



# 2011 Hong Kong Air Quality Review

by Clean Air Network

## Highlight

- 2011 recorded the 3<sup>rd</sup> worst visibility in HK's history (p.1-2)
- 2011 roadside NO<sub>2</sub> concentrations set a record high in history, likely resulting in more respiratory disease and deaths (p.2-3)
- 2011 PM<sub>2.5</sub> levels were more than 3 times worse than WHO guidelines (p.4-5)
- 2011 ozone concentrations ranked the 3<sup>rd</sup> worst in history (p.5)
- Estimated overall air pollution health cost – 906 deaths, an increase of >100 people from last year (p.7)
- Is the proposed Air Quality Objectives (AQOs) a solution? (p.8-10)
- What are the recommendations? (p.11)

## Overview - Visibility and the Trend of Air Pollution

Visibility in Hong Kong has deteriorated significantly over the past two decades, and is continuing the trend of degradation for the year of 2011. Days of reduced visibility in 2011 with visibility below 8 km in the absence of fog, mist, or precipitation totaled 58 days, ranking the third worst in HK's history.

Loss of visibility is a direct indicator of air pollution, attributed from increase in the concentration of PM<sub>2.5</sub> and photochemical pollutants that increase the scattering of light. Loss of visibility is found to be linked with increase in non-accidental mortality and other air pollution-related health effects. The continuing loss of visibility in 2011 demonstrated that, despite of various pollution emission reduction efforts, the overall air quality in HK has continued to deteriorate.

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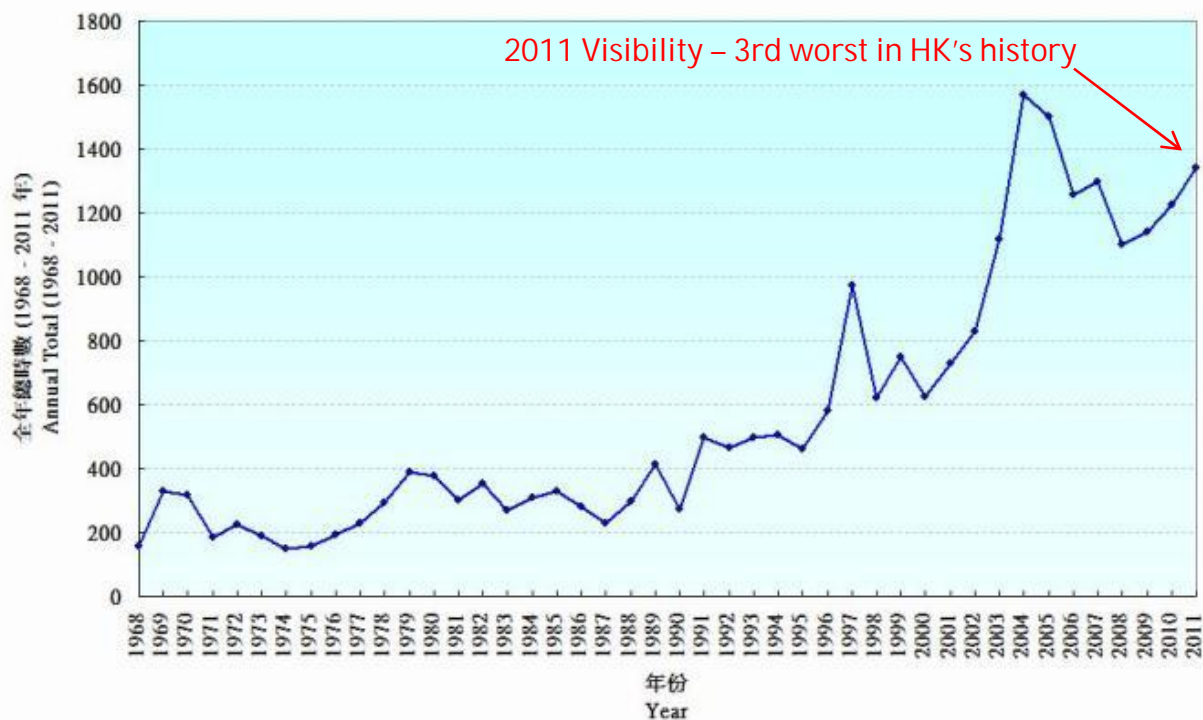
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## Hours of reduced visibility recorded at Hong Kong Observatory (1968-2011)



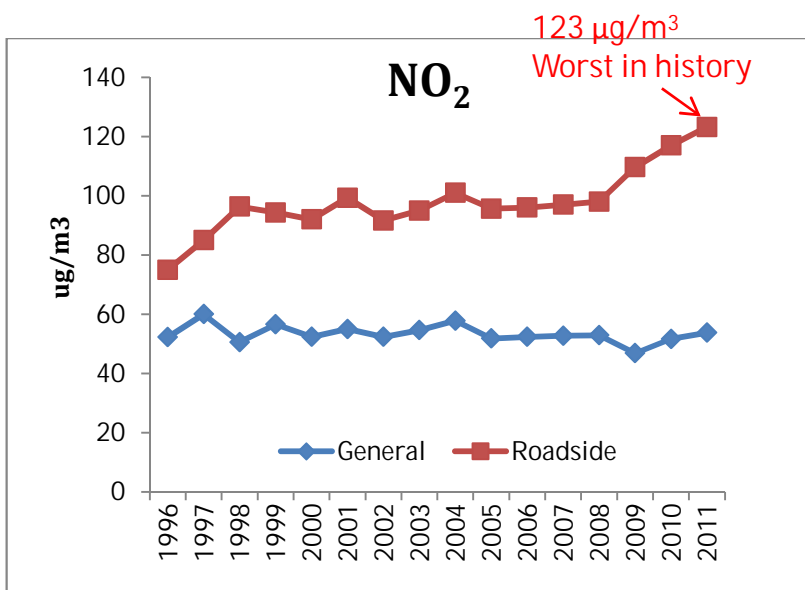
Source: Hong Kong Observatory (criteria: visibility below 8 kilometers when there is no fog, mist, or precipitation)

## 2011 Air Quality by Pollutants

### Nitrogen Dioxide (NO<sub>2</sub>)- the continuing challenge

- NO<sub>2</sub> concentrations have stayed steady at general monitoring stations, but ever increasing at roadsides;
- 2011 roadside NO<sub>2</sub> concentrations set a record high in Hong Kong's history (123 µg/m<sup>3</sup>)

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**NO<sub>2</sub> health impacts:**

- significant inflammation of the respiratory systems;
- reduced lung growth and function;
- lower resistance to respiratory infections such as influenza;
- death;

Source: EDP

According to the 2011 China Statistical Yearbook, HK's urban NO<sub>2</sub> concentrations ranked the second last among the other 31 major Chinese cities (see table below), worse than Beijing, Shanghai, and our neighboring city Guangzhou.

2010 NO<sub>2</sub> ranking

2010 NO <sub>2</sub> ranking	City	2010 NO <sub>2</sub> ranking (cont'ed)	City
1	Hai Kou	17	Tian Jin
2	Tai Yuan	17	Xi An
3	La Sha	19	Zhen Zhou
4	Xi Ning	19	Nan Jing
4	Yin Chuan	19	Kun Ming
6	Gui Yang	19	Chang Sha
6	Ji Nan	23	Nan Zhou
8	Nan Ning	23	Ha Er Bin
8	He Fei	25	Shang Hai
10	Fu Zhou	26	Cheng Du
11	Hu He Hao Te	27	Guang Zhou
12	Shen Yang	28	Hang Zhou
13	Chong Qing	29	Wu Han
14	Shi Jia Zhuang	29	Bei Jing

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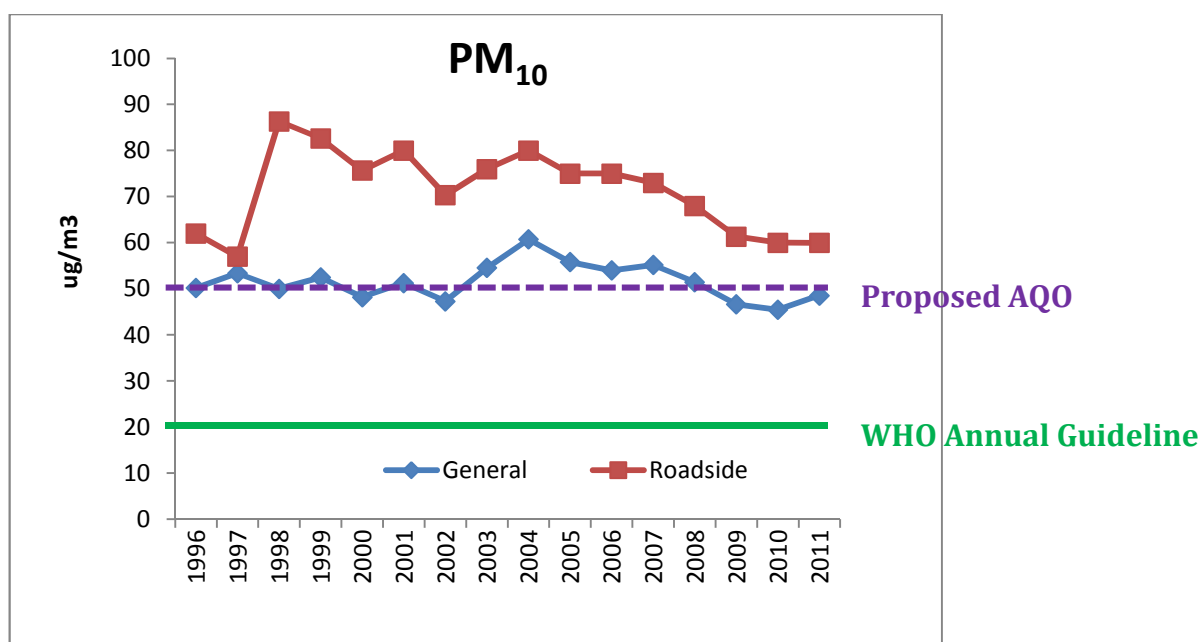


15	Nan Chang	31	Hong Kong
16	Chang Chun	32	Wu Lu Mu Qi

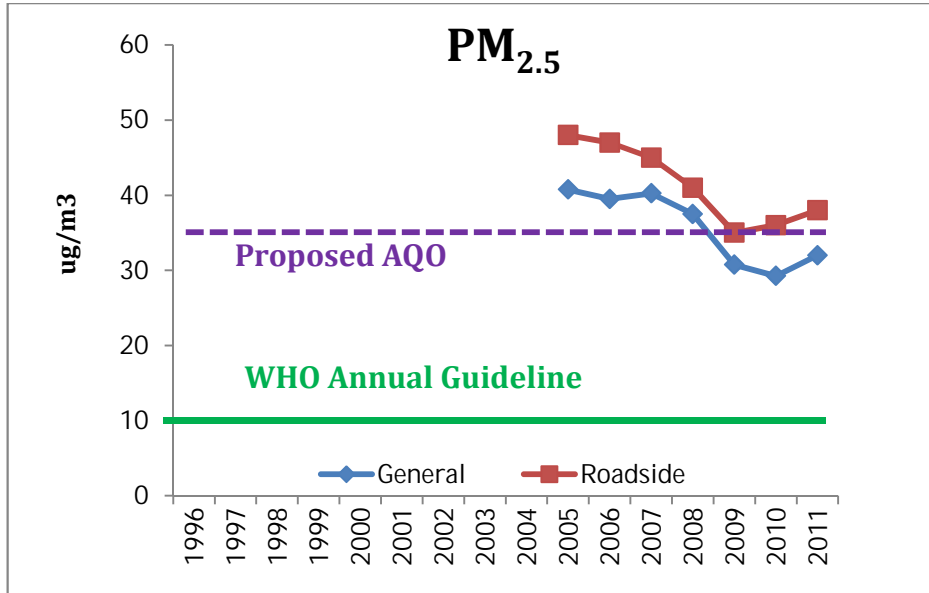
Source: China Statistical Yearbook 2011

### PM<sub>10</sub> & PM<sub>2.5</sub> – the biggest health threat

- Annual PM<sub>10</sub> concentrations remained relatively constant at general monitoring stations and slowly decreased at roadside stations;
- Annual PM<sub>2.5</sub> concentrations decreased from 2005 but started increasing again since 2009;
- 2011 PM<sub>10</sub> and PM<sub>2.5</sub> concentrations were more than 2 times and 3 times higher compared to the WHO annual guidelines



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Source: EDP (Note: 2011 PM<sub>2.5</sub> data only available from Jan to Nov)

**PM<sub>10</sub>&PM<sub>2.5</sub> health impacts:**

- respiratory and cardiovascular diseases and deaths;
- cancer;
- premature births and increased infant mortality;
- many more;

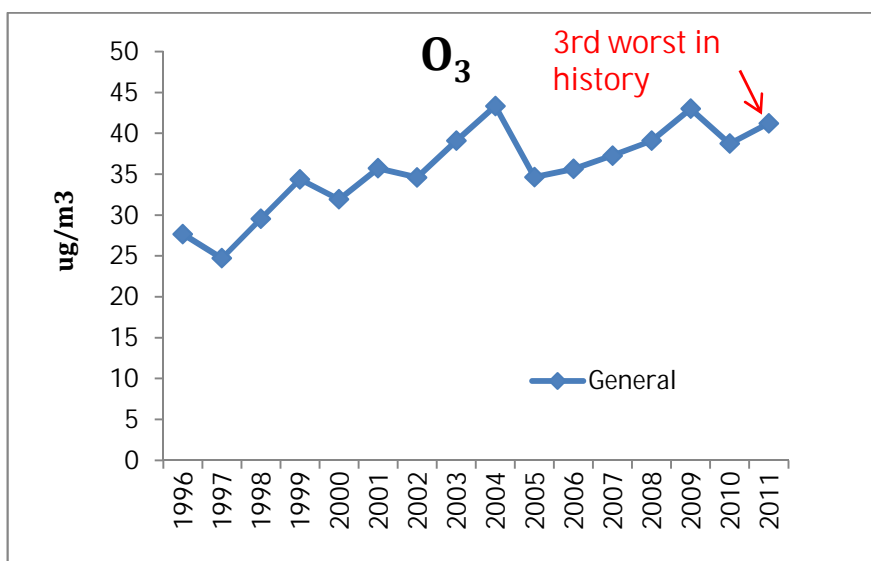
PM<sub>2.5</sub> pose even greater health threat than PM<sub>10</sub> because of their small size (approximately 1/30<sup>th</sup> the average width of human hair) which allows PM<sub>2.5</sub> to lodge deeply into our lungs, and because they are made up of things that are more toxic (like heavy metals and cancer causing organic compounds). A recent health impact assessment study (Xie et al., 2011, Water Air Soil Pollution) estimated that:

- For short-term exposure, the annual number of avoidable deaths would be 110~370 in HK if the PM<sub>2.5</sub> daily concentrations were reduced to below WHO 24-hr guideline value;
- For long-term exposure, the annual number of avoidable deaths would be 5000~13,000 in HK if the PM<sub>2.5</sub> annual concentrations were reduced to below WHO annual guideline value, and the average lifespan of residents would prolong 1~2.8 years.

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## Ozone (O<sub>3</sub>) – the alarming pollutant

- Ozone levels have continuously increased from 1996;
- 2011 ozone concentrations ranked the 3<sup>rd</sup> highest in history (41 µg/m<sup>3</sup>)



Source: EDP

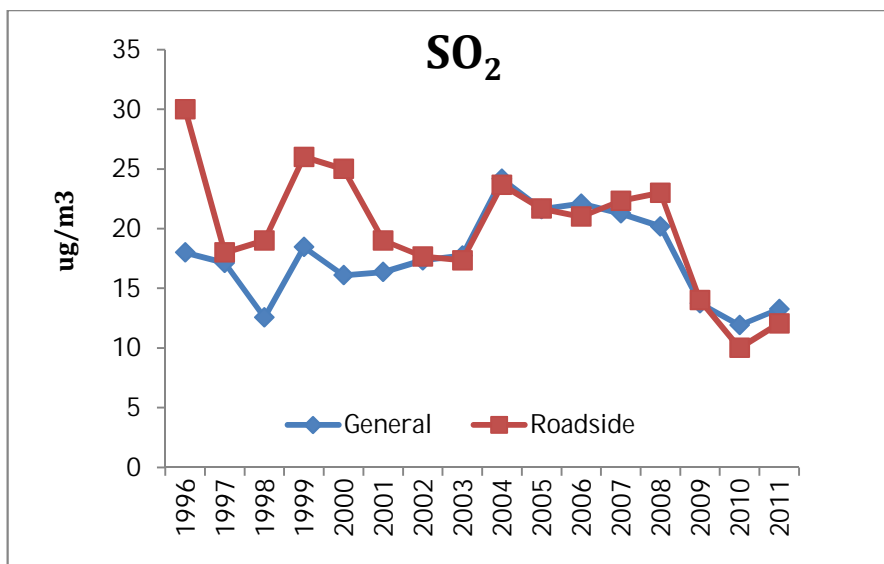
### Ozone health impacts:

- significant irritation of the eyes, nasal passages and lungs with breathing problems;
- asthmatic attacks;
- reduced lung function and cause other lung diseases;

## Sulphur Dioxide (SO<sub>2</sub>)

- SO<sub>2</sub> concentrations have fluctuated but gradually decreased since 1996;
- In 2010 and 2011, SO<sub>2</sub> levels at general stations were slightly worse compared to roadside stations.

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Source: EDP

### SO<sub>2</sub> health impacts:

- inflame the respiratory system;
- affect the functioning of the lungs;
- aggravate asthma and chronic bronchitis;
- increase risk of cardiac disease and mortality;

## Influence of Regional Air Pollution

A research report released in 2007 by the Hong Kong University of Science and Technology and Civic Exchange showed that local sources are the primary influence on Hong Kong's air quality for 53% of the time, compared to 36% of the time for regional sources. Has the influence of regional air pollution increased for the past few years and led to the uprising of pollution such as NO<sub>2</sub> and O<sub>3</sub>? To fully answer this question, sophisticated modeling is needed. However, a quick and rough estimate could be gained by looking at the annual variation of pollution levels at Tap Mun – an EPD monitoring station representative of the regional background. As shown in the figure below, the annual average concentrations of various pollutants have had little variation from 1998 to 2011, which indicates that the regional contribution to Hong Kong's air pollution has remained relatively constant, in other words, the increasing trend of NO<sub>2</sub> and O<sub>3</sub> has come more from local sources.

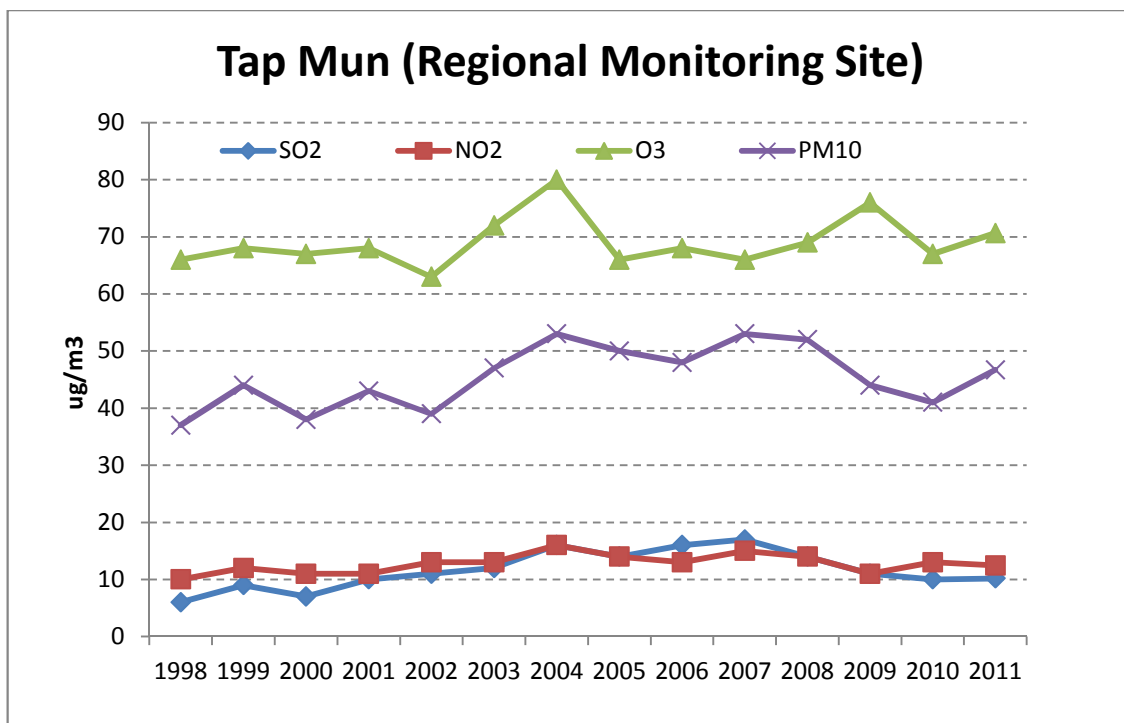
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Source: EDP

## Overall Air Pollution Health Cost

Hedley Index estimated that 2011 air pollution has led to 906 premature deaths, 2048 million dollar loss, 68667 hospital beds, 6.68 million doctor visits, and 856 asthma hospitalization. The death toll due to air pollution has increased more than 100 people from last year.

### Estimates of Health Cost by Hedley Index

	2010	2011
Premature Deaths	792	906
Dollar Cost (million HKD)	1809	2048
Hospital Bed Days	60327	68667
Doctor Visits (million)	5.92	6.68
Asthma Hospitalization	756	856

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## AQO Exceedance – Is the proposed AQO a solution?

### Observation #1:

The numbers of exceedance for 24-hr SO<sub>2</sub> are almost exactly the same under the current AQO and the proposed AQO, despite the fact that the proposed AQO (125 µg/m<sup>3</sup>) seems considerably more stringent compared to the current AQO (350 µg/m<sup>3</sup>).

### Indication:

The proposed AQO for 24-hr SO<sub>2</sub> does not set the bar high enough and make little difference compared to the current AQO in regulating current SO<sub>2</sub> levels. The WHO Interim Target 2 (IT-2) is well within the achievable range.

# of exceedance for 24-hr SO<sub>2</sub>

	Under Current AQO (350 µg/m <sup>3</sup> )	Under Proposed AQO (125 µg/m <sup>3</sup> )	Under WHO Interim Target-2 (50 µg/m <sup>3</sup> )	Under WHO Guideline (20 µg/m <sup>3</sup> )
Central/Western	0	0	1	55
Eastern	0	0	0	17
Kwai Chung	0	0	22	151
Kwun Tong	0	0	0	33
Sha Tin	0	0	0	64
Sham Shui Po	0	1	12	94
Tai Po	0	0	0	6
Tap Mun	0	0	0	20
Tsuen Wan	0	0	2	108
Tung Chung	0	0	1	52
Yuen Long	0	0	0	43
Causeway Bay (Roadside)	0	0	0	34
Central (Roadside)	0	0	1	64
Mong Kok (Roadside)	0	0	3	50

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**Observation #2:**

The number of exceedance for 24-hr PM<sub>10</sub> is somewhat different between the current and proposed AQO, however, significant difference was still found between the proposed AQO and WHO air quality guideline (AQG).

**Indication:**

The proposed AQO is more stringent than current AQO for 24-hr PM<sub>10</sub>, but still far more lax compared to the WHO AQG.

# of exceedance for 24-hr PM<sub>10</sub>

	Under Current AQO (180 µg/m <sup>3</sup> )	Under Proposed AQO (100 µg/m <sup>3</sup> )	Under WHO Guideline (50 µg/m <sup>3</sup> )
Central/Western	0	13	181
Eastern	0	2	139
Kwai Chung	0	9	168
Kwun Tong	0	6	181
Sha Tin	0	6	156
Sham Shui Po	0	8	182
Tai Po	0	5	162
Tap Mun	0	7	162
Tsuen Wan	0	10	175
Tung Chung	0	19	150
Yuen Long	0	26	202
Causeway Bay (Roadside)	0	29	260
Central (Roadside)	0	31	234
Mong Kok (Roadside)	0	16	201

**Observation #3:**

The number of exceedance for 24-hr PM<sub>2.5</sub> is significantly different (~20 times) between the proposed AQO and the WHO AQG.

**Indication:**

The proposed AQO for 24-hr PM<sub>2.5</sub> is far more lax compared to the WHO AQG.

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# of exceedance for 24-hr PM<sub>2.5</sub>\*

	Under Current AQO	Under Proposed AQO (75 µg/m <sup>3</sup> )	Under WHO Guideline (25 µg/m <sup>3</sup> )
Central (Roadside)	-	8	233
Mong Kok (Roadside)	-	5	226
Tung Chung	-	9	199
Tap Mun	-	0	197
Tsuen Wan	-	1	214
Yuen Long	-	8	217

\*Note: data only available from Jan-Nov 2011

#### Observation #4:

The number of exceedance for 1-hr NO<sub>2</sub> is different between the current and proposed AQO.

#### Indication:

The proposed AQO for 1-hr NO<sub>2</sub> is more stringent than the current AQO.

# of exceedance for 1-hr NO<sub>2</sub>

	Under Current AQO (300 µg/m <sup>3</sup> )	Under Proposed AQO (200 µg/m <sup>3</sup> )	Under WHO Guideline (200 µg/m <sup>3</sup> )
Central/Western	0	12	
Eastern	0	11	
Kwai Chung	0	31	
Kwun Tong	0	43	
Sha Tin	0	4	
Sham Shui Po	0	29	
Tai Po	0	1	
Tap Mun	0	0	
Tsuen Wan	0	15	
Tung Chung	0	9	
Yuen Long	0	8	
Causeway Bay (Roadside)	84	783	
Central (Roadside)	59	887	
Mong Kok (Roadside)	35	613	

(Note: the difference between the WHO AQG and the Proposed AQO for 1-hr NO<sub>2</sub> is that WHO AQG allows NO exceedance, while the proposed AQO allows 18 exceedance per year.)

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## Conclusions:

- The proposed AQO is considered lax based on the current air pollution levels in Hong Kong and compared to the WHO guidelines, and makes insignificant difference compared to the current AQO in regulating the current air pollution;
- Neither the current nor the new AQOs will significantly improve protection of public health from air pollution

## Recommendations

- ✓ Hong Kong needs more stringent AQOs and a timetable for execution.
- ✓ AQOs should be reviewed by law every 5 years, not by the willingness of EPD.
- ✓ Abatement of roadside emissions by early replacement of commercial diesel vehicles (mainly old trucks and buses), e.g. providing scrapping incentives and optimizing the current subsidy scheme.
- ✓ Set up low emissions asap as mentioned in 2010's policy address and extend zones to other polluting districts like Tsuen Wan, Kwun Tong and Sham Shui Po.
- ✓ Create a special unit under both the Department of Health and Environment Bureau to address environmental health.
- ✓ Include assessment of pollution contribution from local vs. regional sources in EPD's annual air quality report.
- ✓ Joint effort with the PRD administration to improve regional air quality.

## Summary

- 2011 was the 3<sup>rd</sup> worst year in HK's history in terms of visibility, indicating the continuing deterioration of the overall air quality;
- 2011 roadside NO<sub>2</sub> concentration set a record high in HK's history;
- 2011 PM<sub>10</sub> and PM<sub>2.5</sub> levels were more than 2 times and 3 times higher than WHO annual guidelines;
- 2011 ozone concentrations ranked the 3<sup>rd</sup> worst in HK's history;
- 906 pre-mature deaths were estimated to have resulted from air pollution in 2011, an increase of more than 100 people from 2010;
- Annual variation of pollution levels at the regional monitoring station Tap Mun indicated that the regional contribution to Hong Kong's air pollution has remained relatively constant throughout the past decade;

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- The proposed AQO is considered lax based on the current air pollution levels in Hong Kong and compared to the WHO guidelines, and makes insignificant difference compared to the current AQO in regulating the current air pollution;
- More stringent AQO and joint effort with the regional administration are needed to improve air quality and better protect public health in HK.

## **Acknowledgement**

- Hong Kong Environmental Protection Department
- Environmental Health Research group School of Public health at University of Hong Kong
- Civic Exchange
- Prof. Anthony Hedley

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## Appendix

### More about PM<sub>2.5</sub> in HK

Studies have indicated that PM<sub>2.5</sub> pose even greater health threat compared to PM<sub>10</sub> because of their small size (approximately 1/30<sup>th</sup> the average width of human hair) which allows PM<sub>2.5</sub> to lodge deeply into our lungs, and because they are made up of things that are more toxic (like heavy metals and cancer causing organic compounds).

HK currently has no PM<sub>2.5</sub> standards. In the proposed Air Quality Objectives (AQO), the annual and 24-hr PM<sub>2.5</sub> standards are set at 35 µg/m<sup>3</sup> and 75 µg/m<sup>3</sup>, respectively, significantly backwards compared to the WHO annual and 24-hr PM<sub>2.5</sub> guidelines of 10 µg/m<sup>3</sup> and 25 µg/m<sup>3</sup>. HK's proposed PM<sub>2.5</sub> AQO are more lax compared to other major Asian countries (see table below), backwards even compared to developing countries such as Pakistan and Bangladesh.

Comparison of PM<sub>2.5</sub> standards in different Asia countries

	PM <sub>2.5</sub> (annual) µg/m <sup>3</sup>	PM <sub>2.5</sub> (24-hr) µg/m <sup>3</sup>
WHO Guideline	10	25
HK (proposed)	35	75
Singapore	15	35
Japan	15	35
Taiwan (2012)	15	35
Bangladesh	15	65
Sri Lanka	25	50
India	40	60
Mongolia	25	50
Pakistan (current)	25	40
Pakistan (2012)	15	35

The HK EPD has been monitoring PM<sub>2.5</sub> at five stations (Tung Chung, Tap Mun, Tsuen Wan, Yuen Long and Central-roadside) since 2005, although the data is not open to the public. In 2011, EPD has gradually worked on extending the PM<sub>2.5</sub> continuous measurement network, and till November this year, all 14 monitoring stations have been equipped with PM<sub>2.5</sub> samplers.

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## **2011 Major Air Quality Improvement Policy**

In general, the government is rolling out quite a few initiatives to reduce emissions from the transport sector, which should be applauded, although a majority of them are still at the trial stage. The actual control measures that have been implemented in 2011 were mainly incentive schemes carried over from previous years to replace dirty old vehicles on road and reduce power plant emissions.

### **Initiatives:**

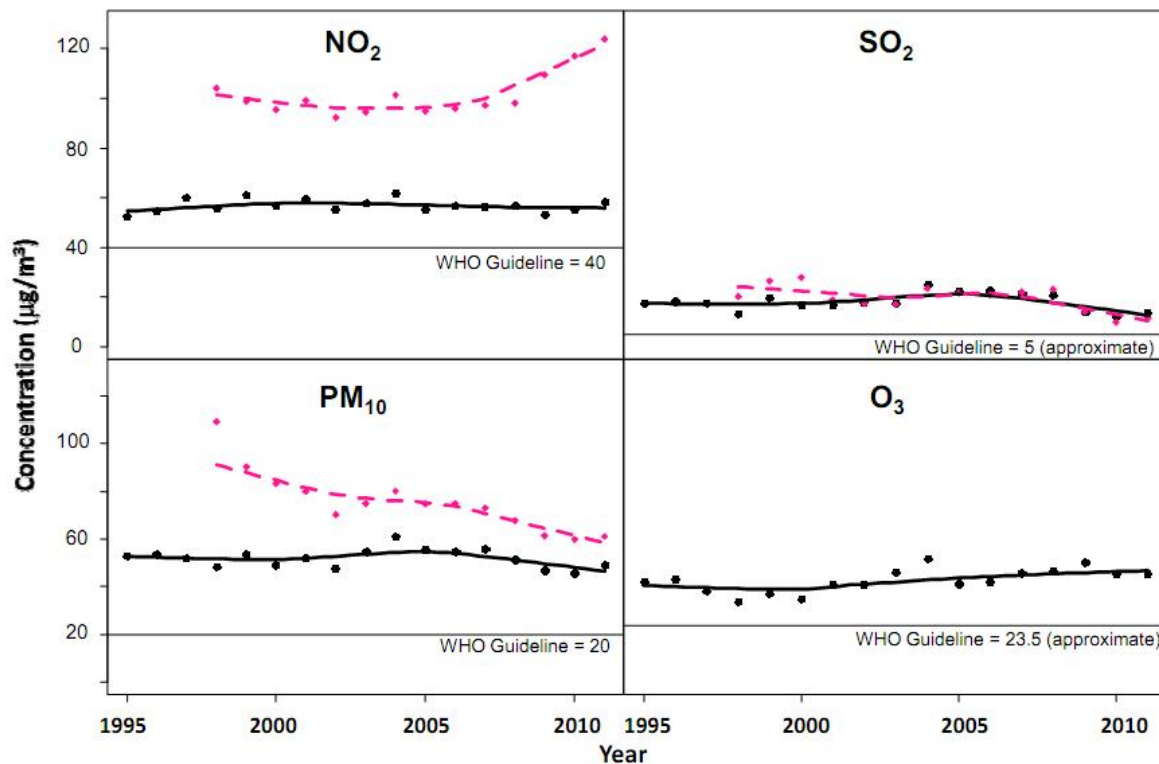
Pilot Green Transport Fund setup  
Hybrid bus trial  
Preparation for a trial to retrofit Euro II and Euro III buses with SCR devices  
Preparation for pilot low-emission zones  
Motor Vehicle Idling Ordinance (in effect Dec 2011)  
Proposal of roadside remote sensing techniques to strengthen emission control

### **Implementation:**

One-off grant scheme for pre-Euro and Euro I diesel commercial vehicle replacement (continued from previous years)  
First Registration Tax incentives for environment-friendly private cars (continued from previous years)  
One-off grant scheme for Euro II diesel commercial vehicle replacement (continued from previous years)  
Continuing imposition of emission caps for the power sector

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### Annual trends of pollutants at general (in black) and roadside stations (in pink) from 1995 to 2011



Source: EPD

Plot courtesy of the Environmental Health Research group at the School of Public health, University of Hong Kong

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