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1.0 Introduction

The most visible sign of environmental degradation in Hong Kong is the haze that periodically settles across the city. On 14 September this year, air pollution in Hong Kong reached record-breaking levels with an Air Pollution Index reading of 201 at Tung Chung. Residents are becoming more concerned as the number of these days increases. Beyond these days of acute air pollution, which has much to do with the rapid pace of development in South China, there are many more days where the mainly locally-generated pollution levels are high enough to cause long-term chronic health problems. Studies have shown that children are most affected by air pollution and life expectancy is reduced in line with increases in pollution levels.

Across the Pearl River Delta (PRD) Region (including Hong Kong), residents experience health-threatening concentrations of ozone, one of the main components of smog. Air quality across the PRD is one of the main threats to public health and continues to adversely impact the economy. Despite high level commitments from the Hong Kong Special Administrative Region (HKSAR) Government and the Guangdong Provincial Government to reduce air pollution by 2010, there is concern over the level of difficulty involved in implementing what are likely to be unpopular measures. However there is much that can be done to reduce pollution but it requires a systematic and long-term approach. Without aggressive and consistent action, residents of the region will suffer unnecessary mortality and illness, and long-term economic growth will be ultimately threatened.

2.0 Background

Existing Problems

In Hong Kong, high numbers of vehicles, especially diesel vehicles, coupled with high population density and high-rise buildings that hinder circulation of air at street level, have resulted in unacceptable air quality which is known to cause chronic health problems (Appendices A and B show pollution sources, trends and levels). Roadside emissions of pollutants such as Particulate Matter (PM; in Hong Kong the term Respirable Suspended Particulates (RSP) is used for PM10), and nitrogen oxides (NOx) continue to exceed statutory Air Quality Objectives (AQOs).

Hong Kong also suffers from the effects of regional pollution as emissions from the PRD region contribute to an ambient air pollution problem. This is characterized by exceedances of ozone and PM standards: the main components of smog. Ozone has increased by 50% in urban areas between 1991 and 2002, with rural areas experiencing higher levels of ozone than urban areas. While urban PM10 has decreased by 16% during the past 12 years to 2002, levels are still unacceptably high. Bad smog days, which are increasingly common in Hong Kong, are in fact considered to be acute pollution experiences, as pollutant levels reach dangerous levels that are especially harmful to the population.
In addition, levels of pollutants known as ‘precursor pollutants’, which react to form PM and ozone, such as sulphur dioxide (for PM) and Volatile Organic Compounds (VOCs; for ozone), which are not in themselves a problem in Hong Kong, must be controlled across the PRD region if Hong Kong is ever to meet its AQOs.

Health Impacts

There is an increasing body of evidence that proves the detrimental impacts of air pollutants, particularly fine particles (PM2.5), on health. The World Health Organization (WHO) has recently reconfirmed that exposure to PM poses a significant risk to human health at concentration levels generally lower than the prevailing levels in Hong Kong. Recent epidemiological studies have been unable consistently to establish threshold levels, in particular for PM and ozone. Rather, they consistently show effects at the levels studied (thus implying there is no safe levels of PM or ozone), and they have also found that PM2.5 is more hazardous than larger particles in terms of mortality and cardiovascular and respiratory illness. Therefore, even if the current limit value or AQO is not exceeded, significant health impacts including a substantial reduction in life expectancy, are to be expected in Hong Kong. Evidence is sufficient to strongly recommend further policy action establish and comply with more stringent air quality standards in order to significantly reduce levels of air pollutants, including PM2.5, nitrogen dioxide and ozone. Evidence is also sufficient to conclude that a reduction of air pollution will lead to considerable health benefits. A summary of health impacts of common local pollutants is included in Appendix C.

International Standards

Europe, the US and Australia, which all currently have more stringent PM10 standards than Hong Kong are all in the process of tightening these standards in view of the increasingly strong evidence of severe health effects associated with PM. In addition these countries have introduced, or are considering the introduction and further tightening of standards for PM2.5. Neither Hong Kong nor Guangdong has standards for PM2.5, and their respective PM10 standards are far more lax than existing and proposed standards in Europe, the US and Australia.

3.0 Hong Kong and Guangdong Government’s Joint Study

In response to the worsening regional air quality, the Hong Kong and Guangdong Governments conducted a joint “Study of Air Quality in the Pearl River Delta Region” (the Joint Study), which was released in 2002. The Joint Study developed an emissions inventory based on the available inventory models, largely from the US, which were adjusted for local peculiarities. The Joint Study determined that approximately 80%-95% of regional pollutants were generated in Guangdong with the rest generated in Hong Kong. However, on a per capita basis emissions are similar in Hong Kong and Guangdong (see Appendix D). The Joint Study also established
pollutant reduction targets (the Regional Emission Reduction Targets), which are to be achieved on a best endeavour basis in both Hong Kong and the PRD. The study estimated that the earliest these targets could be achieved was by 2010. A summary of the Regional Emission Reduction Targets is included in Table 1.

### Table 1. Regional Emission Reduction Targets

<table>
<thead>
<tr>
<th>Pollutants:</th>
<th>Regional Target reduction by 2010 (calculated on a base year of 1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>55%</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>39%</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>20%</td>
</tr>
<tr>
<td>VOC</td>
<td>54%</td>
</tr>
</tbody>
</table>

Source: The Joint Study (see endnote 8)

The Regional Emission Reduction Targets do not include PM$_{2.5}$ pollutants. While it is likely that reduction of emissions of PM$_{10}$ will also reduce levels of PM$_{2.5}$ (since PM$_{2.5}$ is a component of PM$_{10}$), further research would be required to determine how effective this would be.

To work out air pollution control measures and monitor the progress of their implementation, a “PRD Air Quality Management and Monitoring Special Panel” (the Special Panel) has been set up under the Hong Kong and Guangdong Joint Working Group on Sustainable Development and Environmental Protection. The Special Panel created a “Regional Air Quality Management Plan” (the Joint Regional Management Plan) outlining pollution control measures to achieve the Regional Targets. A summary of these measures is included in Appendix D.

In the past, there has been little sign that air quality concerns would override other government commitments to improve economic growth in the region. As many of the control measures will require substantial funds to implement, or will affect influential industrial or business sectors, the two governments will need significant political will to carry them through. The effort to improve air quality in the region is acknowledged in the Joint Study to be “a mammoth task” that will “take the commitment, devotion and collaboration of the two Governments to make it work.”

The key to these regional pollutant control measures obviously lies in their effective implementation. Reports on implementation two years into the eight-year plan have yet to be made public so that there could be an assessment on progress of the measures and/or the achievement of the targets. It is therefore difficult to track if the Joint Regional Management Plan is heading in the right direction.
4.0 Key measures required to improve air quality

4.1 Establish regional air monitoring network

The key to effective air quality policy is accurate and reliable data that is properly compiled and comprehensively analyzed, to ensure that control measures are targeted properly at the key pollutants and emission sources. In order to maintain a system of collecting and analyzing emissions data, adequate long-term funding for air monitoring is essential. At present air quality monitoring is both patchy and inconsistent across the PRD region. Further, there is little data on PM2.5, one of the key pollutants from a health perspective.

While the Special Panel was tasked to implement a regional air-monitoring network this has yet to happen. Furthermore, once in operation, it has not been specified whether the results from this regional air-monitoring network, along with all other data created by the Special Panel, will be released to the public and to scientific and health experts. The release of such data will add to transparency and stimulate open scientific discussion to understand the highly complex air pollution issues within the PRD region.

4.2 Establish and regularly update a reliable emissions inventory

Pollution control strategies developed in the Joint Study were derived through the use of an emissions based model (EBM) that uses emissions inventories to define pollutant sources and complex modeling to determine the actual level and make-up of pollutants in a study area including forecasts of future levels. The results of EBM’s are sensitive to many factors including (a) the emissions inventories used and (b) the projections of economic data such as economic growth and population growth.

The emissions inventories developed for the Joint Study were based on 1997 data and used US methodologies (adapted for local conditions). However, model estimate uncertainties are created since local factors cannot be completely known. The projections of future pollutant emissions are also difficult as they are based on assumptions that are adjusted to take into account rates of economic and population growth.

An emissions inventory for fine particles/ PM2.5 and their precursors is needed in order to fully understand the characteristics of air pollution in the region and to correctly target the pollutant sources. It would be highly desirable for scientific work to be done that can provide regional emission source profiling of sources including but not limited to diesel and leaded gasoline emissions, biomass burning and local meat cooking.

While both the Hong Kong and Guangdong Governments have begun efforts to characterize local emission inventories, they are limited by available funding, not to mention the massive size of the task at hand. This is further complicated by the fact that the PRD is rapidly expanding economically, with a resultant change in the characteristics of pollutant sources. There are no signs this expansion will slow in the future. This means the shelf life of emission inventories are limited and a programme of constant updating is
required to ensure accuracy. Significant cross-border collaboration is also
necessary to ensure the comparability of emission inventory information in
Hong Kong with Guangdong.

4.3 Conduct regular health and economic impacts

Since the overriding rationale for controlling air pollution is the health of the
residents of the PRD region, it is important to have regular information on the
extent to which prevailing levels of air pollution are affecting the health of the
local population. Recent studies have shown that pollution levels in 2002
alone contributed to 800 premature deaths and 8,000 hospital admissions
annually in Hong Kong, costing an estimated HK$1.7 billion annually.¹¹

As many of the control measures in the Joint Regional Management Plan will
require substantial funds to implement, or will affect influential industrial or
business sectors, the two governments will need significant political will to
carry them through. In this respect it would be beneficial to conduct in-depth
cost-benefit analyses of the control measures and the health benefits to
provide political support for the optimal cost-effective measures. There
should be an ongoing programme of health impact studies to establish
population exposure to various types and levels of pollutants and the health
risks associated with those exposures. This information could be used in
developing standards and targets for reducing pollutants to acceptable levels.

In addition to the adverse health consequences of pollution, it also results in
negative economic consequences impacting revenues derived from industries
such as tourism, recreation and property. Moreover investment and economic
expansion in the PRD region may be adversely affected if local and
multinational organizations cannot attract quality personnel to the area due to
the perception that it is unsafe and unattractive as a result of elevated levels of
air pollution.

Leading research in the US attributes economic value to recreational and
residential visibility.¹² While little research in this area has been undertaken
in Asia, many countries recognize that visibility has an economic value. In
Hong Kong, it is anticipated visibility impairment will have an economic
impact on tourist revenues and residential and recreational visibility as Hong
Kong’s topography and hilly terrain provides exceptional views and vistas that
are world famous. With tourism revenues in 2002 amounting to HK$77.4
billion and 40% of Hong Kong’s landmass dedicated to country parks it is
important to understand the economic impact of worsened visibility especially
against the costs required for improved regulatory controls to control
pollution. Further local research into these areas is required to fully
understand the economic implications of pollution and resultant visibility
impacts.

4.4 Build regional capacity

At present, the Special Panel is restricted to helping upgrade the scientific and
technological capabilities of the personnel dealing with air quality issues in the
region.¹³ Yet, the development of air quality management strategies needs the
input of a wide range of experts, including specialists in health and
epidemiology, air monitoring, air modeling, environmental economists, industrial and vehicle design engineering, land use and planning, risk management etc. To effectively upgrade skills and capacity in the air monitoring and management field will require enlisting the support of such specialists.

Cross-border multi-stakeholders collaborative projects, such as a 2-year regional air pilot monitoring project coordinated by Civic Exchange, brought together experts from Hong Kong, Mainland China, the US and Europe to study air quality characteristics within the PRD region\textsuperscript{14}. The combination of wide scientific expertise, relationship development, private sector funding, equipment and training transfer and the implementation of agreed quality assurance procedures added both to the credibility of the study results and the capacity of regional scientists to develop and understand quality regional data.

The experience of other jurisdictions in forming collaborative projects to study air quality is also instructive. In the US, there is a Clean Air Act Scientific Advisory Committee (CASAC), an independent scientific advisory committee of 7 members established under the Clean Air Act, whose role is to provide advice and recommendations related to the EPA’s periodic reviews of the criteria and standards required. To provide the appropriate range of expertise needed for the review of the criteria and standards for different pollutants, a panel of experts is typically formed by supplementing the expertise provided by the seven CASAC members themselves. The panel members are formed from nominees who are recognized, national-level experts in a broad range of disciplines.\textsuperscript{15}

In the European Union, the European Commission (which is responsible for developing and implementing European legislation) has set up an entire program of technical analysis and policy development whose aim is to develop long term, strategic and integrated policy advice on air pollution.\textsuperscript{16} A steering group composed of representatives of the Member States, the European Parliament, stakeholders and relevant international organizations forms the main stakeholder consultation group for the program. In addition there are various Working Groups comprised of international air quality experts, NGOs and industry representatives, whose job it is to advise the Commission on various technical issues.

In Australia, experts from the National Health and Medical Research Council are enlisted to help conduct reviews of air quality standards.

For the PRD Region, an independent scientific/medical committee comprised of experts in a broad range of relevant disciplines from within and outside the region (where expertise within the region may need to be supplemented) is recommended. This committee would have an advisory role but its main task would be initially to review existing air quality research and data to consolidate current knowledge and identify data gaps. The committee should also be tasked with auditing the current Regional Air Quality Management Plan to ensure that, based on existing data and knowledge, the targets and measures proposed are the most appropriate.
4.5 Build political support amongst stakeholders

At present the primary responsibility for developing an air quality management strategy for the region is the Special Panel. The membership of this group is currently confined to officials from the HKSAR and Guangdong Provincial Governments. To effectively improve air quality in the region, the authorities will need the support of all the stakeholders including the private sector, health providers, medical specialists, scientists and NGOs. Since all members of the community ultimately benefit from improved air quality, their participation in the process of developing targets, standards and control plans, needs to be as broad as possible.

As there are countless individuals and organizations in the community who will be affected by the air quality management plans – either in terms of financial or health costs and benefits, the HKSAR and Guangdong Governments may well need to involve them in the management process. The two governments should design and provide a transparent and participatory process so that there can be exchanges of views about targets setting and the current control measures.

In the US, in developing and reviewing standards, there is an established process involving numerous opportunities for consultation with the general public. The opportunities for class action suits and legal appeals in the US, also provides stakeholders with a further opportunity to influence the management strategies. In the European Commission a steering group comprised of different stakeholders is set up to advise the European Commission on standard setting. In Australia, an NGO Advisory Group has been established to facilitate consultation with non-government stakeholders including industry. This advisory group is consulted at key stages in the development and review of various air quality and other standards.

Given the complex nature of air pollution problems facing the region, and the numerous measures that need to be implemented to provide for better air quality, there needs to be a clear and inclusive process for determining the standards and targets to be set, and the emission control strategies to be implemented. Figure A shows a possible process for the region that would arrive at appropriate standards and targets based on broad stakeholder consultation, and help identify the most cost-effective and optimal mix of strategies to achieve those targets.

An NGO advisory committee, analogous to the Australian model, would help involve the key stakeholders, such as industry representatives, health providers, environmental groups, community associations. These would be consulted on draft targets and standards and the results of cost-benefit analyses of the targets and control measures. This would ensure that different points of view are addressed, provide cross-fertilisation of ideas so that the optimum mix of control measures are developed, and provide political support for the air quality management strategy. Not only can this save time and money in the long run, but will also help foster development of ideas and possible new technologies.
Figure A: Flow chart of process for improving air quality management in the PRD

1. **Review existing air quality data & research**
   - HK/PRD Special Panel

2. **Identify additional data needs, e.g.:**
   - emission sources
   - source profiles
   - additional control measures

3. **Establish air monitoring system & conduct further studies on emission sources**

4. **Conduct health impact studies**

5. **Conduct analysis of data:**
   - source apportionment
   - chemical speciation
   - additional control measures

6. **Target setting (selection of standards)**
   - HK/PRD Special Panel

7. **Consultation**

8. **Cost benefit analysis of targets and control measures**
   - Independent scientific/medical committee

9. **Consultation**

10. **Final Air Quality Management Strategy**
    - HK/PRD Special Panel

11. **Audit Regional Air Quality Management Plan**
    - Independent scientific/medical committee

12. **Consultation**

13. **Consultation**

14. **NGO Advisory Committee**
5.0 The Way Forward

To properly control air quality in the region and provide a healthy air environment for residents to breathe and business to prosper, a number of well-coordinated steps will be needed. These steps are inter-linked and necessary to lay the foundation for developing strong regional competence for the entire Hong Kong and South China to be effective in controlling emissions and improving air quality for the fifty million plus residents for the long-term.

Needless to say, political will is needed and the determination to solve problems may well be found through understanding the impacts and costs of air quality deterioration, as well as knowing that economic development and environmental protection need not be mutually exclusive. Indeed, a part of the region’s development plans for the future is to ensure that there will be a well thought-out energy plan that can attract investments to build power plants that supply clean energy throughout the PRD region.

The following actions are recommended:

**Immediate Action**

1. Release of an initial progress report by the Hong Kong and Guangdong authorities to inform the public on the progress of the implementation of the Joint Regional Management Plan over the last two years, and thereafter an annual progress report summarizing progress to meet the Regional Emission Reduction Targets;

2. Release of the on-going effectiveness of the HKSAR Government’s own measures to improve local air quality, such as measures to retrofit vehicles with particulate traps, conversion of taxis from diesel to LPG, etc.

3. Release all completed public health research reports commissioned by the HKSAR Government related to air pollution to enable a wider and deeper public understanding of the impacts and costs involved;

4. Release of funding requests by the Hong Kong Environmental Protection Department (HKEPD) for new air quality related research for 2005-2008 so that priorities could be publicly debated and funding shortfalls made up in view of urgency to solve air pollution problems;

5. Establishment by HKSAR legislators of an Air Quality sub-group under the Legislative Council’s Environmental Affairs Panel, so that legislators may play a more intense role in scrutinizing government plans and actions;

**Short-term Action**

6. Establish the air quality monitoring network across the region as outlined in the Joint Regional Management Plan (see section 4.1);

7. Ensure adequate funding is provided to establish a comprehensive emissions inventory for the region that is regularly updated (see section 4.2);
8. Provide the necessary resources and authority to effectively implement and monitor the Joint Regional Management Plan;

9. Review PM (particularly PM2.5) and Ozone standards for the Hong Kong and the PRD;

Medium-term Action

10. Conduct regular health and economic impact assessments on a long term rather than an ad hoc basis (beyond research already done but yet to be released – see section 4.3);

11. Build cross-border capacity in the economic, scientific, regulatory, inspection and policy sectors to enable middle and top management of both governments to improve understanding of air pollution problems and devise effective solutions (see section 4.4);

12. Build local as well as cross-border political support amongst stakeholders including industry, business and the community for measures to reduce air pollution (see section 4.5);

13. Create a clear and inclusive process for determining standards, targets and control measures to abate regional air pollution (see figure A);

14. Formulate a regional energy plan that considers how investments can be made in the PRD region for clean energy production; and

15. Form an NGO advisory committee on air pollution issues, involving key stakeholders such as industry representatives, health providers, environmental groups and community associations, which can also work on a regional basis in the longer-term (see section 4.5 and figure A).
# Sources of Pollutants including Hong Kong’s Major Sources in 2002

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Caused by:</th>
<th>Major Source in 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide (SO2)</td>
<td>Combustion of sulphur containing fossil fuels.</td>
<td>Power generation (89%); Marine Vessels (5%); Fuel Combustion (industrial/commercial/domestic) (5%);</td>
</tr>
<tr>
<td>Total Suspended Particulates (TSP)</td>
<td>Power stations, construction activities and vehicle exhausts</td>
<td>TSP comes from similar sources to RSP (defined below) – no separate breakdowns are available</td>
</tr>
<tr>
<td>Respirable Suspended Particulates (RSP or PM10)</td>
<td>Combustion sources, in particular diesel vehicle exhaust and emissions from power plants. RSP can also be formed by atmospheric oxidation of SO2 and NO. Dust and marine aerosols are also significant sources.</td>
<td>Vehicles (38%); Power generation (37%); Non-combustion (dust, construction etc.) (15%); Marine Vessel (6%);</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO2)</td>
<td>Fuel combustion.</td>
<td>NOx: Power generation (45%); Vehicles (particularly diesel) (31%); Marine Vessels (16%); Aircraft (4%); Fuel combustion (industrial/commercial/domestic) (3%);</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>Largely through vehicular emissions although a small amount may also come from incomplete combustion of fuels from factories and power stations</td>
<td>Vehicles (90%);</td>
</tr>
<tr>
<td>Photochemical Oxidants (Ozone) (O3)</td>
<td>Ozone is not directly emitted from pollution sources. It is formed by chemical reactions of nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of sunlight and warm temperature.</td>
<td>See breakdowns of sources of the two ozone precursors; NOx and VOCs</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>Leaded petrol (banned in HK since Apr-1999)</td>
<td>Vehicles (100%);</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOC)</td>
<td>Anthropogenic sources (i.e. man made) of VOC’s include combustion and evaporation processes associated with transportation, industry, applications of paints and other surface coatings and general solvent use.</td>
<td>Non Methane VOC: Non combustion (cons. prods., paints, printing etc.) (80%); Vehicles (18%);</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>Predominant contributor to greenhouse gases. Produced through combustion of fossil fuels (wood, natural gas, coal &amp; oil)</td>
<td>Power generation (62%); Vehicles (18%); Waste (12%);</td>
</tr>
</tbody>
</table>

Source: Hong Kong Environmental Protection Department
## Trend of Major Pollutants in Hong Kong, 1990-2002

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Annual Average Concentration in Microgrammes per cubic meter (µg m(^3))</th>
<th>% Increase / Decrease</th>
<th>Highest Annual Average Concentration in 2002 µg m(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pollutant</strong></td>
<td><strong>Year: 1990 (unless otherwise stated)</strong></td>
<td><strong>Year: 2002</strong></td>
<td><strong>Highest Annual Average Concentration in 2002 µg m(^3)</strong></td>
</tr>
<tr>
<td>SO2</td>
<td>Urban - 36</td>
<td>Urban - 20</td>
<td>44% Decrease</td>
</tr>
<tr>
<td></td>
<td>Roadside - 27</td>
<td>Roadside - 18</td>
<td>33% Decrease</td>
</tr>
<tr>
<td>TSP</td>
<td>Urban – 88</td>
<td>Urban - 68</td>
<td>23% Decrease</td>
</tr>
<tr>
<td>RSP or PM10</td>
<td>Urban – 55</td>
<td>Urban – 46</td>
<td>16% Decrease</td>
</tr>
<tr>
<td></td>
<td>Roadside - 91</td>
<td>Roadside - 74</td>
<td>19% Decrease</td>
</tr>
<tr>
<td>NO2</td>
<td>Urban - 53</td>
<td>Urban - 59</td>
<td>11% Increase</td>
</tr>
<tr>
<td></td>
<td>Roadside - 99</td>
<td>Roadside - 92</td>
<td>7% Decrease</td>
</tr>
<tr>
<td>CO</td>
<td>1996: Urban - 490</td>
<td>Urban - 783</td>
<td>60% Increase</td>
</tr>
<tr>
<td></td>
<td>1999: Roadside - 1,324</td>
<td>Roadside - 1,378</td>
<td>0.5% Increase</td>
</tr>
<tr>
<td>O3</td>
<td>Urban – 17</td>
<td>Urban – 28</td>
<td>65% Increase</td>
</tr>
<tr>
<td></td>
<td>1998: Rural - 66</td>
<td>Rural - 63</td>
<td>5% Decrease</td>
</tr>
<tr>
<td>Pb</td>
<td>Total - 70</td>
<td>Total – 60</td>
<td>14% Decrease</td>
</tr>
<tr>
<td>VOC</td>
<td>Not measured</td>
<td>Not measured</td>
<td>Not Available</td>
</tr>
<tr>
<td>CO2</td>
<td>Not measured</td>
<td>Not measured</td>
<td>Not Available</td>
</tr>
</tbody>
</table>

Source: Hong Kong Environmental Protection Department
# Common Pollutants in Hong Kong and their Health Effects

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide (SO2)</td>
<td>Impairment of respiratory function and aggravation of existing respiratory disease causing severe respiratory distress and cardiac illnesses.</td>
</tr>
<tr>
<td>Total Suspended Particulates (TSP)</td>
<td>TSP’s larger than 10 micrometers in aerodynamic diameter are not normally absorbed into the lungs. They mainly cause aesthetic problems such as soiling, dust, soot etc.</td>
</tr>
<tr>
<td>Respirable Suspended Particulates (PM10)</td>
<td>Chronic and acute effects on pulmonary function (deep penetration into the lungs) causing respiratory problems. Effects are enhanced if high RSPs are associated with higher levels of other pollutants such as SO2. Smaller particulates in RSP also impact visibility.</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM2.5)</td>
<td>In general, the smaller the PM the deeper it can penetrate into the respiratory system and the more damage caused. PM2.5 can damage lung tissue, aggravate existing respiratory and cardiovascular diseases and cause cancer.</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO2)</td>
<td>Lowers a person’s resistance to respiratory infections and aggravate existing chronic respiratory diseases.</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>Reduction of oxygen delivery to the body’s organs and tissues. CO poisoning causes shortness of breath, chest pain, headaches and loss of co-ordination. Health threat is increased for those with heart disease.</td>
</tr>
<tr>
<td>Photochemical Oxidants (Ozone)</td>
<td>At low concentrations: cause irritation to the eye, nose and throat. At high concentrations: increase susceptibility to respiratory infections and aggravate pre-existing respiratory illnesses such as asthma.</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>Chronic effects include anemia, slowed nerve conduction, interference with vitamin D metabolism, lower IQ and hearing impairments in children. Affects blood pressure, kidneys, and nervous, immune, cardiovascular, and reproductive systems.</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOC)</td>
<td>VOCs are precursor pollutants contributing to the formation of ground-level ozone and particulate matter. See health impacts of ozone and PM2.5 and PM10.</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>Increases in greenhouse gases can lead to climate change. Hotter temperatures can lead to cardiovascular problems, heat exhaustion and respiratory problems. May also increase the risk of infectious diseases.</td>
</tr>
</tbody>
</table>

Source: Hong Kong Environmental Protection Department
APPENDIX D

The Joint Study: Regional Emission Summary, Contributions of Major Sectors; and Pollution Control Measures.

Base Year (1997) PRD Regional Emissions Summary

<table>
<thead>
<tr>
<th></th>
<th>PRD Economic Zone (PRDEZ)</th>
<th>HK SAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions per capita:</td>
<td>50 kg</td>
<td>40 kg</td>
</tr>
<tr>
<td>Emissions %:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td>88%</td>
<td>12%</td>
</tr>
<tr>
<td>RSP (PM_{10})</td>
<td>95%</td>
<td>5%</td>
</tr>
<tr>
<td>Nox</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>SO₂</td>
<td>87%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Contributions of Major Sectors to Regional Emissions

<table>
<thead>
<tr>
<th>Emission</th>
<th>VOC</th>
<th>PM_{10}</th>
<th>NOx</th>
<th>SO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>1%</td>
<td>15%</td>
<td>42%</td>
<td>54%</td>
</tr>
<tr>
<td>Industry</td>
<td>11%</td>
<td>60%</td>
<td>13%</td>
<td>39%</td>
</tr>
<tr>
<td>Motor Vehicle</td>
<td>55%</td>
<td>14%</td>
<td>31%</td>
<td>4%</td>
</tr>
<tr>
<td>VOC Containing Products</td>
<td>23%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>90%</td>
<td>89%</td>
<td>86%</td>
<td>97%</td>
</tr>
</tbody>
</table>

Pollution Control Measures for the HKSAR and Guangdong

In the HKSAR measures include:
- Encourage the replacement of light diesel buses with light buses using cleaner fuels;
- Require the retrofitting of particulate removal devices on pre-Euro diesel vehicles;
- Enhance the vapor recovery systems at petrol filling stations;
- Tighten the motor fuel standards;
- Tighten vehicle emission standards;
- Reduce the emission of VOC from printing operations, paints and consumer products; and
- Reduce emissions from power stations.

In Guangdong measures include:
- Use of cleaner energy;
- Control the sulphur contents of fuels;
- Reduce emissions from coal-fired and oil-fired power stations;
- Control emissions from industrial boilers and industrial processes;
- Reduce the emission of VOC from paints; and
- Reduce exhaust emissions from motor vehicles.

Source: The Joint Study (see endnote 8)
1 The API is calculated by comparing the measured concentrations of the major air pollutants like respirable suspended particulate (RSP or PM10), sulphur dioxide (SO2), carbon monoxide (CO), ozone (O3) and nitrogen dioxide (NO2) with their respective health related Air Quality Objectives (AQOs). The API ranges from 0 to 500 according to the potential effects on health. If the API exceeds 100, which corresponds to the short-term air quality objectives, health warnings are issued. The API has regularly exceeded the 100 level since the year 2000. In 2003 API readings of over 100 increased by 130% over those recorded in 2002 and individual pollution ‘episodes’ are getting much higher on the scale as evidence by the recent record breaking 201 on 14 September 2004. This indicates a deterioration of local air quality.

2 Public opinion surveys undertaken by the Hong Kong Transition Project (HKTP) in August and September 2004 (as a part of the Hong Kong Legislative Council Election analysis) revealed that air and water pollution are areas of concern that continue to trouble more than half the people living in Hong Kong at a ‘fairly’ or ‘very worried’ level, with one in four people very worried about it. “Half-way to Where? The Electoral Structures and Public Opinion Contexts”: 2004 Hong Kong Legislative Council Election” August 2004, HKTP, published by Civic Exchange (available at www.civic-exchange.org under publications).

3 For further information on PM standards in Hong Kong, including a review of these standards compared to the US, Europe and Australia, see “Air Pollution: A review of particulate matter standards in Hong Kong”, November 2004, by Lisa Hopkinson, Civic Exchange (http://civic-exchange.org, under publications, November 2004).

4 According to HKEPD, in 2002 short term AQO were exceeded in eight of 14 districts where air quality is monitored for NO2, and six of 11 districts for O3. With respect to long-term (annual) AQO, three of 14 districts also failed to comply with the limit for RSP/PM10 and two of the 14 districts failed to comply for NO2.


6 PM2.5 refers to particles in the air with an aerodynamic diameter of less than 2.5 micrometers (µm), while PM10 refers to relatively larger particles with an aerodynamic diameter of less than 10 µm. Further details of PM standards and levels in Hong Kong and the Pearl River Delta region can be found in “Air Pollution: Particulate Matter Standards in Hong Kong and the Pearl River Delta Region”, see endnote 3.

7 “Air Pollution: Particulate Matter Standards in Hong Kong and the Pearl River Delta Region”, see endnote 3.


9 Section 3.2 of the Executive Summary of “Study of Air Quality in the Pearl River Delta Region”, see endnote 8.

10 The Civic Exchange Pilot Air Monitoring Project (see endnote 14), used an Observation Based Model (OBM) to infer the influence of a variety of sources on air quality in Hong Kong, as opposed to the Joint Study, which used an Emission Based Model (EBM). An OBM collects samples of ambient concentrations of pollutants (i.e. air samples) and along certain analytical techniques is able to evaluate the accuracy of existing emission inventories and assess the relative benefits of various control strategies. Conversely EBMs use emission inventories (largely US created) adapted for local conditions which serve as inputs into sophisticated models to ultimately define the pollutant sources in the air. An OBM is considered a complementary approach to the use of EBM methods, as it avoids some of the uncertainties inherent in an EBM (largely because it does not use emission inventories).

11 Department of Community Medicine, The University of Hong Kong: “Provision of Service for “Study of Short-term Health Impact and Costs Due to Road Traffic Related Air Pollution” HKEPD Tender Ref: AS00-378, March 2002.

12 Further information on international best practice at valuing the economic effects of visibility, including implications for Hong Kong can be found in: “Air Pollution: Evaluating

13 The terms of reference of the Special Panel comprise: (1) To consider the enhanced control measures recommended in the Report of the "Joint Study on Air Quality in the Pearl River Delta (PRD) Region" and, having assessed their feasibility, recommend to the Hong Kong - Guangdong Joint Working Group on Sustainable Development and Environmental Protection (JWG) the work priority and an action plan for the implementation of a series of additional preventive measures; (2) To set up a PRD regional air quality monitoring network to monitor and analyze the changes in regional air quality; (3) To help upgrade the scientific and technological capabilities of the personnel dealing with air quality issues in the region through strengthening technical exchanges and training; (4) To analyze the effectiveness of the joint air pollution preventive measures in the PRD region; (5) To collect local and overseas information on new technology and measures for improving regional air quality, and study the feasibility of introducing those technologies and measures into the PRD region; (6) To closely monitor the tightening of motor diesel standards in Hong Kong and Guangdong and study the feasibility of enhancing the motor diesel standards of both sides; (7) To report progress to the Expert Group under the JWG.

14 For more information on the 2-year collaborative “Hong Kong and Pearl River Delta Pilot Air Monitoring Study” coordinated by Civic Exchange refer to http://www.ce.gatech.edu/~mhbergin/hk_prd_public. The Project results are expected to be published in November 2004 and will be available thereafter from Civic Exchange (http://civic-exchange.org, under publications, November 2004).

15 For example, Atmospheric Science; Exposure and Risk Assessment/Modeling; Ecological Effects and Resource Valuation; Dosimetry; Toxicology; Controlled Human Exposure; Epidemiology and Biostatistics.


17 Since 2000, the HKSAR Government has implemented various programmes to retrofit various types of diesel vehicles with emission reduction devices and converting diesel taxis to liquid petroleum gas. While there are records of the retrofitting programmes provided to the Hong Kong Legislative Council, there is no report on the on-going effectiveness of the programmes on the levels of pollution. For a list of the various measures dealing with local vehicles, see LegCo Paper CB(1) 79/04-05(04) from the Environment, Transport and Works Bureau, October 2004.