	0.04	0.04
24	Ship Street (South of QRE)	T86-T88	0.04	0.04	0.03	0.03	0.03	0.03
25	Ship Street Garden	T89-T93, T135	0.04	0.04	0.02	0.03	0.04	0.04
26	Kennedy Road	T94-T110	0.16	0.17	0.14	0.14	0.14	0.13
27	Monmouth Terrace	T111-T113	0.06	0.07	0.09	0.08	0.03	0.03
28	Back Lane on North Side of HC II Podium	T114-T116	0.10	0.09	0.03	0.02	0.10	0.10
29	Bowen Road	T117-T125	0.40	0.40	0.20	0.20	0.23	0.23
30	St. Francis Canossian College	T126	0.06	0.07	0.08	0.07	0.04	0.03
31	Lee Tung Avenue	T127-T128	0.03	0.03	0.07	0.07	0.06	0.06

No.	Location Name	Test Points	SSE (A-not used) (S-8.6%)		S (A-not used) (S-10.9%)		SSW (A-6.5%) (S-14.9%)	
			B	ID	B	ID	B	ID
32	Electric Street	T129-T130	0.10	0.12	0.08	0.08	0.06	0.07
33	Bowen Road Temporary Sitting-out Area	T131	0.27	0.27	0.24	0.24	0.18	0.17
34	Monmouth Terrace Playground	T132-T133	0.10	0.11	0.09	0.10	0.03	0.04
35	Kwong Ming Street Children's Playground	T134	0.06	0.05	0.08	0.07	0.04	0.04
36	Site Perimeter (SVR)	P01-P30	0.11	0.15	0.08	0.09	0.05	0.05
37	Special Test Points	S01-S12	0.14	0.16	0.10	0.10	0.04	0.05

Table F4 Comparisons of Location VR Values for Baseline Scheme (B) and Indicative Development Scheme (ID) at Wind Directions of SW and WSW

No.	Location Name	Test Points	SW (A-5.4%) (S-12.9%)		WSW (A-not used) (S-6.5%)	
			B	ID	B	ID
1	Hennessey Road	T01-T03	0.25	0.25	0.14	0.14
2	Johnston Road	T04-T11	0.06	0.06	0.03	0.02
3	Thomson Rd Johnston Rd Junction	T12	0.04	0.04	0.01	0.02
4	Anton Street	T13-T15	0.07	0.07	0.04	0.04
5	Landale Street	T16-T18	0.03	0.04	0.03	0.03
6	Li Chit Street	T19-T20	0.03	0.03	0.02	0.02
7	Gresson Street	T21-T23	0.03	0.03	0.02	0.02
8	Lun Fat Street	T24-T26	0.03	0.03	0.03	0.03
9	Ship Street (North of QRE)	T27-T29	0.02	0.01	0.02	0.03
10	Tai Wong Street West	T30-T32	0.02	0.02	0.03	0.03
11	Tai Wong Street East	T33-T36	0.03	0.03	0.03	0.03
12	Swatow Street	T37-T39	0.01	0.01	0.05	0.05
13	Amoy Street	T40-T41	0.02	0.02	0.08	0.08
14	St. Francis' Canossian School	T42-T44	0.02	0.02	0.03	0.04
15	Queen's Road East (QRE)	T45-T59	0.15	0.15	0.07	0.07
16	Wing Fung Street	T60-T61	0.11	0.11	0.06	0.06
17	Sun Street & Moon Street	T62-T66	0.07	0.07	0.03	0.03
18	St. Francis Yard	T67-T68	0.01	0.01	0.02	0.01
19	Star Street	T69-T73	0.13	0.13	0.03	0.03
20	St. Francis Street	T74-T77	0.02	0.02	0.02	0.02
21	Sau Wa Fong	T78-T81	0.03	0.04	0.05	0.05
22	Schooner Street	T82-T84	0.01	0.02	0.02	0.01
23	Sik On Street	T85	0.03	0.03	0.04	0.02
24	Ship Street (South of QRE)	T86-T88	0.02	0.01	0.04	0.04
25	Ship Street Garden	T89-T93, T135	0.03	0.03	0.04	0.04
26	Kennedy Road	T94-T110	0.15	0.15	0.13	0.13
27	Monmouth Terrace	T111-T113	0.17	0.17	0.07	0.07
28	Back Lane on North Side of HC II Podium	T114-T116	0.09	0.09	0.14	0.13
29	Bowen Road	T117-T125	0.16	0.16	0.18	0.18
30	St. Francis Canossian College	T126	0.04	0.04	0.04	0.05
31	Lee Tung Avenue	T127-T128	0.05	0.04	0.07	0.08

No.	Location Name	Test Points	SW (A-5.4%) (S-12.9%)		WSW (A-not used) (S-6.5%)	
			B	ID	B	ID
32	Electric Street	T129-T130	0.12	0.12	0.09	0.09
33	Bowen Road Temporary Sitting-out Area	T131	0.27	0.27	0.14	0.14
34	Monmouth Terrace Playground	T132-T133	0.05	0.05	0.06	0.06
35	Kwong Ming Street Children's Playground	T134	0.02	0.02	0.02	0.03
36	Site Perimeter (SVR)	P01-P30	0.02	0.02	0.04	0.06
37	Special Test Points	S01-S12	0.02	0.02	0.05	0.06

Table F5 Overall Test Point VR Values for Baseline Scheme (11 Wind Directions)

Baseline	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T01	0.06	0.19	0.23	0.33	0.20	0.06	0.02	0.07	0.03	0.25	0.14
T02	0.04	0.18	0.24	0.34	0.21	0.04	0.08	0.08	0.10	0.25	0.15
T03	0.05	0.18	0.25	0.35	0.22	0.06	0.11	0.16	0.17	0.24	0.15
T04	0.05	0.10	0.08	0.07	0.02	0.04	0.11	0.18	0.05	0.08	0.04
T05	0.04	0.09	0.10	0.07	0.02	0.04	0.03	0.09	0.05	0.04	0.02
T06	0.10	0.10	0.12	0.10	0.05	0.06	0.05	0.15	0.07	0.06	0.02
T07	0.05	0.11	0.14	0.13	0.09	0.10	0.11	0.14	0.04	0.09	0.02
T08	0.09	0.13	0.17	0.14	0.08	0.11	0.12	0.13	0.08	0.08	0.02
T09	0.12	0.16	0.20	0.18	0.10	0.11	0.13	0.12	0.12	0.08	0.03
T10	0.13	0.17	0.22	0.20	0.11	0.10	0.14	0.11	0.14	0.05	0.02
T11	0.12	0.16	0.19	0.18	0.11	0.08	0.09	0.10	0.14	0.02	0.04
T12	0.09	0.12	0.13	0.13	0.10	0.03	0.06	0.05	0.10	0.04	0.01
T13	0.07	0.08	0.16	0.19	0.05	0.05	0.11	0.16	0.10	0.06	0.05
T14	0.09	0.13	0.16	0.16	0.02	0.06	0.09	0.11	0.07	0.10	0.06
T15	0.12	0.17	0.19	0.16	0.03	0.05	0.08	0.11	0.05	0.05	0.02
T16	0.08	0.08	0.10	0.09	0.03	0.06	0.12	0.18	0.09	0.04	0.03
T17	0.07	0.07	0.07	0.07	0.01	0.05	0.07	0.12	0.08	0.02	0.02
T18	0.09	0.10	0.10	0.08	0.02	0.06	0.08	0.05	0.09	0.05	0.03
T19	0.03	0.06	0.06	0.03	0.01	0.04	0.07	0.12	0.03	0.01	0.01
T20	0.04	0.07	0.05	0.04	0.02	0.01	0.02	0.07	0.03	0.05	0.03
T21	0.14	0.13	0.11	0.07	0.02	0.02	0.04	0.01	0.08	0.02	0.02
T22	0.13	0.12	0.10	0.06	0.03	0.02	0.03	0.02	0.08	0.03	0.01
T23	0.10	0.11	0.06	0.03	0.03	0.04	0.04	0.05	0.07	0.04	0.03
T24	0.04	0.06	0.04	0.05	0.03	0.03	0.07	0.02	0.04	0.02	0.03
T25	0.08	0.11	0.10	0.09	0.03	0.02	0.06	0.02	0.05	0.01	0.02
T26	0.06	0.09	0.04	0.02	0.02	0.02	0.07	0.04	0.03	0.05	0.05
T27	0.11	0.15	0.18	0.16	0.08	0.02	0.12	0.01	0.07	0.02	0.04
T28	0.05	0.09	0.12	0.10	0.03	0.01	0.05	0.02	0.02	0.01	0.02
T29	0.06	0.10	0.10	0.08	0.03	0.02	0.08	0.01	0.08	0.02	0.01
T30	0.06	0.09	0.07	0.04	0.01	0.07	0.13	0.04	0.10	0.02	0.02
T31	0.10	0.14	0.12	0.11	0.04	0.04	0.06	0.04	0.09	0.01	0.05
T32	0.09	0.12	0.11	0.08	0.03	0.03	0.05	0.02	0.10	0.02	0.02
T33	0.06	0.11	0.14	0.12	0.06	0.06	0.11	0.05	0.05	0.03	0.05
T34	0.02	0.05	0.05	0.05	0.02	0.03	0.05	0.04	0.05	0.02	0.01
T35	0.07	0.09	0.07	0.05	0.02	0.04	0.07	0.04	0.09	0.04	0.02
T36	0.04	0.06	0.05	0.05	0.02	0.02	0.04	0.06	0.06	0.01	0.01
T37	0.09	0.11	0.09	0.02	0.03	0.01	0.01	0.07	0.07	0.01	0.04
T38	0.09	0.12	0.08	0.03	0.04	0.03	0.02	0.08	0.10	0.02	0.06
T39	0.06	0.08	0.07	0.04	0.06	0.03	0.05	0.02	0.08	0.01	0.05
T40	0.05	0.05	0.07	0.05	0.04	0.04	0.05	0.06	0.08	0.03	0.08
T41	0.03	0.04	0.05	0.05	0.07	0.05	0.06	0.13	0.08	0.02	0.09
T42	0.01	0.02	0.01	0.01	0.02	0.02	0.03	0.06	0.02	0.02	0.02
T43	0.02	0.02	0.02	0.01	0.04	0.03	0.03	0.05	0.03	0.02	0.02
T44	0.03	0.03	0.03	0.02	0.04	0.04	0.03	0.02	0.03	0.02	0.06
T45	0.08	0.11	0.11	0.11	0.05	0.07	0.10	0.08	0.14	0.25	0.13
T46	0.06	0.10	0.10	0.09	0.10	0.04	0.07	0.11	0.12	0.25	0.13
T47	0.04	0.06	0.05	0.09	0.11	0.09	0.16	0.14	0.06	0.22	0.11
T48	0.03	0.03	0.03	0.10	0.13	0.07	0.13	0.12	0.08	0.21	0.11
T49	0.06	0.06	0.11	0.12	0.14	0.05	0.13	0.14	0.04	0.20	0.10
T50	0.08	0.06	0.13	0.13	0.15	0.02	0.06	0.13	0.03	0.18	0.07
T51	0.07	0.07	0.14	0.14	0.16	0.06	0.05	0.12	0.04	0.17	0.07
T52	0.08	0.09	0.14	0.13	0.16	0.09	0.05	0.10	0.04	0.16	0.07
T53	0.09	0.11	0.15	0.15	0.17	0.10	0.11	0.08	0.05	0.15	0.08
T54	0.10	0.14	0.19	0.19	0.18	0.11	0.17	0.03	0.08	0.14	0.04
T55	0.08	0.12	0.21	0.21	0.19	0.12	0.19	0.08	0.11	0.11	0.05
T56	0.07	0.14	0.23	0.24	0.20	0.13	0.20	0.12	0.16	0.10	0.04
T57	0.07	0.16	0.24	0.26	0.19	0.11	0.22	0.16	0.20	0.08	0.02
T58	0.06	0.07	0.13	0.16	0.13	0.10	0.19	0.11	0.14	0.07	0.04
T59	0.04	0.08	0.10	0.13	0.10	0.06	0.15	0.10	0.13	0.05	0.02

Baseline	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T60	0.02	0.06	0.12	0.08	0.08	0.09	0.13	0.13	0.08	0.11	0.07
T61	0.01	0.05	0.08	0.06	0.05	0.07	0.10	0.11	0.06	0.11	0.05
T62	0.06	0.08	0.08	0.08	0.05	0.07	0.10	0.04	0.09	0.05	0.05
T63	0.04	0.06	0.04	0.04	0.04	0.08	0.12	0.08	0.07	0.08	0.02
T64	0.01	0.02	0.01	0.01	0.02	0.02	0.03	0.01	0.03	0.04	0.02
T65	0.02	0.03	0.02	0.02	0.03	0.05	0.04	0.04	0.06	0.09	0.03
T66	0.01	0.01	0.02	0.02	0.07	0.09	0.07	0.05	0.02	0.10	0.05
T67	0.03	0.04	0.03	0.02	0.02	0.03	0.07	0.07	0.02	0.01	0.01
T68	0.01	0.03	0.01	0.01	0.01	0.04	0.05	0.03	0.02	0.01	0.02
T69	0.05	0.09	0.09	0.06	0.05	0.08	0.10	0.12	0.12	0.17	0.04
T70	0.03	0.05	0.04	0.05	0.05	0.08	0.08	0.09	0.13	0.16	0.01
T71	0.01	0.02	0.02	0.02	0.11	0.11	0.13	0.10	0.07	0.12	0.07
T72	0.01	0.03	0.03	0.02	0.04	0.06	0.07	0.06	0.06	0.14	0.02
T73	0.01	0.03	0.02	0.02	0.02	0.04	0.08	0.08	0.04	0.06	0.01
T74	0.03	0.02	0.03	0.01	0.04	0.05	0.08	0.09	0.02	0.02	0.02
T75	0.03	0.04	0.03	0.03	0.03	0.09	0.08	0.07	0.03	0.03	0.03
T76	0.05	0.07	0.05	0.03	0.01	0.05	0.10	0.11	0.02	0.02	0.02
T77	0.04	0.05	0.03	0.02	0.01	0.04	0.08	0.10	0.05	0.02	0.02
T78	0.05	0.07	0.05	0.02	0.02	0.06	0.09	0.11	0.04	0.03	0.06
T79	0.03	0.04	0.03	0.01	0.02	0.03	0.10	0.06	0.03	0.02	0.05
T80	0.05	0.05	0.04	0.02	0.01	0.01	0.08	0.05	0.02	0.04	0.05
T81	0.03	0.06	0.03	0.04	0.03	0.04	0.05	0.07	0.06	0.05	0.05
T82	0.03	0.05	0.02	0.04	0.02	0.05	0.06	0.03	0.03	0.03	0.03
T83	0.03	0.05	0.02	0.04	0.03	0.07	0.07	0.04	0.03	0.01	0.02
T84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T85	0.01	0.02	0.01	0.03	0.02	0.02	0.01	0.02	0.04	0.03	0.04
T86	0.02	0.03	0.04	0.07	0.05	0.07	0.06	0.04	0.05	0.02	0.03
T87	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.02
T88	0.02	0.03	0.04	0.05	0.04	0.01	0.04	0.02	0.02	0.02	0.07
T89	0.03	0.05	0.02	0.01	0.03	0.08	0.07	0.05	0.04	0.01	0.03
T90	0.03	0.04	0.03	0.01	0.02	0.04	0.03	0.03	0.02	0.01	0.01
T91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T92	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
T93	0.12	0.13	0.11	0.10	0.08	0.07	0.11	0.04	0.15	0.13	0.16
T94	0.06	0.04	0.06	0.03	0.14	0.13	0.10	0.15	0.09	0.18	0.04
T95	0.02	0.05	0.03	0.03	0.02	0.05	0.09	0.05	0.02	0.11	0.08
T96	0.08	0.10	0.07	0.09	0.12	0.16	0.05	0.09	0.05	0.23	0.10
T97	0.15	0.17	0.16	0.13	0.12	0.18	0.10	0.14	0.09	0.20	0.08
T98	0.17	0.18	0.17	0.14	0.11	0.21	0.08	0.05	0.12	0.24	0.20
T99	0.13	0.10	0.10	0.11	0.08	0.18	0.11	0.05	0.14	0.32	0.30
T100	0.10	0.06	0.05	0.05	0.04	0.12	0.07	0.06	0.04	0.27	0.27
T101	0.13	0.08	0.06	0.14	0.15	0.17	0.20	0.17	0.25	0.18	0.23
T102	0.13	0.09	0.08	0.17	0.17	0.17	0.30	0.25	0.33	0.19	0.22
T103	0.09	0.04	0.02	0.06	0.04	0.20	0.27	0.18	0.19	0.16	0.16
T104	0.06	0.03	0.06	0.05	0.10	0.34	0.29	0.20	0.19	0.10	0.04
T105	0.03	0.09	0.09	0.11	0.12	0.08	0.31	0.28	0.24	0.07	0.10
T106	0.10	0.10	0.10	0.13	0.16	0.07	0.33	0.28	0.27	0.06	0.09
T107	0.15	0.12	0.10	0.06	0.06	0.23	0.13	0.13	0.14	0.07	0.06
T108	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.00	0.01
T109	0.08	0.07	0.13	0.09	0.09	0.31	0.19	0.14	0.08	0.05	0.10
T110	0.10	0.04	0.11	0.06	0.03	0.27	0.13	0.08	0.09	0.08	0.03
T111	0.06	0.08	0.07	0.06	0.07	0.04	0.06	0.08	0.07	0.08	0.10
T112	0.05	0.07	0.05	0.06	0.08	0.09	0.08	0.10	0.02	0.17	0.03
T113	0.06	0.07	0.07	0.06	0.04	0.05	0.05	0.09	0.01	0.25	0.09
T114	0.08	0.03	0.06	0.05	0.03	0.03	0.08	0.02	0.09	0.10	0.14
T115	0.03	0.07	0.03	0.04	0.08	0.09	0.16	0.04	0.16	0.14	0.21
T116	0.02	0.04	0.01	0.02	0.03	0.02	0.05	0.02	0.04	0.03	0.06
T117	0.17	0.18	0.13	0.09	0.02	0.29	0.33	0.20	0.14	0.24	0.18
T118	0.17	0.15	0.12	0.11	0.06	0.32	0.31	0.23	0.14	0.19	0.23
T119	0.15	0.13	0.12	0.10	0.08	0.31	0.30	0.18	0.15	0.07	0.20
T120	0.15	0.18	0.22	0.16	0.11	0.43	0.37	0.23	0.25	0.12	0.20

Baseline	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T121	0.12	0.18	0.22	0.21	0.13	0.45	0.40	0.23	0.27	0.14	0.16
T122	0.11	0.18	0.23	0.25	0.17	0.42	0.37	0.14	0.25	0.15	0.15
T123	0.14	0.22	0.28	0.30	0.23	0.51	0.49	0.16	0.29	0.16	0.20
T124	0.12	0.23	0.29	0.32	0.26	0.52	0.53	0.20	0.31	0.18	0.19
T125	0.07	0.19	0.25	0.29	0.23	0.47	0.47	0.20	0.26	0.17	0.14
T126	0.02	0.02	0.02	0.01	0.04	0.03	0.06	0.08	0.04	0.04	0.04
T127	0.06	0.02	0.11	0.16	0.09	0.03	0.03	0.07	0.07	0.04	0.07
T128	0.08	0.05	0.05	0.05	0.06	0.02	0.03	0.06	0.05	0.05	0.08
T129	0.03	0.02	0.07	0.02	0.12	0.11	0.12	0.11	0.07	0.09	0.08
T130	0.03	0.01	0.07	0.01	0.07	0.03	0.07	0.05	0.06	0.15	0.10
T131	0.08	0.14	0.10	0.10	0.07	0.11	0.27	0.24	0.18	0.27	0.14
T132	0.02	0.01	0.06	0.02	0.05	0.05	0.10	0.08	0.04	0.05	0.05
T133	0.02	0.02	0.04	0.02	0.03	0.04	0.10	0.09	0.01	0.05	0.07
T134	0.01	0.03	0.01	0.02	0.01	0.02	0.06	0.08	0.04	0.02	0.02
T135	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.04

Table F6 Perimeter Test Point VR Values for Baseline Scheme (11 Wind Directions)

Baseline	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
P01	0.07	0.12	0.09	0.05	0.06	0.13	0.15	0.12	0.05	0.04	0.04
P02	0.05	0.10	0.04	0.09	0.06	0.12	0.21	0.14	0.09	0.02	0.07
P03	0.01	0.06	0.04	0.09	0.08	0.12	0.13	0.08	0.10	0.02	0.06
P04	0.02	0.07	0.06	0.10	0.10	0.11	0.08	0.06	0.12	0.03	0.07
P05	0.01	0.05	0.03	0.10	0.13	0.16	0.11	0.08	0.14	0.02	0.06
P06	0.05	0.03	0.03	0.11	0.16	0.24	0.22	0.13	0.17	0.01	0.05
P07	0.01	0.04	0.04	0.01	0.03	0.06	0.07	0.04	0.03	0.00	0.01
P08	0.02	0.06	0.05	0.03	0.04	0.09	0.10	0.05	0.04	0.01	0.02
P09	0.05	0.07	0.05	0.05	0.04	0.10	0.05	0.08	0.01	0.00	0.01
P10	0.05	0.04	0.03	0.07	0.02	0.05	0.06	0.09	0.03	0.01	0.02
P11	0.06	0.04	0.03	0.06	0.01	0.03	0.11	0.12	0.04	0.01	0.02
P12	0.07	0.07	0.04	0.06	0.01	0.02	0.16	0.16	0.06	0.01	0.03
P13	0.06	0.06	0.02	0.05	0.02	0.02	0.19	0.16	0.06	0.02	0.04
P14	0.05	0.05	0.03	0.06	0.04	0.04	0.21	0.17	0.06	0.02	0.04
P15	0.03	0.03	0.02	0.05	0.05	0.04	0.21	0.14	0.05	0.02	0.04
P16	0.05	0.02	0.05	0.03	0.05	0.09	0.16	0.08	0.03	0.03	0.08
P17	0.05	0.06	0.05	0.02	0.04	0.10	0.13	0.07	0.03	0.03	0.09
P18	0.05	0.08	0.05	0.01	0.04	0.09	0.11	0.08	0.01	0.02	0.10
P19	0.04	0.05	0.04	0.03	0.03	0.08	0.08	0.10	0.02	0.02	0.10
P20	0.04	0.04	0.04	0.04	0.02	0.07	0.13	0.10	0.02	0.02	0.09
P21	0.04	0.05	0.05	0.03	0.03	0.10	0.18	0.09	0.05	0.01	0.07
P22	0.02	0.03	0.03	0.01	0.01	0.02	0.05	0.03	0.02	0.01	0.04
P23	0.02	0.03	0.02	0.01	0.02	0.06	0.08	0.05	0.03	0.01	0.03
P24	0.02	0.03	0.03	0.05	0.02	0.03	0.07	0.01	0.01	0.00	0.01
P25	0.03	0.04	0.01	0.04	0.01	0.03	0.05	0.02	0.01	0.01	0.02
P26	0.03	0.05	0.02	0.04	0.02	0.05	0.05	0.02	0.02	0.03	0.03
P27	0.04	0.05	0.01	0.03	0.03	0.08	0.09	0.04	0.04	0.01	0.02
P28	0.03	0.05	0.02	0.04	0.03	0.07	0.06	0.04	0.03	0.01	0.02
P29	0.03	0.04	0.02	0.04	0.04	0.09	0.07	0.05	0.03	0.01	0.03
P30	0.03	0.04	0.03	0.04	0.04	0.09	0.07	0.05	0.03	0.01	0.03

Table F7 Special Test Point VR Values for Baseline Scheme (11 Wind Directions)

Baseline	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
S01	0.07	0.13	0.09	0.03	0.04	0.20	0.19	0.13	0.03	0.02	0.06
S02	0.06	0.11	0.09	0.04	0.05	0.21	0.22	0.13	0.02	0.03	0.06
S03	0.03	0.07	0.05	0.01	0.05	0.11	0.19	0.12	0.04	0.02	0.02
S04	0.04	0.07	0.06	0.06	0.04	0.10	0.07	0.05	0.02	0.01	0.02
S05	0.06	0.06	0.04	0.06	0.04	0.05	0.20	0.16	0.06	0.02	0.04
S06	0.02	0.02	0.03	0.03	0.04	0.10	0.20	0.13	0.04	0.03	0.06
S07	0.08	0.11	0.09	0.02	0.02	0.05	0.12	0.10	0.03	0.00	0.04
S08	0.03	0.03	0.06	0.02	0.02	0.09	0.03	0.07	0.02	0.03	0.06
S09	0.05	0.06	0.06	0.03	0.02	0.12	0.17	0.08	0.01	0.04	0.08
S10	0.04	0.06	0.03	0.03	0.02	0.10	0.13	0.09	0.01	0.03	0.02
S11	0.01	0.02	0.04	0.05	0.04	0.07	0.02	0.08	0.01	0.01	0.02
S12	0.04	0.09	0.03	0.10	0.10	0.13	0.14	0.09	0.12	0.02	0.08

Table F8 Overall Test Point VR Values for Indicative Development Scheme (11 Wind Directions)

ID	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T01	0.07	0.19	0.23	0.33	0.20	0.06	0.02	0.09	0.03	0.25	0.14
T02	0.04	0.18	0.24	0.34	0.21	0.04	0.04	0.09	0.09	0.25	0.15
T03	0.05	0.18	0.25	0.35	0.22	0.03	0.03	0.17	0.16	0.24	0.15
T04	0.05	0.10	0.08	0.07	0.02	0.03	0.07	0.19	0.05	0.08	0.04
T05	0.04	0.09	0.09	0.07	0.02	0.06	0.03	0.10	0.05	0.04	0.02
T06	0.10	0.10	0.12	0.10	0.05	0.08	0.07	0.15	0.07	0.06	0.01
T07	0.05	0.11	0.14	0.13	0.09	0.11	0.10	0.15	0.04	0.09	0.02
T08	0.09	0.13	0.17	0.14	0.08	0.11	0.11	0.13	0.09	0.08	0.02
T09	0.11	0.16	0.20	0.18	0.10	0.12	0.12	0.12	0.12	0.07	0.03
T10	0.13	0.17	0.22	0.20	0.11	0.10	0.13	0.11	0.14	0.05	0.02
T11	0.12	0.16	0.19	0.18	0.11	0.08	0.08	0.09	0.14	0.03	0.03
T12	0.09	0.12	0.13	0.13	0.10	0.03	0.06	0.05	0.10	0.04	0.02
T13	0.07	0.08	0.16	0.19	0.05	0.04	0.10	0.17	0.10	0.06	0.04
T14	0.09	0.13	0.16	0.16	0.02	0.05	0.10	0.11	0.07	0.10	0.06
T15	0.12	0.17	0.19	0.16	0.03	0.07	0.07	0.11	0.05	0.05	0.02
T16	0.08	0.08	0.10	0.09	0.03	0.04	0.10	0.18	0.09	0.04	0.03
T17	0.07	0.06	0.07	0.07	0.01	0.05	0.09	0.11	0.09	0.02	0.02
T18	0.09	0.10	0.10	0.07	0.02	0.07	0.10	0.07	0.09	0.05	0.03
T19	0.03	0.06	0.06	0.03	0.02	0.01	0.03	0.13	0.04	0.01	0.01
T20	0.04	0.07	0.05	0.04	0.02	0.02	0.06	0.06	0.03	0.05	0.03
T21	0.14	0.13	0.11	0.07	0.03	0.02	0.03	0.01	0.09	0.02	0.02
T22	0.13	0.12	0.10	0.05	0.03	0.01	0.02	0.01	0.08	0.03	0.01
T23	0.10	0.10	0.06	0.03	0.03	0.02	0.01	0.06	0.07	0.04	0.03
T24	0.04	0.06	0.04	0.05	0.03	0.03	0.07	0.02	0.04	0.02	0.03
T25	0.08	0.11	0.10	0.09	0.03	0.01	0.02	0.01	0.05	0.02	0.01
T26	0.06	0.08	0.04	0.02	0.02	0.02	0.05	0.04	0.03	0.05	0.04
T27	0.10	0.15	0.18	0.16	0.08	0.02	0.13	0.05	0.07	0.01	0.03
T28	0.05	0.09	0.12	0.09	0.03	0.01	0.04	0.04	0.03	0.01	0.02
T29	0.06	0.10	0.10	0.08	0.03	0.01	0.09	0.05	0.08	0.02	0.03
T30	0.06	0.09	0.06	0.04	0.01	0.06	0.13	0.04	0.09	0.01	0.01
T31	0.10	0.14	0.13	0.11	0.04	0.02	0.06	0.02	0.09	0.01	0.04
T32	0.09	0.12	0.11	0.08	0.03	0.02	0.05	0.01	0.10	0.02	0.03
T33	0.06	0.11	0.14	0.12	0.06	0.05	0.12	0.04	0.05	0.04	0.06
T34	0.02	0.05	0.05	0.05	0.02	0.02	0.04	0.04	0.05	0.02	0.01
T35	0.06	0.09	0.07	0.04	0.03	0.02	0.07	0.02	0.09	0.03	0.03
T36	0.04	0.06	0.05	0.05	0.02	0.02	0.05	0.01	0.06	0.01	0.02
T37	0.09	0.11	0.09	0.03	0.03	0.04	0.03	0.07	0.07	0.01	0.04
T38	0.09	0.11	0.08	0.03	0.04	0.05	0.03	0.08	0.10	0.02	0.07
T39	0.06	0.08	0.06	0.04	0.06	0.03	0.06	0.02	0.08	0.01	0.05
T40	0.05	0.05	0.07	0.05	0.04	0.03	0.05	0.06	0.08	0.03	0.08
T41	0.03	0.04	0.05	0.05	0.07	0.05	0.05	0.13	0.07	0.01	0.09
T42	0.02	0.02	0.01	0.01	0.02	0.03	0.05	0.05	0.01	0.02	0.02
T43	0.03	0.03	0.02	0.01	0.04	0.03	0.05	0.03	0.01	0.02	0.02
T44	0.03	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.08
T45	0.08	0.11	0.12	0.11	0.05	0.07	0.14	0.10	0.14	0.25	0.13
T46	0.06	0.10	0.10	0.09	0.10	0.02	0.04	0.15	0.12	0.25	0.13
T47	0.04	0.06	0.05	0.11	0.11	0.02	0.10	0.16	0.06	0.22	0.11
T48	0.02	0.03	0.04	0.11	0.13	0.08	0.04	0.14	0.07	0.21	0.10
T49	0.06	0.06	0.12	0.13	0.14	0.10	0.12	0.13	0.04	0.20	0.10
T50	0.08	0.06	0.14	0.14	0.15	0.11	0.13	0.10	0.03	0.18	0.08
T51	0.07	0.07	0.14	0.14	0.16	0.11	0.12	0.09	0.04	0.17	0.08
T52	0.08	0.09	0.14	0.14	0.16	0.11	0.09	0.05	0.04	0.16	0.08
T53	0.09	0.11	0.15	0.15	0.17	0.10	0.13	0.03	0.05	0.15	0.08
T54	0.09	0.14	0.19	0.19	0.18	0.09	0.16	0.06	0.08	0.14	0.04
T55	0.07	0.12	0.21	0.22	0.19	0.11	0.18	0.10	0.11	0.11	0.04
T56	0.07	0.14	0.23	0.24	0.20	0.12	0.19	0.12	0.16	0.09	0.04
T57	0.07	0.16	0.24	0.26	0.19	0.11	0.21	0.16	0.20	0.07	0.02

ID	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T58	0.05	0.07	0.14	0.16	0.13	0.10	0.19	0.11	0.14	0.07	0.03
T59	0.04	0.07	0.10	0.13	0.10	0.06	0.15	0.10	0.13	0.04	0.02
T60	0.02	0.06	0.11	0.07	0.09	0.10	0.14	0.14	0.08	0.11	0.07
T61	0.01	0.05	0.08	0.06	0.05	0.07	0.11	0.14	0.06	0.11	0.05
T62	0.06	0.08	0.08	0.08	0.05	0.06	0.12	0.07	0.09	0.05	0.04
T63	0.03	0.06	0.04	0.04	0.04	0.08	0.10	0.09	0.07	0.08	0.02
T64	0.01	0.02	0.01	0.01	0.02	0.02	0.06	0.03	0.03	0.03	0.02
T65	0.02	0.03	0.01	0.02	0.04	0.05	0.04	0.07	0.06	0.08	0.02
T66	0.00	0.01	0.02	0.01	0.08	0.11	0.14	0.13	0.02	0.10	0.05
T67	0.03	0.04	0.03	0.03	0.02	0.01	0.04	0.07	0.02	0.02	0.01
T68	0.02	0.03	0.02	0.01	0.00	0.03	0.04	0.03	0.01	0.01	0.01
T69	0.05	0.09	0.08	0.06	0.05	0.06	0.09	0.09	0.12	0.17	0.04
T70	0.02	0.05	0.04	0.05	0.05	0.08	0.10	0.08	0.13	0.16	0.01
T71	0.01	0.02	0.03	0.02	0.11	0.12	0.16	0.10	0.07	0.11	0.07
T72	0.01	0.01	0.03	0.02	0.04	0.08	0.10	0.08	0.06	0.14	0.02
T73	0.01	0.02	0.01	0.02	0.03	0.05	0.09	0.06	0.04	0.06	0.01
T74	0.03	0.03	0.03	0.01	0.04	0.05	0.06	0.07	0.02	0.02	0.02
T75	0.04	0.05	0.03	0.03	0.03	0.08	0.08	0.06	0.03	0.03	0.03
T76	0.05	0.08	0.05	0.04	0.01	0.04	0.05	0.08	0.02	0.02	0.00
T77	0.04	0.06	0.03	0.03	0.01	0.04	0.04	0.03	0.05	0.02	0.01
T78	0.06	0.07	0.06	0.02	0.01	0.06	0.08	0.09	0.03	0.03	0.03
T79	0.05	0.06	0.03	0.02	0.03	0.03	0.09	0.03	0.03	0.03	0.06
T80	0.05	0.07	0.05	0.03	0.02	0.02	0.07	0.02	0.02	0.04	0.05
T81	0.04	0.06	0.03	0.04	0.03	0.03	0.05	0.02	0.06	0.05	0.04
T82	0.04	0.05	0.02	0.05	0.05	0.03	0.07	0.04	0.03	0.04	0.03
T83	0.04	0.05	0.02	0.04	0.04	0.07	0.11	0.07	0.04	0.02	0.02
T84	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
T85	0.02	0.03	0.02	0.05	0.03	0.05	0.06	0.05	0.04	0.03	0.02
T86	0.01	0.02	0.04	0.06	0.04	0.08	0.06	0.05	0.04	0.01	0.05
T87	0.01	0.01	0.01	0.02	0.02	0.04	0.04	0.03	0.02	0.01	0.02
T88	0.02	0.03	0.04	0.05	0.04	0.02	0.03	0.01	0.02	0.02	0.06
T89	0.03	0.04	0.03	0.01	0.04	0.08	0.08	0.06	0.04	0.01	0.04
T90	0.02	0.03	0.03	0.01	0.02	0.05	0.06	0.04	0.03	0.01	0.03
T91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T92	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
T93	0.12	0.13	0.11	0.10	0.08	0.05	0.03	0.02	0.15	0.13	0.16
T94	0.05	0.06	0.04	0.02	0.13	0.12	0.11	0.14	0.10	0.18	0.04
T95	0.02	0.04	0.04	0.02	0.02	0.05	0.08	0.06	0.02	0.11	0.09
T96	0.07	0.08	0.08	0.08	0.10	0.15	0.05	0.09	0.03	0.23	0.11
T97	0.12	0.17	0.15	0.14	0.11	0.18	0.11	0.14	0.07	0.20	0.08
T98	0.15	0.18	0.18	0.15	0.09	0.21	0.10	0.06	0.09	0.23	0.20
T99	0.10	0.10	0.11	0.11	0.08	0.18	0.11	0.06	0.11	0.32	0.30
T100	0.07	0.07	0.06	0.05	0.06	0.12	0.08	0.07	0.03	0.27	0.28
T101	0.13	0.09	0.08	0.14	0.15	0.18	0.20	0.17	0.25	0.18	0.23
T102	0.13	0.10	0.10	0.17	0.18	0.18	0.32	0.25	0.32	0.20	0.22
T103	0.08	0.04	0.02	0.07	0.05	0.20	0.27	0.18	0.19	0.17	0.17
T104	0.04	0.03	0.07	0.05	0.10	0.34	0.28	0.19	0.19	0.13	0.05
T105	0.03	0.09	0.08	0.11	0.12	0.07	0.31	0.28	0.24	0.05	0.09
T106	0.10	0.10	0.10	0.13	0.16	0.08	0.33	0.28	0.27	0.05	0.09
T107	0.14	0.12	0.09	0.06	0.06	0.23	0.13	0.13	0.14	0.07	0.07
T108	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.00	0.01
T109	0.08	0.07	0.13	0.09	0.09	0.31	0.19	0.14	0.08	0.06	0.10
T110	0.10	0.04	0.11	0.06	0.03	0.26	0.13	0.09	0.09	0.09	0.04
T111	0.06	0.08	0.06	0.06	0.06	0.03	0.06	0.08	0.07	0.08	0.10
T112	0.05	0.06	0.04	0.06	0.08	0.09	0.09	0.10	0.02	0.17	0.03
T113	0.07	0.07	0.07	0.05	0.04	0.06	0.06	0.07	0.02	0.25	0.08
T114	0.08	0.03	0.06	0.05	0.03	0.02	0.08	0.02	0.09	0.10	0.14
T115	0.03	0.07	0.04	0.03	0.08	0.08	0.15	0.03	0.16	0.14	0.20
T116	0.02	0.04	0.01	0.02	0.03	0.02	0.05	0.01	0.04	0.03	0.05
T117	0.17	0.18	0.13	0.09	0.02	0.29	0.34	0.20	0.14	0.24	0.18
T118	0.17	0.15	0.13	0.11	0.06	0.32	0.31	0.23	0.14	0.19	0.23

ID	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
T119	0.15	0.13	0.13	0.10	0.08	0.31	0.30	0.18	0.15	0.07	0.20
T120	0.15	0.19	0.22	0.16	0.12	0.43	0.37	0.23	0.25	0.11	0.21
T121	0.12	0.18	0.22	0.20	0.13	0.45	0.40	0.23	0.27	0.14	0.16
T122	0.11	0.18	0.23	0.25	0.17	0.42	0.37	0.13	0.26	0.14	0.14
T123	0.14	0.22	0.28	0.30	0.23	0.51	0.49	0.16	0.29	0.16	0.20
T124	0.12	0.23	0.29	0.32	0.26	0.52	0.52	0.20	0.31	0.18	0.19
T125	0.07	0.19	0.25	0.29	0.23	0.47	0.47	0.20	0.26	0.17	0.13
T126	0.02	0.02	0.01	0.02	0.03	0.03	0.07	0.07	0.03	0.04	0.05
T127	0.06	0.02	0.11	0.16	0.09	0.03	0.03	0.07	0.07	0.04	0.07
T128	0.08	0.05	0.05	0.05	0.06	0.03	0.03	0.06	0.05	0.05	0.08
T129	0.04	0.04	0.08	0.01	0.12	0.13	0.16	0.09	0.07	0.09	0.08
T130	0.03	0.03	0.07	0.01	0.07	0.04	0.07	0.07	0.06	0.15	0.10
T131	0.07	0.14	0.10	0.10	0.07	0.11	0.27	0.24	0.17	0.27	0.14
T132	0.03	0.01	0.07	0.02	0.05	0.05	0.11	0.09	0.05	0.05	0.05
T133	0.01	0.03	0.03	0.02	0.04	0.06	0.12	0.10	0.03	0.05	0.07
T134	0.01	0.02	0.02	0.02	0.01	0.02	0.05	0.07	0.04	0.02	0.03
T135	0.03	0.03	0.02	0.02	0.02	0.05	0.06	0.03	0.02	0.03	0.03

Table F9 Perimeter Test Point VR Values for Indicative Development Scheme (11 Wind Directions)

ID	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
P01	0.07	0.12	0.09	0.06	0.07	0.22	0.28	0.18	0.05	0.02	0.08
P02	0.05	0.10	0.05	0.09	0.07	0.16	0.25	0.16	0.08	0.01	0.10
P03	0.02	0.06	0.04	0.08	0.08	0.12	0.17	0.10	0.10	0.01	0.08
P04	0.02	0.06	0.06	0.09	0.09	0.12	0.10	0.07	0.11	0.01	0.08
P05	0.02	0.05	0.03	0.10	0.13	0.15	0.10	0.10	0.14	0.01	0.07
P06	0.04	0.03	0.04	0.11	0.15	0.23	0.19	0.12	0.17	0.02	0.05
P07	0.03	0.06	0.05	0.02	0.04	0.07	0.09	0.04	0.04	0.01	0.02
P08	0.03	0.06	0.06	0.03	0.05	0.11	0.10	0.05	0.05	0.01	0.02
P09	0.07	0.07	0.06	0.07	0.04	0.07	0.08	0.09	0.02	0.02	0.08
P10	0.07	0.04	0.03	0.09	0.05	0.11	0.20	0.14	0.05	0.02	0.07
P11	0.08	0.04	0.04	0.09	0.05	0.09	0.24	0.17	0.06	0.01	0.07
P12	0.09	0.05	0.04	0.09	0.05	0.12	0.27	0.20	0.07	0.01	0.07
P13	0.06	0.04	0.03	0.07	0.04	0.11	0.24	0.18	0.06	0.01	0.08
P14	0.03	0.02	0.03	0.06	0.05	0.10	0.26	0.17	0.07	0.02	0.07
P15	0.02	0.03	0.04	0.03	0.04	0.08	0.23	0.14	0.06	0.01	0.07
P16	0.03	0.05	0.07	0.02	0.04	0.06	0.19	0.10	0.05	0.02	0.08
P17	0.05	0.07	0.07	0.02	0.03	0.07	0.21	0.08	0.04	0.02	0.11
P18	0.06	0.07	0.07	0.02	0.02	0.03	0.07	0.06	0.02	0.02	0.09
P19	0.05	0.05	0.06	0.03	0.02	0.05	0.12	0.06	0.02	0.02	0.08
P20	0.08	0.09	0.08	0.03	0.02	0.07	0.14	0.06	0.03	0.02	0.10
P21	0.05	0.06	0.06	0.02	0.02	0.09	0.18	0.09	0.04	0.01	0.09
P22	0.03	0.03	0.03	0.03	0.00	0.01	0.08	0.03	0.02	0.01	0.05
P23	0.03	0.04	0.01	0.03	0.03	0.02	0.10	0.06	0.02	0.02	0.05
P24	0.05	0.06	0.02	0.02	0.03	0.04	0.06	0.02	0.01	0.01	0.02
P25	0.04	0.05	0.01	0.04	0.04	0.04	0.06	0.03	0.01	0.01	0.02
P26	0.04	0.05	0.02	0.05	0.05	0.02	0.07	0.04	0.02	0.03	0.03
P27	0.04	0.06	0.01	0.03	0.04	0.06	0.05	0.05	0.04	0.03	0.02
P28	0.04	0.05	0.02	0.03	0.04	0.07	0.10	0.06	0.04	0.03	0.02
P29	0.03	0.04	0.02	0.03	0.04	0.08	0.11	0.08	0.05	0.03	0.02
P30	0.02	0.03	0.02	0.03	0.04	0.06	0.08	0.06	0.04	0.03	0.02

Table F10 Special Test Point VR Values for Indicative Development Scheme (11 Wind Directions)

ID	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
Annual	6.5%	8.8%	15.3%	21.5%	8.8%	5.4%	-	-	6.5%	5.4%	-
Summer	-	-	-	10.1%	7.8%	7.5%	8.6%	10.9%	14.9%	12.9%	6.5%
S01	0.03	0.05	0.04	0.04	0.07	0.21	0.25	0.16	0.04	0.02	0.05
S02	0.04	0.10	0.10	0.06	0.08	0.19	0.22	0.13	0.06	0.03	0.05
S03	0.03	0.05	0.04	0.02	0.07	0.12	0.23	0.13	0.06	0.02	0.03
S04	0.06	0.07	0.06	0.08	0.05	0.12	0.08	0.03	0.04	0.02	0.06
S05	0.02	0.03	0.03	0.05	0.06	0.09	0.26	0.16	0.07	0.02	0.08
S06	0.02	0.03	0.03	0.02	0.03	0.05	0.15	0.06	0.04	0.02	0.08
S07	0.10	0.13	0.11	0.08	0.03	0.07	0.18	0.12	0.03	0.02	0.09
S08	0.08	0.08	0.04	0.02	0.02	0.07	0.04	0.07	0.01	0.03	0.09
S09	0.06	0.08	0.07	0.03	0.02	0.04	0.08	0.04	0.02	0.00	0.03
S10	0.03	0.05	0.03	0.02	0.04	0.14	0.20	0.12	0.04	0.04	0.02
S11	0.03	0.03	0.01	0.03	0.02	0.04	0.06	0.03	0.01	0.01	0.03
S12	0.04	0.09	0.04	0.10	0.09	0.15	0.18	0.12	0.11	0.01	0.10

Appendix G

Summary of Full-scale Velocity Ratio Plots for both Schemes

Not in Use

Velocity Ratio (VR) Plots – Baseline Scheme

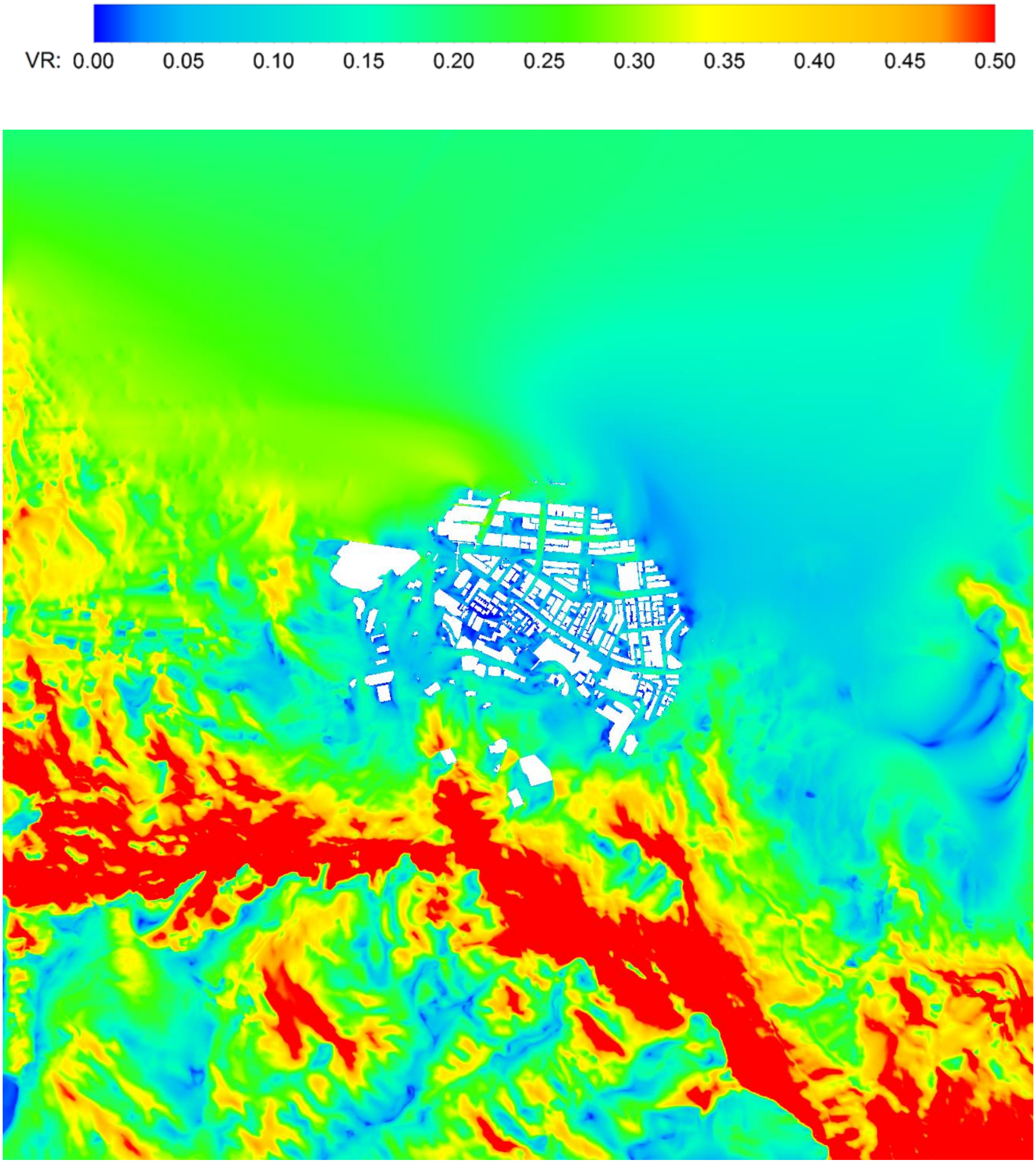


Figure G1. VR Plot at 2m above Ground Level under NNE wind

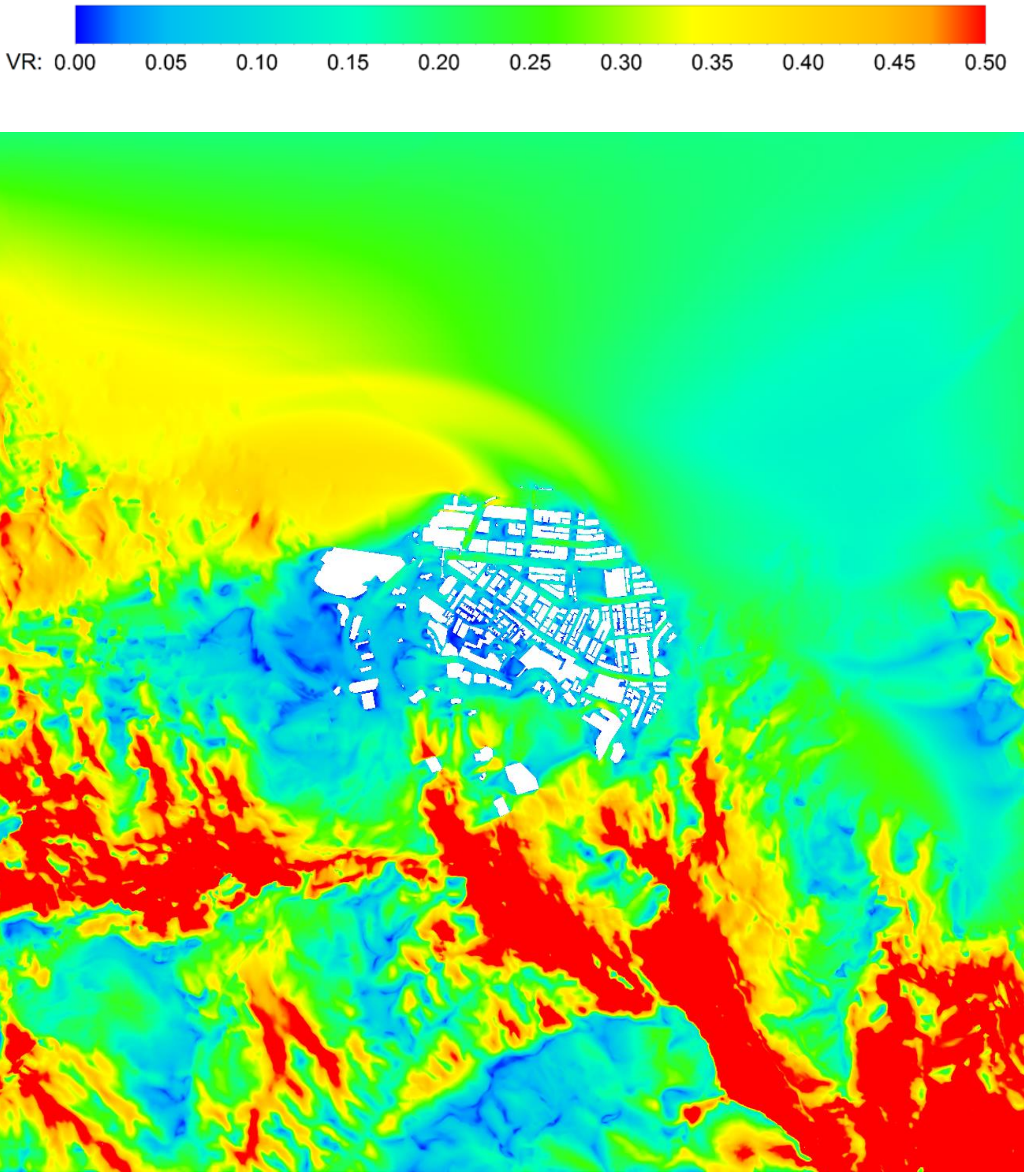


Figure G2. VR Plot at 2m above Ground Level under NE wind

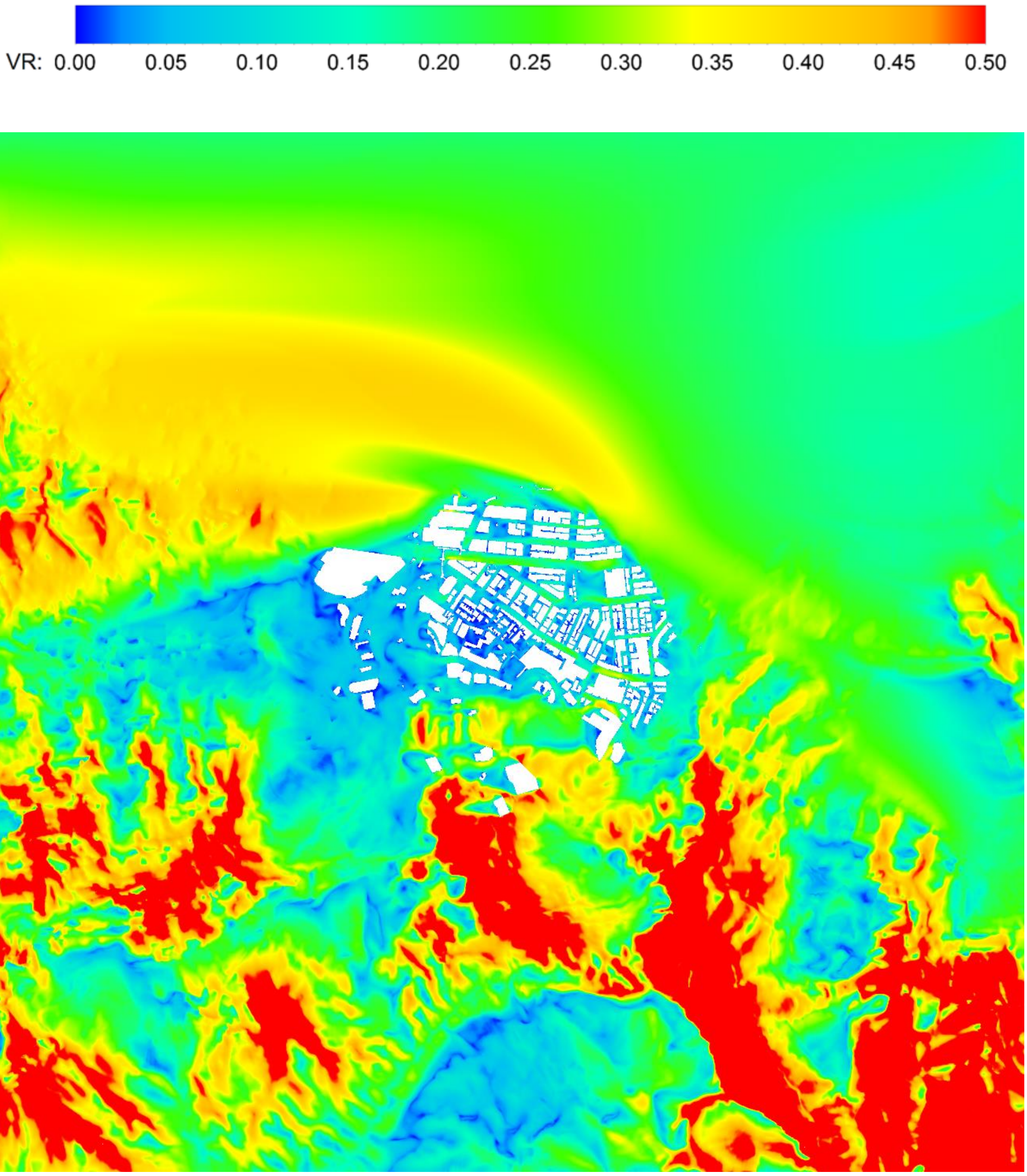


Figure G3. VR Plot at 2m above Ground Level under ENE wind

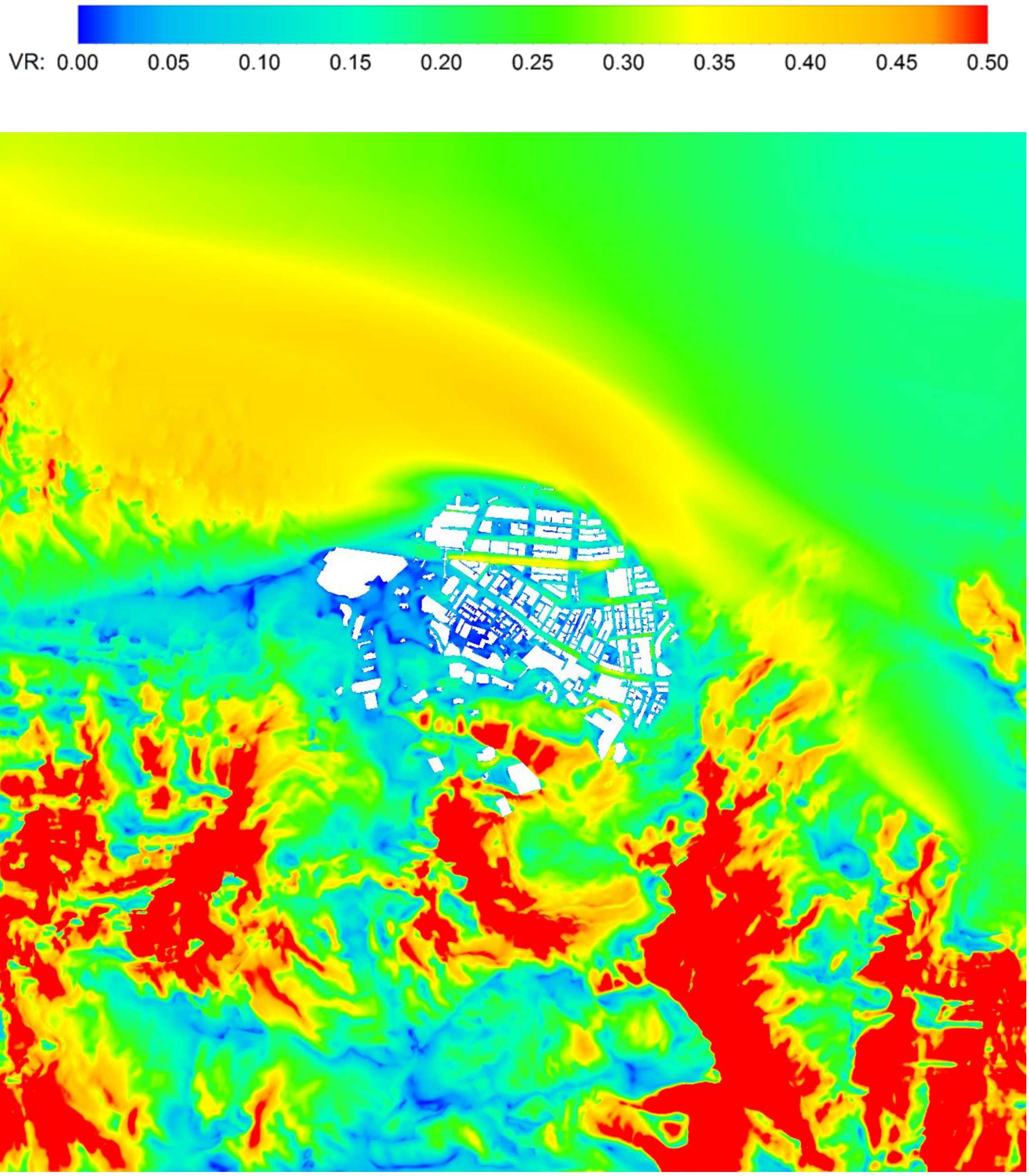


Figure G4. VR Plot at 2m above Ground Level under E wind

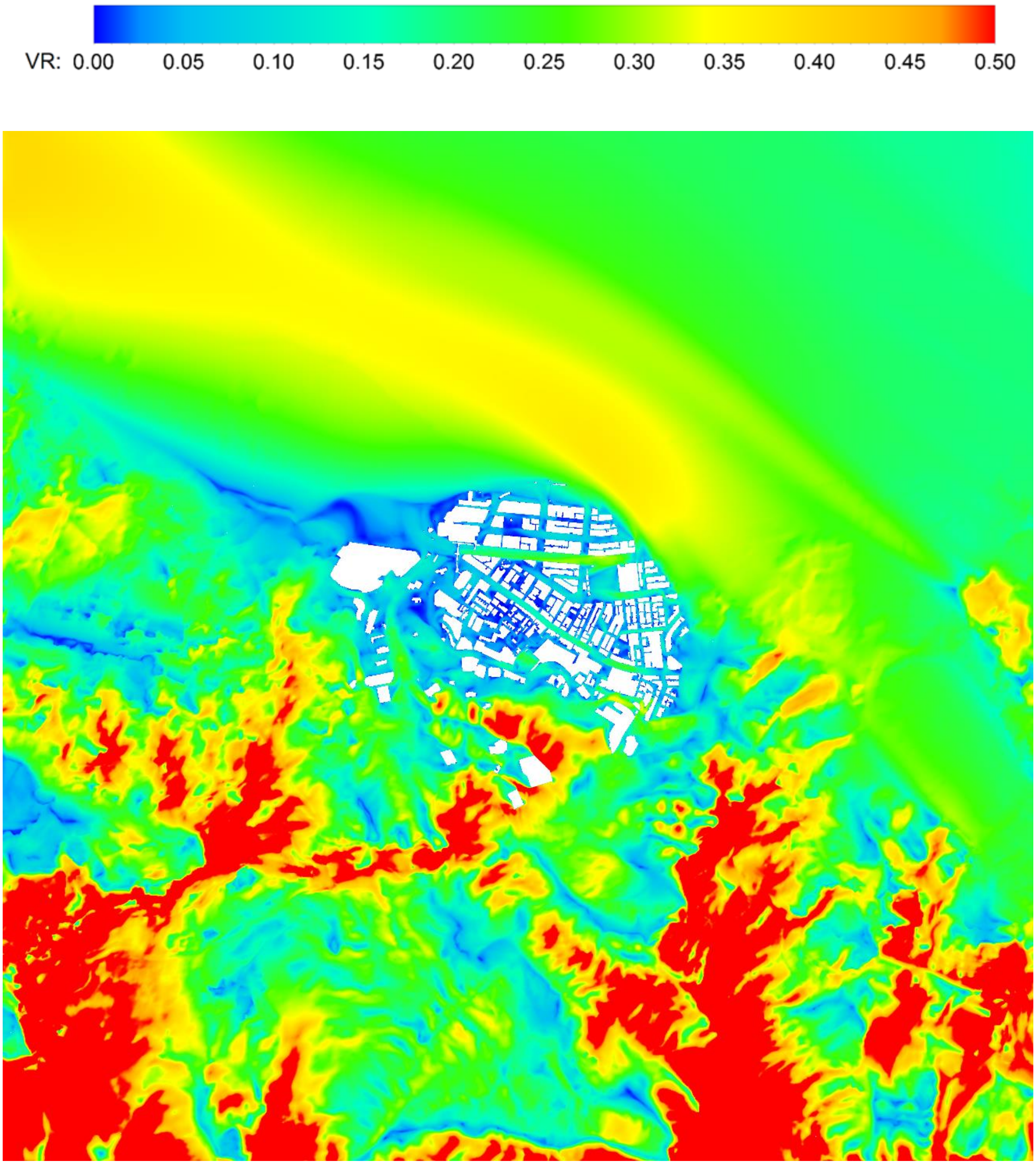


Figure G5. VR Plot at 2m above Ground Level under ESE wind

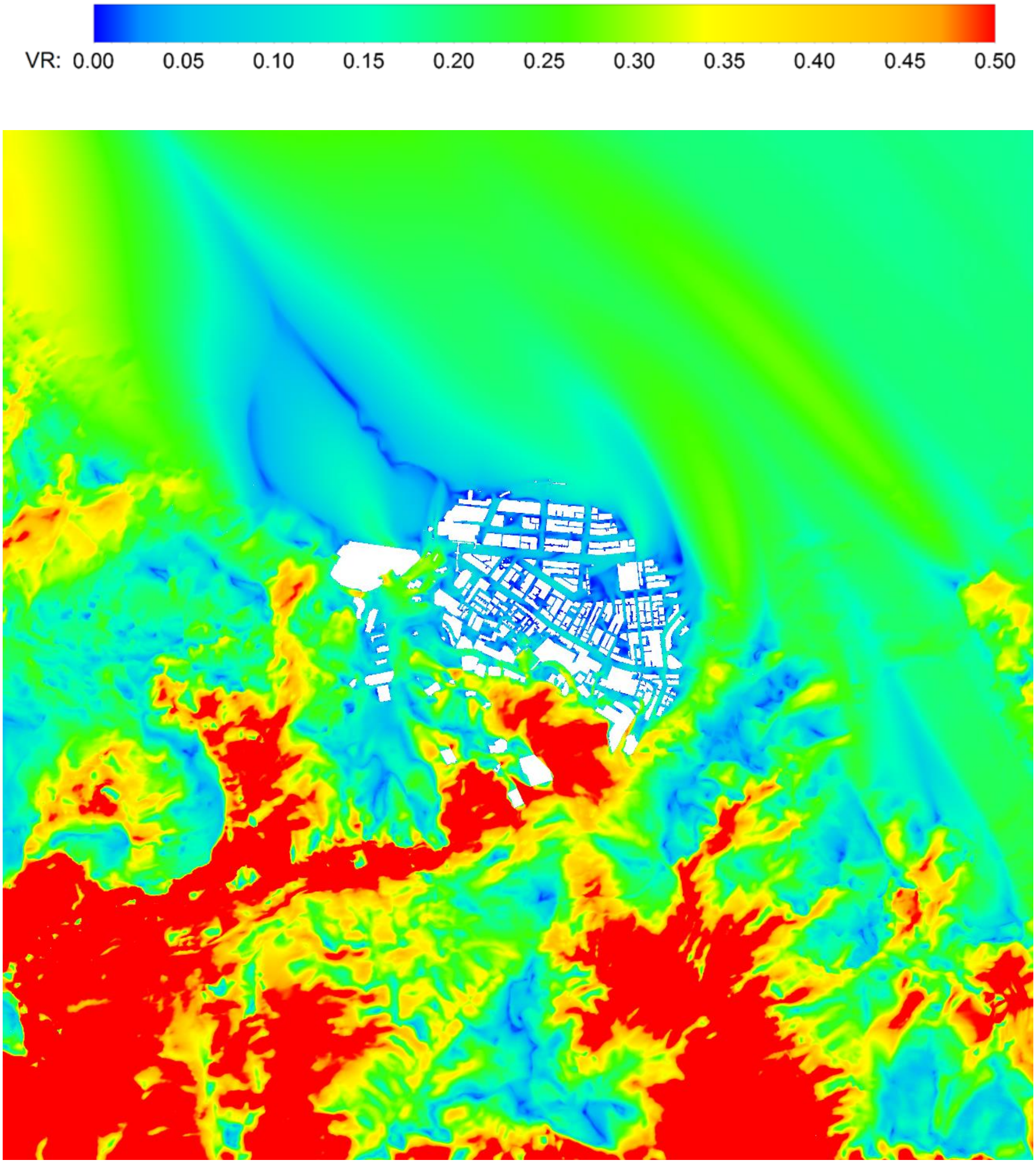


Figure G6. VR Plot at 2m above Ground Level under SE wind

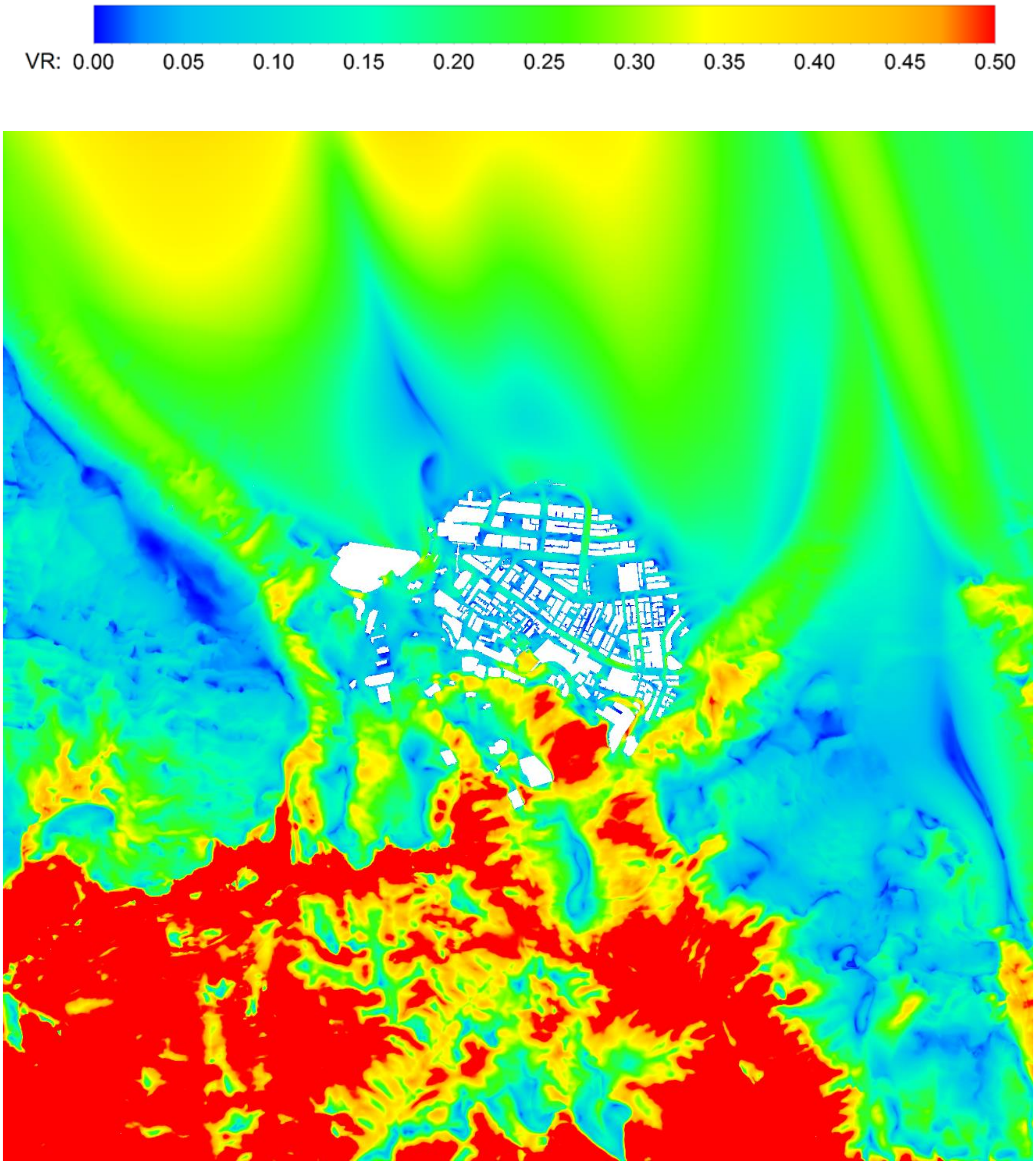


Figure G7. VR Plot at 2m above Ground Level under SSE wind

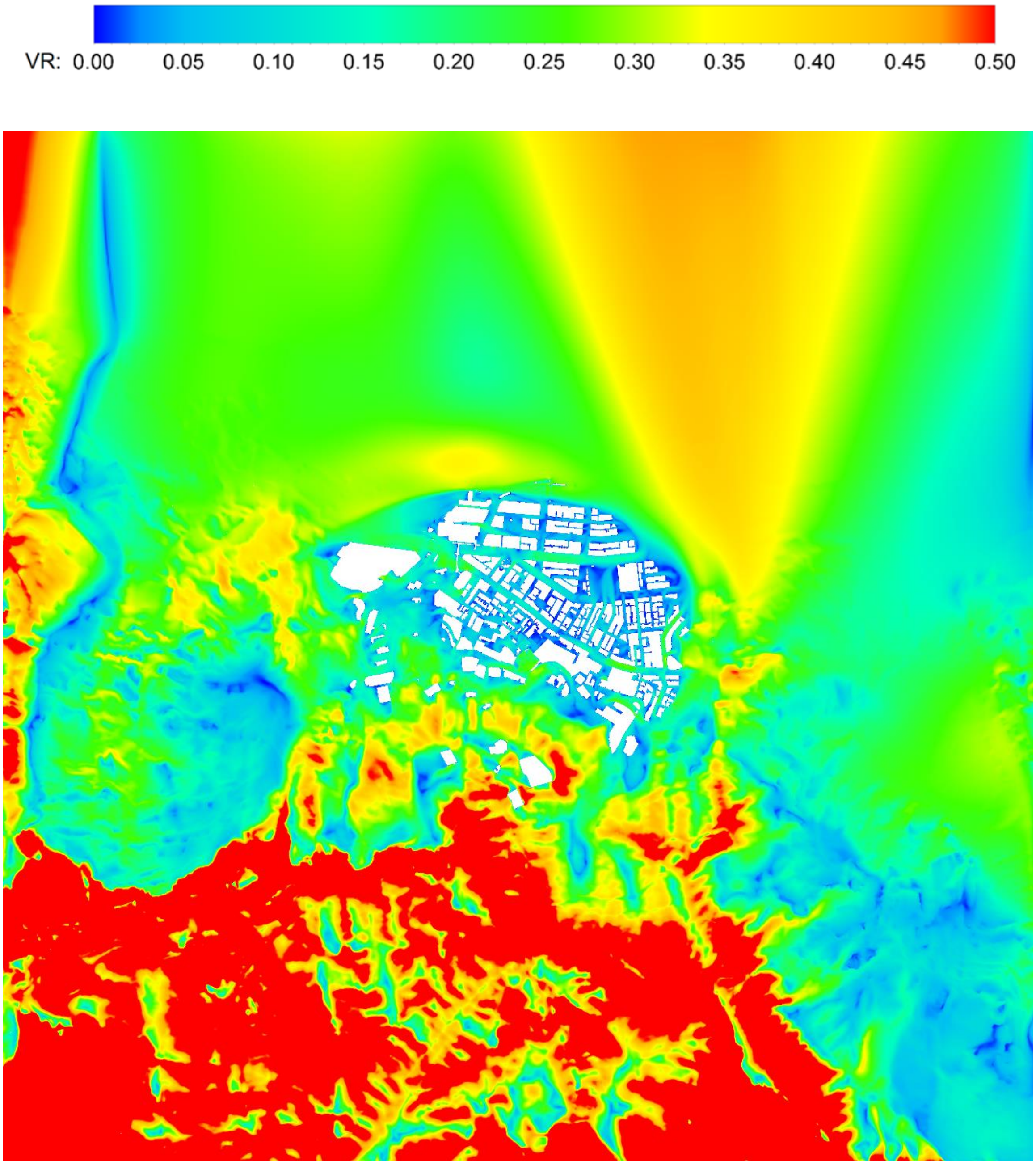


Figure G8. VR Plot at 2m above Ground Level under S wind

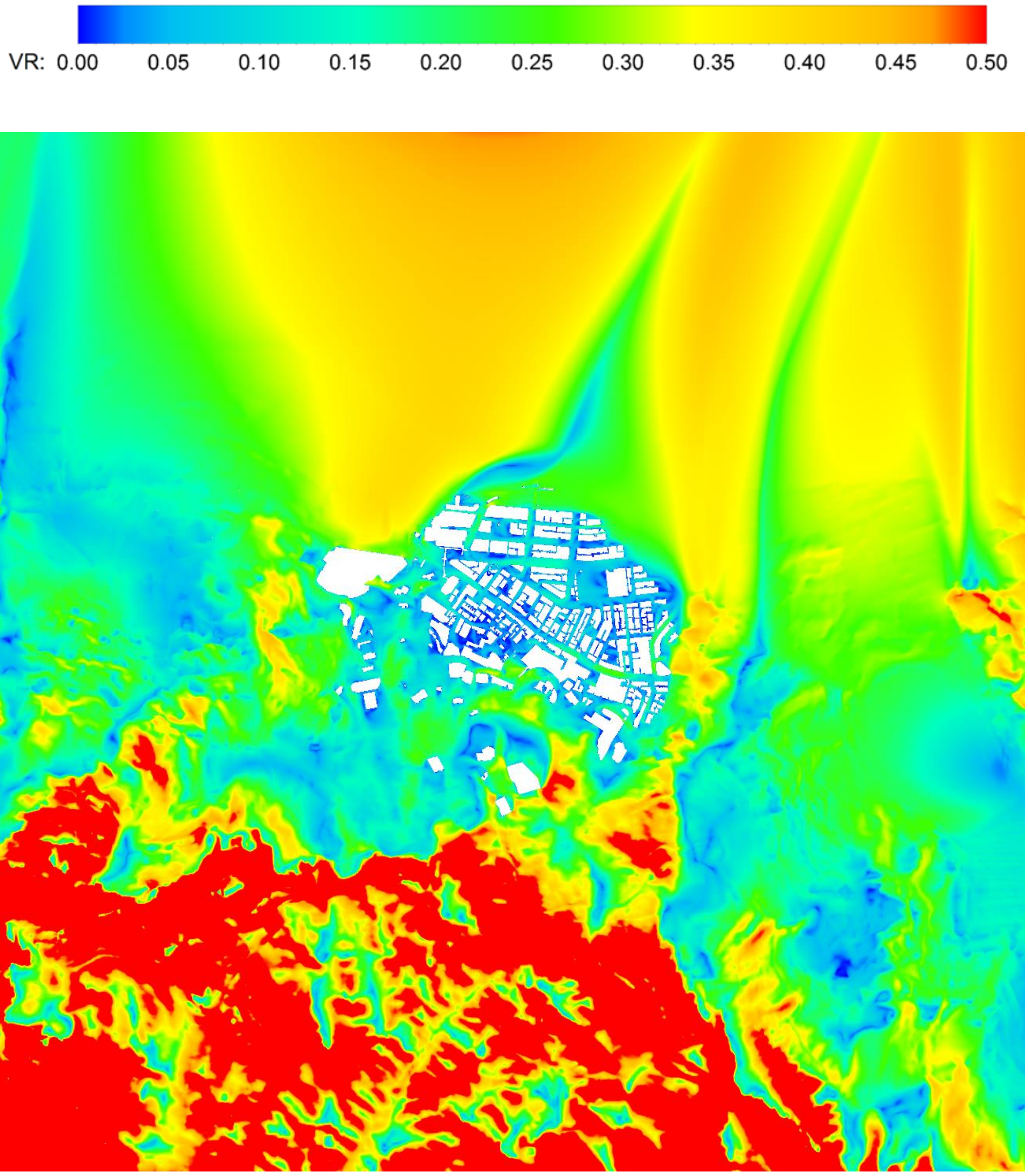


Figure G9. VR Plot at 2m above Ground Level under SSW wind

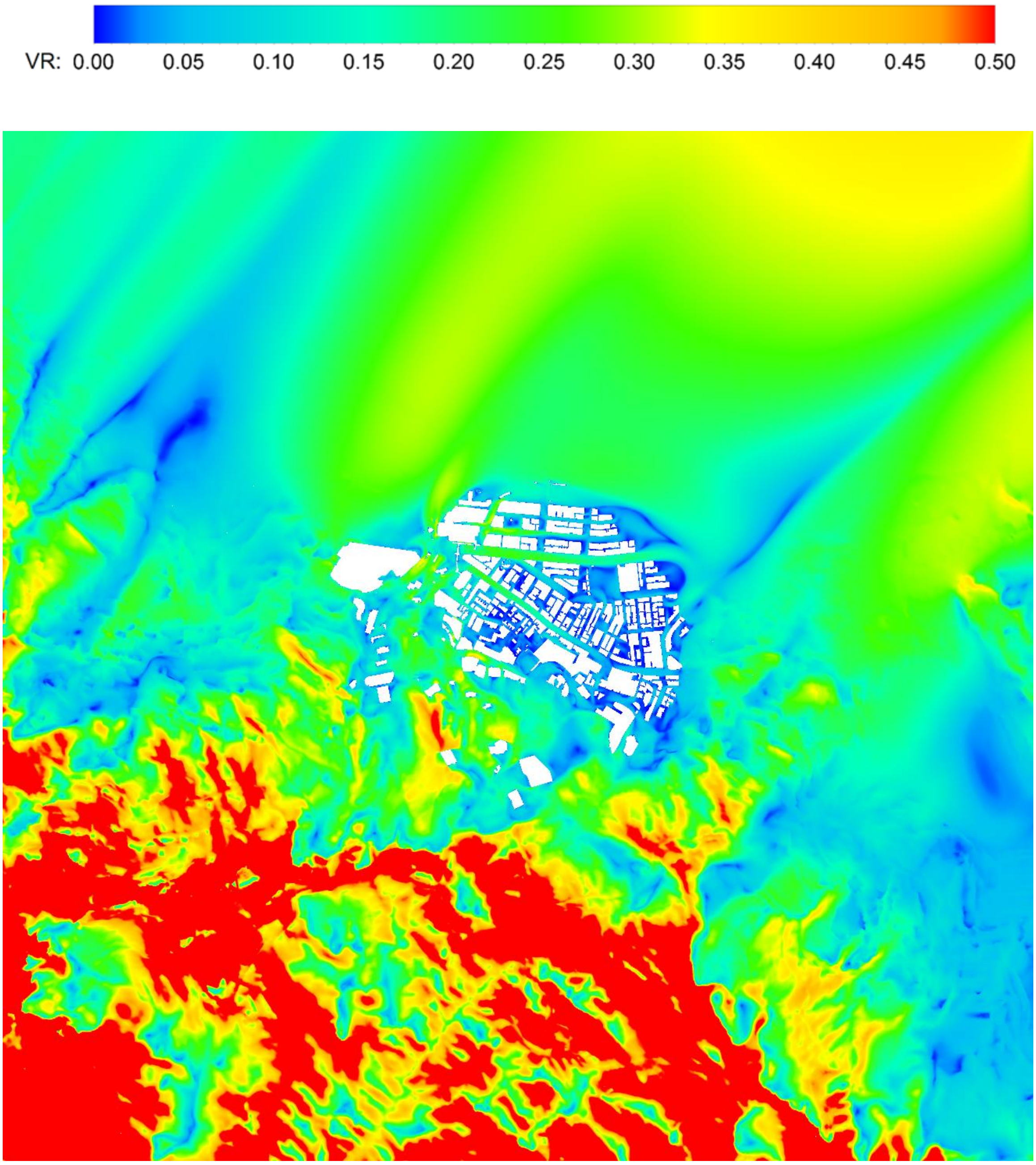


Figure G10. VR Plot at 2m above Ground Level under SW wind

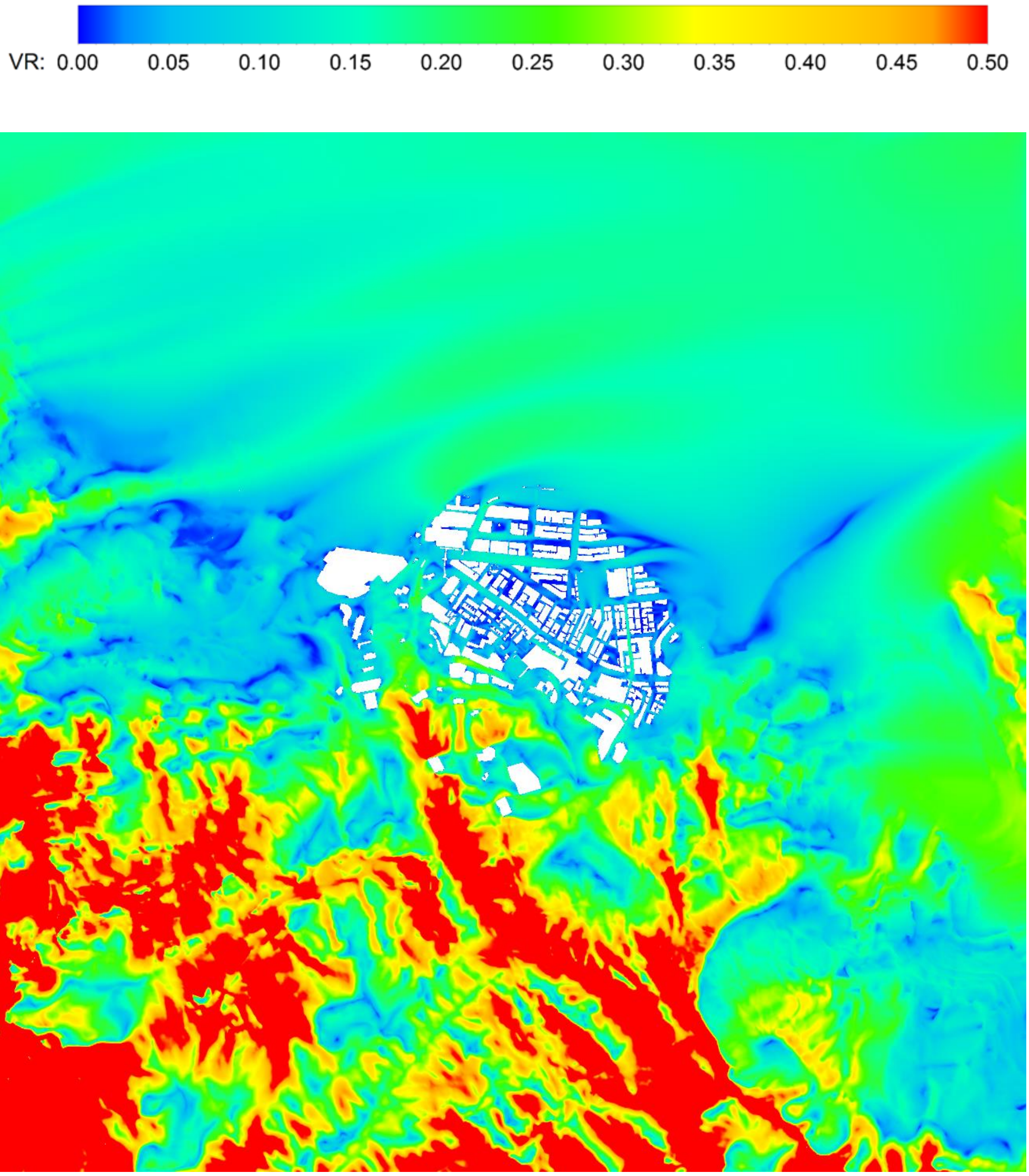


Figure G11. VR Plot at 2m above Ground Level under WSW wind

Velocity Ratio (VR) Plots – Indicative Development Scheme

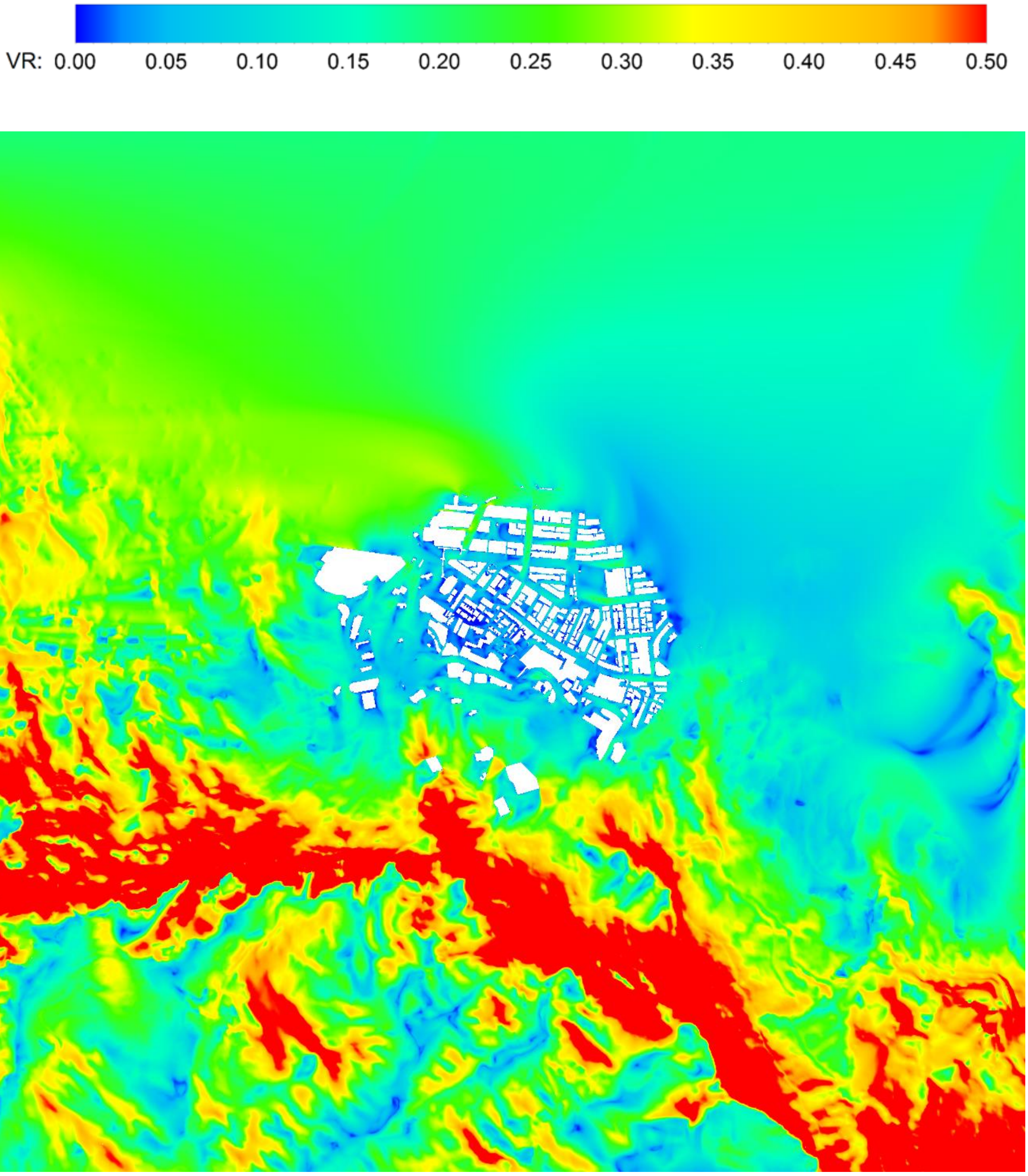


Figure G12. VR Plot at 2m above Ground Level under NNE wind

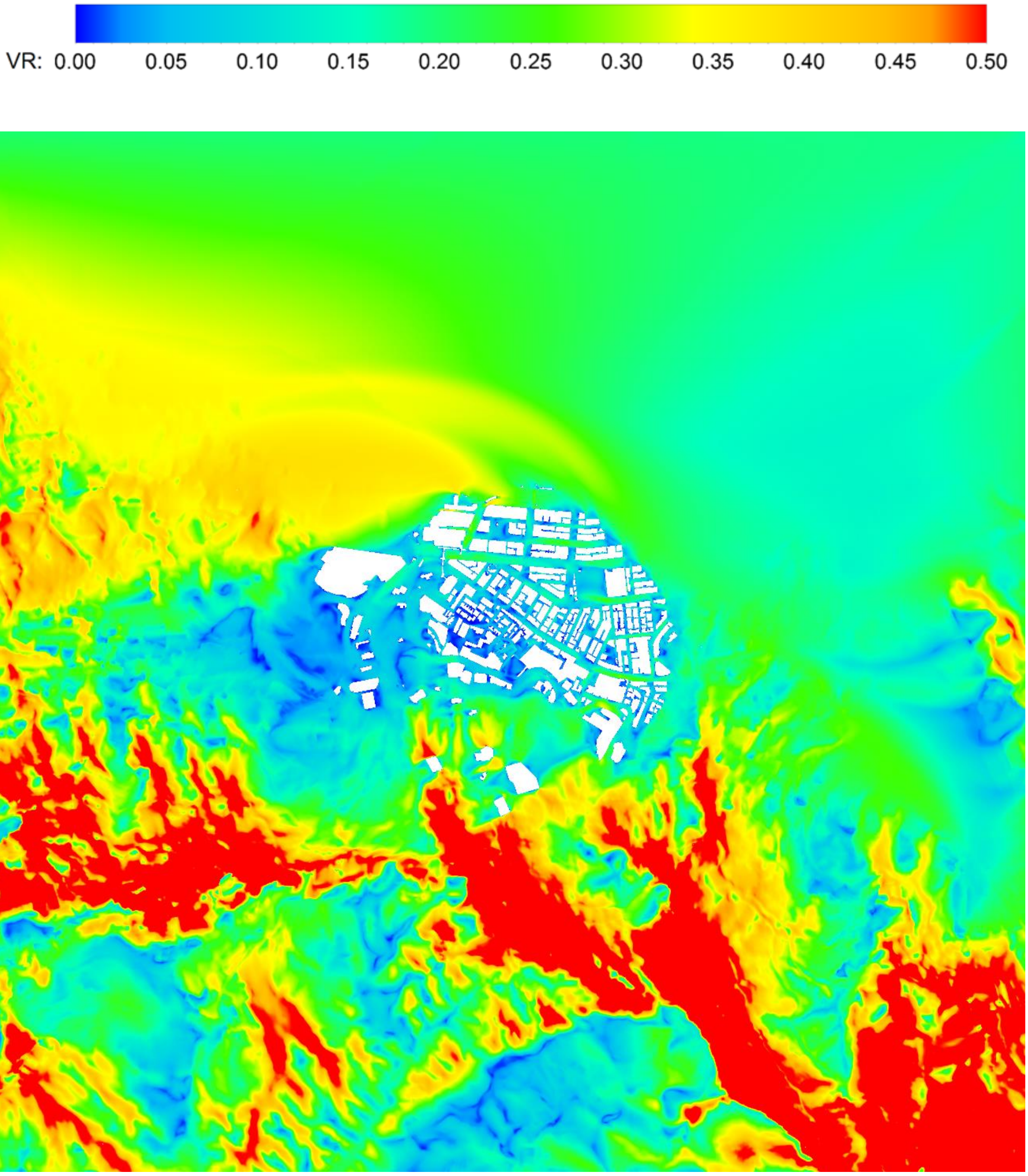


Figure G13. VR Plot at 2m above Ground Level under NE wind

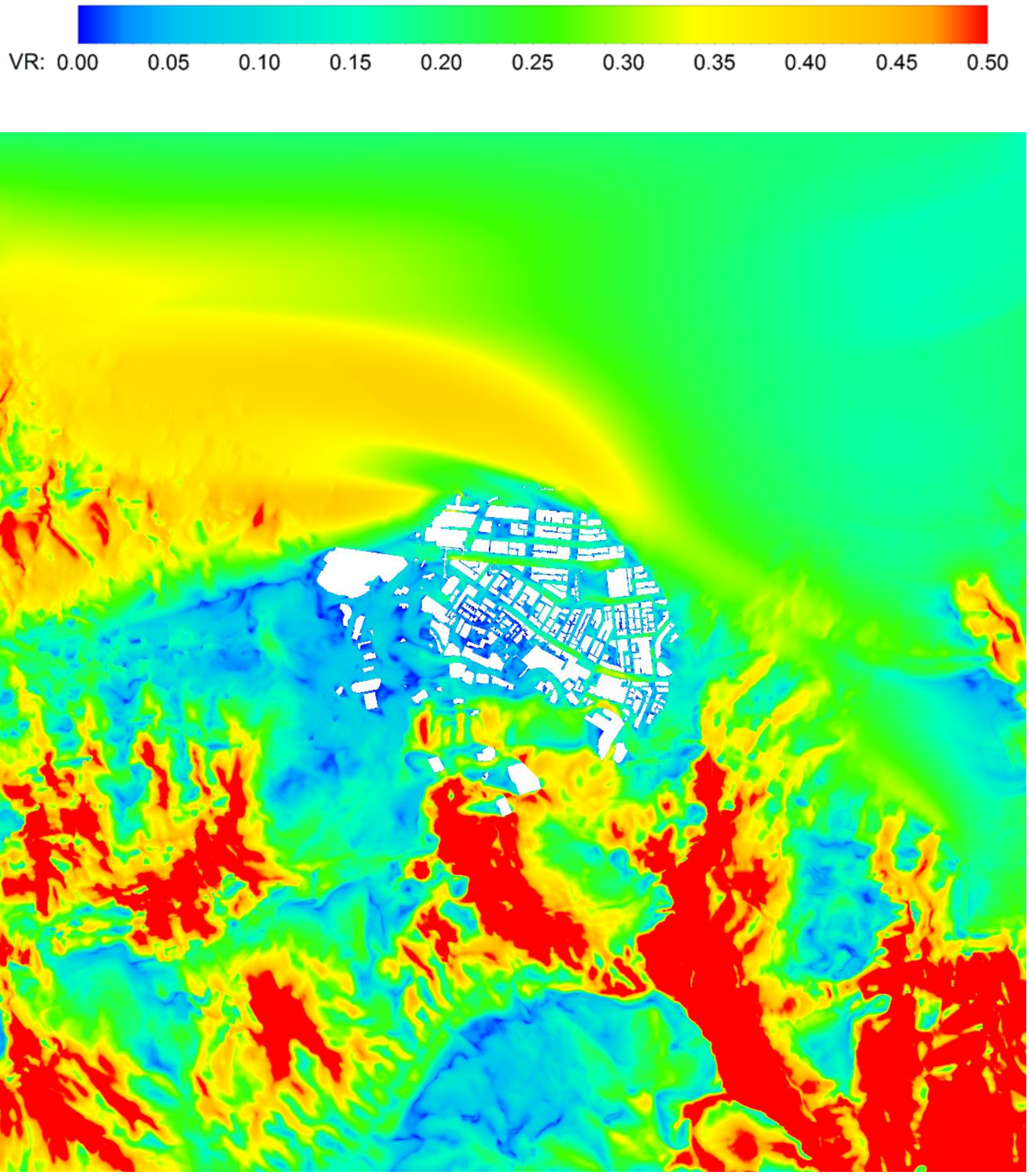


Figure G14. VR Plot at 2m above Ground Level under ENE wind

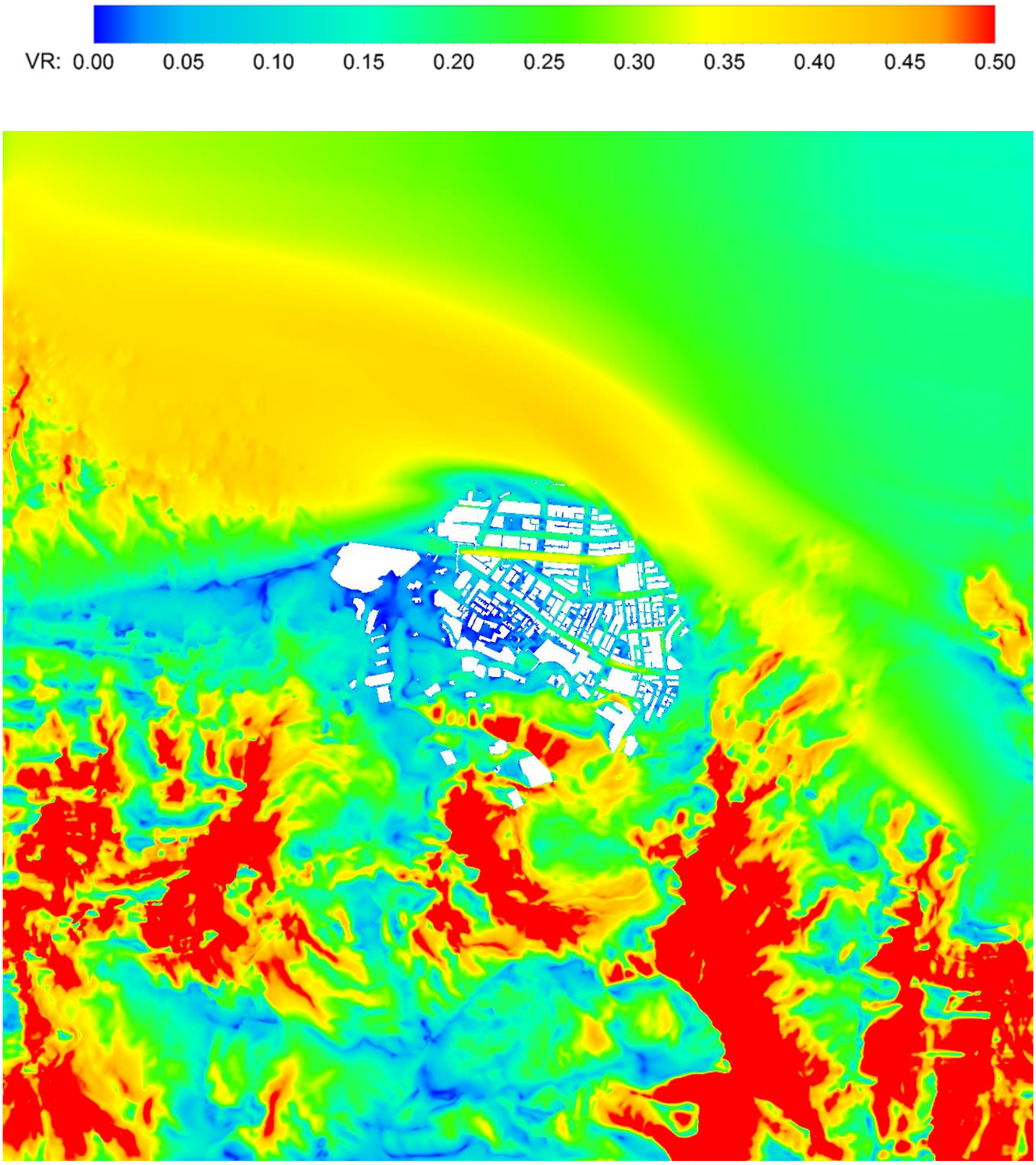


Figure G15. VR Plot at 2m above Ground Level under E wind

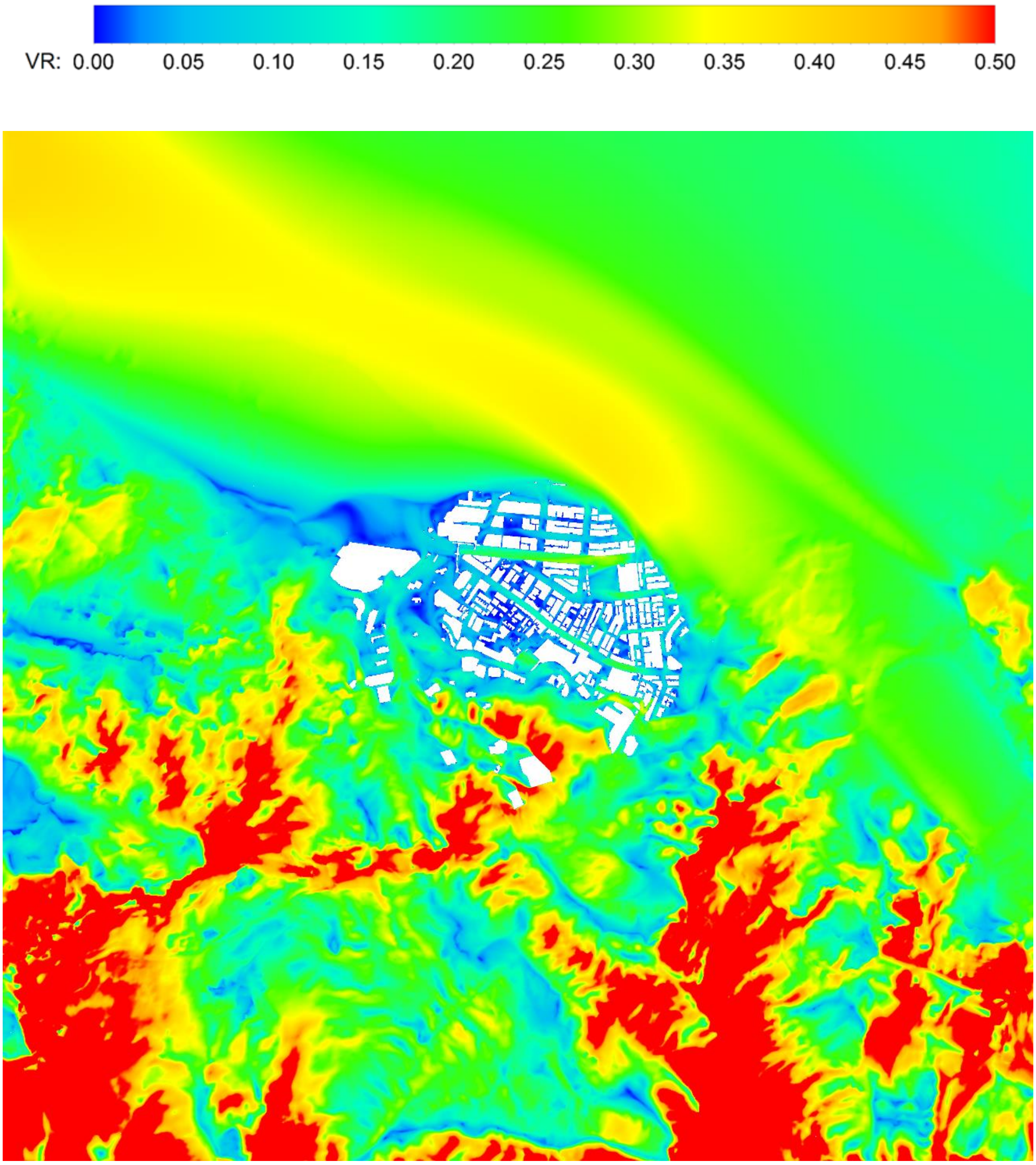


Figure G16. VR Plot at 2m above Ground Level under ESE wind

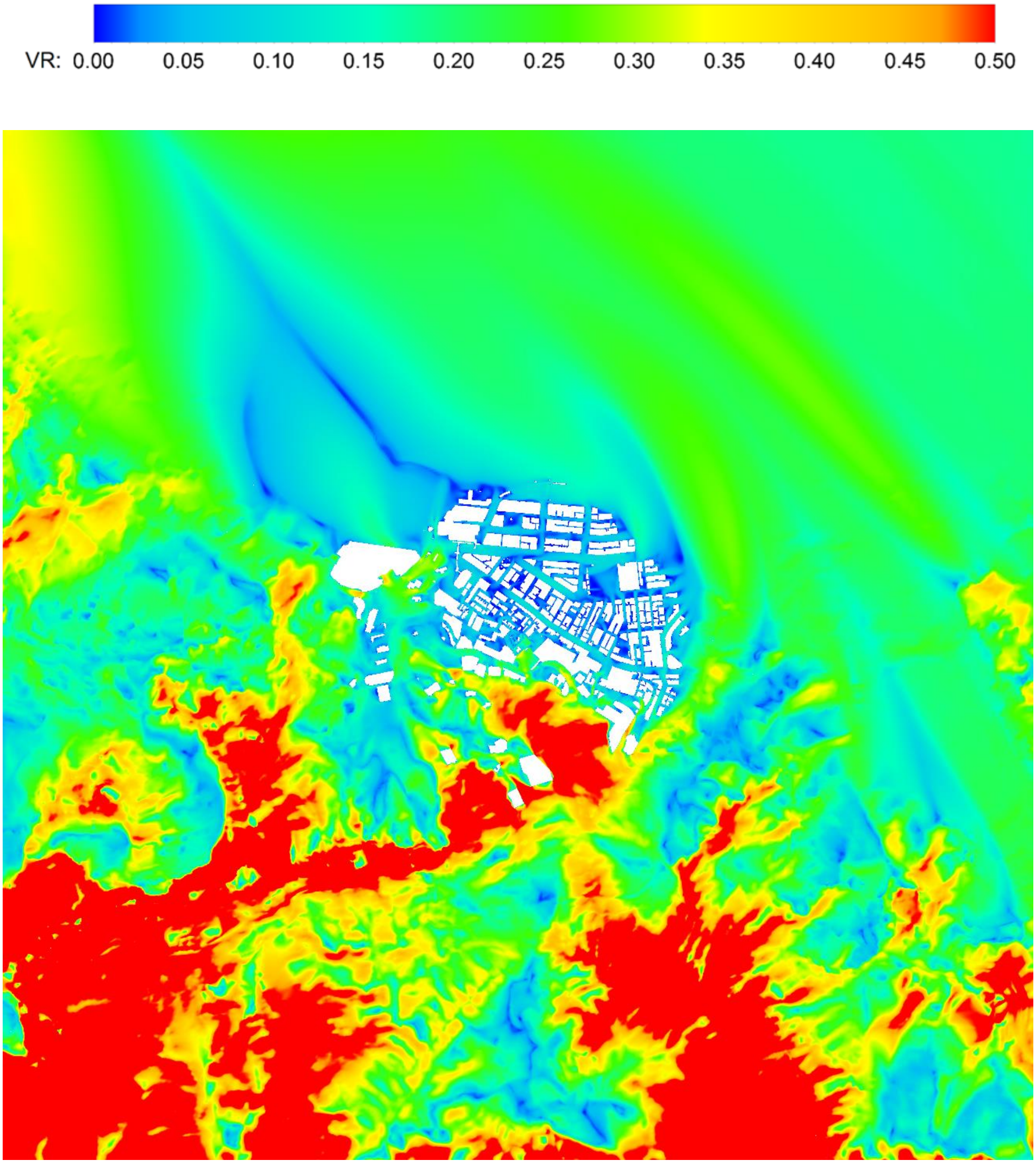


Figure G17. VR Plot at 2m above Ground Level under SE wind

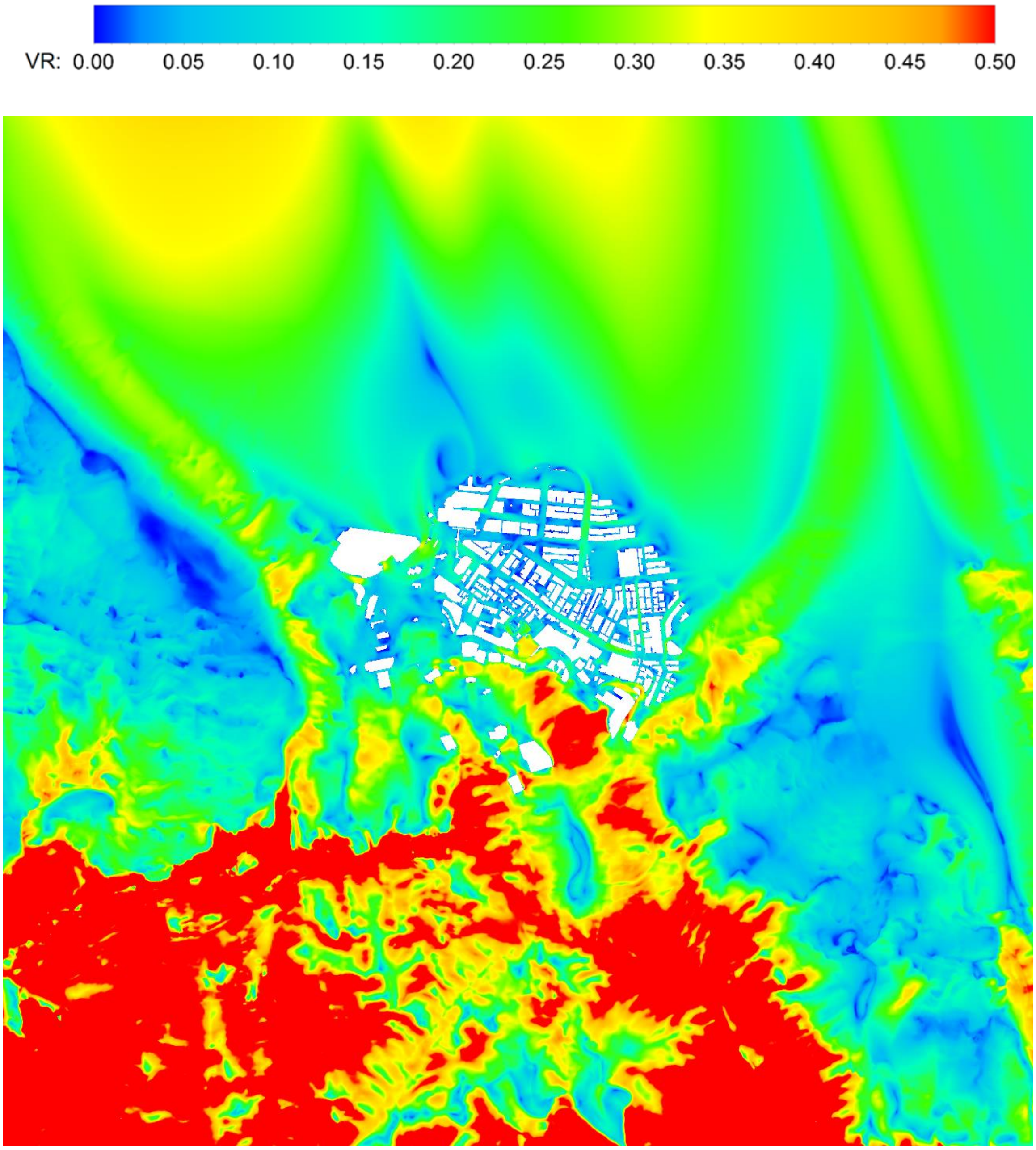


Figure G18. VR Plot at 2m above Ground Level under SSE wind

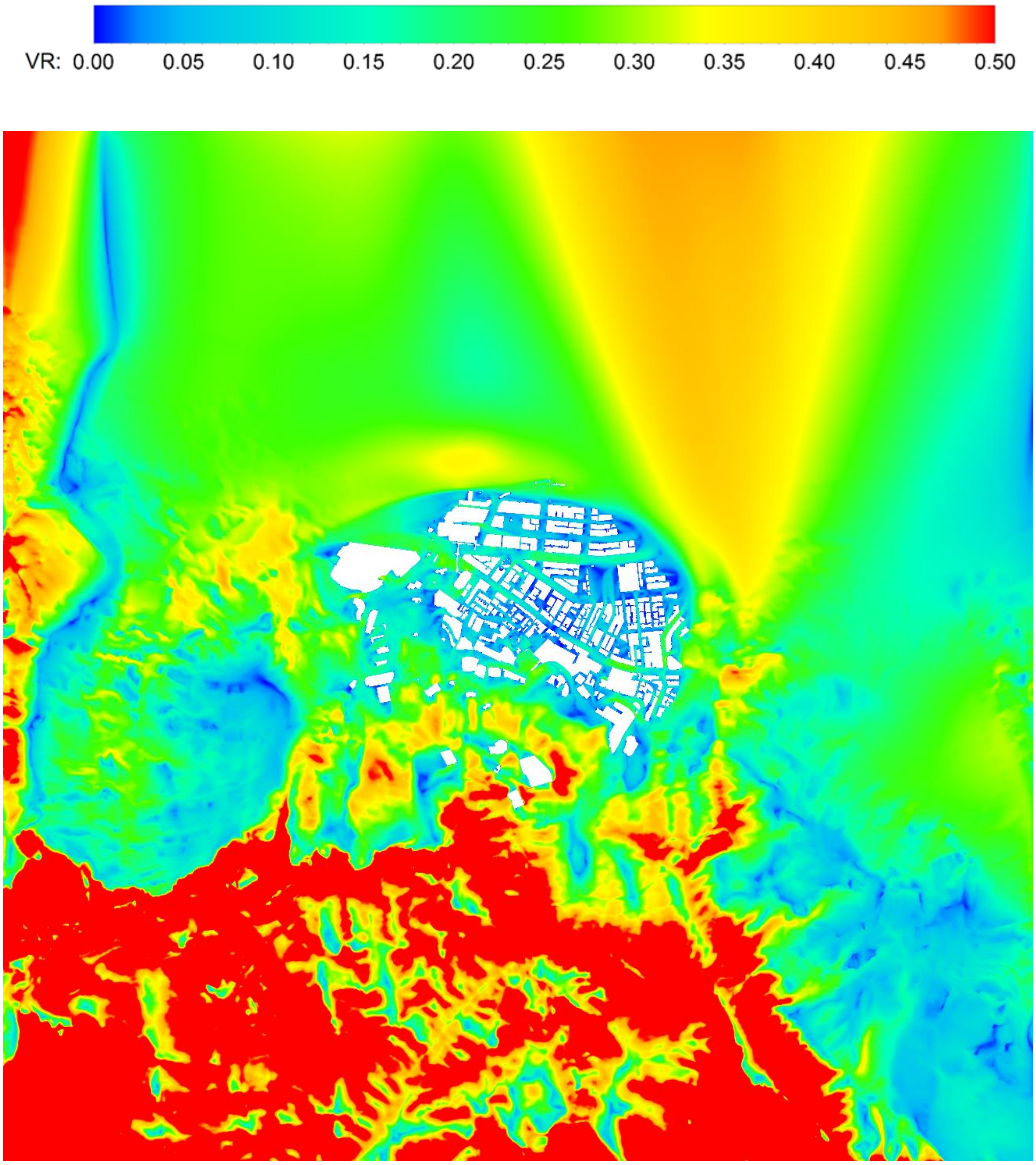


Figure G19. VR Plot at 2m above Ground Level under S wind

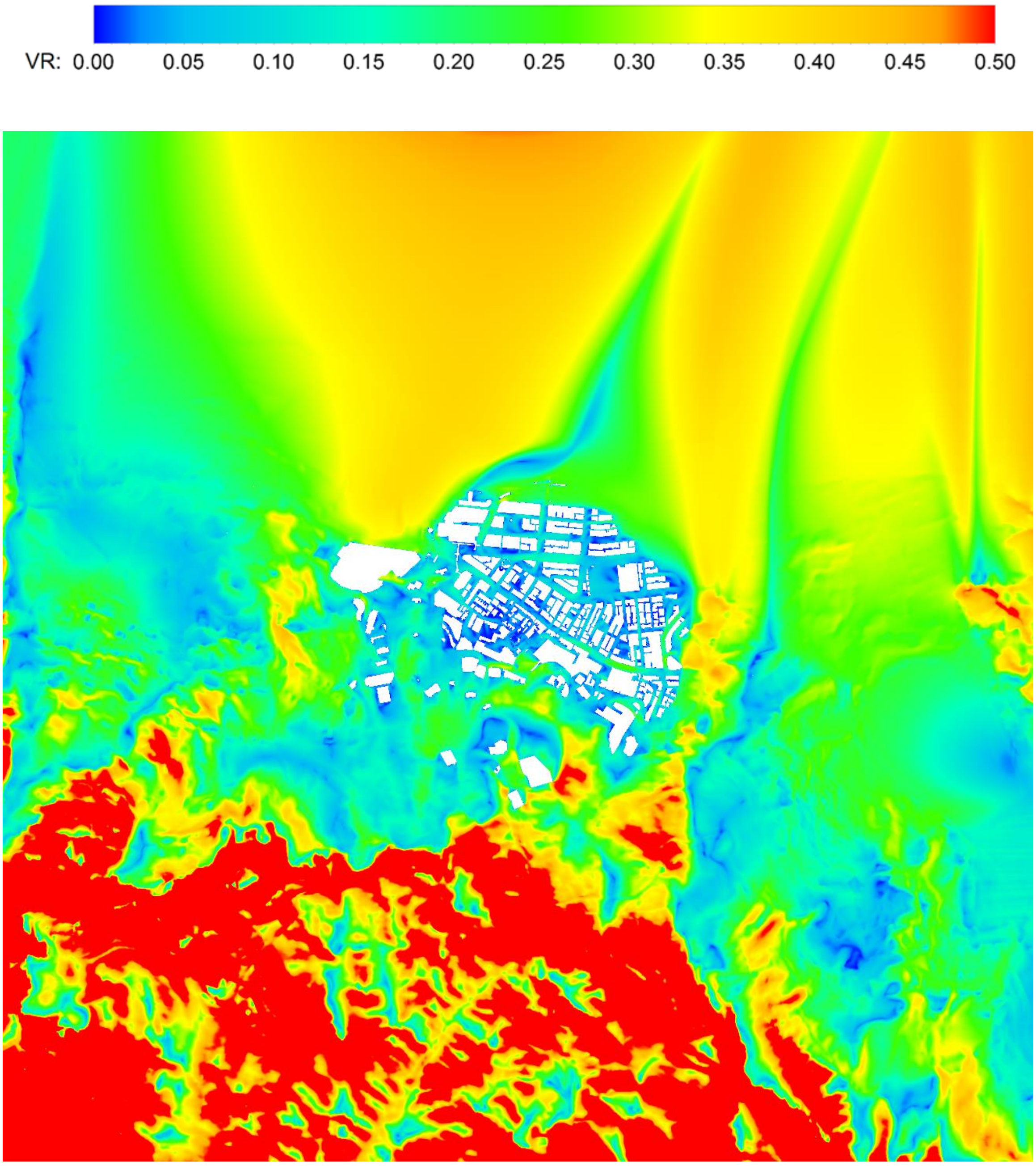


Figure G20. VR Plot at 2m above Ground Level under SSW wind

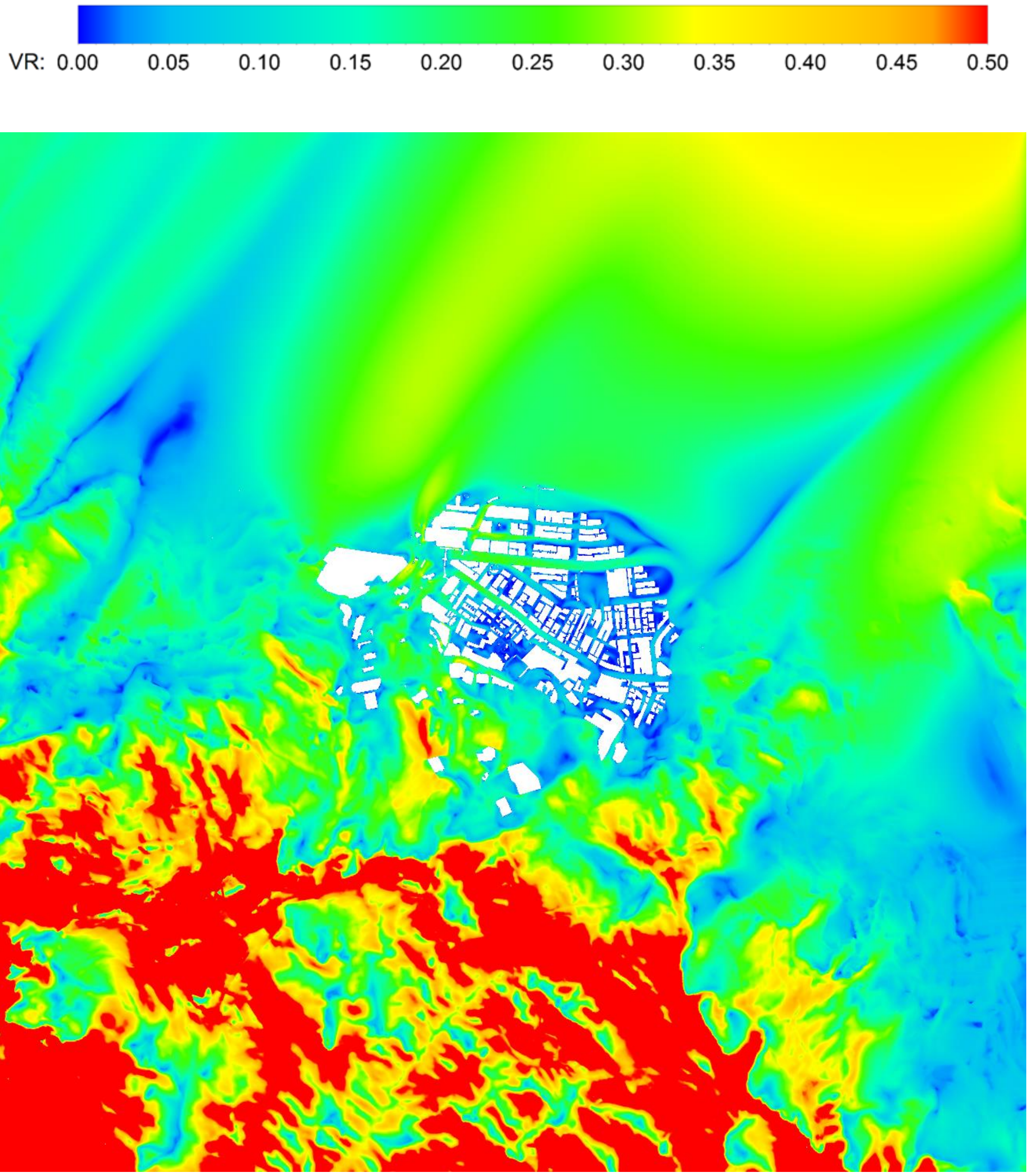


Figure G21. VR Plot at 2m above Ground Level under SW wind

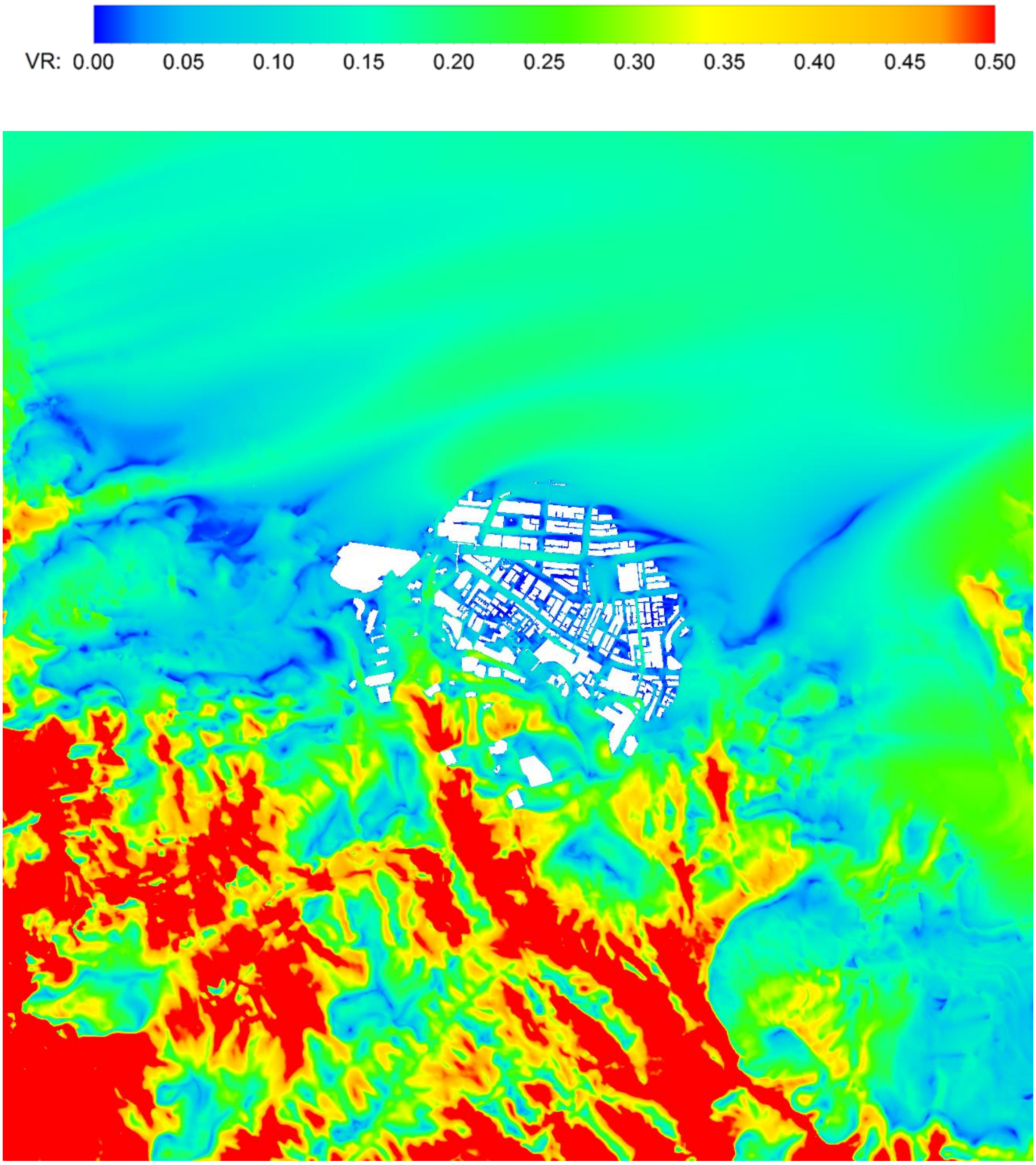


Figure G22. VR Plot at 2m above Ground Level under WSW wind

Appendix H

Summary of the Major Elevated Structures, Planned and Committed Developments within the Surrounding Area

Not in Use

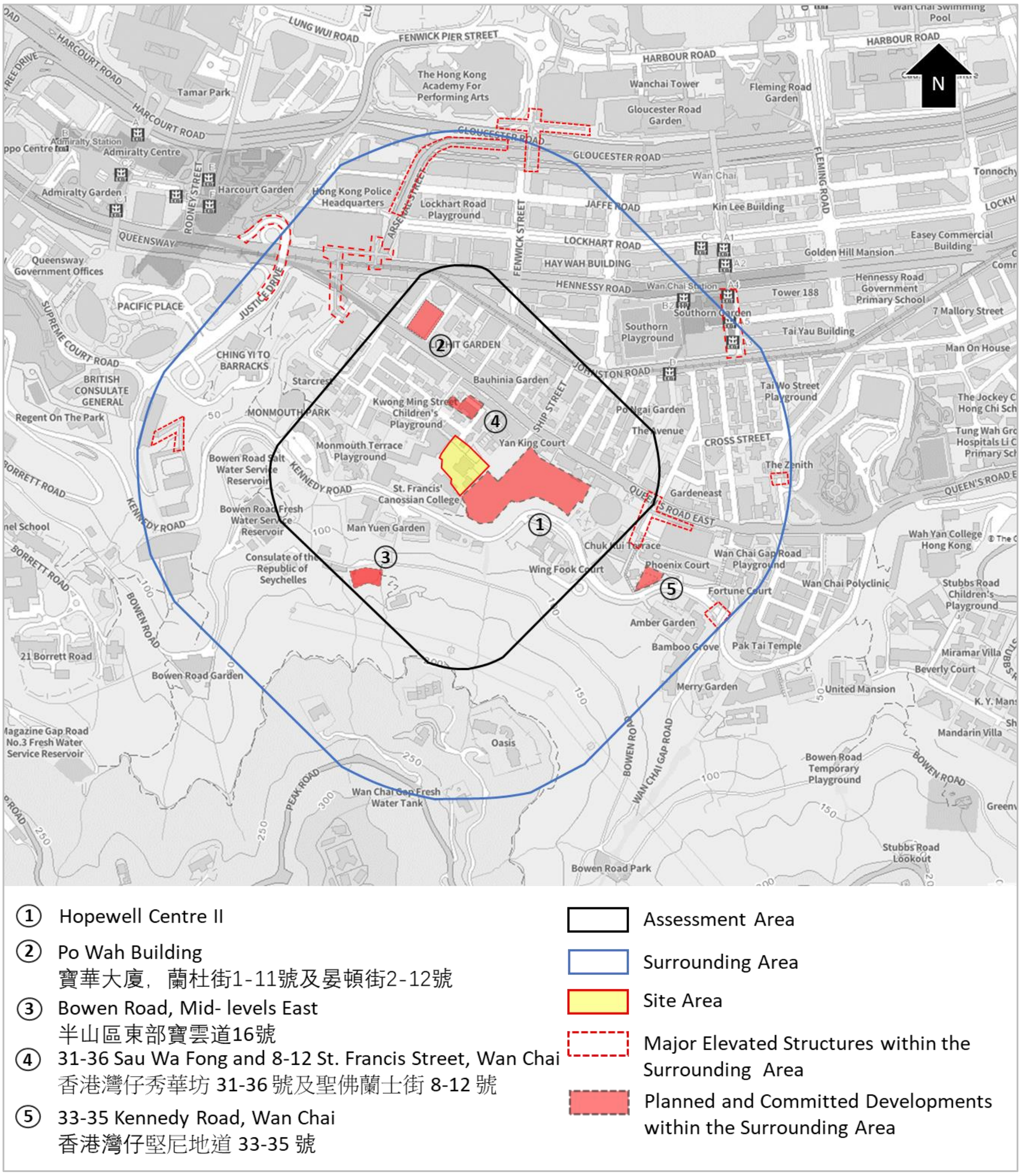


Figure H1. Summary of the Major Elevated Structures, Planned and Committed Development within the Surrounding Area (Schematic Plan)

① Hopewell Centre II

② Po Wah Building
寶華大廈，蘭杜街1-11號及晏頓街2-12號

③ Bowen Road, Mid- levels East
半山區東部寶雲道16號

④ 31-36 Sau Wa Fong and 8-12 St. Francis Street, Wan Chai
香港灣仔秀華坊 31-36 號及聖佛蘭士街 8-12 號

⑤ 33-35 Kennedy Road, Wan Chai
香港灣仔堅尼地道 33-35 號

Assessment Area

Surrounding Area

Site Area

Major Elevated Structures within the Surrounding Area

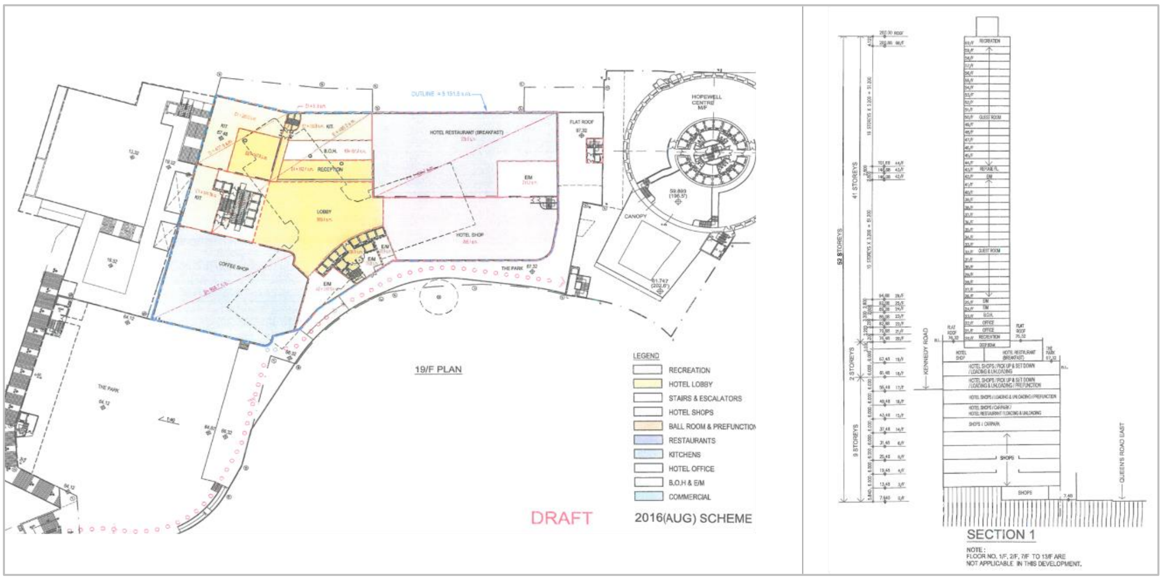
Planned and Committed Developments within the Surrounding Area

Figure H2. Summary of the Major Elevated Structures, Planned and Committed Development within the Surrounding Area (CFD Model)

Information Source

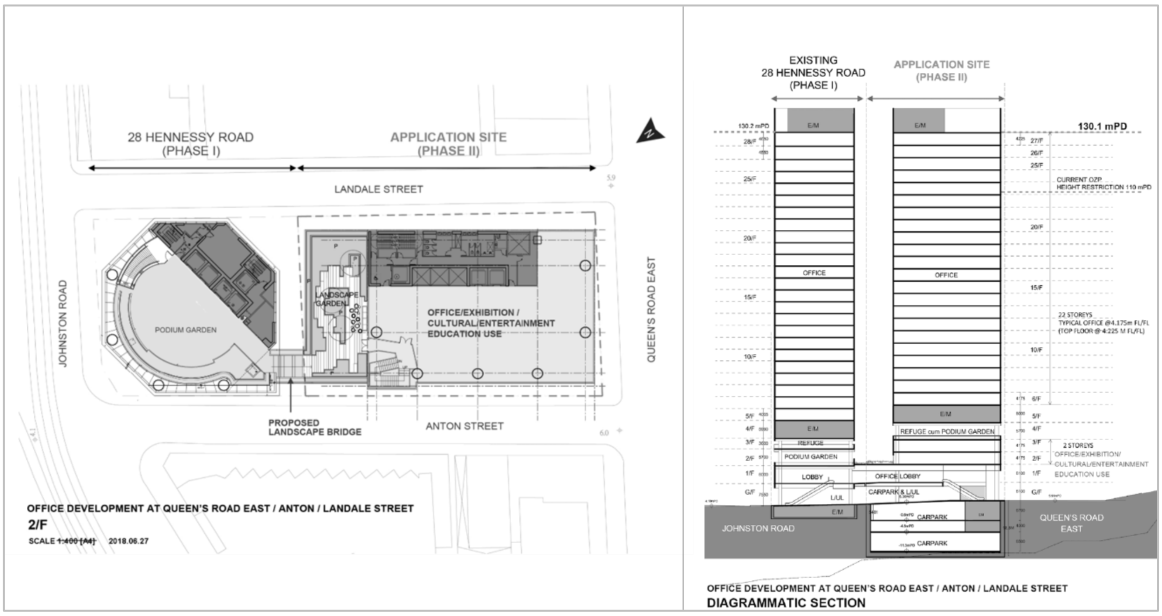
(1) Hopewell Centre II

Maximum Building Height: about 200m height.



(2) Po Wah Building 寶華大廈，蘭杜街 1-11 號及晏頓街 2-12 號

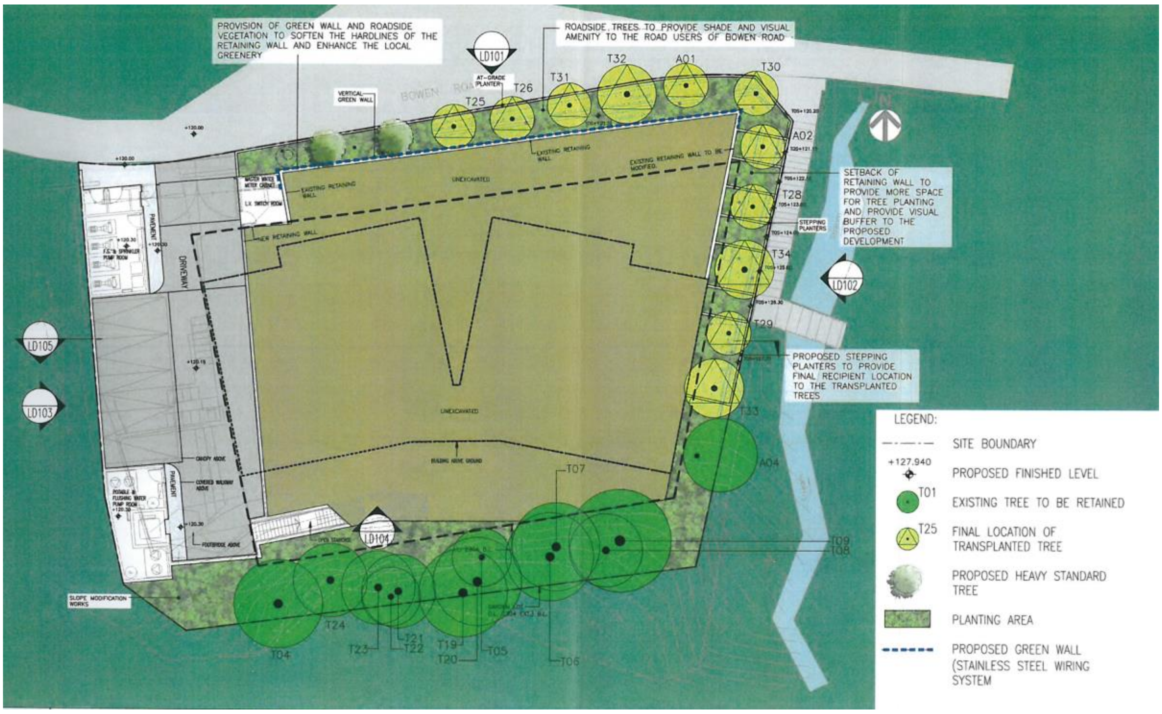
Maximum Building Height: about 130mPD

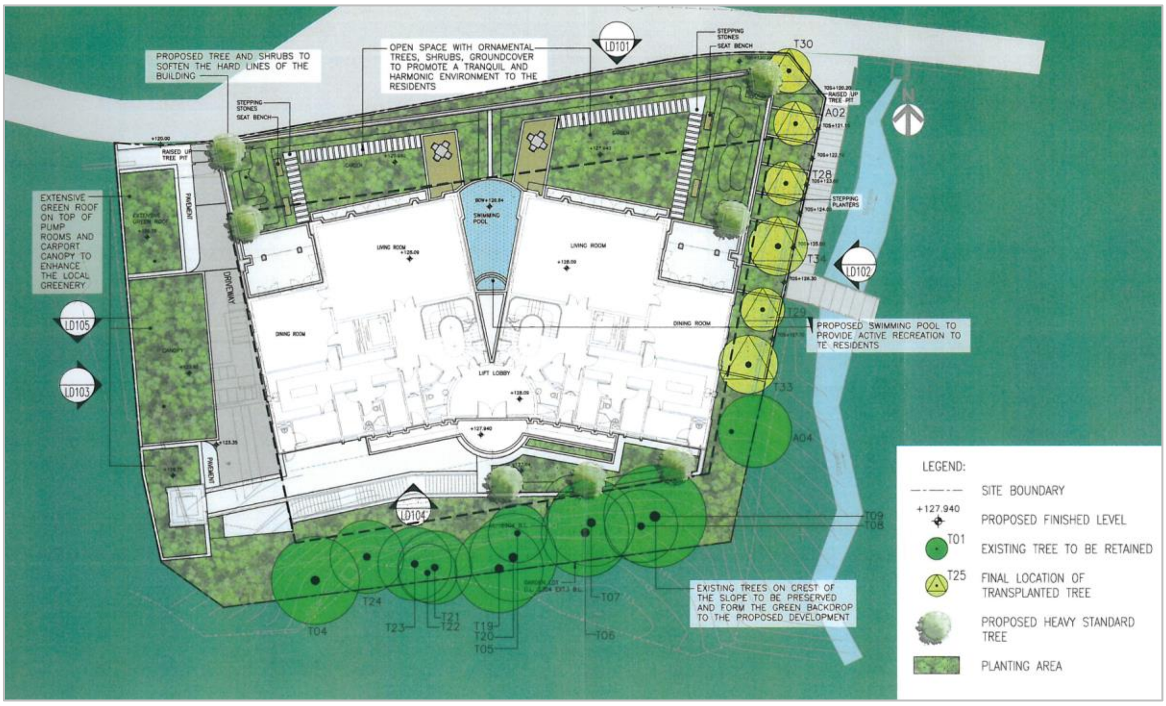


https://www.info.gov.hk/tpb/en/papers/MPC/HK/A-H5-411/A-H5-411B-Plan.pdf

(3) Bowen Road, Mid- levels East 半山區東部寶雲道 16 號

Maximum Building Height: about 10m height

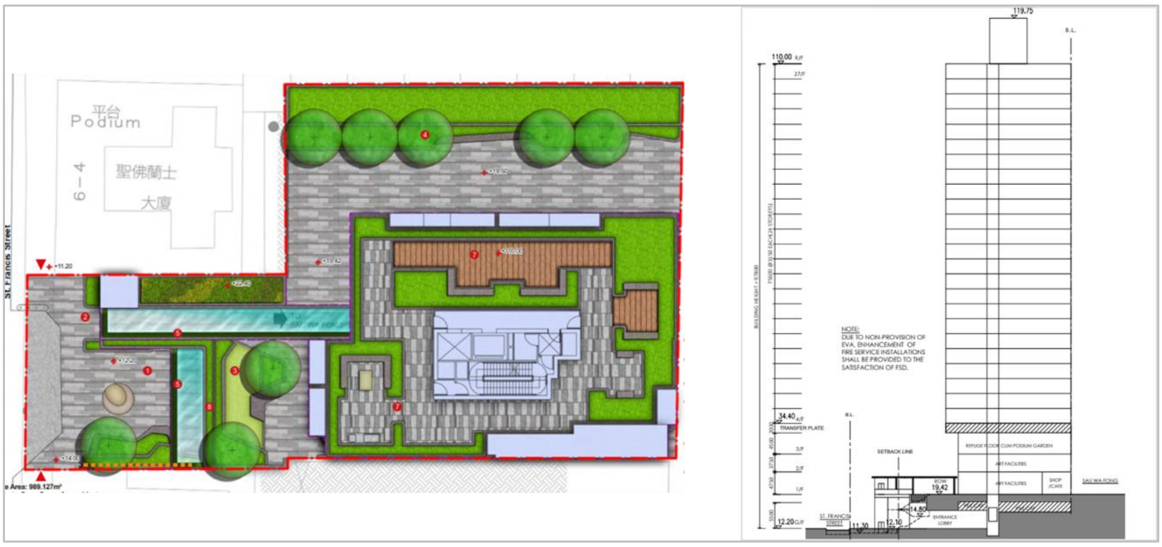




https://www2.ozp.tpb.gov.hk/gos/download.aspx?type=apply&caseno=A/H12/29&lang=0

(4) 31-36 Sau Wa Fong&8-12 St. Francis Street, Wan Chai 秀華坊 31-36 號及聖佛蘭士街 8-12 號

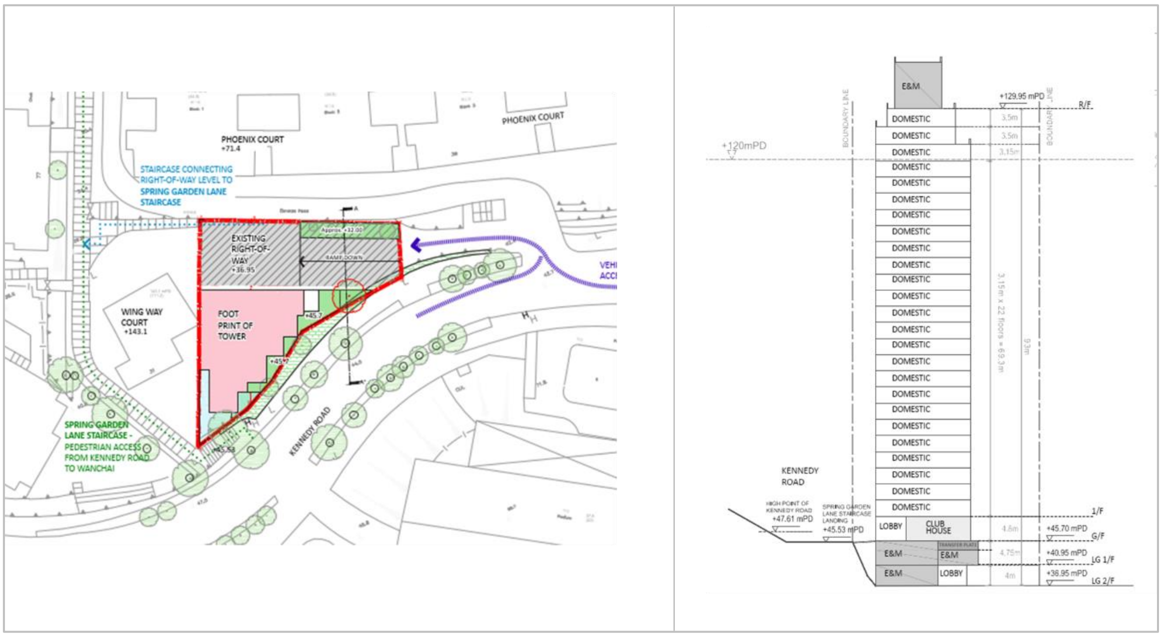
Maximum Building Height: about 110mPD



https://www.tpb.gov.hk/tc/plan_application/Attachment/20221125/s12a_Y_H5_7_0_gist.pdf

(5) 33-35 Kennedy Road, Wan Chai 香港灣仔堅尼地道 33-35 號

Maximum Building Height: about 130mPD



https://www.info.gov.hk/tpb/tc/plan_application/Attachment/20220722/s16_A_H5_419_0_gist.pdf