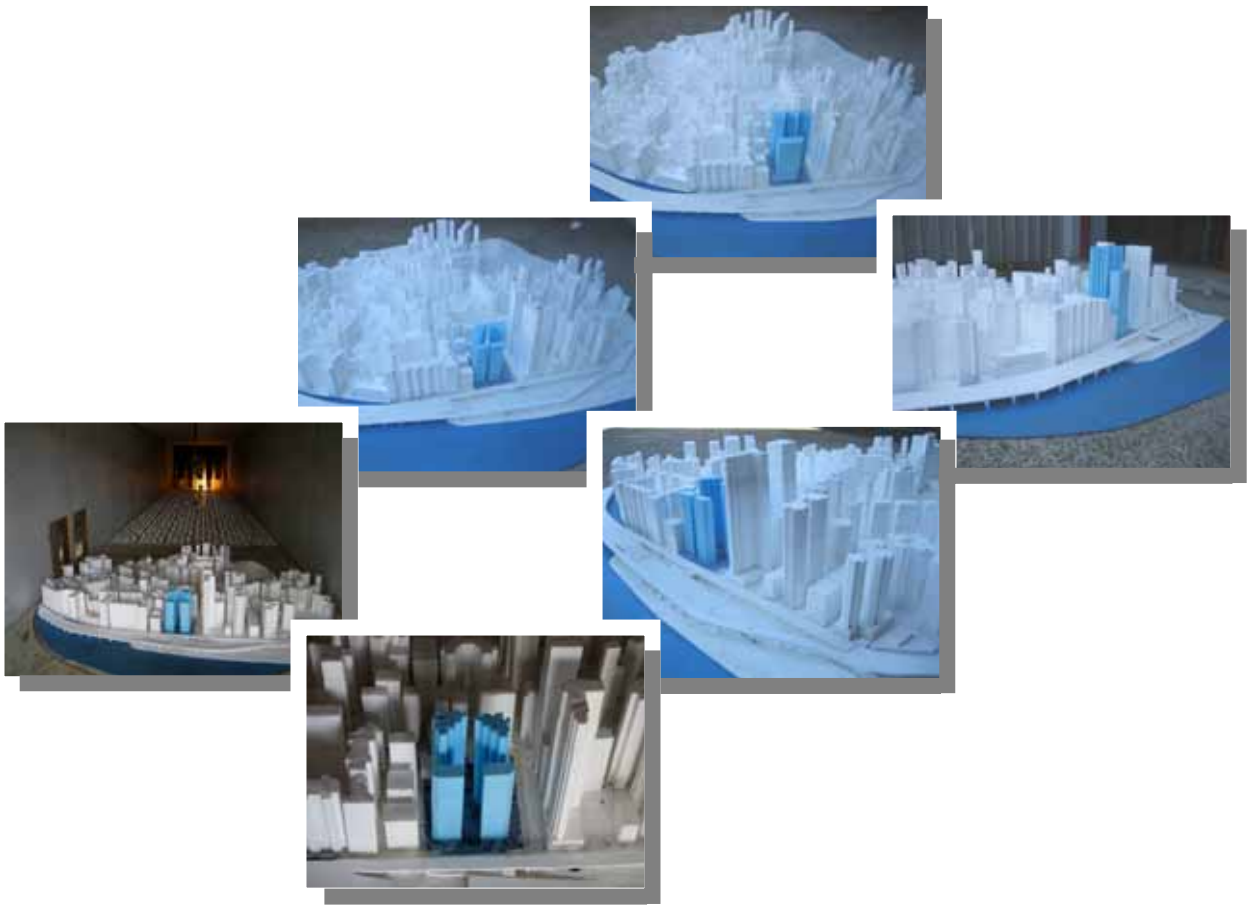
Planning Department

Air Ventilation Assessment Report

Oil Street Site

EXECUTIVE SUMMARY



CH2M HILL Hong Kong Limited
Suite 1801, Harcourt House
39 Gloucester Road, Wanchai
Hong Kong

August 2007

TABLE OF CONTENTS

Keyword

Wind Velocity Ratio (VR)	An indicator of wind availability, which is defined as Vp/V∞ (V pedestrian/V infinity). V∞ captures the wind velocity at the top of the wind boundary layer (assumed to be 500 m above ground in this study). V∞ is taken as the wind availability of the site. Vp captures the wind velocity at the pedestrian level (2 m above ground) after taking into account the effects of buildings and urban features. It is a common practice in wind engineering study to account for wind coming from 16 main directions. The Wind Velocity Ratio is the sum of the Wind Velocity Ratio of wind from direction i (VRi) multiply by the probability (Fi) of wind coming from that direction as expressed by the formulae $$VR_w = \sum_{i=1}^{16} F_i \times VR_i$$
Project Area	Defined by the project site boundaries including all open areas that pedestrians are likely to access.
Assessment Area	Generally including the project's surrounding up to a perpendicular distance H from the project boundary, H being the height of the tallest building on site.
Surrounding Area	The area that "conditions" the approaching wind profiles appropriately. The Surrounding Area of up to a perpendicular distance of 2H from the project boundary must be included in the study. Sometimes it may be necessary to enlarge the Surrounding Area if there are prominent features (e.g. tall buildings or large and bulky obstructions) immediately outside the 2H zone.
Test Points	Selected locations where Wind VRs are reported.
Perimeter Test Points	Test Points positioned on the project site boundary.
Overall Test Points	Test Points evenly distributed and positioned in the open spaces, on the streets and places of the Project and Assessment Areas where pedestrians frequently access.
Expert Evaluation	A qualitative assessment of the design and/or design options and to facilitate the identification of problems and issues.
Detailed Study	A quantitative assessment and comparison of design options to facilitate option selection.
Site spatial average Velocity Ratio (SVR)	The average Wind VR of the Perimeter Test Points to give a hint of how the development proposal impacts the wind environment of its immediate vicinity.
Local spatial average velocity ratio (LVR)	The average Wind VR of the Overall Test Points and the Perimeter Test Points to give a hint of how the development proposal impacts the wind environment of the local area.

1. INTRODUCTION

1.1 Background and Objectives

1.1.1 Planning Department has commissioned CH2M HILL Hong Kong Limited (in association with Windtech Consultants Pty Limited (Australia)) to provide term consultancy services for undertaking air ventilation assessment in September 2006.

1.1.2 The objective of this study is to complete the air ventilation assessments for three design schemes and to facilitate the Government to decide an appropriate design scheme for better air ventilation.

1.2 Site Environs

1.2.1 The proposed development is located at the waterfront area bounded by Oil Street to the southwest and Electric Road to the southeast. To the northwest of the subject site is the waterfront. **Figure 1** shows the location of the subject site and its environs.

1.2.2 To the immediate northeast is an electricity sub-station (ESS), the Electric Centre building and the Electric Road Municipal Services Building. To the further northeast is a high-rise residential development, the City Garden. City Garden Road is aligned in parallel to the coast and ends at the subject site.

1.2.3 To the southeast on the opposite side of Electric Road are an existing hotel development, some commercial and residential buildings. The hotel development is of long frontage to the waterfront with the height reaching about 83mPD. The heights of other existing buildings adjacent to the hotel development range from about 20 to 23mPD. The heights of row of buildings at the back along King's Road range from about 46 to 78mPD. The topography to the further south is of much higher elevation.

1.2.4 King Wah Road and Wang On Road are aligned in parallel to the waterfront to the southwest of the subject site and ends at the subject site. An L-shaped hotel building is planned at a site bounded by King Wah Road and Oil Street. A commercial development, AIA Tower, is bounded by Electric Road and Oil Street to the south of the subject site and is about 177mPD. To the further southwest is the Harbour Heights development comprising 3 towers each of about 120mPD.

1.2.5 A section of the proposed Central-Wan Chai Bypass and ancillary facilities including the administration building is proposed at grade to the northwest of the subject site. A future waterfront park is proposed to the further northwest.

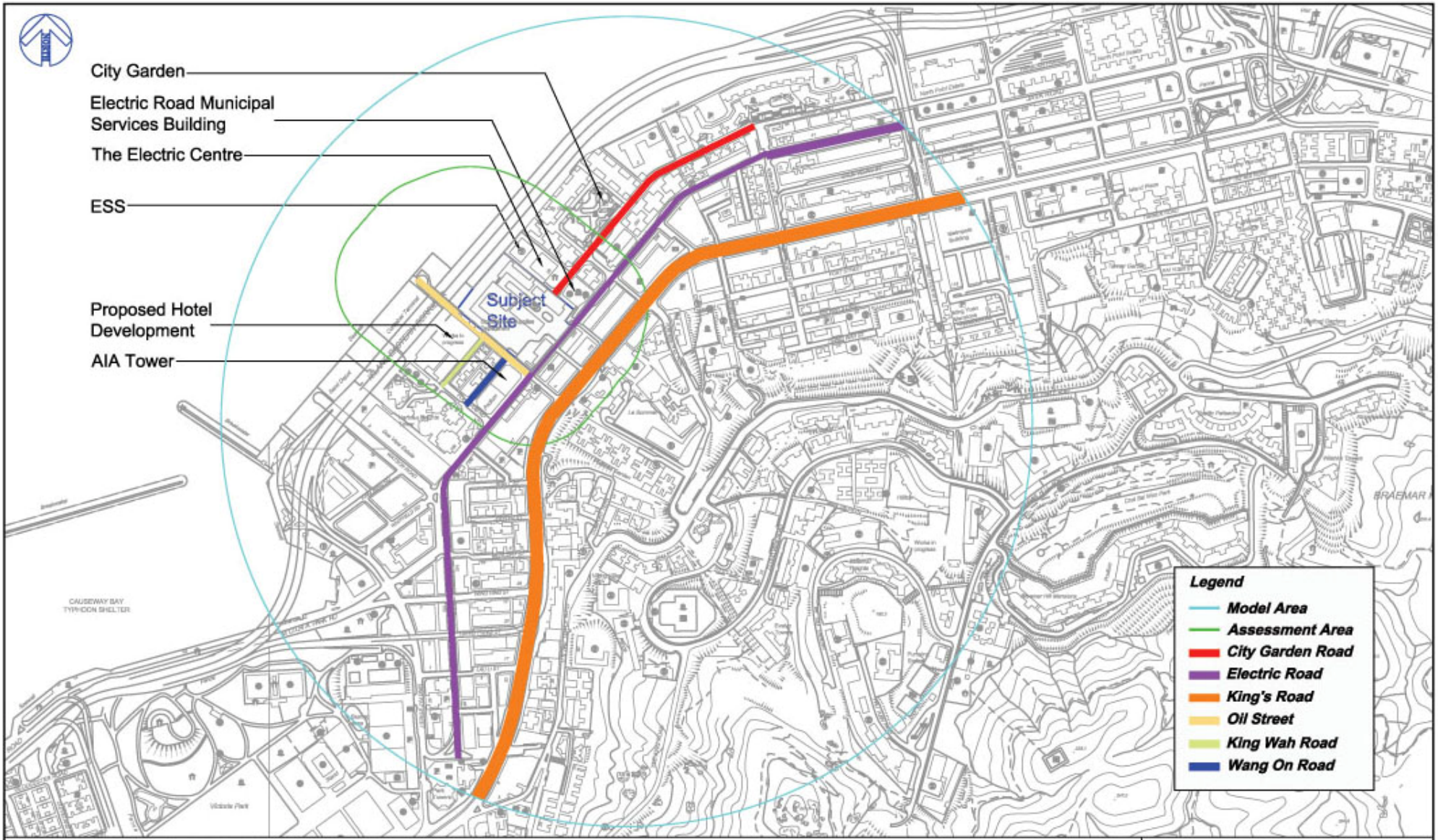
1.2.6 The land topography is relatively flat on site and in its immediate surrounding. There is, however, an escarpment with the peak rising to a height of approximately 500m within 5km from the site in the east to west directions (**Figure 2**).

1.3 General Features Affecting the Wind Environment

1.3.1 The air ventilation assessment would generally be affected by the wind availability under all wind directions and frequency of occurrence of individual wind directions, and in particular predominated by the prevailing wind flow.

1.3.2 The general prevailing wind flow in Hong Kong is east to northeast wind. Locating at waterfront in a northwest alignment, the overall air ventilation performance of the site cannot significantly benefit from the prevailing wind.

1.3.3 The escarpment on the east to west direction is expected to reduce wind availability as well as generate additional turbulence at the levels close to the ground under southerly wind. The closely packed tall buildings located immediately upstream in the southerly directions such as the

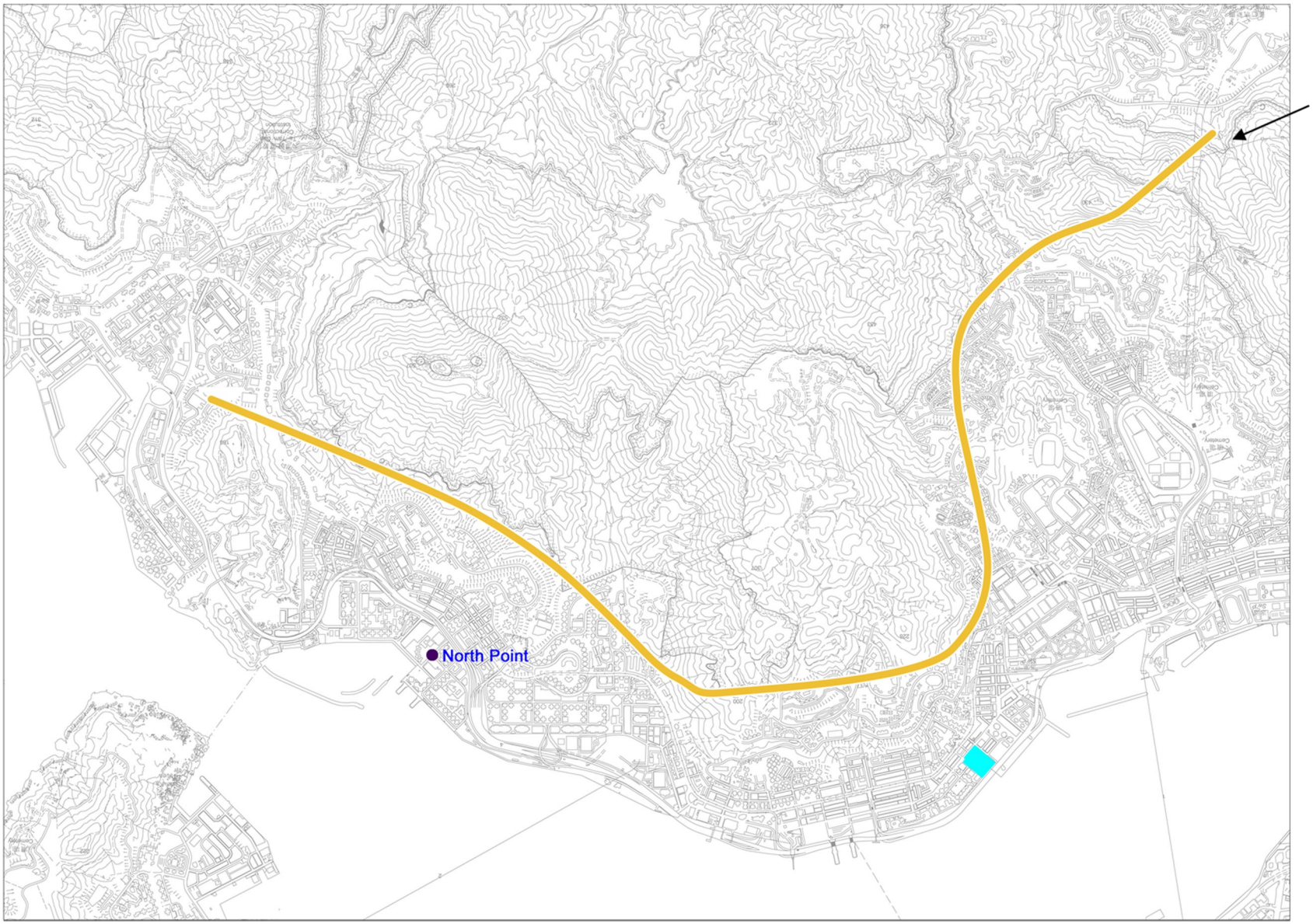


Title: Location of the Oil Street Site

CH2M HILL Hong Kong Limited

Project: Air Ventilation Assessment For Oil Street Site - Executive Summary

Figure: 1



Title: **Local Area from the North-West**	**CH2M HILL HONG KONG LIMITED**
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 2**

existing hotel development along Electric Road further reduce the wind availability. Weaker southerly wind may likely be experienced.

1.3.4 The existing high-rise buildings to the northeast of the project site would likely result in lower wind permeability and reduction of wind flow to the project site from north-east sector.

2. DESIGN SCHEMES UNDER DETAILED STUDY

2.1 Three Design Schemes

2.1.1 A total of 3 design schemes have been subject to Detailed Study. They are:

(a) Base Scheme (Figures 3 and 4), i.e. the scheme with development parameters permitted under the existing land sale conditions. The maximum residential and commercial GFA are 78,046 m^2 and 45,424 m^2 respectively;

(b) Revised Scheme (Figures 5 and 6), i.e. the scheme agreed by the Town Planning Board on 17/11/2006. The maximum residential and commercial GFA are 49,240 m^2 and 20,960 m^2 respectively; and

(c) Second Revised Scheme (Figure 7 and 8), which is iteratively developed based on the good features and problem areas of the first two design schemes with a view to enhancing air ventilation as well as mitigating the stagnant or excessive airflow. It has the same residential and commercial GFA as the Revised Scheme.

2.2 Major Features of Three Design Schemes

2.2.1 The major features of the Base Scheme are:

- a higher building height (165mPD) for the proposed residential towers which may have additional capability to capture air flow from high level leading to downwash to the pedestrian level. But, at the same time, there may be a larger wake area at the downstream of the buildings;
- narrow building gaps between the three residential towers that may reduce building permeability;
- a podium underneath proposed buildings that may block air flow at lower elevations; and
- a frontage of about 70m for the commercial block that results in wider separation from the northeast and southwest boundaries (i.e. 20 and 35 m respectively).

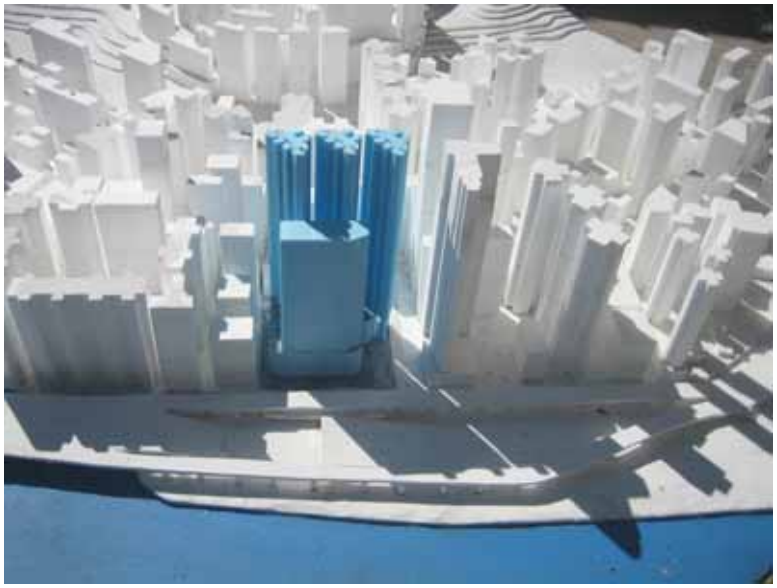
2.2.2 The major features of the Revised Scheme are:

- a lower building height (120mPD) for the proposed residential towers. Comparatively speaking, there is a lower capability to capture air flow from high level, whilst the wake area is smaller;
- a wider gap of about 13m between the two residential towers to allow wind penetration;
- no podium proposed and hence reduce any potential blockage of air flow at lower elevation;
- shorter frontage of two commercial blocks with a gap of about 15m to allow wind penetration;
- 15m and 40m separation distance from the southwest boundary for the proposed residential tower and for the proposed commercial block respectively; and
- no setback from the northeast boundary for the proposed commercial block. Some blockage to the wind flow may happen.

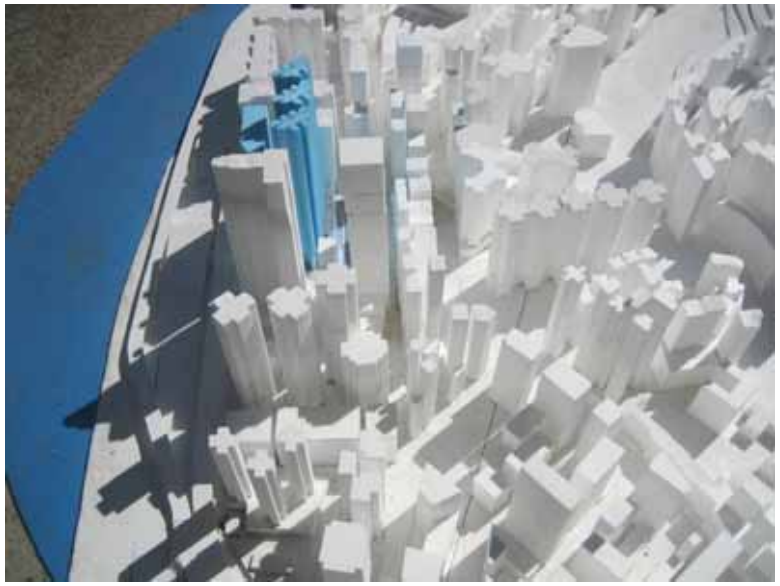
2.2.3 The major features of the Second Revised Scheme are:

- building height (120mPD) and domestic/non-domestic gross floor areas same as the Revised Scheme;
- two podium-free developments same as the Revised Scheme;
- 15m separation distance from the southwest and northeast boundaries by shifting the commercial blocks of the Revised Scheme to create wind corridors; and
- a building gap of about 25m between the two proposed commercial blocks to increase permeability of the proposed development.

Title: **Base Scheme Block Plan (Indicative)**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 3**



North-West View



South-West View

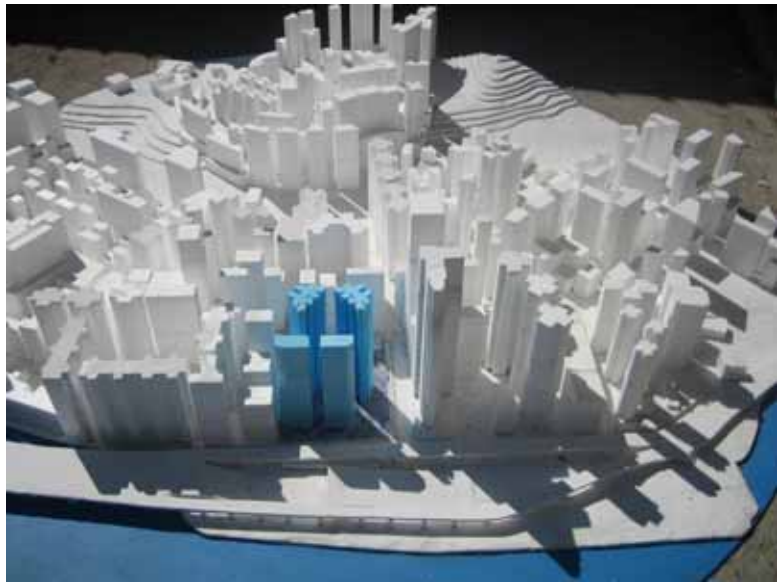
North-East View

South-East View

Title: **The 1:400 Scale Model of the Base Scheme**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 4**

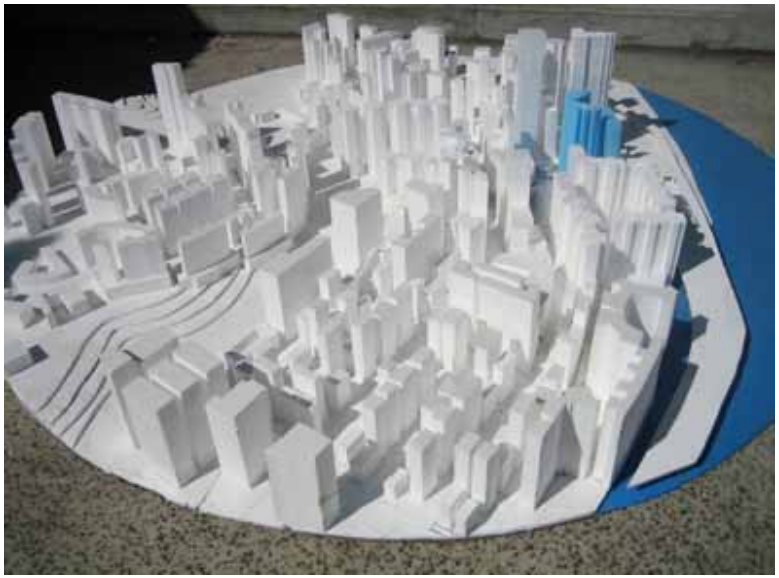
Title: **Revised Scheme Block Plan (Indicative)**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 5**

North-West View



South-West View

North-East View

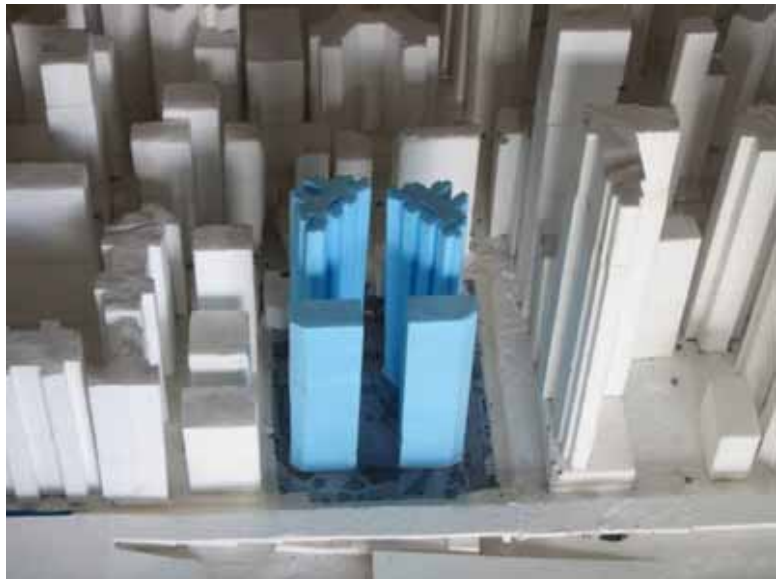


Top-Down View

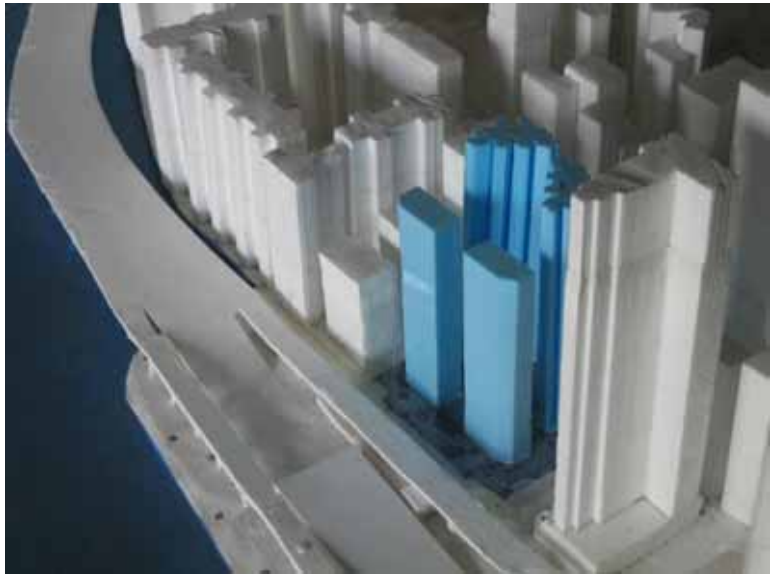
Title: **The 1:400 Scale Model of the Revised Scheme**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 6**

Title: **Second Revised Scheme Block Plan (Indicative)**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 7**

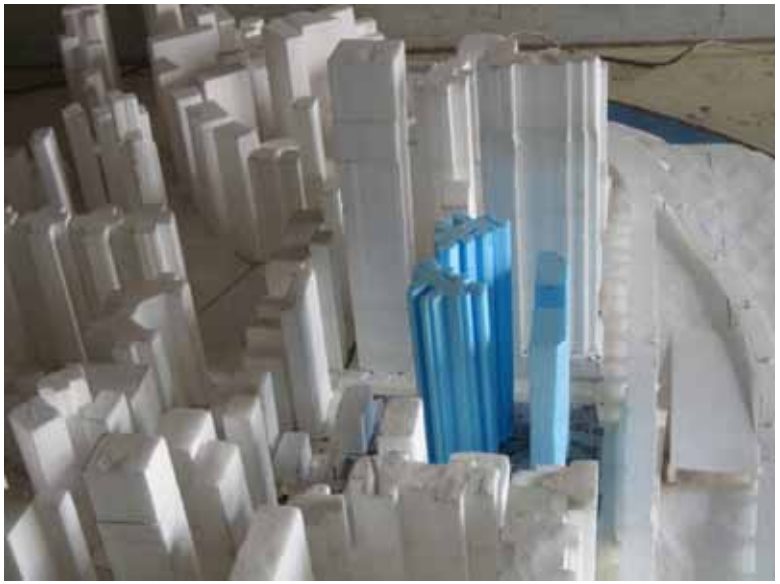
North-West View



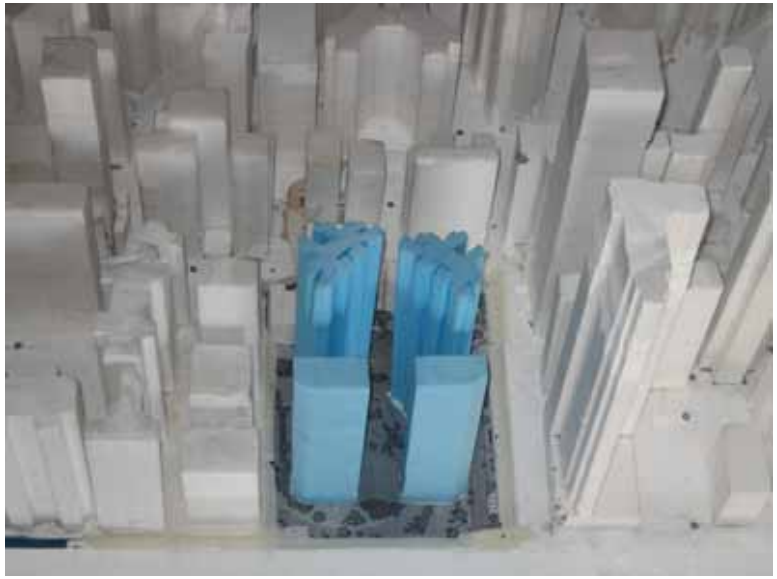
West View



North-East View



Top-Down View



Title: **The 1:400 Scale Model of the Second Revised Scheme**	CH2M HILL HONG KONG LIMITED
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	Figure: 8

3. ASSESSMENT APPROACH

3.1 General

3.1.1 The methodology of this air ventilation assessment study follows that being set out in the Technical Guide for Air Ventilation Assessment for Developments in Hong Kong (2005) (referred hereafter as Technical Guide).

3.1.2 Wind Velocity Ratio (VR) has been adopted as the indicator of wind performance for the three design schemes to show how much wind is available and enjoyed by pedestrians on ground taking into account the surrounding buildings and topography and the proposed development. It is defined as Vp/V∞ (V pedestrian/V infinity). V∞ captures the wind velocity at the top of the wind boundary layer and is taken as the wind availability of the site. Vp captures the wind velocity at the pedestrian level.

3.1.3 The general rule is that the higher the Wind Velocity Ratio, the less likely would be the impact of the proposed development on the wind availability. The reported velocity ratios provide a basis for comparing the merits and demerits of alternative designs and help identify wind problems for improvement purpose. There is yet any benchmark for evaluating the acceptability of a particular design.

3.1.4 In this study, a 2-stage assessment has been conducted, namely the Expert Evaluation and Detailed Study. An Experimental Site Wind Availability Data Study has been carried out to determine the wind availability and characteristics, as input data for the Detailed Study.

3.1.5 The qualitative Expert Evaluation provides an insight on the likely interaction between the topography and the building morphology on the wind environment (Section 2) and determines the test point locations.

3.1.6 Further details of assessment approach of Site Wind Availability Data Study and Detailed Study are described below.

3.2 Experimental Site Wind Availability Data

3.2.1 For the Experimental Site Wind Availability Data study, a topographical model of 1:4000 scale (**Figure 9**) covering the surrounding area up to a distance of not less than 10km from the project site boundary showing the major topographical features and buildings of Hong Kong Island and Kowloon have been constructed.

3.2.2 Precise wind availability and characteristics information in terms of wind rose (directions, magnitudes and frequencies), wind profiles and wind turbulence intensity profiles of the site are determined by wind tunnel testing. Hong Kong Observatory Waglan Island wind data was referenced to for the study.

3.2.3 **Figure 10** shows the windrose and wind profile results of the Experimental Site Wind Availability Study. According to the windrose, over 53% of the site approaching wind at 200m above the ground would be from north-east sector (wind from ENE and E direction occurs in more than 40% of time on average) and is considered prevailing. On the other hand, 28% and 15% of wind will come from south-east and south-west sectors respectively. The remaining 4% of wind will be northwesterly wind.

3.3 Detailed Study

3.3.1 A physical model of 1:400 covering the project site, the assessment area and the surrounding model area showing all existing/planned buildings and topographical features have been constructed for each design scheme (**Figure 4**, **Figure 6** and **Figure 8)**. Wind from all 16 directions and their probability of occurrences have been accounted for when calculating the wind VRs.

3.3.2 The assessment area is about 160m (maximum height of the tallest building of the project) from the project site boundary. It covers up to the promenade area to the northwest, King's Road to the southeast, Fook Yum Street to the southwest and a part of City Garden to the northeast.

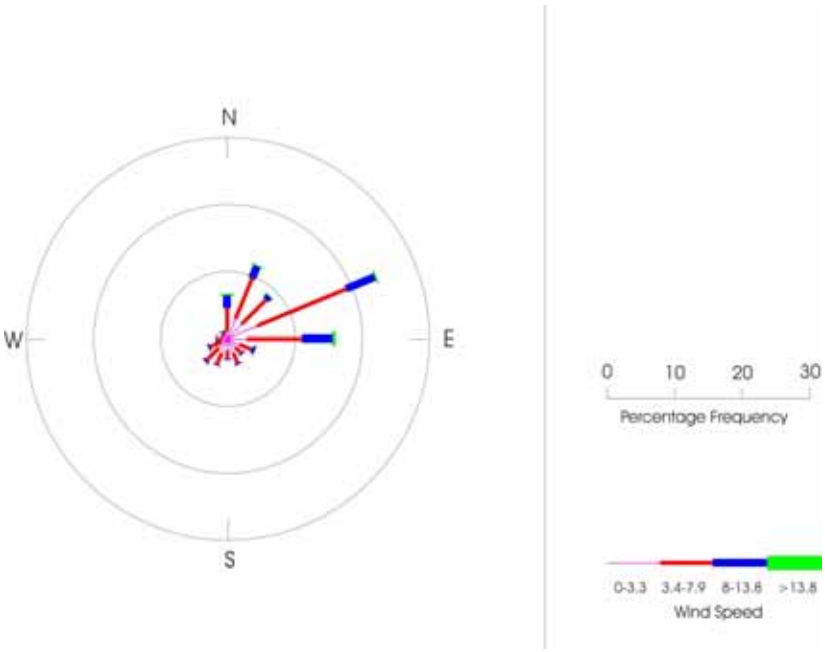
3.3.3 Test points are placed at the junctions of all roads leading to the project site, at main entrances to the project and at corners of the project site, in open spaces, on the streets and places where pedestrians frequently access. The test point locations outside and along the project site boundary are the same for all design schemes for comparison. Test points within the site are not entirely the same because of a need to cater for the different design and disposition of buildings on site. **Figure 11** to **Figure 13** show the selected test point locations for the Detailed Study for each design scheme.

3.3.4 Under the Site Air Ventilation Assessment, site spatial average VR (SVR) of all perimeter test points shall give a hint of how the development proposal impacts the wind environment of its immediate vicinity. For the Local Air Ventilation Assessment, the local spatial average VR (LVR) of all perimeter and overall test points shall give a hint of how the development proposal impacts the wind environment of the local area.

View of overall model from the South-East direction

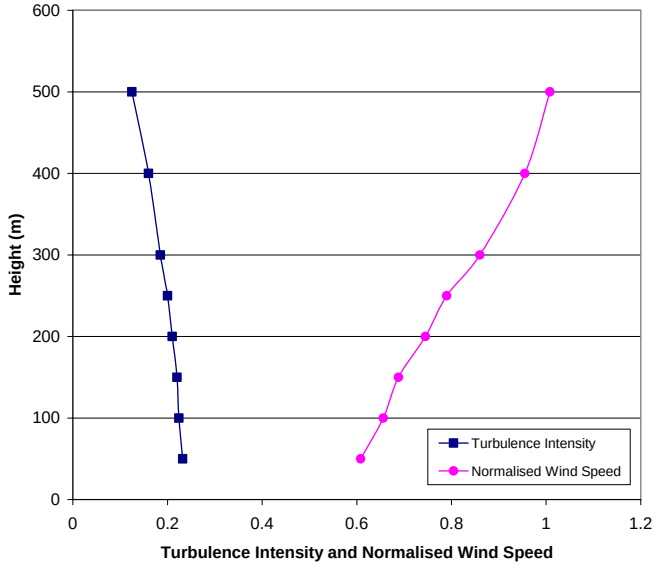
View of overall model from the South-West direction

Title: **The 1:4000 Scale Model**	**CH2M HILL Hong Kong Limited**
Project: **Air Ventilation Assessment For Oil Street Site – Executive Summary**	**FIGURE: 9**

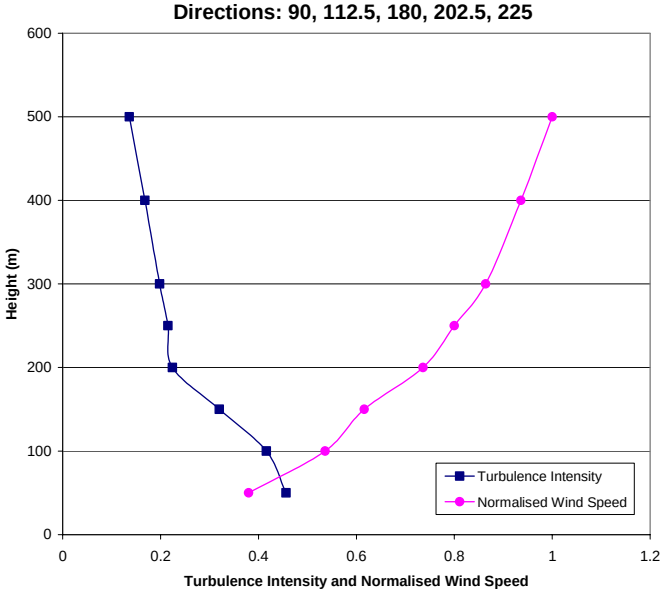


Wind Rose for Oil Street Site at 200m (with the Effect of Yaw Angle)

For Profile 1
Directions: 0, 22.5, 45, 67.5, 135, 157.5, 247.5, 270, 292.5, 315, 337.5



For Profile 2
Directions: 90, 112.5, 180, 202.5, 225



Wind Speed Profiles Adopted for Detailed Study

Title: **Wind Rose and Wind Profile**	**CH2M HILL Hong Kong Limited**
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**FIGURE: 10**

Test Points at 07, 08, 61 and 73 are located on footbridge or podium.

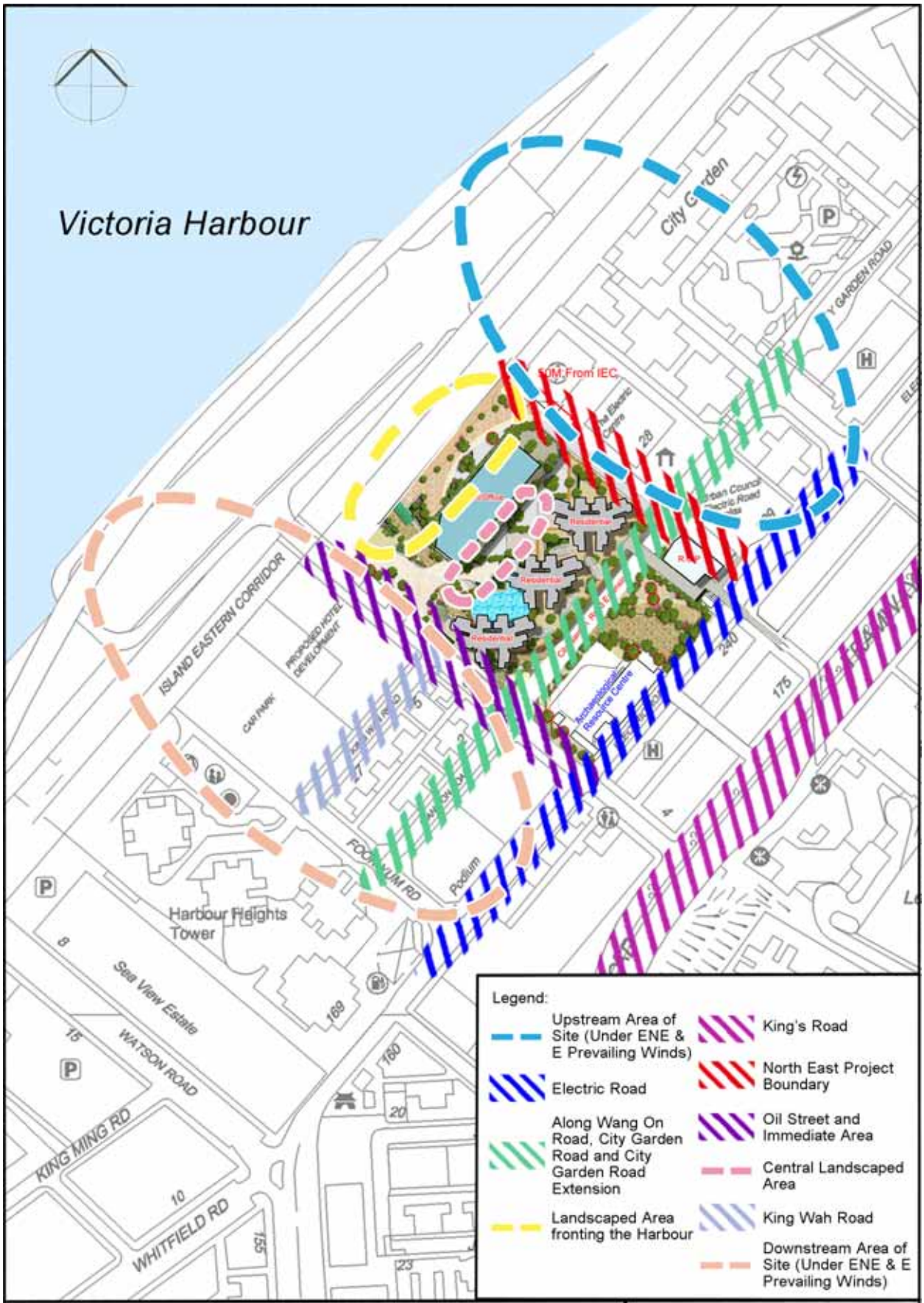
Title: **Location of Test Points for Base Scheme**	CH2M HILL Hong Kong Limited
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 11**

Test Points at 07, 08, 63 and 71 are located on footbridge or podium.

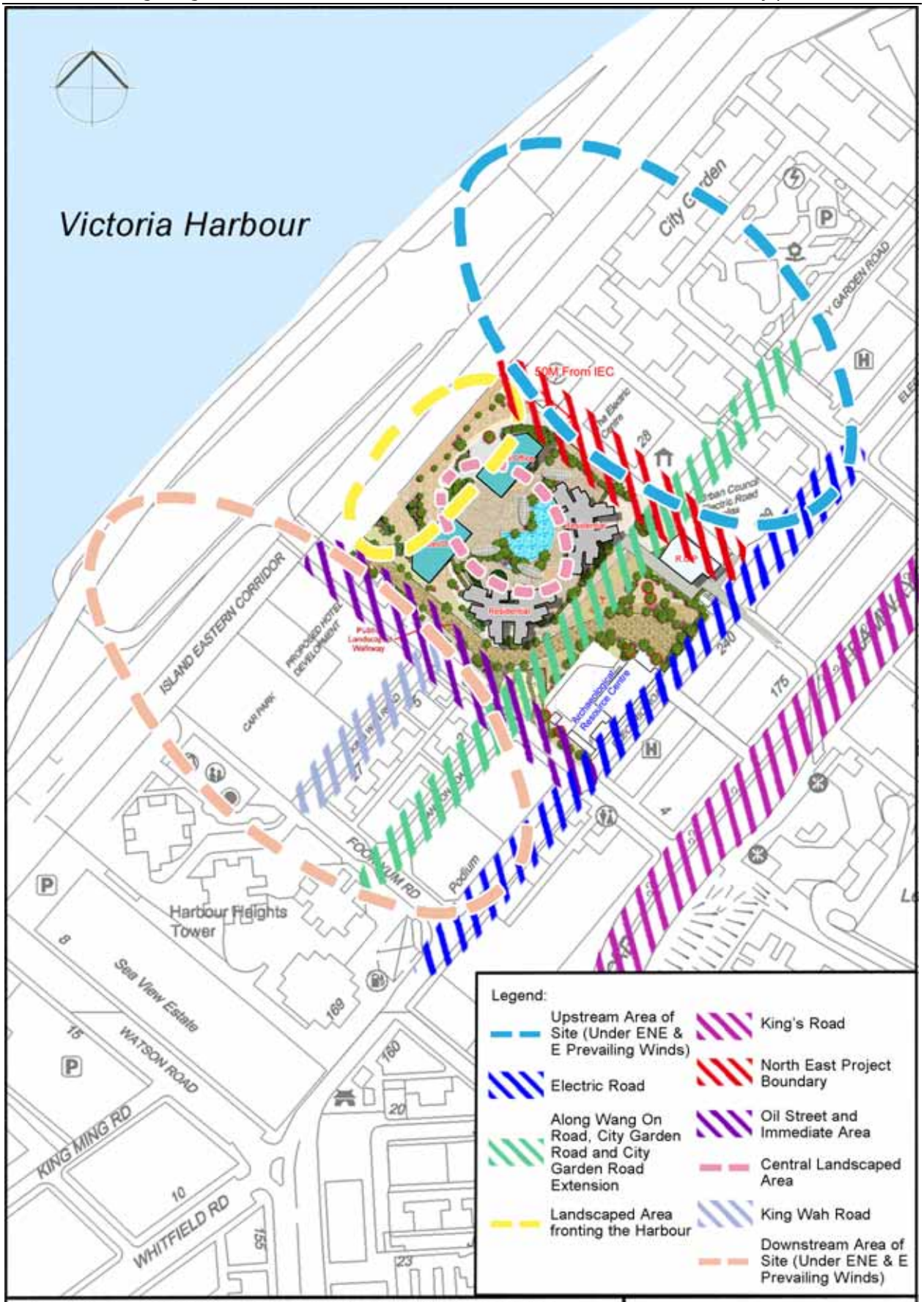
Title: **Location of Test Points for Revised Scheme**	CH2M HILL Hong Kong Limited
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 12**

Test Points at 07, 08, 63 and 71 are located on footbridge or podium.

Title: **Location of Test Points for Second Revised Scheme**	CH2M HILL Hong Kong Limited
Project: **Air Ventilation Assessment For Oil Street Site - Executive Summary**	**Figure: 13**



Title: Summary of Test Points Representation for the Base Scheme	**CH2M HILL HONG KONG LIMITED**
Project: Air Ventilation Assessment For Oil Street Site - Executive Summary	**Figure: 14**



Title: Summary of Test Points Representation For the Revised And Second Revised Schemes	**CH2M HILL HONG KONG LIMITED**
Project: Air Ventilation Assessment For Oil Street Site - Executive Summary	**Figure: 15**

4. SUMMARY OF RESULTS AND DISCUSSION

4.1 Site and Local Spatial Average Velocity Ratios

4.1.1 The SVR and LVR of the three design schemes are tabulated in **Table 1**. In addition, the average VR of the test points representing a specific road/street/area was computed and tabulated in the same table for discussion purpose (Figures 14 & 15).

Table 1 Summary of SVR, LVR and Average VRs of Other Areas

Design Scheme	**Base Scheme**	**Revised Scheme**	**Second Revised Scheme**
SVR	0.19	0.18	0.19
LVR	0.15	0.14	0.15
Average VR for			
King's Road and immediate area	0.14	0.14	0.14
Electric Road	0.13	0.12	0.13
City Garden Road, City Garden Road Extension and Wang On Road	0.14	0.13	0.13
King Wah Road	0.26	0.23	0.25
Fook Yum Road	0.14	0.14	0.14
Oil Street and immediate area	0.26	0.25	0.26
Northeast project boundary	0.16	0.10	0.15
Promenade	0.20	0.20	0.20
Waterfront to the southeast and under Island Eastern Corridor (IEC)	0.15	0.14	0.14
Central landscaped area on site	0.09	0.13	0.13
Landscaped area to the immediate north of Oil Street and Electric Road	0.12	0.10	0.11
Landscaped area fronting the harbour	0.22	0.18	0.17
Building gap between commercial or residential blocks on site	0.12	0.14	0.14
Upstream area of the project site (under prevailing northeast and east wind)	0.09	0.09	0.09
Downstream area of the project site (under prevailing northeast and east wind)	0.18	0.17	0.17

4.2 Discussions on Assessment Results

4.2.1 ***General Performance –*** Both the Base Scheme and the Second Revised Scheme perform the same in terms of SVR and LVR and are better than the Revised Scheme.

4.2.2 ***Wind Availability on the Surroundings Insensitive to the Change of Design Schemes -*** The variation of the design schemes does not result in any significant change in VR of the test points in the surroundings. The difference of the average VRs of the test points outside the project site (and excluding those along the project boundary) among all three schemes is insignificant despite the significant differences in terms of building height and disposition. The air ventilation

performance of test points located within the assessment area is more likely dictated by the immediate building configurations and is less impacted by the proposed development.

4.2.3 ***No Adverse Impact on the Surroundings -*** There is no indication that the proposed development would have significant blockage to air flow and adverse impacts on the air ventilation performance of the surrounding areas. The VRs of test points to the southwest and west of the project site, equivalent to the downstream area of the project site under prevailing east to northeast wind, are generally higher than those on the northeast and eastern sides of the project site (upstream areas under prevailing wind condition).

4.2.4 ***No Effective Breezeway along Prevailing Wind Direction within the Assessment Area -*** King's Road, Electric Road, City Garden Road, City Garden Road Extension and Wang On Road are aligned in parallel along the prevailing wind direction. While it is understood that carriageways along prevailing wind direction can generally help to maximise wind penetration through the district, the average VR along these carriageways is not particularly high and even slightly lower than the LVR. This suggests that these carriageways cannot serve effectively as a breezeway.

4.2.5 ***A Sufficiently Wide Separation Between Rows of Buildings will Form Wind Corridor -*** Oil Street and the immediate area are of higher VRs (0.25 to 0.26) when compared with the LVR. This demonstrates that a sufficiently wide separation between building blocks on both sides of Oil Street is effective to improve air ventilation. When VRs under individual wind directions are examined, it is found that VRs at test points along Oil Street under wind direction from WSW to NNE directions (with an angle span of 135 degree) are generally higher. It can be concluded that the carriageway opens to wind coming from these directions. Despite that north-westerly wind parallel to Oil Street occurs least frequently, the wind availability is still high.

4.2.6 ***Wind Availability along Northeast Project Boundary Reduced by Commercial Block -*** The individual test points at the northeast side of the project site for both Base Scheme and Second Revised Scheme were better than the Revised Scheme. This is because the commercial block is located closer to the northeast boundary of the project site under the Revised Scheme and has critical impacts on the nearby wind environment. Among the three design schemes, the closer the building is located near the north-east boundary, the lower ventilation performance is envisaged.

4.2.7 ***Building Gap between Commercial Blocks Allows Better Wind Availability at the Central Landscaped Area -*** For test points within the central landscaped area of the project site, both the Revised Scheme and Second Revised Scheme outperform the Base Scheme. The average VR of the test points within the central landscaped area for the Base Scheme is 0.09 whereas that of the Revised Scheme and the Second Revised Scheme amounts to 0.13. The provision of building gap can effectively improve the wind permeability of the central landscaped area between building blocks.

4.2.8 ***Impact of IEC and Associated Structures on Wind Availability -*** The promenade within the assessment area represents an open area with least influence of building morphology except under south-easterly wind. The average VR at the promenade is around 0.20. However, the average VRs for the areas under IEC and immediate areas behind the proposed administration buildings are lower (0.14-0.15). The highways and the associated building and structure, although limited in extent, will reduce wind availability.

4.2.9 ***Larger Open Area Beneficial to Air Ventilation -*** King Wah Road, with VRs of (0.23 to 0.26), is much higher than the LVR. It is likely that the nearby vacant waterfront site (a large open area) will enhance localised air ventilation performance.

4.2.10 ***Overall Performance -*** Taking into account the above analysis, whilst the three schemes are very similar in the overall air ventilation performance, the Second Revised Scheme, with wind corridors along the southwest and northeast boundaries and a higher wind permeability in the middle part of the project site, would allow greater flexibility for achieving a better wind environment in detailed design stage.

5. RECOMMENDATIONS AND CONCLUSION

5.1 General

5.1.1 The final design of the proposed development will be subject to a multitude of planning, urban design and environmental considerations such as building bulk and heights, setback and need of noise mitigation measures such as non-noise sensitive building/structure. This Study investigates the pedestrian wind environment and provides the necessary information for a balanced decision on the site planning and design. More importantly, it identifies design features beneficial to the wind environment through the iterative Detailed Study.

5.2 Recommended Design Features for Better Air Ventilation

Wind Corridors/Building Gap

5.2.1 In view that the project site is enclosed by dense and tall buildings on its three landward sides, the only effective source of wind for improving the ventilation of the site and area to its south is the wind from the harbour. It is therefore essential to provide effective wind corridors perpendicular to the waterfront. Three wind corridors are recommended at:

(a) Oil Street to capture and divert wind from a wide angle ranging from WSW to NNE wind directions. The high VRs at test points along Oil Street for all the design schemes demonstrate the effects;

(b) Northeast project site boundary (with setback of building) to allow wind penetration. This is demonstrated by the good performance of Base Scheme and the Second Revised Scheme; and

(c) Middle part of the project site by providing building gap between commercial blocks in alignment with the residential towers to increase the site permeability. The positive effect is demonstrated when comparing the VRs at the central landscaped area for the Base Scheme and the two Revised Schemes.

Amelioration of Excessive Wind Flow

5.2.2 High VRs are detected at several test points along Oil Street and other areas (test points 24, 55, 60, 74, 75, 77 and 81) under West to North wind directions.

5.2.3 To ameliorate excessive wind, it is suggested to plant trees with wide crown and dense foliation along Oil Street in the detailed design stage.