



香港房屋委員會
Hong Kong Housing Authority

Urban Micro-climate Study
Sharing of Hong Kong Housing Authority's Experience
at Kai Ching Estate

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Hong Kong Housing Authority

Technical Seminar and Launch Event for HKGBC Guidebook
on Urban Microclimate Study

16 January 2018



1.

簡介

Introduction

Public Housing Estates in Hong Kong

- Established in **1973**
 - one of the **largest** public housing programme in the World,
 - Adopt **functional** and **cost-effective** design;
 - Promote **healthy living** & **green** environment in work;
 - Act with **caring** and **partnering** culture
- 1973** 年成立;
 - 全球其中一項**最大**型的公營房屋計劃;
 - 採用合乎**實用性**及**經濟效益**的設計
 - 提倡**健康生活**和**綠色**工作環境
 - 以**關愛**和**夥伴**文化行事



756,000
flats in use
現存公營租住房屋單位



280,000
new rental & subsidized sale flats from 2017/18 to 2026/27
由2017/18至2026/27年度
新建公營租住及資助出售單位

2,140,000 (30%) population
(約三成) 人口

14,000+ workers daily 每日工人數量

99 listed contractors
已列入名冊的承建商

80+ active suppliers
有效供應商

9,000+ HA staff 房委會員工





To provide affordable rental housing to low-income families with housing needs, and to help low to middle-income families gain access to subsidised home ownership.

為有住屋需要的低收入家庭提供可以負擔的租住房屋，並透過推出資助出售單位協助中低收入家庭自置居所。



- To provide affordable quality housing, management, maintenance and other housing related services to meet the needs of our customers in a proactive and caring manner.
以積極進取、體恤關懷的態度，提供市民能力可以負擔的優質房屋，包括優良的管理、妥善的保養維修，以及其他房屋相關服務，以切合顧客的需要。
- To provide an age-friendly and barrier-free estate environment to address the needs of residents of different ages and physical ability.
致力締造長者宜居及無障礙的屋邨環境，照顧不同年齡及身體能力的居民的需要。
- To ensure cost-effective and rational use of public resources in service delivery and allocation of housing assistance in an open and equitable manner.
本着開明的態度、公允持平的立場，提供服務及房屋資助，確保公共資源得到合理的運用，符合成本效益。
- To maintain a competent, dedicated and performance-oriented team.
繼續建立能幹盡責、講求效率的工作隊伍。

Quality = Fitness for Purpose

優質

實而不華

People-centric approach 以人為本



4Cs Core Values

基本信念

關懷為本

Caring

顧客為本

Customer-focused

創新為本

Creative

盡心為本

Committed



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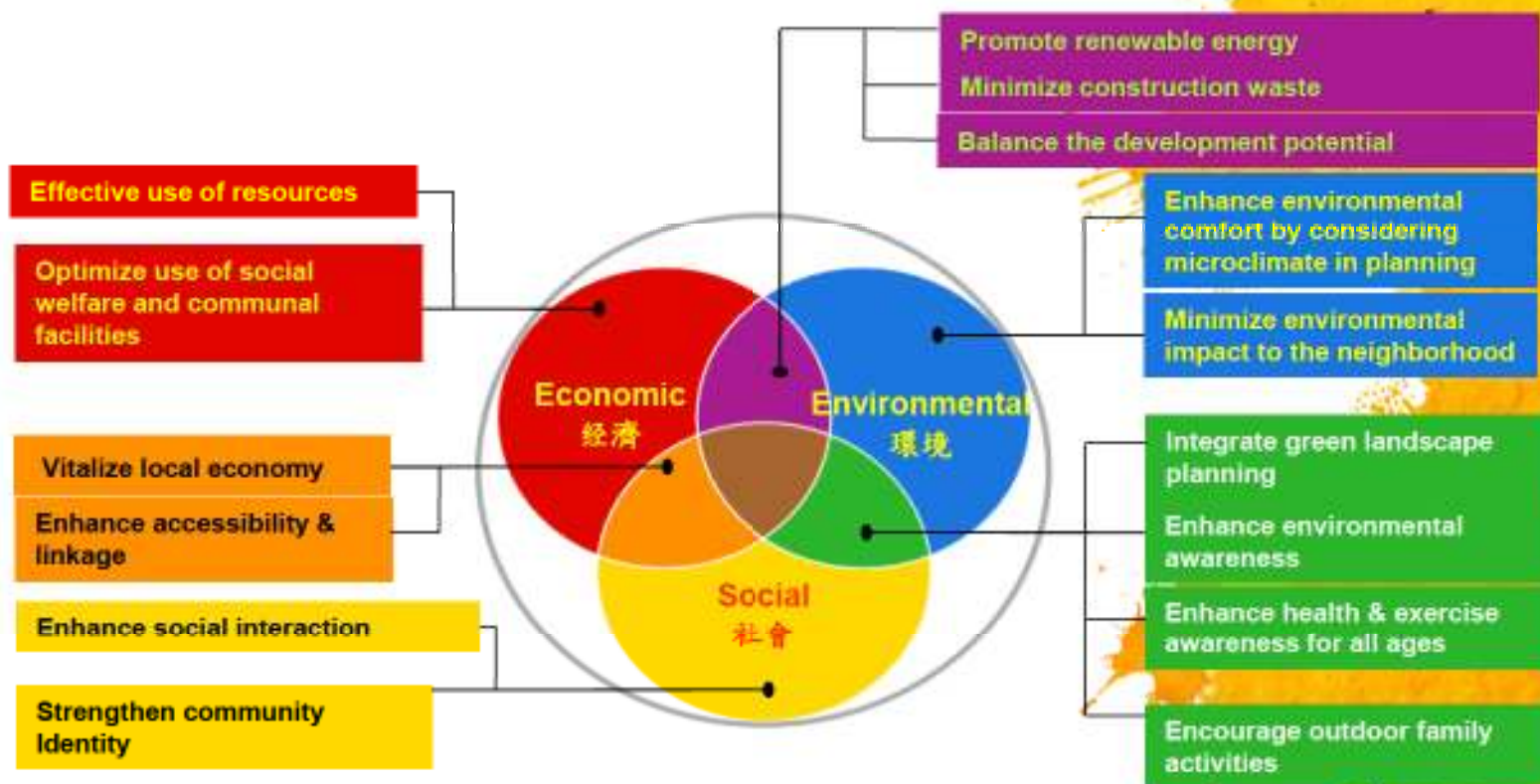
Hong Kong Housing Authority

Building a Sustainable Community

構建一個可持續發展的社區

To meet present social, economic and environmental needs but NOT at the expense of future generations.

滿足目前的社會，經濟和環境方面的需要，**但**不能以犧牲後代為原則。



Caring, Committed, Creative, Customer-focused

關懷為本

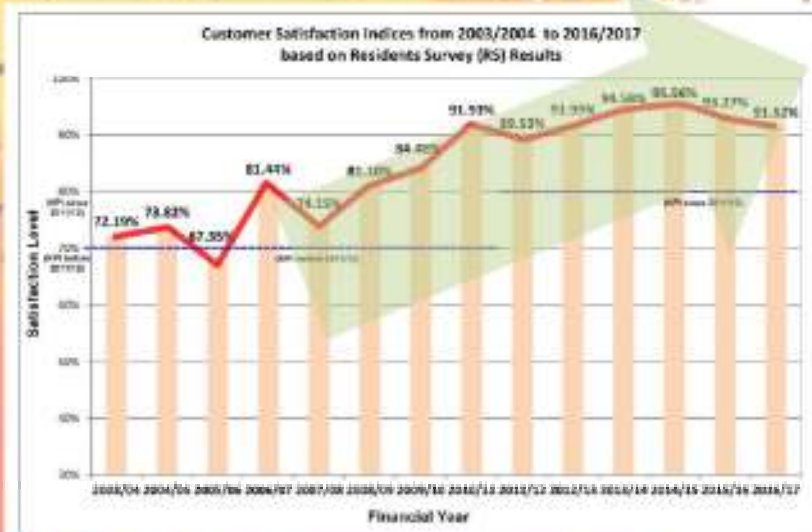
盡心為本

創新為本

顧客為本

We are committed to achieving **"SMARTER and better public HOUSING design in the 21st Century HONG KONG"** as we truly believe **"Living in Harmony"** and a people-centric approach.

我們真誠相信“和諧共處”及以人為本，致力實現“廿一世紀香港 更有智慧，更優質的公營房屋設計”。



High Customer satisfaction index

in last 5 years

顧客滿意指數

過去五年

>90%



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Hong Kong Housing Authority

Background

- **In 2001**, Hong Kong Housing Authority piloted the use of Micro-climate Studies with the Open Design Competition for Shui Chuen O .
- After the outbreak of SARS in 2003, **all new public housing projects have adopted Micro-climate Studies since 2004.**
- **Over 100 projects have now adopted the Micro-climate studies.**



HKIA Special Architectural Award **2006**



HKIP Annual Award **2007**



Green Building Award **2008**



CIOB International Innovation and Research Award **2009**

Process of Micro-climate Studies

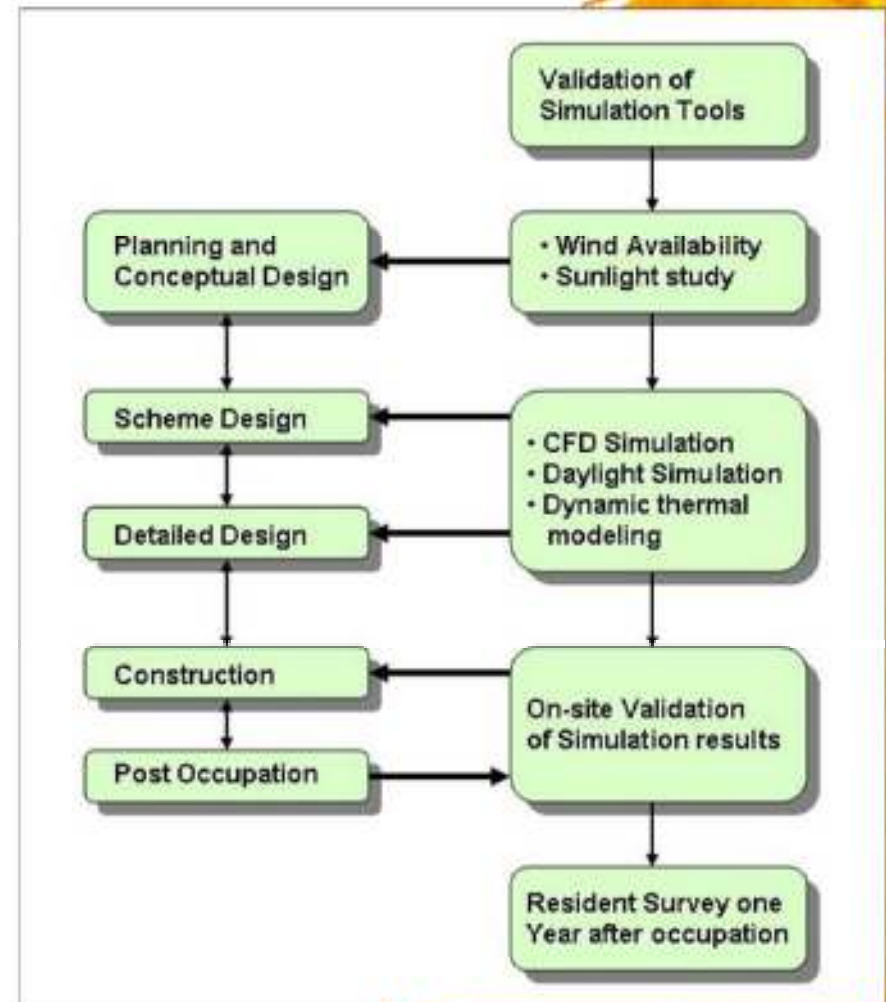
1. Simulation at Planning & Design Stage –

Involve application of **proven** scientific technologies, including **Computer Simulation by calibrated software**, to compare different design options with topics including:

- Wind Environment
- Natural Ventilation
- Daylight and Sun-shading
- Solar Heat Gain etc.

2. Validation at Post Occupation Stage

- On-site measurement** upon building completion
- Resident Survey** one year after occupation

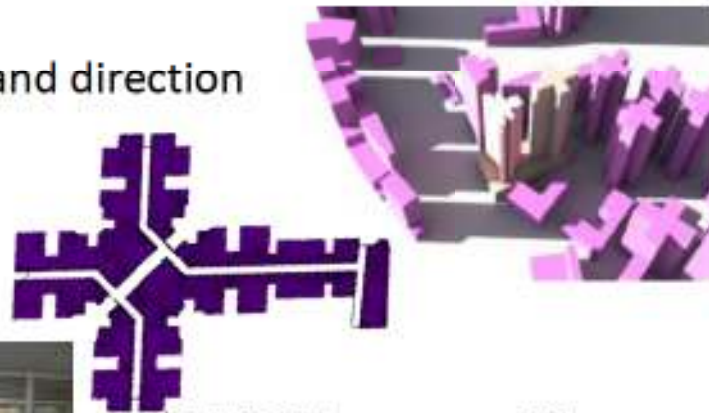


Fine Calibration of Computer Software for Simulation

Fortune Estate & Aldrich Bay Phase 5

CFD simulation

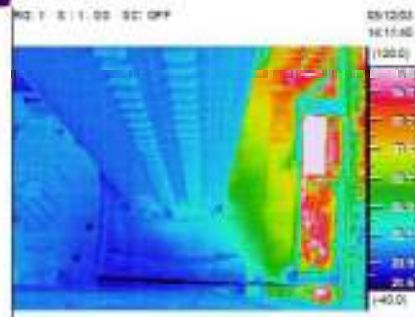
- External wind profile and direction
- Turbulence intensity
- Turbulence modeling



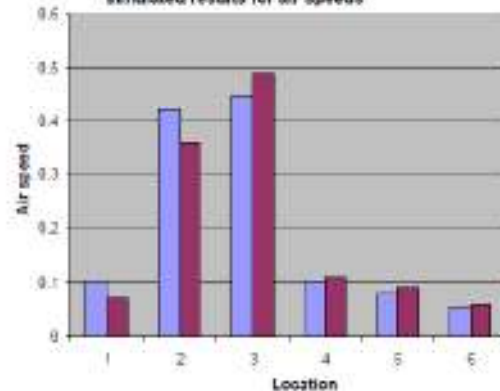
CFD model



On-site Measurement



Comparison of the measured data and computer simulated results for air speeds



Floor	Measurement Point	Computer simulated DF by Radiance	Measured DF	Discrepancy (%)
5F	1	7.00	9.06	22.91
	2	2.90	3.20	9.34
	3	2.73	2.31	16.02
	4	7.26	7.03	3.34
	5	3.47	4.34	19.91
	6	7.91	6.97	13.42
	7	6.26	5.24	16.40
Average discrepancy				15.19
20F	1	8.14	9.87	17.50
	2	2.94	3.67	19.92
	3	3.12	2.53	23.25
	4	7.22	7.70	6.24
	5	4.42	5.02	11.95
	6	10.43	9.61	6.30
	7	7.35	6.72	9.43
Average discrepancy				13.52
36F	1	7.25	8.91	18.64
	2	2.90	3.71	21.77
	3	2.99	3.20	6.72
	4	7.26	7.43	2.27
	5	7.30	8.31	12.15
	6	10.65	9.05	17.67
	7	7.16	8.88	19.28
Average discrepancy				14.07
Overall average discrepancy				14.26

On-site Measurement upon Building Completion

Parameter	Instrument	Range	Accuracy
Air temperature	Hobo logger	-20 to 70 °C	± 0.1 °C
Relative humidity	Hobo logger	25% - 95%	± 3.5%
Wind speed	R.M. Young U-V-W anemometer 81000	0.01 – 30 m/s	± (1% + 0.05 m/s)
Globe temperature	IEQ analyzer (developed by PolyU)	-50 to 50 °C	± 0.1 °C
Lux	Lutron LX-102	0 – 50000 lux	± 1 lux
Total solar intensity	Middleton pyranometer model SK-08	0 – 2000 W/m ²	± 2.5%

Instrument List for Ground Floor Level Measurement Points



Typical mobile environmental measurement rig setup

Resident Survey – one year after occupation

Kai Ching Estate		
Item	Areas	Survey Findings (Satisfactory Rating)
(a)	Overall satisfaction levels of the “Estate as a whole”	93%
(b)	Pedestrian wind environment at the External Areas	Over 95% Main entrance of the block (96.1%), Covered walkways (99.3%), Outdoor leisure areas (99.5%) Children’s playgrounds (99.5%)
(c)	Planning and Design of Domestic Blocks	90%
(d)	Natural lighting and ventilation in the public areas inside blocks	90%
(e)	Greenery and soft landscaping design	85%

Satisfactory rating above 80% is well acceptable.



2.

Urban Micro-climate Study
Kai Ching Estate

Kai Tak Airport in the old days

Serving as an icon for 77 years



Kai Ching Estate retains Heritage image of Kai Tak



The Kai Tak Development

Kai Tak development is a huge and highly complex project spanning **320 hectares**. It offers quality living environment for around **86,000 residents**, revitalizes surrounding districts and cultivates a comprehensive network of parks and gardens.



Kai Ching and Tak Long Estate

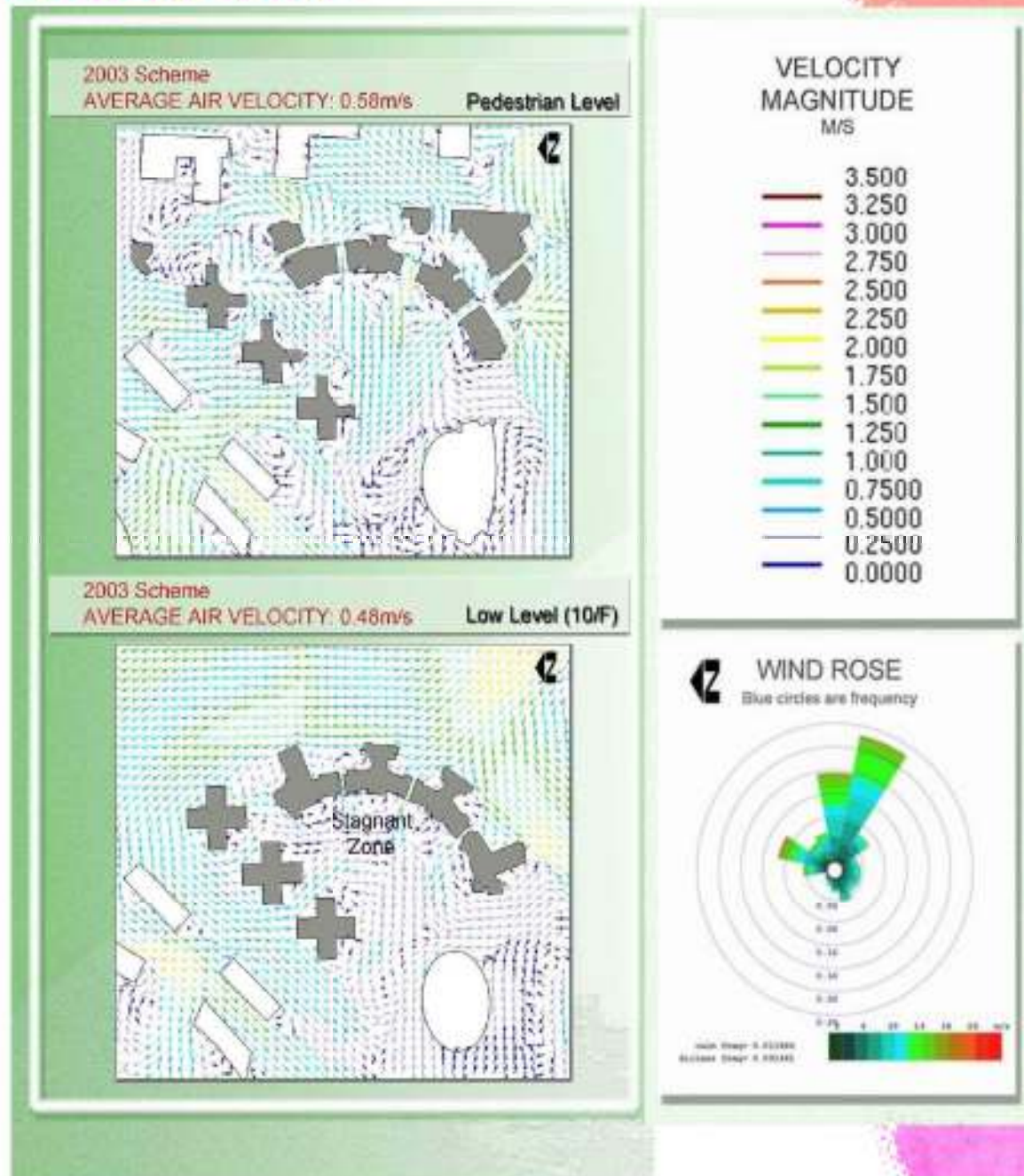
Theme – “Homes in the Park”



The two estates, namely **Kai Ching Estate** (6 blocks) and **Tak Long Estate** (9 blocks), are public rental housing estates with **total site area of 9.1 hectares** providing about **13,300 flats** for **34,000 residents** in **15 domestic blocks**. **Domestic Plot Ratio** is up to **6.3**. Population intake was completed in **February 2014**.

Site Constraints of Kai Ching Estate

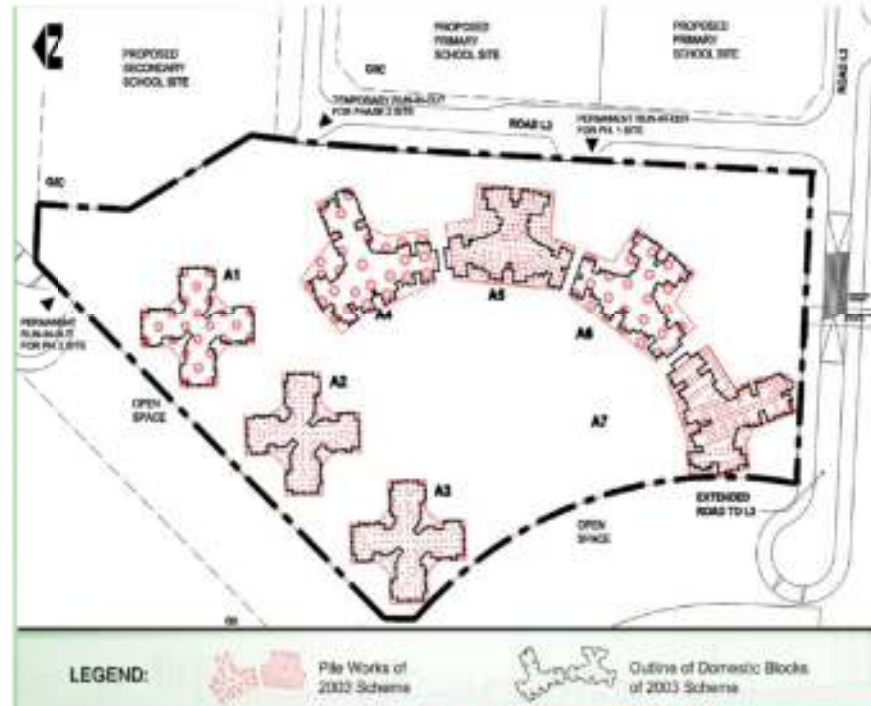
- The site was originally planned for **Home Ownership Scheme (HOS)** development with foundation works completed before 2003.
- After the suspension of HOS development in 2002, **the site was developed into Public Rental Housing based on the as-built foundation works** for the previous scheme design with less desirable urban micro-climatic conditions.
- **Over 70% of the existing piles were reused.**



Kai Ching Estate

Over 70% of the existing piles were reused.

Original Master Layout *before* 2003



- Site Area : 3.47 hectares
- Plot Ratio (Domestic): 6.39
- Greening Ratio : 30%
- Flat Production : 6,200

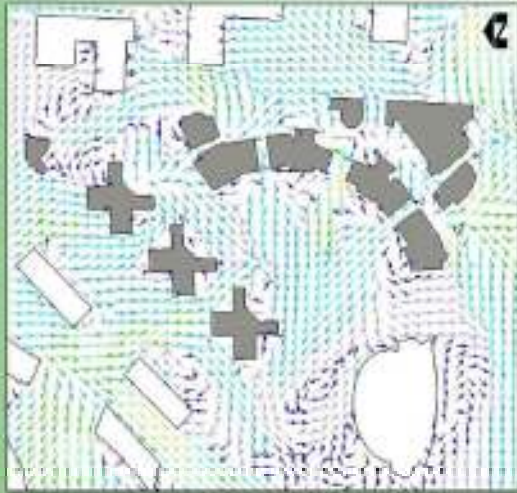
Refined Master Layout *after* 2003



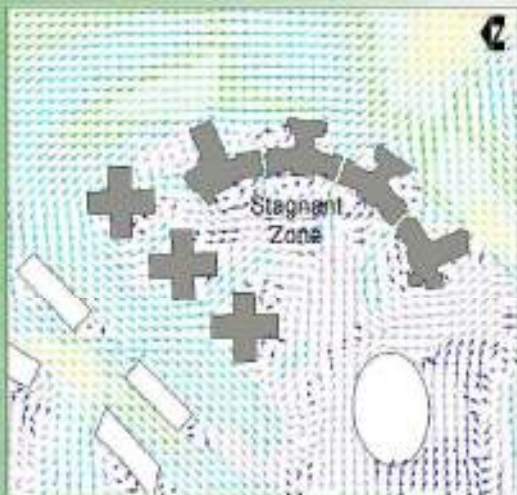
Refined Design based on Urban Micro-climate Study

Original Design

2003 Scheme
 AVERAGE AIR VELOCITY: 0.58m/s Pedestrian Level

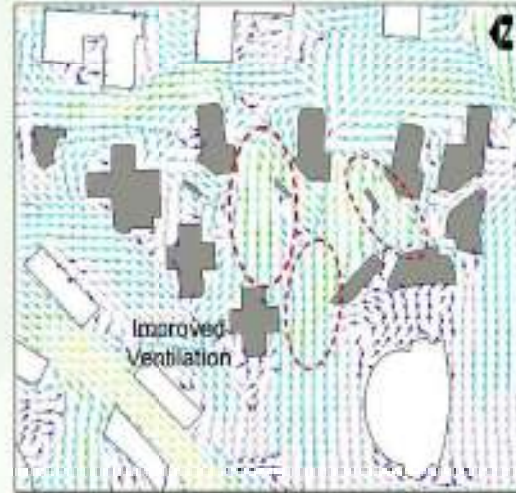


2003 Scheme
 AVERAGE AIR VELOCITY: 0.48m/s Low Level (10/F)

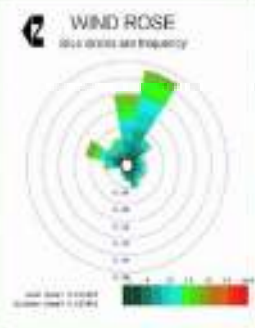
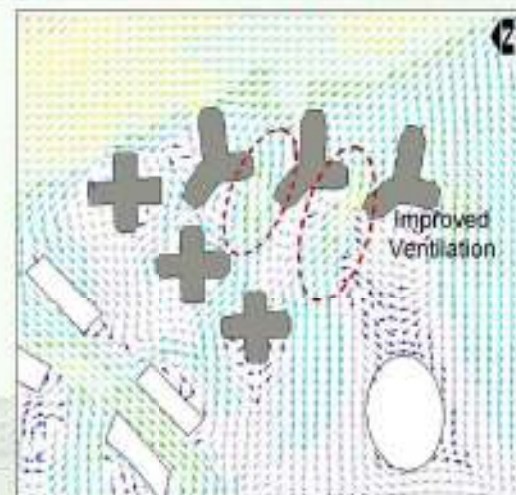


Refined Design

Proposed Scheme
 AVERAGE AIR VELOCITY: 0.80m/s Pedestrian Level
 + 37.9% Compare to 2003 Scheme



Proposed Scheme
 AVERAGE AIR VELOCITY: 0.78m/s Low Level (10/F)
 + 62.5% Compare to 2003 Scheme



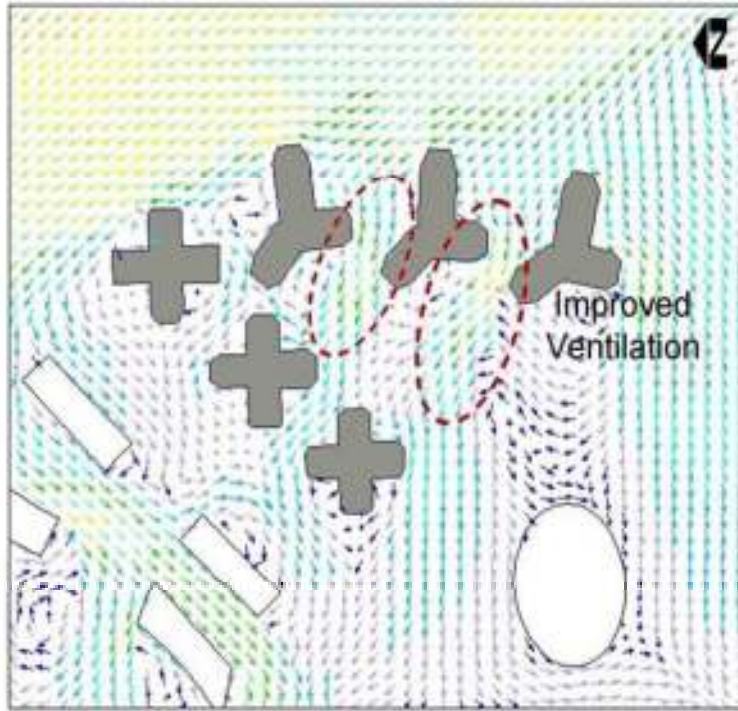
COMPARISON OF VENTILATION EFFECTIVENESS

Urban Micro-climate Design Strategies

Out of the **31 nos.** urban micro-climate design strategies, Kai Ching Estate has incorporated **18 nos. with Residents Satisfactory Rating up to 93%**.

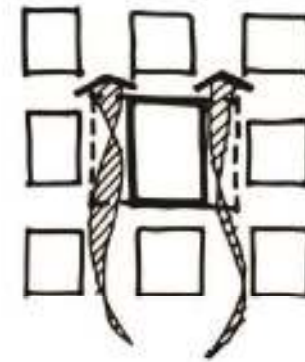
Kai Ching Estate		
Wind		
Increase ventilation with site planning		
1	Manipulate layout massing to increase wind flow	▪
2	Wind corridor to align with the prevailing wind	▪
3	Connect open spaces	▪
4	Arrange buildings to channel wind	▪
5	Building setback (adopted in planning terms)	
6	Increase permeability of building blocks / no wall buildings	▪
7	Stepped building height profile (stepped by H/2 demands large site area)	
Increase ventilation with building design		
8	Increase building permeability (building permeability optimized)	
9	Permeable sky garden (users' preference in resident survey)	
10	Reduce building frontage (optimization for domestic use)	
11	Ventilation bay / permeable podium	▪
12	Reduce ground coverage (ground coverage minimized without podium)	
13	Increase ground zone air volume (ground level permeability optimized)	

Urban Micro-climate Design Strategies



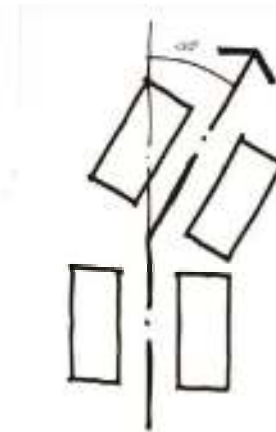
Strategy 1

Manipulate layout massing to increase wind flow



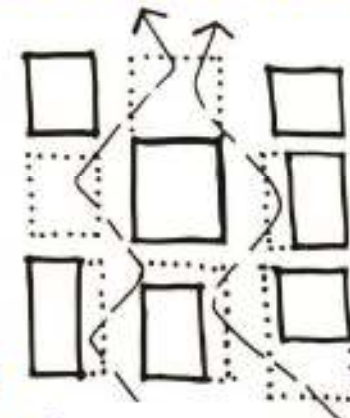
Strategy 2

Wind Corridor to align with the prevailing wind



Strategy 3

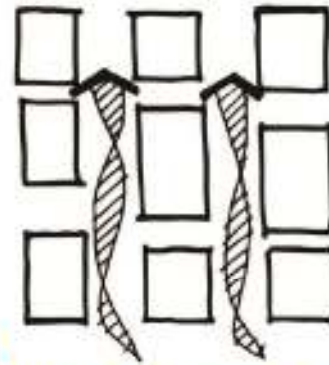
Connect Open Spaces



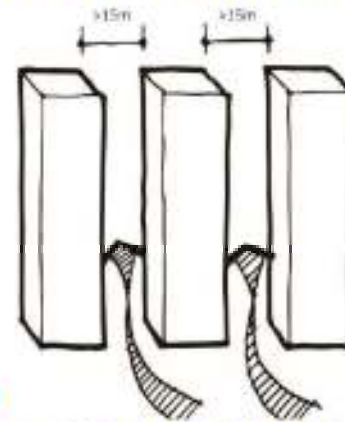
Urban Micro-climate Design Strategies



Strategy 4
Arrange buildings to channel wind



Strategy 6
Increase permeability of building blocks / no wall buildings

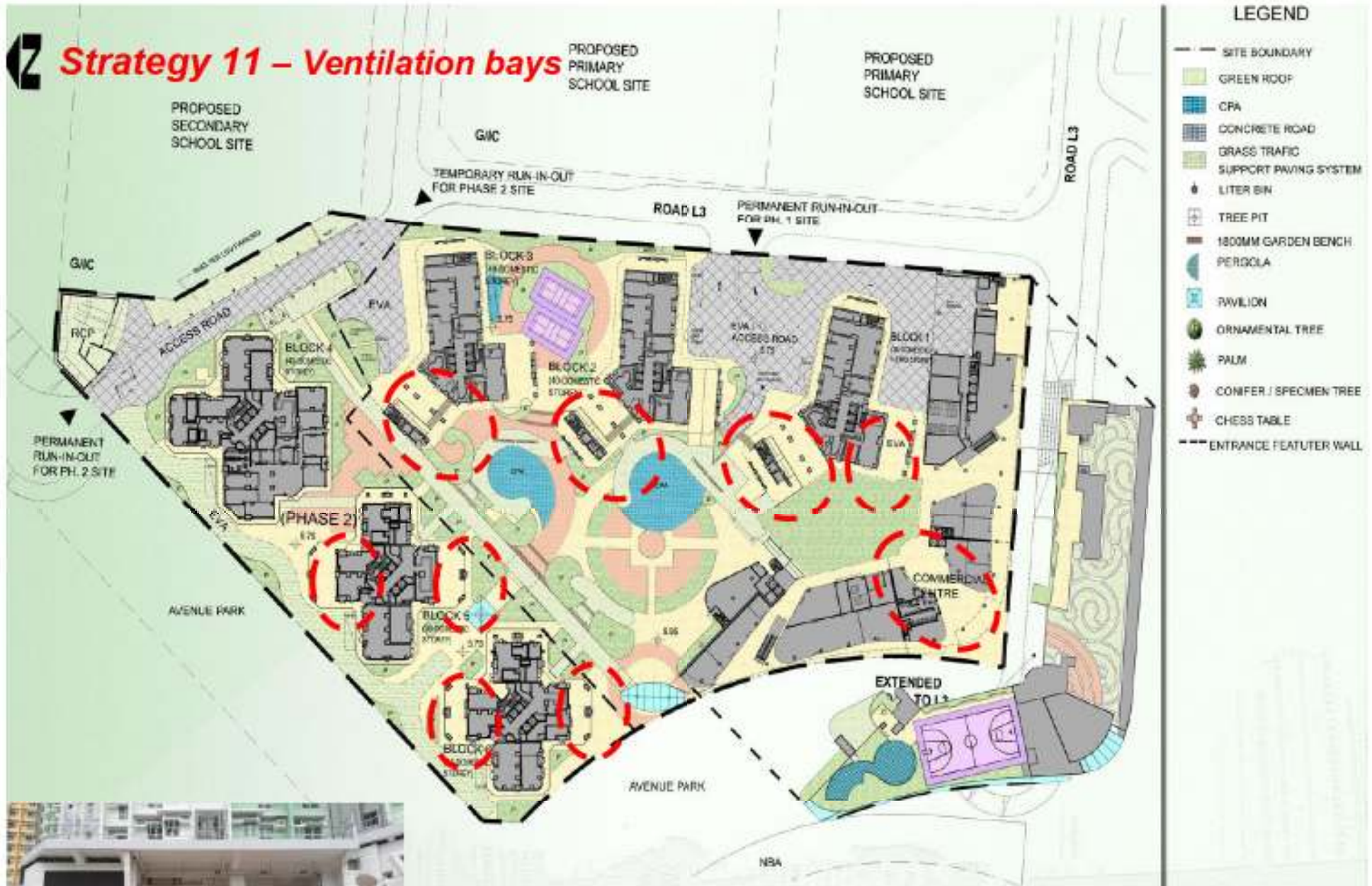


Strategy 11
Ventilation bay / permeable podium





Strategy 11 – Ventilation bays

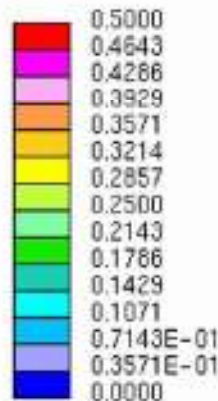


Ground Floor Ventilation Bays to enhance Wind Environment at Pedestrian Level

Computer Simulation Result of the Urban Micro-climate Conditions



VELOCITY RATIO (VR)



SVR & LVR of the Proposed Scheme

Site Spatial average Velocity Ratio (SVR) 0.18
 Local Spatial average Velocity Ratio (LVR) 0.16

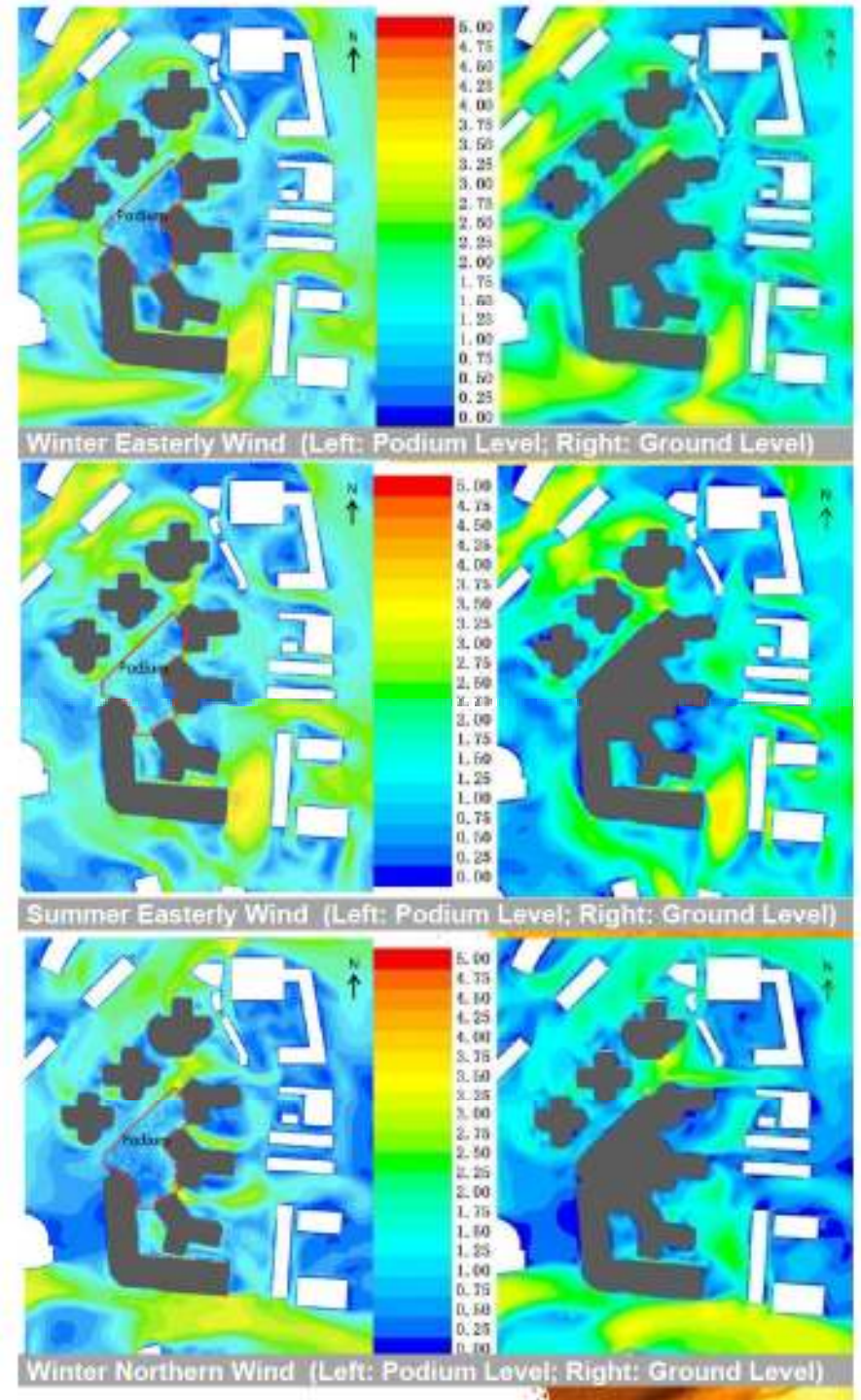
Average Velocity Ratio of the Focus Areas

Rhythm Garden 采頤花園	0.13
Choi Hung Estate 彩虹邨	0.12
Ping Shek Estate 坪石邨	0.16
Richland Gardens 麗晶花園	0.13

Velocity Ratio for the Proposed Scheme at pedestrian level (2m above ground)

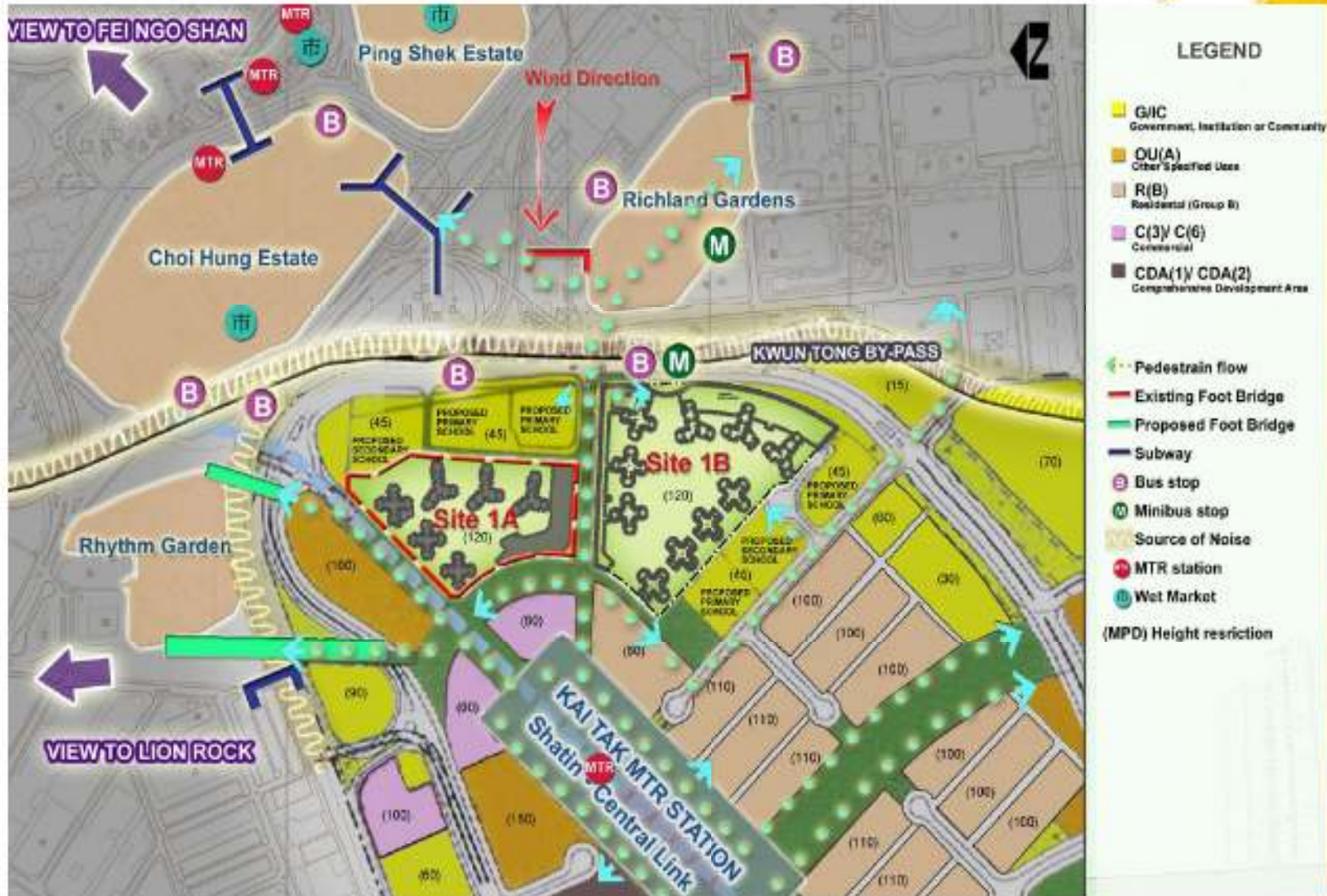
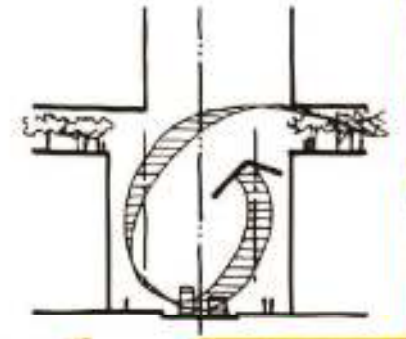
Computer Simulation Result of the Urban Micro-climate Conditions

Wind Direction	Pedestrian Level Wind Speed (≤ 5 m/s)
Summer Easterly Wind (Max.)	3.00 m/s
Winter Northern Wind (Max.)	2.93 m/s
Winter Easterly Wind (Max.)	3.00 m/s
Summer Easterly Wind (Average)	1.73 m/s
Winter Northern Wind (Average)	1.61 m/s
Winter Easterly Wind (Average)	1.73 m/s

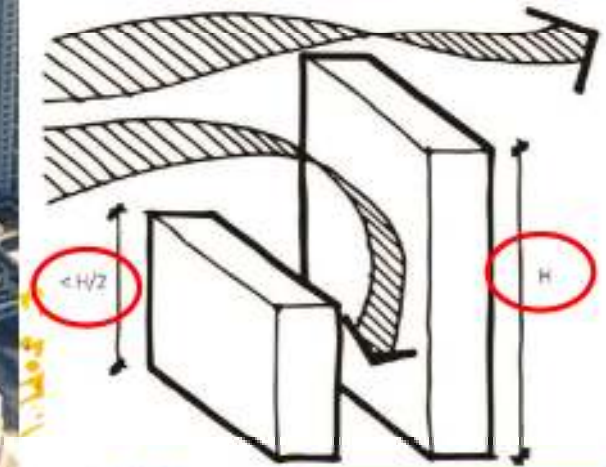


Strategy 5 – Building Setback (not implemented)

The Site has been **set back** and surrounded by **schools** and **district open spaces** as **buffering zones**.



Strategy 7 – Stepped Building Profile (partly implemented)



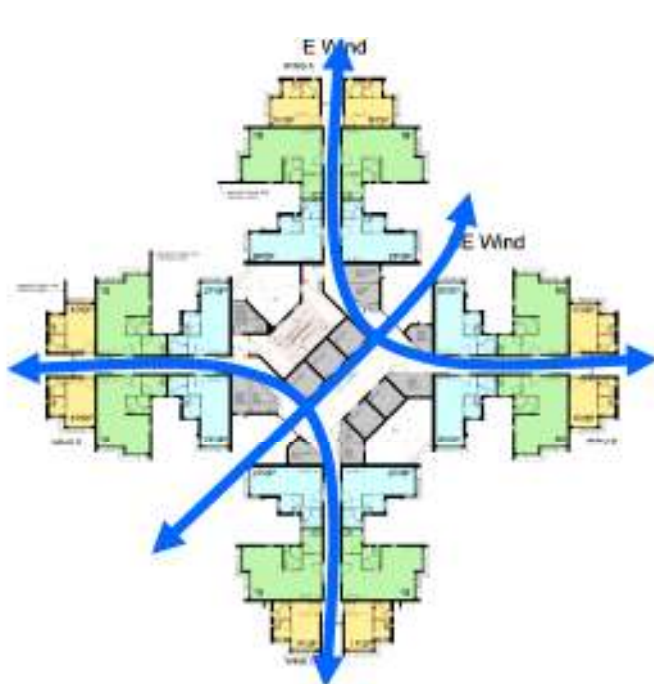
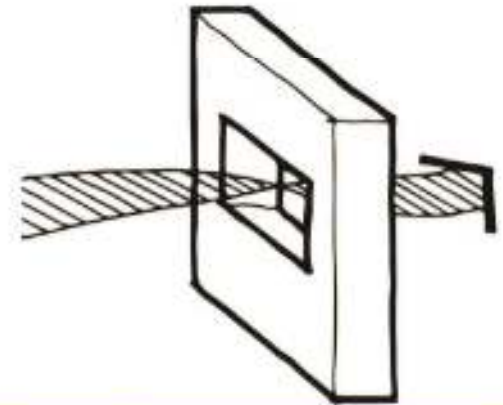
This strategy may not be applicable to all building development sites.

Recommendation:

Stepped Building profile can better be applied in urban planning scale through **statutory maximum height limit** imposed for individual sites.

Strategy 8 – Increase Building Permeability (partly implemented)

- For **passive design approach** in **low cost public housing developments**, we optimize the **natural cross ventilation** for **typical lift lobbies** and **corridors**.
- *Big opening in Building Block may suit better for building developments with active design approach.*

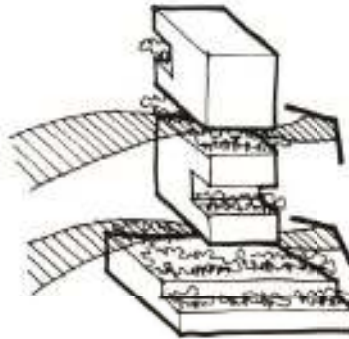


Natural ventilation performance rates in domestic flat - 7.3 – 13.7 Air Change per Hour (ACH)

Natural ventilation performance rates in corridor and lift lobby: 8.3 – 18.3 ACH

Strategy 9

Permeable Sky Gardens
(not implemented)



Strategy 10

Reduce Building Frontage
(partly implemented)



According to Resident Survey :

- Favourable micro-climatic conditions for *sky gardens at upper floors are limited to summer and autumn months*;
- Green roofs/gardens at upper floors of the domestic blocks attracts *mosquito problem*, which adversely affects the residents of the nearby flats;
- *Podium roof gardens* are acceptable which *should better be integrated with ground level open spaces*

- *Master Layout with block configurations following prevailing wind direction to enhance wind penetration*



2-STOREY HIGH COVERED
LANDSCAPE GARDEN

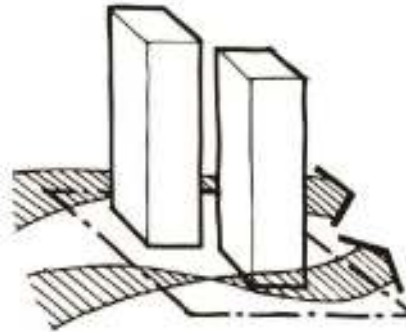
GROUND LEVEL GARDEN



Strategy 12

Reduce Ground Coverage
(partly implemented)

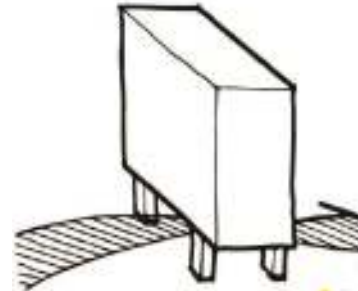
- We have optimized ground coverage and avoid large podium design underneath domestic blocks to enhance wind penetration.



Strategy 13

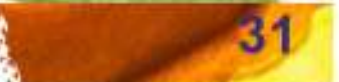
Increase Ground Zone Air Volume
(partly implemented)

- We have designed various ventilation bays at ground level to increase ground zone air volume.
- This site is specifically surrounded by district open spaces to enhance the air penetration volume.





Urban Micro-climate Design Strategies

Thermal Radiation	
Reduce direct solar radiation	
14	Provide shading for pedestrian activities
15	Provide tree canopies
16	Manipulate building façade design to provide shading
17	Shade open space by building blocks
Reduce surface temperature	
18	Use cool material for ground surface
19	Green wall to reduce façade surface temperature
20	Increase albedo in buildings
21	Increase sky view to improve night cooling (Design Optimized)



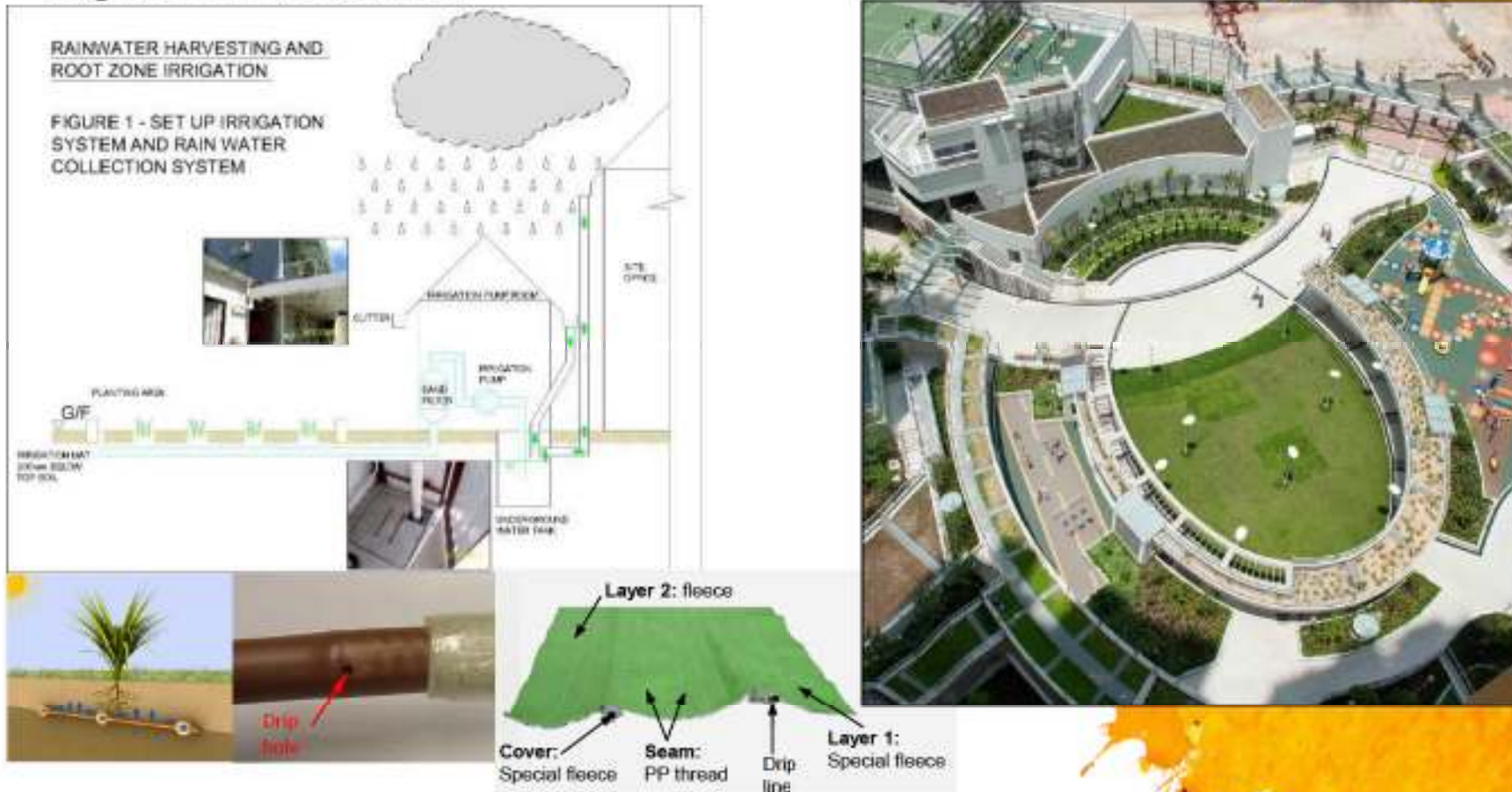
Urban Micro-climate Design Strategies

Temperature		
Increase Evaporative cooling		
22	Water features to increase evaporation (<i>Resident Survey</i>)	
23	Green wall to increase evapotranspiration	▪
24	Greening to increase evapotranspiration	▪
25	Use permeable paving 	▪
Reduce heat accumulation		
26	Increase ventilation to carry away heat energy (<i>Design optimized</i>)	
27	Allow downhill wind flow (<i>not applicable for this flat site</i>)	
28	Allow sea breezes (<i>Design optimized</i>)	
Reduce heat release		
29	Reduce anthropogenic heat discharge near pedestrian area	▪
30	Reduce thermal mass heat storage of building materials (<i>Not applicable for low cost housing</i>) 	
Precipitation		
Provide Rain protection		
31	Provide cover for rain protection	▪



Strategy 25 - Use permeable paving

Rainwater Harvesting System helps reduce fresh water consumption by providing filtered rainwater for irrigation while **Root Zone Irrigation System** supplies water directly to plant roots. Evaporation of water can thus be minimized and the amount of irrigation can be reduced.



Water Saving by adopting Rainwater Harvesting System
= **around 20%** during rain season

Homes In The Parks 一個可持續發展的社區



China Green Building label
中國綠色建築標識
三星級別 2014

HK-BEAM Provisional Platinum 2010
HK-BEAM Provisional Platinum 2012 (Phase 1 & 2)
香港建築環境評估
(商場及停車場)
白金級 2010
香港建築環境評估
(發展計畫一期及二期)
白金級 2012

Green Building Award 2012
Grand Award
環保建築大獎
2012



3.

總結與展望

Conclusion

&

Way Forward



Impact of Climate Change

2016 - New Record for **Highest**
Global Average Surface Temperature

22 August 2017
The Hottest Day in
Hong Kong Since 1885



36.6°C



	Max. Wind Speed (km/h)	Formation Date	Dissolved Date	
Hato 天鴿	190 (強烈颱風)	20 Aug 2017	24 Aug 2017	Super Typhoon Damaged Macau seriously

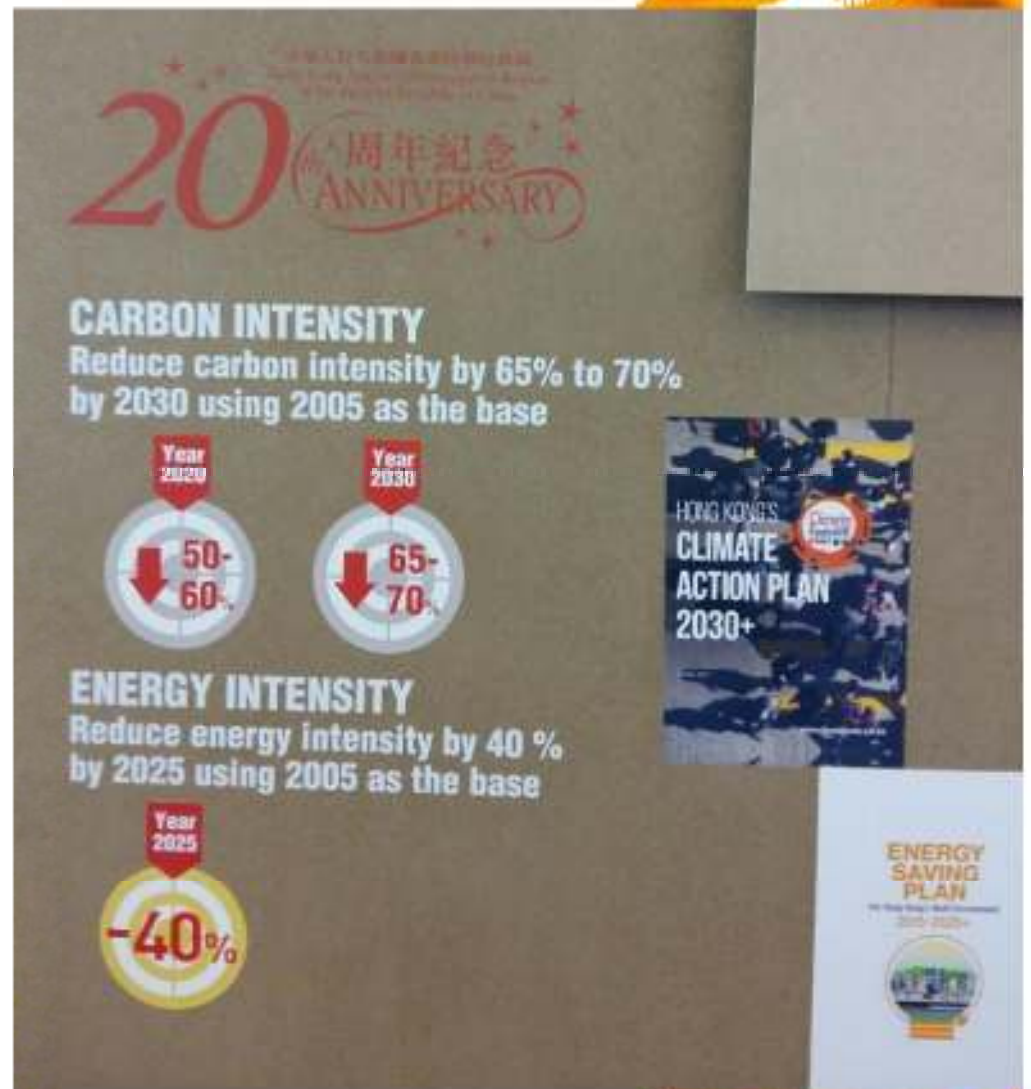
International Effort to combat Climate Change

In December 2015, 195 countries, including China, adopted the Paris Agreement with a view to containing global temperature rise to well below 2°C compared with pre-industrial times, while striving to limit it even to 1.5°C.

The Paris Agreement, already came into force in November 2016, and applies to Hong Kong as well.

The HKSAR Government sets a target to reduce our carbon intensity by 65 – 70% by 2030 compared with the 2005 level.

Adoption of the Urban Micro-climate Strategies is one of the means for reducing carbon footprint.



Community Engagement

We have conducted **Green Delight in Estates** community educational programme since 2005.

- Green Living Carnivals, Eco- workshops, Green Days, Organic Farming Days



- EstateTree Ambassadors programme since 2010

Community Educational Programme

- Partnership with mass media



- Environmental corporate video

- Eco-Expo



- Community educational activities e.g.

綠樂無窮在屋邨、屋邨是我家 減廢靠大家



- Website (i.e. Green Living Website) & publications



- Community engagement workshops

Caring, Committed, Creative, Customer-focused

關懷為本

盡心為本

創新為本

顧客為本

We are committed to achieving "SMARTER and better public HOUSING design in the 21st Century HONG KONG" as we truly believe "Living in Harmony" and a people-centric approach.

我們真誠相信“和諧共處”及以人為本，致力實現“廿一世紀香港 更有智慧，更優質的公營房屋設計”。



High Customer satisfaction index in last 5 years
顧客滿意指數過去五年 >90%



Thank you!