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ACE Paper 17/2023
For discussion on 4 September 2023

Review of Air Quality Objectives (AQOs)

PURPOSE

This paper serves to report to Members the findings on the review of the Air Quality Objectives (AQOs) and seeks their views on the recommendations and the way forward.

THE REVIEW

2. Under Section 7A of the Air Pollution Control Ordinance (Cap. 311) (APCO), the Secretary for Environment and Ecology (SEE) is required to review the AQOs at least once every five years and submit to the Advisory Council on the Environment (ACE) a report of the review.

3. The Government has embarked on this round of review of the AQOs to be completed by the end of 2023. The AQOs Review Working Group[1] established for the current review has endorsed the review findings in May 2023. The report on the review is at **Appendix 1**.

PROPOSED TIGHTENING OF THE AQOS

4. We propose in the current AQOs review the following updates of the AQOs:

(a) tighten the 24-hour AQO for sulphur dioxide (SO_2) from Interim Target-2 (IT-2) level (50μg/m^3) of the World Health Organisation's (WHO) Global Air Quality

[1] The AQOs Review Working Group, led by the Under Secretary for Environment and Ecology, has been set up to engage stakeholders and gauge their views on the current review. The Working Group deliberated on air quality improvement measures with substantial emission reduction impacts, and evaluated the scope for tightening the AQOs having regard to the findings of the air quality and health and economic impact assessments.

Guidelines (AQGs) to AQG level (40μg/m^3) with the current number of exceedances allowed (three) remains unchanged;

(b) tighten the annual AQO for respirable suspended particulates (RSP/PM_{10}) from IT-2 (50μg/m^3) to IT-3 (30μg/m^3); and its 24-hour AQO from IT-2 (100μg/m^3) to IT-3 (75μg/m^3) with the number of exceedances allowed (nine) remains unchanged;

(c) tighten the annual AQO for fine suspended particulates (FSP/$PM_{2.5}$) from IT-2 (25μg/m^3) to IT-3 (15μg/m^3); and its 24-hour AQO from IT-2 (50μg/m^3) to IT-3 (37.5μg/m^3) with the number of exceedances allowed decreased from the current 35 to 18;

(d) add three new AQO parameters introduced by the WHO (namely the 24-hour AQO for nitrogen dioxide (NO_2) and set at IT-1 (120μg/m^3) with a number of exceedances allowed at nine; the peak season AQO for ozone (O_3) and set at IT-1 (100μg/m^3); the 24-hour AQO for carbon monoxide (CO) and set at AQG level (4 000μg/m^3) with no exceedance allowed).

TRANSITIONAL ARRANGEMENT FOR INTERFACING BETWEEN NEW AQOS AND PROJECTS SUBJECT TO ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

5. Under the Environmental Impact Assessment (EIA) Ordinance (Cap. 499), approval of EIA reports and issue of Environmental Permits (EPs) by the Director of Environmental Protection have to make reference to the prevailing AQOs at the time when he makes his decision. We propose to provide a transitional period of 36 months in the current round of tightening, as in the case of the tightening of the AQOs in 2022. That is, for DPs with EPs granted before the commencement of the new AQOs, the new AQOs will not apply to an application for variation of EP submitted within 36 months of the commencement of the new AQOs.

6. To underscore the Government's continuous commitment to adopting the best practices, we have already suggested that Government projects for which EIA studies have not yet been commenced should endeavour to adopt the proposed AQOs as the benchmark for conducting air quality impact assessment under the EIA studies as far as practicable from the time when the Government makes a decision to update the AQOs. Similar practice was adopted in the last AQOs review.

WAY FORWARD

7. A 2-month public consultation has been launched on 31 August 2023 to tap public views on the proposed tightening of the AQOs. After completing the public consultation, we shall report to the Panel on Environmental Affairs of the Legislative Council (LegCo) on the outcome of the public consultation; and accordingly prepare to amend the APCO with a view

to introducing an APCO amendment bill to the LegCo in 2024 and implement the new AQOs in January 2025.

ADVICE SOUGHT

8. Members are invited to comment on the recommendations set out in paragraphs 4 and 5 above.

Environment and Ecology Bureau
August 2023

Appendix 1

Report on the Review of Air Quality Objectives

This report sets out the background, process and outcome of the review of the Air Quality Objectives (AQOs), conducted pursuant to section 7A of the Air Pollution Control Ordinance (APCO) (Cap. 311) and endorsed by the AQOs Review Working Group (the Working Group) in May 2023.

BACKGROUND

World Health Organisation's Air Quality Guidelines and Interim Targets

2. In September 2021, the World Health Organisation (WHO) has promulgated the updated Global Air Quality Guidelines (AQGs) and their Interim Targets (ITs) for various key air pollutants including respirable suspended particulates (RSP/PM_{10}), fine suspended particulates (FSP/$PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and carbon monoxide (CO), based on a wealth of studies on the effects of air pollution on health. The latest WHO AQGs included much more stringent limits compared with the previous edition, and introducing three new parameters, namely the peak season level for O_3[2], 24-hour level for NO_2 and 24-hour level for CO.

3. It is important to note that the WHO AQGs do not serve as suggestion of legally binding standards. Furthermore, the WHO AQGs state that in considering air quality standards, *"other features such as legal aspects, cost–benefit or cost–effectiveness may also be examined ... These can be considered during the standard-setting process or when designing appropriate measures to control emissions. This process may result in the establishment of ... less stringent interim standards to be achieved within shorter periods of time."*. Indeed, the setting of ITs for air pollutants serves as incremental steps in progressive reduction of air pollution.

Guiding Principles of the AQOs Review

4. Having regard to the recommendations of the WHO and the practices of other advanced economies, the Government has adopted the following guiding principles in setting AQOs and in conducting all subsequent AQOs reviews –

(a) for the protection of public health, a progressive approach should be adopted with a view to achieving the WHO AQGs as an ultimate goal, with reference

[2] The WHO AQGs defined peak season O_3 as "average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration.".

to international practices, the latest technological developments and local circumstances in accordance with the WHO recommendations; and

(b) the AQOs should be updated by benchmarking against the AQGs and ITs of the WHO.

5. The current air quality management policy of Hong Kong is to improve air quality to achieve the ultimate WHO AQGs to protect public health, through introducing various measures to reduce emissions from various sources such as power stations, industrial activities and transportation. The statutory AQOs, apart from being a timely goal for developing short-term air quality improvement plans, also serve as a benchmark for consideration of the air quality impact of designated projects (DPs) under the Environmental Impact Assessment (EIA) Ordinance (Cap. 499) as well as a key factor to be considered when deciding whether a licence should be issued to a specified process under the APCO. Following the WHO recommendations as well as the guiding principles referred to in paragraph 4 above, we set the statutory AQOs by taking into consideration, among others, the latest technological development and the availability of practicable air quality improvement measures.

6. Schedule 5 to the APCO prescribes the AQOs for seven key air pollutants (namely, RSP/PM_{10}, FSP/$PM_{2.5}$, SO_2, NO_2, O_3, CO and Pb). The prevailing AQOs are benchmarked against a combination of WHO AQGs / ITs. Five of the prevailing AQOs are already pegged at the most stringent levels of the WHO AQGs (namely 10-minute SO_2, 1-hour NO_2, 1-hour and 8-hour CO and annual Pb), whereas the remaining are set at WHO ITs levels (see **Annex A**).

Progress Made in Improving Air Quality

7. The overall air quality of Hong Kong has been improving. From 2013 to 2022, the concentrations of key air pollutants in the ambient air reduced by 43-62% or in the roadside air by 47-64%. In 2022, except for O_3 and NO_2, the AQOs for the remaining air pollutants have all been attained (see **Annex B**).

8. Meanwhile, the Hong Kong Government has been actively collaborating with the Guangdong Provincial Government to reduce regional air pollution, including the joint study on post-2020 regional air pollutant emission reduction targets and concentration levels. Riding on the substantial progress in the past ten years, both governments will continue the efforts on regional O_3 problem through reduction on nitrogen oxides (NO_x) and volatile organic compounds.

Modus Operandi of the Current AQOs Review

9. Similar to the practice of previous AQOs review, the Working Group, led by the Under Secretary for Environment and Ecology (USEE), had been formed in early

2022 to engage stakeholders and gauge their views on the current review of the AQOs. The Working Group comprises some twenty external members in the fields of air science, environmental groups, business groups, professional institutions and relevant trade, as well as representatives of related Government bureaux and departments.

10. An Air Science and Health Task Force (ASHTF) comprising air scientists and medical experts was established to advise the Working Group on methodologies and findings of the air quality and health and economic impact assessments, which were carried out by a consultant engaged by the Environment and Ecology Bureau (EEB). A total of eight meetings have been held among the Working Group and the ASHTF. The terms of references and membership of the Working Group and the ASHTF are at **Annex C-1** and **C-2** respectively.

FINDINGS OF THE CURRENT AQOS REVIEW

A. Air Quality Improvement Measures

11. In 2021, the Government published the *Hong Kong Roadmap on Popularisation of Electric Vehicles*, the *Clean Air Plan for Hong Kong 2035* and the *Hong Kong's Climate Action Plan 2050* to set out the targets and measures to continuously improve air quality and achieve carbon neutrality. The three blueprints have laid down the foundation for Hong Kong's decarbonisation and environmental protection work, which formed the basis of the Working Group's deliberations in the current AQOs review. The Working Group deliberated and provided recommendations on various fronts, and endorsed 21 air quality improvement measures (see **Annex D)**.

B. Air Quality Impact Assessment

12. To explore the room to tighten the AQOs, EEB, with the assistance of the consultant, has assessed the air quality of Hong Kong in 2030 based on the following key tasks, in accordance with methodologies agreed at the ASHTF[3]:

(a) appraise the latest air quality levels and trends in Hong Kong and the Pearl River Delta (PRD) region;

(b) examine the progress and effectiveness of on-going and committed air quality improvement measures, and deliberate on new air quality improvement measures, and deliberate on new air quality improvement measures with substantial emission reduction impacts by 2030 (see **Annex E**);

[3] The ASHTF has endorsed the use of the updated "Pollutants in the Atmosphere and their Transport over Hong Kong", as the air quality model for conducting air quality assessment.

(c) evaluate the air quality improvement in 2030, and the associated health and economic benefits in 2030 taking into consideration the implementation of air quality improvement measures in Hong Kong and the PRD; and

(d) assess the scope for tightening the AQOs in 2030 with reference to the latest WHO AQGs.

C. Proposed Tightening of the AQOs

13. The results of air quality assessment are summarised as follows (details provided in **Annex F** and **Annex G**):

(a) five prevailing AQO parameters continue to comply with WHO AQG levels;

(b) of the remaining seven existing AQO parameters, there is a scope to tighten five of them (24-hour SO_2, 24-hour and annual RSP/PM_{10}, and 24-hour and annual FSP/$PM_{2.5}$); and

(c) of the three new AQO parameters introduced by the WHO in 2021, two of them (24-hour NO_2 and 24-hour CO) can comply with their respective AQG or IT levels, while peak season O_3 has not reached its IT-1 (most lenient) level.

14. The 2030 assessment result of peak season O_3, as well as that of the 8-hour O_3, have not reached their respective IT-1 levels. To tackle this regional O_3 issue, we together with the Guangdong Provincial Government and the Government of Macao are going to conduct a three-year joint study on "Characterization of photochemical ozone formation, regional and super-regional transportation in the Greater Bay Area" to better understand the origin of O_3 formation and its spreading characteristics. The findings will provide scientific supports to help devise improvement measures. With a long-term target to reduce O_3 level in Hong Kong, we suggest keeping the 8-hour O_3 at the prevailing AQO level; and setting the peak season O_3 at IT-1 level of WHO AQGs. Although the rising trend of O_3 remains a challenge of air pollution to tackle and is unable to be resolved in the short term, with our continuous effort to reduce the local NO_x and VOCs emissions by means of reducing vehicle emissions, promoting the use of electric vehicles and tightening the control of emission from the power plants as well as the concerted efforts of the Government and the Guangdong Provincial Government in improving regional air quality, we envisage that the O_3 level could reach IT-1 in the medium term.

15. As for the annual NO_2 level, the air quality assessment result shows that most areas in Hong Kong have already met the IT-1 level in 2030 except the airport and anchorage area. The exceedance is due to aircraft and marine emissions. Hence, we propose to keep the annual NO_2 at the prevailing AQO level.

16. The 24-hour CO level in Hong Kong has remained well below its WHO AQG level in the past decade. Therefore, it is recommended that the AQO for 24-hour CO be pitched at the WHO AQG level.

17. Accordingly, we propose in the current AQOs review the following updates of the AQOs:

(a) tighten the 24-hour AQO for SO_2 from IT-2 level (50μg/m^3) to AQG level (40μg/m^3) with the current number of exceedances allowed (three) remains unchanged;

(b) tighten the annual AQO for RSP/PM_{10} from IT-2 (50μg/m^3) to IT-3 (30μg/m^3); and its 24-hour AQO from IT-2 (100μg/m^3) to IT-3 (75μg/m^3) with the number of exceedances allowed (nine) remains unchanged;

(c) tighten the annual AQO for FSP/$PM_{2.5}$ from IT-2 (25μg/m^3) to IT-3 (15μg/m^3); and its 24-hour AQO from IT-2 (50μg/m^3) to IT-3 (37.5μg/m^3) with the number of exceedances allowed decreased from the current 35 to 18;

(d) add three new AQO parameters introduced by the WHO (namely the 24-hour AQO for NO_2 and set at IT-1 (120μg/m^3) with a number of exceedances allowed at nine; the peak season AQO for O_3[4] and set at IT-1 (100μg/m^3); the 24-hour AQO for CO and set at AQG level (4 000μg/m^3) with no exceedance allowed).

D. Health and Economic Impact Assessment

18. Improvements in air quality can bring along health benefits, such as reducing premature deaths, hospital admissions, clinic visits, and medical costs in particular in relation to respiratory and cardiovascular diseases, and indirectly raising labour productivity. According to the assessment results based on a tool for assessing the

[4] For the purpose of setting this new parameter as one of Hong Kong's AQOs, we have proposed a detailed definition with reference to the prevailing definition of "maximum daily 8-hour mean concentration" in the APCO as follows:

(a) the peak season level of O_3 of a calendar year in air is the highest value selected by calculating the 6-month running averages of maximum daily 8-hour mean O_3 concentrations by month.

(b) Each 6-month running average calculated for the purposes of (a) is assigned to the calendar year which covers three months before and inclusive of the last day of a particular month and three months after it, that is -

(i) the first 6-month calculation period for a calendar year is the period from 1 November in the previous year to 30 April in that year, that is, covering three months before and inclusive of 31 January in that year and three months after it; and

(ii) the last 6-month calculation period for a calendar year is the period from 1 October in that year to 31 March in the following year, that is, covering three months before and inclusive of 31 December in that year and three months after it.

health and economic impacts of air pollution developed by the Chinese University of Hong Kong[5] and the air quality assessments results of 2030, about 3 150 premature deaths might be reduced as a result of improvement in long-term exposure to air pollutants in particular FSP/$PM_{2.5}$ (as compared with 2019). About 2 300 cases of hospital admission (through the Accident and Emergency Departments operated by the Hospital Authority) might be saved as a result of improvement in short-term exposure to air pollutants in particular NO_2 (as compared with 2019). About 928 000 cases of clinic visits might be saved as a result of improvement in short-term exposure to air pollutants in particular NO_2. The corresponding savings from hospital admissions and clinic visits were estimated at about HK$275 million. A summary of the health and economic benefits is at **Annex H**.

[5] The ASHTF has endorsed the use of a tool developed by the Chinese University of Hong Kong under the study "Developing an Instrument for Assessing the Health and Economic Impacts of Air Pollution in Hong Kong" commissioned by the Environmental Protection Department (completed in 2016), together with data from the Census and Statistics Department, the Hospital Authority and the Air Quality Impact Assessment of the AQOs review, to conduct the Health and Economic Impact Assessment of the AQOs review.

Annex A

Hong Kong Air Quality Objectives (AQOs) vs. World Health Organisation Global Air Quality Guidelines (AQGs)

Pollutant	Averaging Time	**WHO AQGs** ($\mu g/m^3$)					No. of Allowable Exceedances of Prevailing AQOs (per calendar year)
		Interim Targets				AQG Level	
		1	2	3	4		
FSP/$PM_{2.5}$	Annual	35	25	15	10	5	Not applicable
	24-hour	75	50	37.5	25	15	35
RSP/PM_{10}	Annual	70	50	30	20	15	Not applicable
	24-hour	150	100	75	50	45	9
O_3	Peak season#@	100	70	-	-	60	-
	8-hour	160	120	-	-	100	9
NO_2	Annual	40	30	20	-	10	Not applicable
	24-hour#	120	50	-	-	25	-
	1-hour	-	-	-	-	200	18
SO_2	24-hour	125	50	-	-	40	3
	10-minute	-	-	-	-	500	3
CO	24-hour#	7 000	-	-	-	4 000	-
	8-hour	-	-	-	-	10 000	0
	1-hour	-	-	-	-	35 000 (30 000 as current AQO)	0
Pb	Annual	-	-	-	-	0.5*	Not applicable

Notes:

New parameters introduced in WHO's AQGs

@ The WHO AQGs defined peak season O_3 as "average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration".

* Annual average of Pb level 0.5μg/m^3 in the Air quality guidelines for Europe 2nd Edition published by WHO in 2000 remains valid as there is no update for this parameter in WHO's subsequent publications.

Current AQOs adopted.

Annex B

AQOs Compliance Status in 2022

Station		Long-term				Short-term							
		PM_{10}	$PM_{2.5}$	NO_2	Pb	O_3	NO_2	PM_{10}	$PM_{2.5}$	SO_2		CO	
		1-year				8-hr	1-hr	24-hr	24-hr	10-min	24-hr	1-hr	8-hr
General Station	Central/ Western	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	--	--
	Southern	✓	✓	✓	--	×	✓	✓	✓	✓	✓	✓	✓
	Eastern	✓	✓	✓	--	×	✓	✓	✓	✓	✓	--	--
	Kwun Tong	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	--	--
	Sham Shui Po	✓	✓	×	✓	×	✓	✓	✓	✓	✓	--	--
	Kwai Chung	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	--	--
	Tsuen Wan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Tseung Kwan O	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
	Yuen Long	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tuen Mun	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tung Chung	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
	Tai Po	✓	✓	✓	--	×	✓	✓	✓	✓	✓	--	--
	Sha Tin	✓	✓	✓	--	×	✓	✓	✓	✓	✓	--	--
	North	✓	✓	✓	--	×	✓	✓	✓	✓	✓	✓	✓
	Tap Mun	✓	✓	✓	--	×	✓	✓	✓	✓	✓	✓	✓
Roadside Station	Causeway Bay	✓	✓	×	--	✓	×	✓	✓	✓	✓	✓	✓
	Central	✓	✓	×	--	✓	×	✓	✓	✓	✓	✓	✓
	Mong Kok	✓	✓	×	✓	✓	×	✓	✓	✓	✓	✓	✓

Notes:
"✓" Complied with the AQO
"×" Not in compliance with the AQO
"--" Not measured

Annex C-1

Terms of Reference and Membership of the Working Group

Terms of Reference

1. To deliberate on air quality improvement measures with substantial emission reduction impacts by 2025 and 2030; and

2. To evaluate the scope for tightening the AQOs having regard to findings of the air quality and health and economic impact assessments.

Membership

Chairperson :	Under Secretary for Environment and Ecology
Vice-chairperson :	Deputy Secretary for Environment and Ecology (Environment) 2
Members :	Mr. CHAN King Ming, Ryan
	Dr. CHENG Luk Ki
	Ir. CHOI Chung Ming
	Ir. Chris CHONG
	Mr. FUNG Kin Wai, Patrick
	Ir. HO Yin Piu, Bill
	Dr. HUNG Oi Shing, Jeffrey
	Mr. IU Chun Yip, Lawrence
	Mr. JIANG Chu Sheng[#]
	Prof. LAU Kai Hon, Alexis
	Mr. LAW Ka Chun, Joseph
	Mr. LEE Chak Cheong, Roger
	Dr. LEE Yiu Pui, Ringo
	Mr. LIU Tieh Ching, Brandon
	Dr. NG Chi Yun, Jeanne
	Mr. NG Ka Wing, Simon
	Mr. SO Kwok Kin, Kenny
	Mr. TANG Ching Leung, Kent
	Ir. TANG Wing Hong, Madison
	Mr. TSE Chi Hin, Eddie

Ms. YEUNG Mei Fong, Elsa
Dr. YU Yuen Ping, William
Representatives from Development Bureau
Representatives from Environment and Ecology Bureau
Representatives from Transport and Logistics Bureau
Representatives from Civil Engineering and Development Department
Representatives from Environmental Protection Department
Representatives from Electrical and Mechanical Services Department
Representatives from Department of Health
Representatives from Marine Department
Representatives from Planning Department
Representatives from Transport Department

Note:
[#] Resigned from the Working Group in October 2022.

Annex C-2

Terms of Reference and Membership of the ASHTF

Terms of Reference

1. To review the latest development on air quality standards and the health effects of air pollution; and;

2. To advise the AQOs Review Working Group on the methodologies and findings of air quality and health and economic impact assessments.

Membership

Chairperson :	Principal Assistant Secretary (Air Policy)
Vice-chairperson :	Principal Environmental Protection Officer (Air Science and Modelling)
Members :	Prof. FUNG Chi Hung, Jimmy*
	Prof. HO Kin Fai
	Dr. LAM Yun Fat, Nicky
	Prof. LAO Xiang Qian
	Prof. LAU Kai Hon, Alexis
	Dr. SO Kit Ying, Loletta
	Prof. WANG Tao
	Prof. WONG Tze Wai*
	Representatives from Environment and Ecology Bureau
	Representatives from Environmental Protection Department
	Representatives from Department of Health

Note:

* Resigned from the ASHTF in June 2022.

Annex D

Air Quality Improvement Measures

Sector	No.	Measures
Road Transportation	1	No new registration of fuel-propelled and hybrid private cars in 2035 or earlier
	2	Electrification of franchised bus fleets and phase-out of conventional diesel franchised buses
	3	Introduction of hydrogen fuel cell vehicles
	4	Electrification of public light buses
	5	Electrification of taxis
	6	Electrification of goods vehicles, light buses, non-franchised buses, motorcycles, etc.
	7	Phase-out of old diesel commercial vehicles
	8	Electrification of Government's and public organisations' vehicle fleets
	9	Development of electric vehicle (EV) charging network comprising public and private charging facilities
	10	Training of professionals and mechanics on EV repair and maintenance and handling of retired EV batteries
	11	Development of green transport network
	12	Adoption of green features (including pedestrian-friendly and bicycle-friendly features) in urban areas, new towns and new development areas
Marine Transportation	13	Replacement of traditional ferries with new energy ferries
	14	Tightening of sulphur content limit of locally supplied marine light diesel
	15	Imposition of emission standards for new petrol-powered outboard engines
	16	Use of liquefied natural gas by marine vessels
	17	Use of marine fuel with sulphur content not exceeding 0.1% by ocean-going vessels

Sector	No.	Measures
Power Generation	18	Tightening of emission limits of power plants under the new low-carbon electricity generation strategy
	19	Reduction of energy consumption of new and existing commercial and residential buildings
Volatile Organic Compounds (VOCs)	20	Tightening and extension of control on products containing VOCs (a) Architectural paints (b) Consumer products
Non-road Mobile Machinery (NRMM)	21	Tightening of emission standards on NRMMs newly supplied to Hong Kong

Note: Among the 21 identified measures, the emission estimations and reduction potential of 17 measures (i.e. measures 1-8 and 13-21) with substantial emission reduction impacts by 2030 have undergone quantifications.

Annex E

Estimated Emission Reduction Impacts

For simulating the air quality improvements in 2030, emission reduction impacts in 2030 resulting from the endorsed air quality improvement measures were estimated[6]. The estimation reductions for 2030 under different emission source categories including road transportation, marine transportation, power generation and other measures (volatile organic compounds from products and non-road mobile machineries) are summarised in the table below.

Estimated Emission Reduction of Pollutants in 2030 against 2019

Emission Source Categories	**Estimated Emission Reduction of Pollutants in 2030 against 2019** tonnes* (% reduction)					
	CO	**NOx**	**VOC**	**FSP/ $PM_{2.5}$**	**RSP/ PM_{10}**	**SO_2**
Road Transportation (Measures 1-12)	-14 280 (-48%)	-7 420 (-58%)	-2 500 (-51%)	-70 (-24%)	-80 (-25%)	-10 (-17%)
Marine Transportation (Measures 13-17)	+1 440 (+7%)	-2 140 (-8%)	+40 (+1%)	-290 (-30%)	-310 (-30%)	-2 220 (-87%)
Power Generation (Measures 18-19)	-1 360 (-41%)	-14 250 (-62%)	-140 (-35%)	-70 (-24%)	-260 (-46%)	-3 440 (-64%)
Other Measures (Measures 20-21)	-140 (-7%)	-1 230 (-29%)	-400 (-4%)	-80 (-25%)	-80 (-25%)	<5 (+10%)

* Figures are rounded to the nearest ten.

[6] 2019 was used as the base year. Air quality assessment was made for 2030 to evaluate the compliance status of the prevailing AQOs taking into account the implementation of on-going and committed Government's initiatives until 2030.

Annex F

Assessments of 2030 Air Quality Results

The results of 2030 air quality assessment are summarised in the table below. For simplicity, the results are shown based on the WHO AQGs or their respective ITs.

2030 Air Quality Assessment Results against Prevailing AQOs

Pollutants	Averaging Time	Prevailing AQOs		2030 Air Quality Assessment Results	
		Concentration ($\mu g/m^3$)^	No. of allowable exceedances (per calendar year)	Compliance with respect to WHO AQGs ($\mu g/m^3$)^	No. of allowable exceedances (per calendar year)
SO_2	10-minute	500 [AQG]	3	500 [AQG]	3
	24-hour	50 [IT-2]	3	**40 [AQG]**	3
RSP/PM_{10}	24-hour	100 [IT-2]	9	**75 [IT-3]**	9
	Annual	50 [IT-2]	Not applicable	**30 [IT-3]**	Not applicable
FSP/$PM_{2.5}$	24-hour	50 [IT-2]	35	**37.5 [IT-3]**	18
	Annual	25 [IT-2]	Not applicable	**15 [IT-3]**	Not applicable
NO_2	1-hour	200 [AQG]	18	200 [AQG]	18
	24-hour	(WHO AQGs' new parameter)		**120 [IT-1]**	9
	Annual	40 [IT-1]	Not applicable	40 [IT-1] (generally comply)	Not applicable
O_3	8-hour	160 [IT-1]	9	160 [IT-1] (not comply)	9
	Peak season	(WHO AQGs' new parameter)		**100 [IT-1]** (not comply)	Not applicable
CO	1-hour	30 000 [AQG]	0	30 000 [AQG]@	0
	8-hour	10 000 [AQG]	0	10 000 [AQG]@	0
	24-hour	(WHO AQGs' new parameter)		**4 000 [AQG]**@	0
Pb	Annual	0.5 [AQG]	Not applicable	0.5 [AQG]@	Not applicable

^ All measurements of the concentration of gaseous air pollutants, i.e. SO_2, NO_2, O_3 and CO, are adjusted to a reference temperature of 293 Kelvin and a reference pressure of 101.325 kPa.

@ The maximum levels in the past decade of 1-hour CO, 8-hour CO, 24-hour CO and annual Pb were 4 070 $\mu g/m^3$, 2 860 $\mu g/m^3$, 2 588 $\mu g/m^3$ and 0.041 $\mu g/m^3$ respectively, which are well below their respective AQG levels.

The information indicated in **bold** under "Compliance with respect to WHO AQGs" are parameters to be tightened (or set) in this round of review of the AQOs.

Annex G

Predicted Pollutant Concentration Distributions over the Hong Kong Territory in 2030

Respirable Suspended Particulates (RSP/PM_{10})

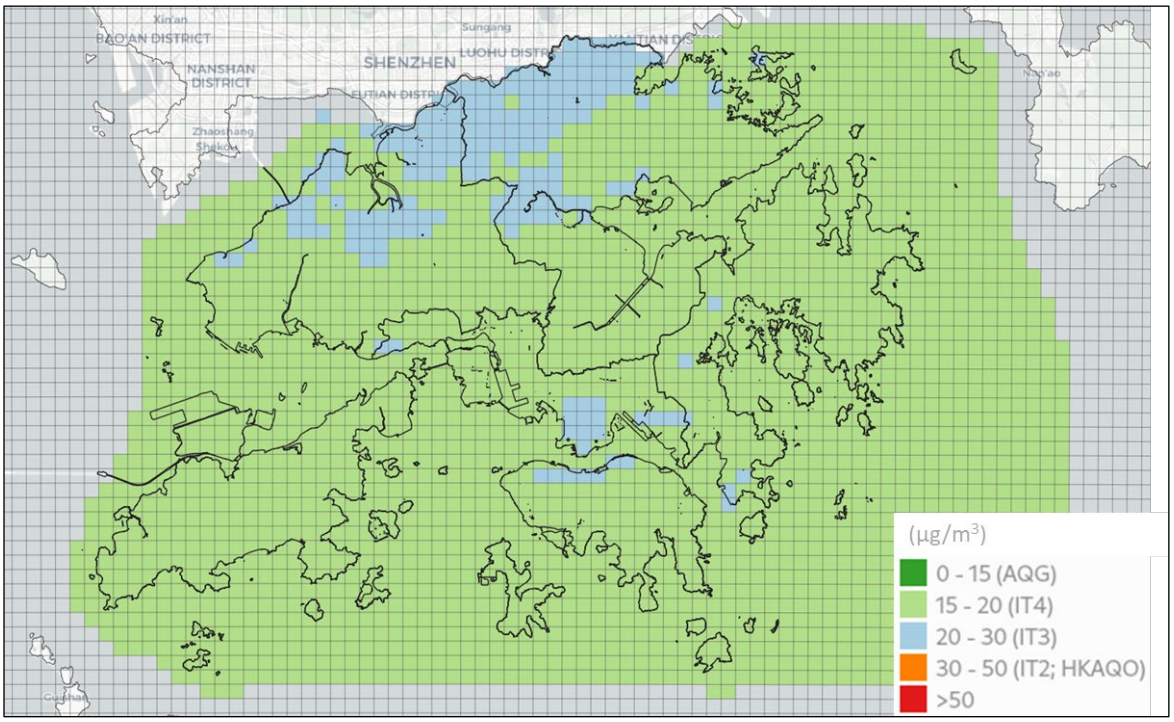

Figure 1 – Annual averaged RSP/PM_{10} concentration in 2030

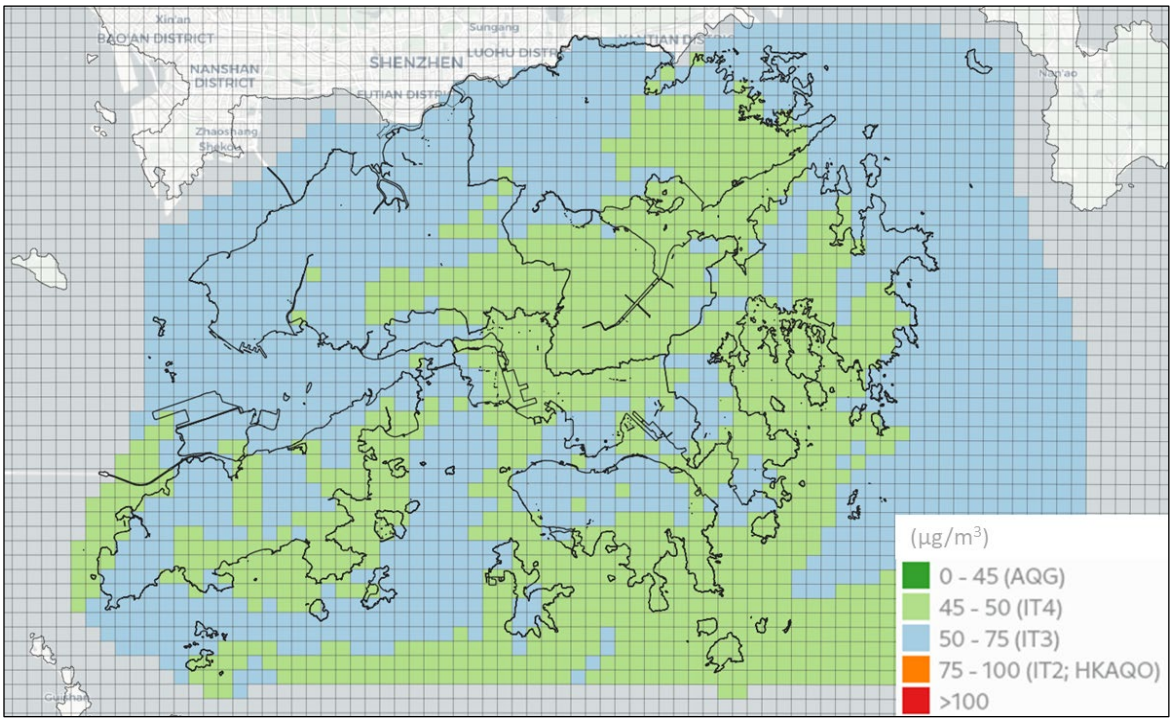

Figure 2 – 10th highest daily RSP/PM_{10} concentration in 2030

Fine Suspended Particulates (FSP/$PM_{2.5}$)

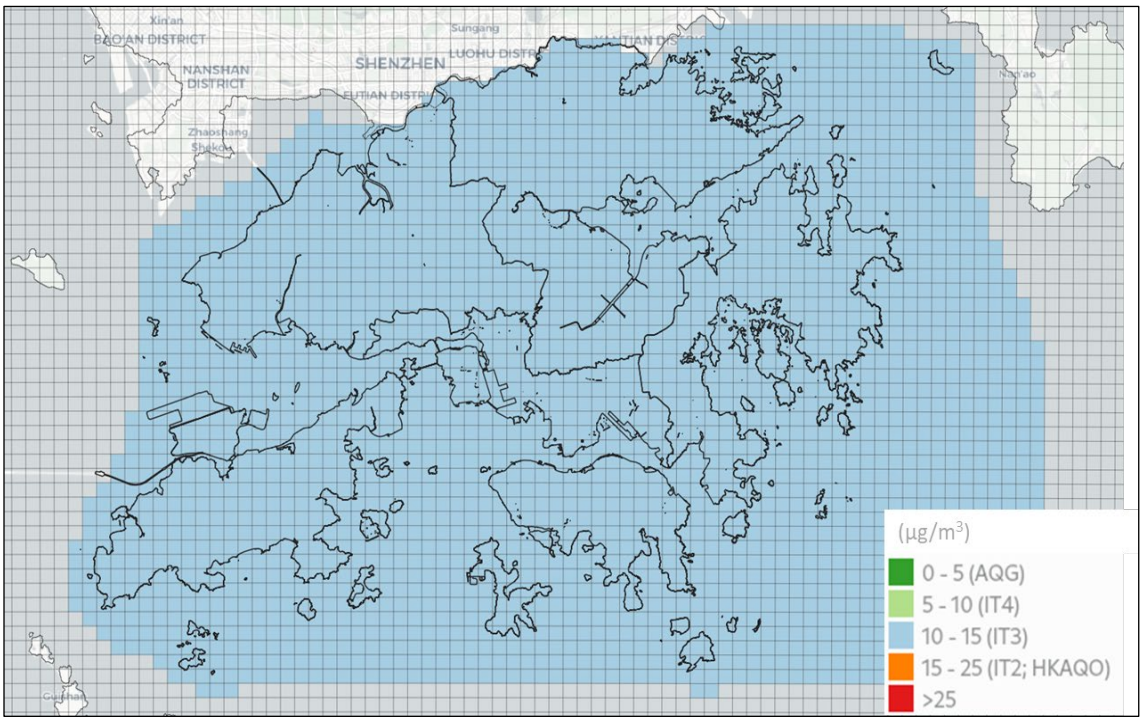

Figure 3 – Annual averaged FSP/$PM_{2.5}$ concentration in 2030

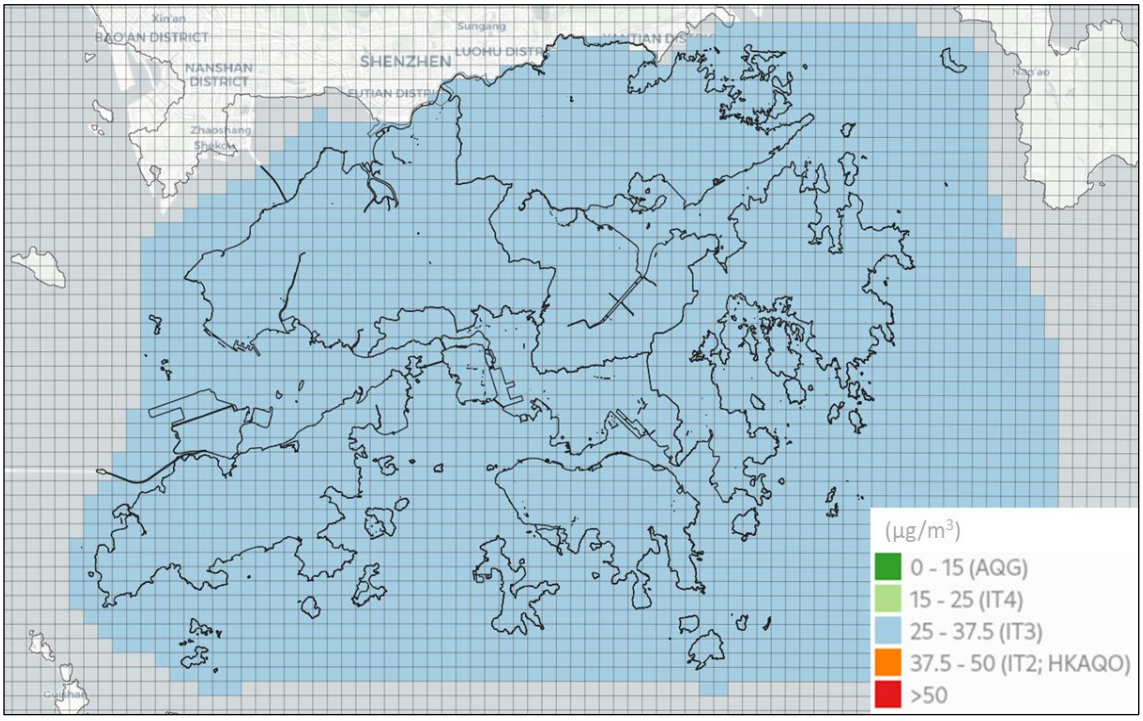

Figure 4 – 19th highest daily FSP/$PM_{2.5}$ concentration in 2030

Nitrogen Dioxide (NO_2)

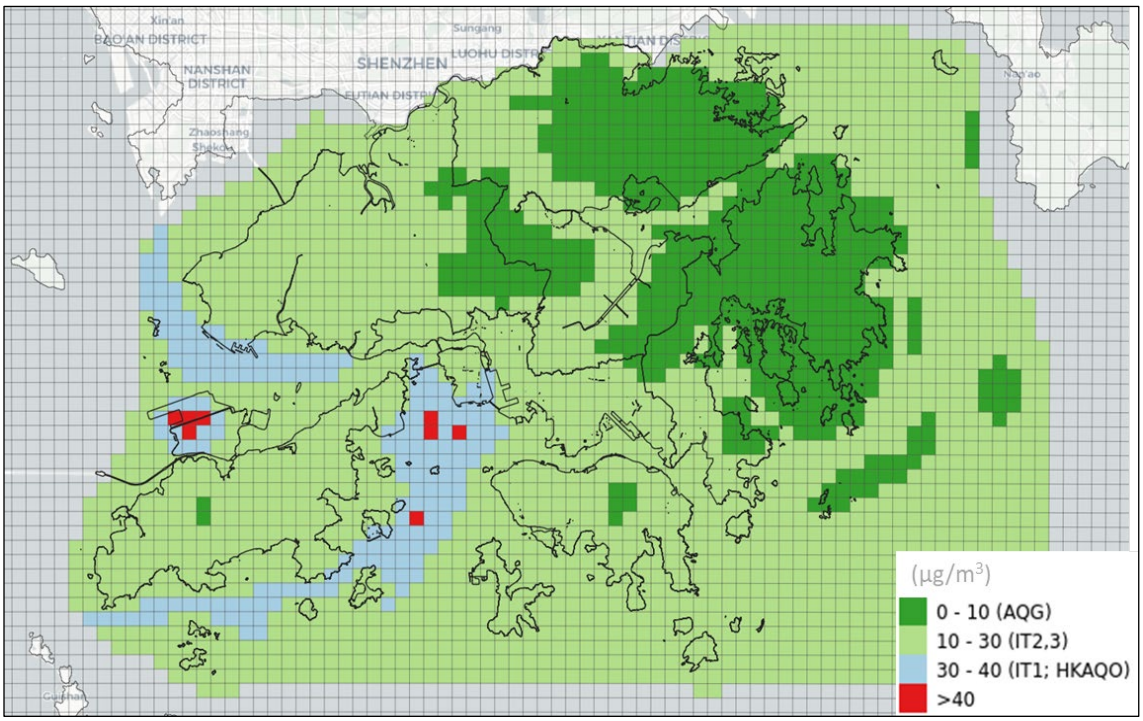

Figure 5 – Annual averaged NO_2 concentration in 2030

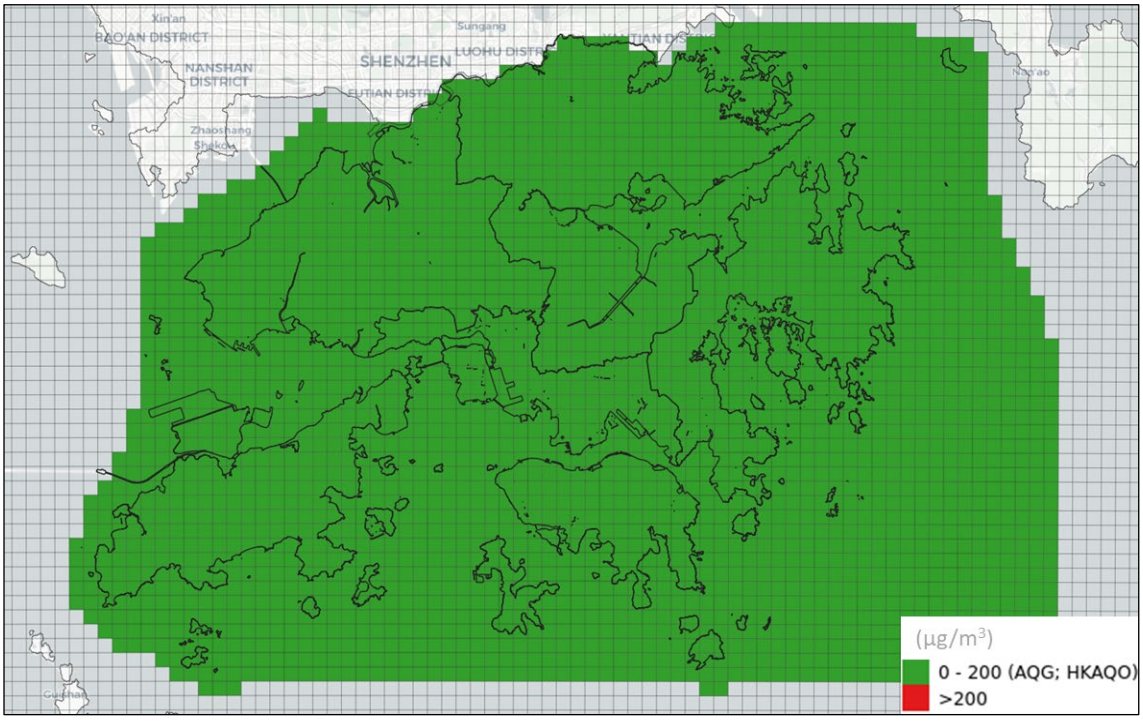

Figure 6 – 19th highest hourly NO_2 concentration in 2030

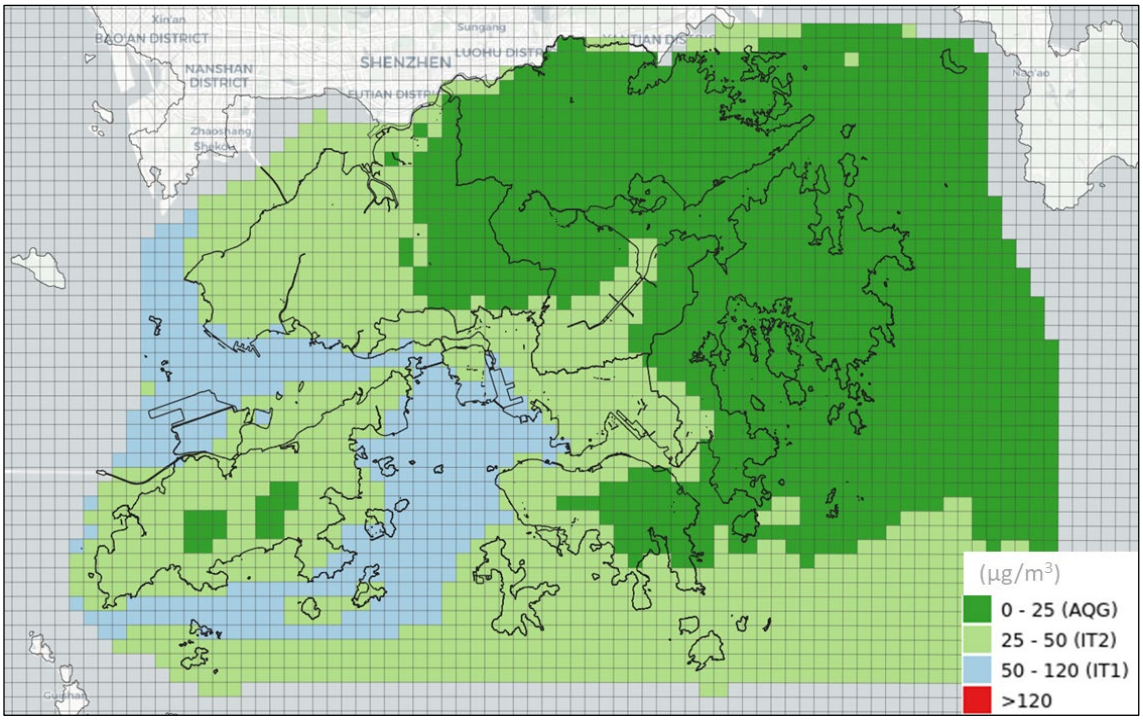

Figure 7 – 10th highest daily NO_2 concentration in 2030

Sulphur Dioxide (SO_2)

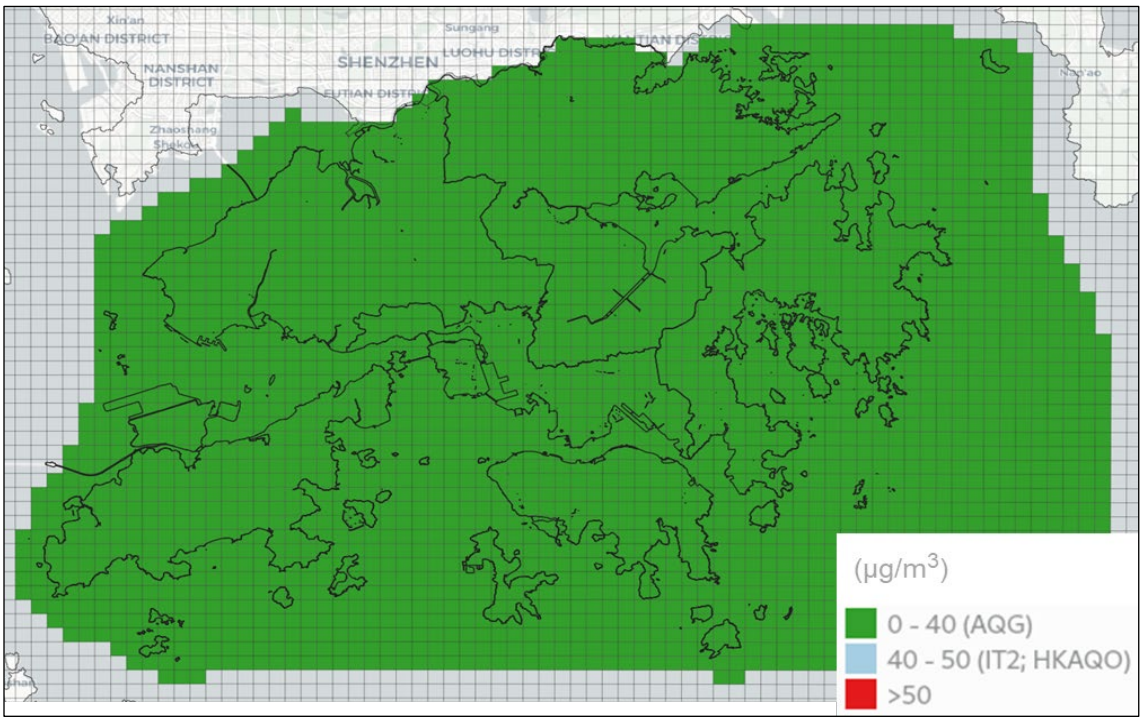

Figure 8 – 4th highest daily SO_2 concentration in 2030

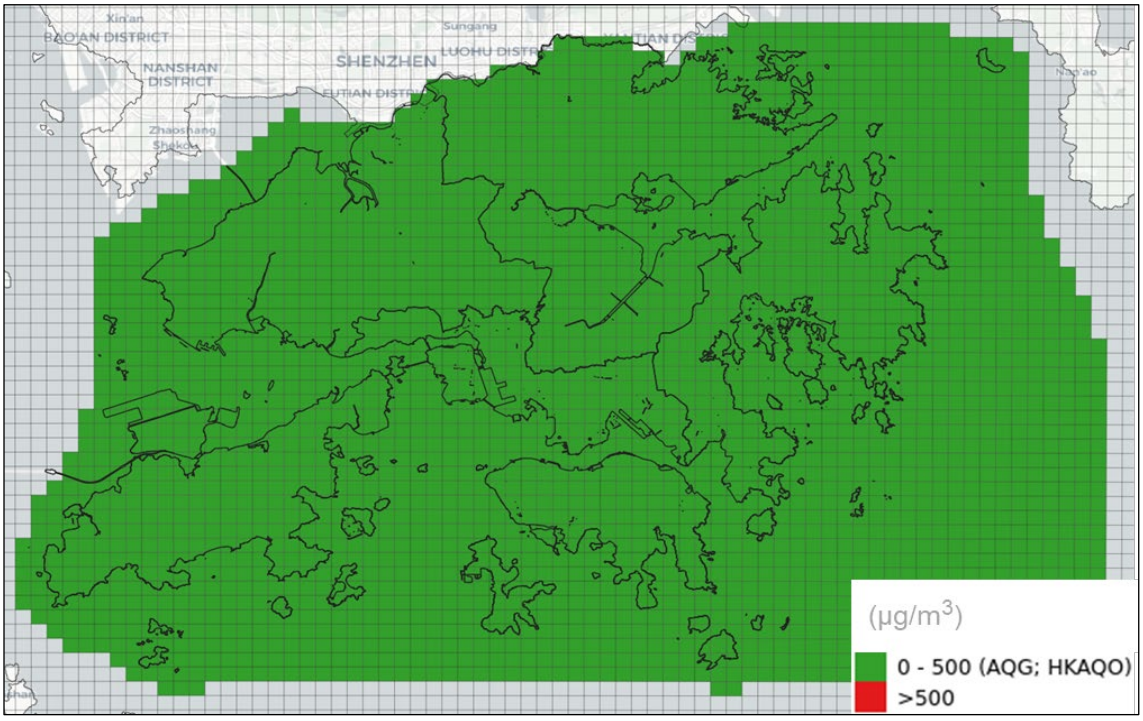

Figure 9 – 10-minute averaged SO_2 concentration in 2030

Ozone (O_3)

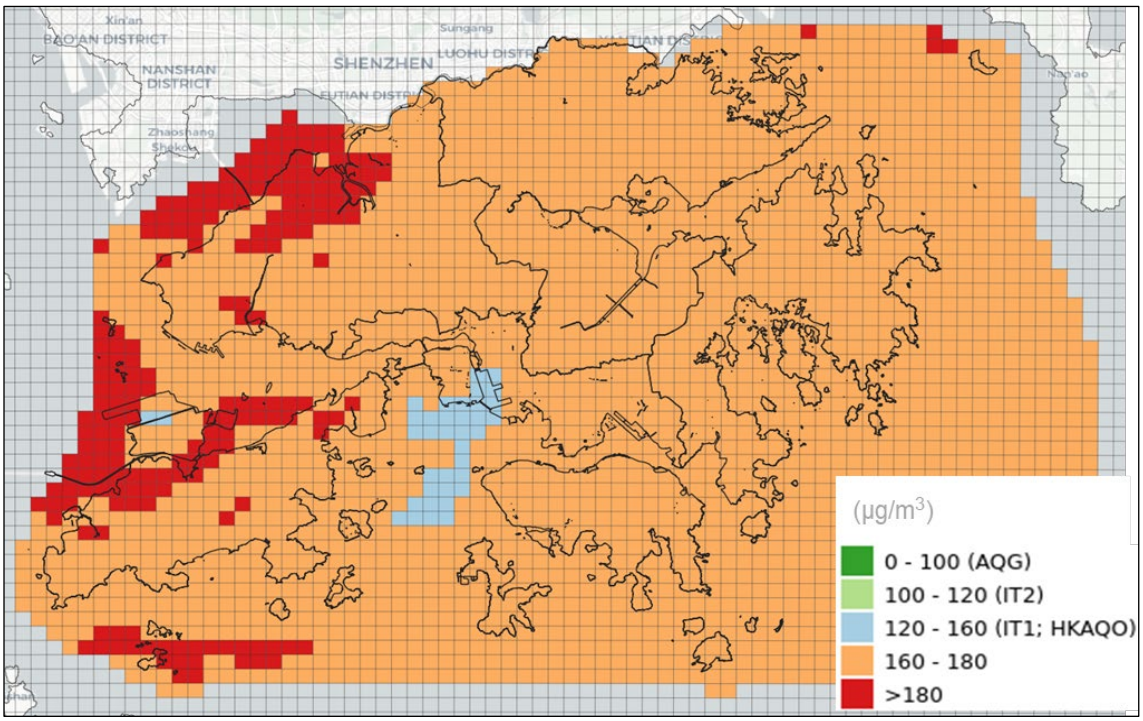

Figure 10 – 10th highest daily maximum 8-hour O_3 concentration in 2030

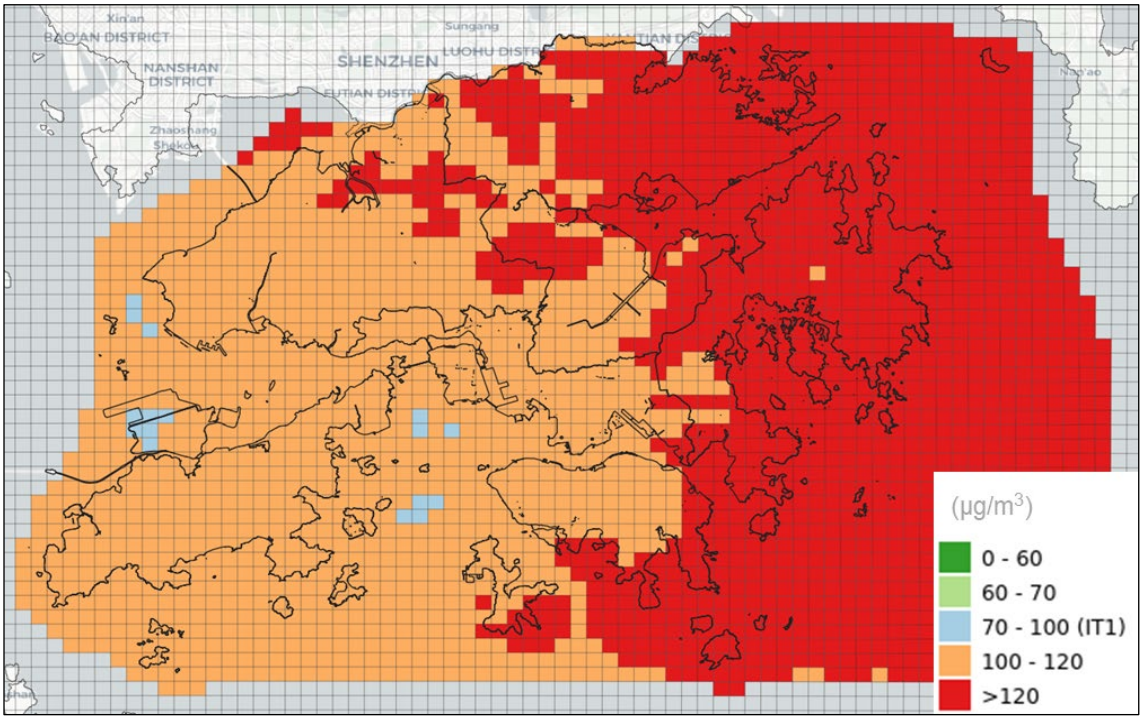

Figure 11 – Peak season O_3 concentration in 2030

Annex H

Health and Economic Benefits Due To Projected Air Quality Improvements

Table 1 Health benefits attributable to the changes in air quality level between 2019 and 2030

Health Outcomes		Air Pollutants				Max. Short-term / Long-term Impact[a]
		FSP/$PM_{2.5}$	**NO_2**	**O_3**	**SO_2**	
Short-term health outcome: Reductions in number of hospital admissions and clinic visits						
Emergency hospital admissions saved	Cardiovascular diseases	250	***1 041***	/	/	***2 302***
	Respiratory diseases	647	***1 261***	-226[b]		
Clinic visits saved (for new episodes of URTI)	GOPC visits	4 435	/	-1 799[b]		***927 856***
	GP visits	217 561	***927 856***	-110 332[b]		
Long-term health outcome: Reductions in number of premature deaths						
Reductions in number of premature deaths (all natural causes)[c]		***3 148***	1 968	-614[b]	/	***3 148***

Notes:
GOPC = General Outpatient Clinic
GP = General Practitioner
URTI = Upper Respiratory Tract Infections
/ = Health outcome not assessed as the relative risk for the respective air pollutant is either statistically not significant or available.

a. To avoid over-counting of health effects, impacts of different air pollutants are not added up. Instead, the maximum value among the air pollutants is taken.
b. The negative (-) sign indicates the air pollutant exerts negative impact.
c. Short-term premature death is covered in the long-term premature death.

Table 2 Economic Benefits due to savings in reduced hospital admissions and clinic visits attributable to the changes in air quality level between 2019 and 2030

	Costs Saved (HK$)[a]
Hospital Admissions [b]	43,361,200
Clinic Visits [c]	231,964,000

Notes:

a. Figures are rounded to the nearest hundred and adjusted to 2019 values.

b. The cost of hospital admissions relates to Accidents and Emergency (A&E) attendance due to cardiovascular and respiratory diseases and cost of hospital beds.

c. The cost of clinic visits includes doctor consultation of both public and private practitioners due to new episodes of upper respiratory tract infections (URTIs).