CHAPTER SIX AIR QUALITY

1. With the extent of development forecast, the protection of air quality is a fundamental concern. The deterioration in air quality, especially in the Metro Area and NWNT, has been the focus of much public attention and was a key issue arising from the TDS Review. The main contributors to the decline in air quality were identified as industrial and vehicle traffic emissions as a consequence of the scale of developments proposed within the Territory and in the PRD.

2. To enable the extent of these issues to be quantified, a box model was developed to represent the ten major ACZs in the Territory. The fundamental aim of the air quality assessments was to identify whether each of the ACZs could accommodate the level of emissions forecast as a result of the transport and industrial proposals without compromising the Air Quality Objectives (AQOs). The three Medium-Term Options were modelled and the air quality impacts under three different vehicle emissions control scenarios were assessed.

Criteria Adopted

3. Analyses of monitored hourly air quality data indicate that Hong Kong's AQOs may be under threat when the predicted annual concentrations of SO_2 and NO_2 reach $40\mu g/m^3$. Thus, a preliminary indication of potential air quality problems was set at $40\mu g/m^3$ for both SO_2 and NO_2 for the TDS Review (referred to hereafter as the trigger level). The model input relates to NO_x emission rates, and thus the output generated must be converted to NO_2 when comparing the results with Hong Kong's AQOs.

4. As previously noted, the formulation of the box model does not allow for vertically disparate emission sources to be simulated together. Since ground level emissions have a more direct impact on the area of concern, the box model has been set up to assess only the impact of low level emissions.

Discussion of Results

Traffic Emissions

5. The results of the traffic tests for the three medium-term options were used as input to the air quality model and the results are summarised in Table 6.1. On the basis of the results obtained under vehicle emissions control EURO I and EURO II, it is apparent that the trigger level for AQOs NO_2 will likely be exceeded in Tuen Mun ACZ at 2006 as a result of vehicular emissions only, regardless of the scenario adopted.

6. If the cumulative impacts of vehicle traffic and industrial emissions are considered, then the trigger levels in Tuen Mun will be exceeded by between 13% for Recommended Strategy and 15% for NT-Biased Option. There is thus relatively little difference between the three options although the NT-Biased Option gives marginally more cause for concern than the other two options because of the topographical constraints in the area.

7. As anticipated, the forecast pollution levels are highest under the NT-Biased scenario in Tuen Mun ACZ. Although this equates to 2%, in numerical terms difference, this still indicates exceedance of AQOs. Two additional sensitivity tests were conducted, which assumed higher penalties for smoky vehicles, maintenance and inspection programmes and diesel to petrol programmes.

8. The results of the sensitivity tests are given in Tables 6.2 and 6.3.

Scenario (i)	:	EURO I/0.2% Sulphur diesel (1995) and EURO II/0.05% Sulphur diesel (1997)
Scenario (ii)	:	Higher penalties for smoky vehicles and inspection, maintenance programme (sensitivity test)
Scenario (iii)	:	Diesel to petrol programme (sensitivity tests)

9. From the results of the air quality modelling study, it may be surmised that a 5% reduction in emissions could be achieved in Tuen Mun if EURO I, EURO II and higher penalties for smoky vehicles and improved maintenance were all implemented. If the diesel to petrol programme was also implemented a reduction of 7% in emissions could be achieved.

10. Similar reductions are forecast under the three medium-term options. It is pertinent to note that, although the trigger levels of AQOs for NO_2 are not under threat for vehicle emissions, the cumulative impacts of vehicle and industrial emissions are still predicted to exceed the trigger levels in Tuen Mun ACZ, regardless of the medium-term options adopted.

11. Under the NT-Biased Option, the redistribution of vehicles is also forecast to increase the pollution load to be assimilated in the Yuen Long, Fanling/Sha Tau Kok and Lantau ACZs. This emphasis the "knock-on" effects of the proposals which seek to shift the emphasis from a balanced approach to the NT-Biased Option.

12. Under the HB-Biased Option, not unexpectedly, the emissions are higher in the Harbour ACZ, compared to the Recommended or NT-Biased Options. Other ACZs in the HB-Biased Option which are shown to be more adversely affected by the shift in development to the Metro Area include Hong Kong Island South Lamma and, to a much lesser extent, Tseung Kwan O.

13. On the basis of the model results, it may be surmised that the Recommended Strategy would cause the least deterioration in air quality, of the three options although there is certainly no room for complacency and very stringent measures will need to be adopted to alleviate the existing and forecast air quality problems especially in Tuen Mun ACZ.

14. Respirable suspended particulates (RSP) cannot be modelled within the linked box model framework and, thus, routine monitoring data (provided by EPD) and the traffic forecasts were used previously to give an indication of any areas of particular concern. Assuming that goods vehicles are the major source of vehicular RSP it may be surmised, for the purposes of this assessment, that at least 50% of the RSP generated throughout the Territory is due to this category of vehicles.

Table 6.1 Summary of SO_2 and NO_2 Concentration due to Traffic Development - Scenario i only

Air Control Zone	SO_2 Concentration ($\mu g/m^3$)			NO_2 Concentration ($\mu g/m^3$)		
	Strategic Growth			Strategic Growth		
	NT-Biased Option	HB-Biased Option	Recommended Strategy	NT-Biased Option	HB-Biased Option	Recommended Strategy
1. Harbour	2.555	2.674	2.605	34.353	35.950	34.987
2. Tseung Kwan O	0.583	0.587	0.587	7.942	8.024	7.985
3. Lantau	1.046	0.995	1.029	13.477	12.805	13.191
4. Fanling/Sha Tau Kok	0.394	0.361	0.365	5.171	4.631	4.687
5. Port Shelter	0.050	0.051	0.050	0.670	0.695	0.680
6. South HK Island/Lamma Island	0.269	0.282	0.280	3.840	4.032	4.016
7. Tolo Harbour	0.773	0.753	0.749	10.908	10.604	10.502
8. Tsuen Wan/Kwai Tsing	2.097	2.143	2.093	27.337	27.867	27.179
9. Tuen Mun	3.179	3.150	3.141	41.217	40.570	40.438
10. Yuen Long	0.947	0.878	0.902	12.359	11.186	11.591

NB - Convert NO_x to NO_2 by x 0.7

Table 6.2 Summary of SO_2 and NO_2 Concentration due to Traffic Development - Scenario i & ii only

Air Control Zone	SO_2 Concentration ($\mu g/m^3$)			NO_2 Concentration($\mu g/m^3$)		
	Strategic Growth			Strategic Growth		
	NT-Biased Option	HB-Biased Option	Recommended Strategy	NT-Biased Option	HB-Biased Option	Recommended Strategy
1. Harbour	2.555	2.674	2.605	32.732	34.256	33.346
2. Tseung Kwan O	0.583	0.587	0.587	7.513	7.591	7.556
3. Lantau	1.046	0.995	1.029	12.832	12.197	12.565
4. Fanling /Sha Tau Kok	0.394	0.361	0.365	5.392	4.845	4.902
5. Port Shelter	0.050	0.051	0.050	0.638	0.662	0.647
6. South HK Island/Lamma	0.269	0.282	0.280	3.626	3.808	3.792
7. Tolo Harbour	0.773	0.753	0.749	10.378	10.087	9.995
8. Tsuen Wan/Kwai Chung	2.097	2.143	2.093	25.864	26.369	25.722
9. Tuen Mun	3.179	3.150	3.141	39.097	38.490	38.372
10. Yuen Long	0.947	0.878	0.902	11.631	10.547	10.920

NB - Convert NO_x to NO_2 by x 0.7

Table 6.3 Summary of SO_2 and NO_2 Concentration due to Traffic Development- Scenario i, ii & iii only

Air Control Zone	SO_2 Concentration ($\mu g/m^3$)			NO_2 Concentration ($\mu g/m^3$)		
	Strategic Growth			Strategic Growth		
	NT-Biased Option	HB-Biased Option	Recommended Strategy	NT-Biased Option	HB-Biased Option	Recommended Strategy
1. Harbour	1.714	1.795	1.749	31.373	32.839	31.962
2. Tsueng Kwan O	0.382	0.390	0.386	7.179	7.266	7.223
3. Lantau	0.751	0.713	0.740	12.374	11.754	12.116
4. Fanling/Sha Tau Kok	0.339	0.315	0.319	5.286	4.760	4.817
5. Port Shelter	0.033	0.034	0.034	0.611	0.634	0.620
6. South HK Island/Lamma	0.193	0.202	0.201	3.496	3.670	3.654
7. Tolo Harbour	0.581	0.575	0.564	10.090	9.830	9.720
8. Tsuen Wan/Kwai Chung	1.590	1.620	1.589	25.194	25.672	25.055
9. Tuen Mun	2.485	2.451	2.455	38.163	37.541	37.450
10. Yuen Long	0.723	0.672	0.692	11.336	10.286	10.653

NB - Convert NO_x to NO_2 by x 0.7

15. Considering the results of the monitoring data collected by EPD, illustrated by Figure 6.1, it is evident that at present only the station at Sha Tin marginally complies with the AQO while all other annual statistics demonstrate non-compliance. Increases in RSP due to increased vehicle fleets (including goods vehicles, taxis and buses) and vehicle kilometers travelled through the ACZs could cause a further deterioration in air quality.

Industrial Emissions

16. From the interpretation of the results given in Tables 6.4 and 6.5 it is apparent that areas where air quality (SO_2) could be adversely affected by industrial emissions are Harbour ACZ, Tuen Mun ACZ and to a lesser extent Tsuen Wan/Kwai Chung ACZ.

17. It should be noted that the trigger level for the AQO's for SO_2 will not be exceeded for the industrial scenarios in isolation, nor will the contribution of SO_2 from vehicular sources be significant enough to elevate the forecasts to trigger levels even in Tuen Mun. However, this does not preclude the need to aim for a further decrease in the industrial emissions to improve air quality especially in Harbour and Tuen Mun.

Dusts

18. The primary concerns associated with dust generation relate to health, and as dust is a territory wide issue, there is clearly a need to study this problem in detail and to define effective measures to minimise ambient dust levels.

19. Large scale development plans such as those predicted for the HB-Biased Option, which require a considerable amount of land formation and construction works to be undertaken, are likely to result in increased levels of dust in the atmosphere. The annual TSP values recorded at the EPD routine monitoring stations are illustrated by Figure 6.2 and indicate non-compliance with the AQO's at all stations. Increases in land requirements on the scale forecast (even if these are not on reclamation) will result in further increases in the TSP levels recorded.

20. It will therefore be imperative, regardless of the Medium-Term Strategy adopted, to ensure all reasonable measures are taken to minimise fugitive dust emissions as far as practical. Dusts from construction works are a serious issue to be considered and while dust control has been practised in the Territory over the past few years on the major construction sites, more stringent enforcement may be required in future.

Industries Within Confined Airsheds

21. Descriptions of topographical constraints on the airsheds in relation to prevailing air quality were adopted from the Baseline Studies Report. It is apparent that the greatest number of exceedances of the AQOs occur in the Metro Area and the industrial developments located therein could cause concern in terms of future air quality.

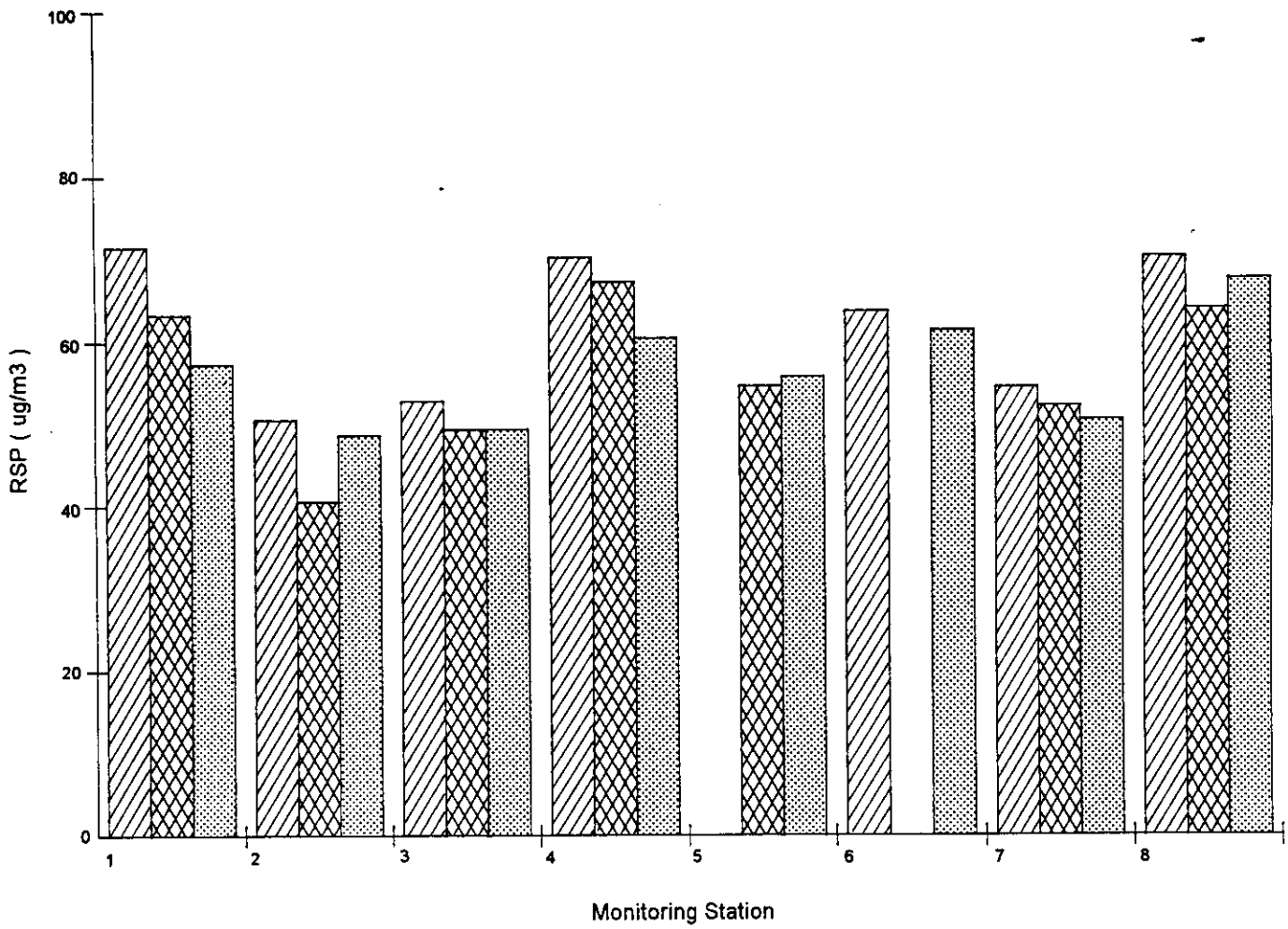
22. Serious consideration will also need to be given to the NT-Biased Option in which more vehicles will be used to convey workers/materials/products around the territory. Moreover, the promotion of 'clean' industries and the changing face of the industrial sector especially in the Metro Area would suggest that this is not such a major issue as the vehicle emissions in confined airsheds.

Table 6.4 Summary of NO_2 Concentration ($\mu g/m^3$)

Air Control Zone	NT-Biased Option	HB-Biased Option	Recommended Strategy
1. Harbour			
Industry	3.7	3.8	3.8
Traffic	34.3	35.9	35.0
Total	37.1	39.7	38.8
2. Tseung Kwan O			
Industry	1.3	1.3	1.3
Traffic	7.9	8.0	8.0
Total	9.2	9.3	9.3
3. Lantau			
Industry	1.9	1.6	1.6
Traffic	13.5	12.8	13.2
Total	15.1	14.4	14.8
4. Fanling/Sha Tau Kok			
Industry	0.6	0.5	0.5
Traffic	5.2	4.6	4.7
Total	5.7	5.1	5.2
5. Port Shelter			
Industry	0.6	0.6	0.6
Traffic	0.7	0.7	0.7
Total	1.3	1.3	1.3
6. South Hong Kong Island			
Industry		0.5	0.5
Traffic	0.5	4.0	4.0
Total	3.8	4.5	4.5
	4.3		
7. Tolo			
Industry	1.4	1.4	1.4
Traffic	10.9	10.6	10.5
Total	12.3	12.0	11.9
8. Tsuen Wan/Kwai Chung			
Industry	2.8	2.8	2.8
Traffic	27.3	27.9	27.2
Total	30.1	30.7	30.0
9. Tuen Mun			
Industry	4.9	4.9	4.9
Traffic	41.2	40.6	40.4
Total	46.1	45.5	45.3
10. Yuen Long			
Industry	1.0	1.0	1.0
Traffic	12.4	11.2	11.6
Total	13.4	12.2	12.6

Table 6.4 Summary of SO_2 Concentration ($\mu g/m^3$)

Air Control Zone	NT-Biased Option	HB-Biased Option	Recommended Strategy
1. Harbour			
Industry	20.8	21.4	21.4
Traffic	2.6	2.7	2.6
Total	24.0	24.7	24.0
2. Tseung Kwan O			
Industry	7.2	7.2	7.2
Traffic	0.6	0.6	0.6
Total	7.8	7.8	7.8
3. Lantau			
Industry	10.4	9.2	9.2
Traffic	1.0	1.0	1.0
Total	10.2	10.2	10.2
4. Fanling/Sha Tau Kok			
Industry	3.1	3.0	3.0
Traffic	0.4	0.4	0.4
Total	3.4	3.4	3.4
5. Port Shelter			
Industry	3.6	3.4	3.4
Traffic	0.05	0.05	0.05
Total	3.4	3.4	3.4
6. South Hong Kong Island			
Industry	2.7	2.8	2.8
Traffic	0.3	0.3	0.3
Total	3.1	3.1	3.1
7. Tolo			
Industry	8.3	7.9	7.9
Traffic	0.8	0.8	0.8
Total	8.7	8.7	8.7
8. Tsuen Wan/Kwai Chung			
Industry	15.6	15.6	15.6
Traffic	2.1	2.1	2.1
Total	17.7	17.7	17.7
9. Tuen Mun			
Industry	28.0	27.8	27.8
Traffic	3.2	3.2	3.1
Total	31.0	31.0	30.9
10. Yuen Long			
Industry	5.7	5.6	5.6
Traffic	1.0	0.9	0.9
Total	6.6	6.5	6.5

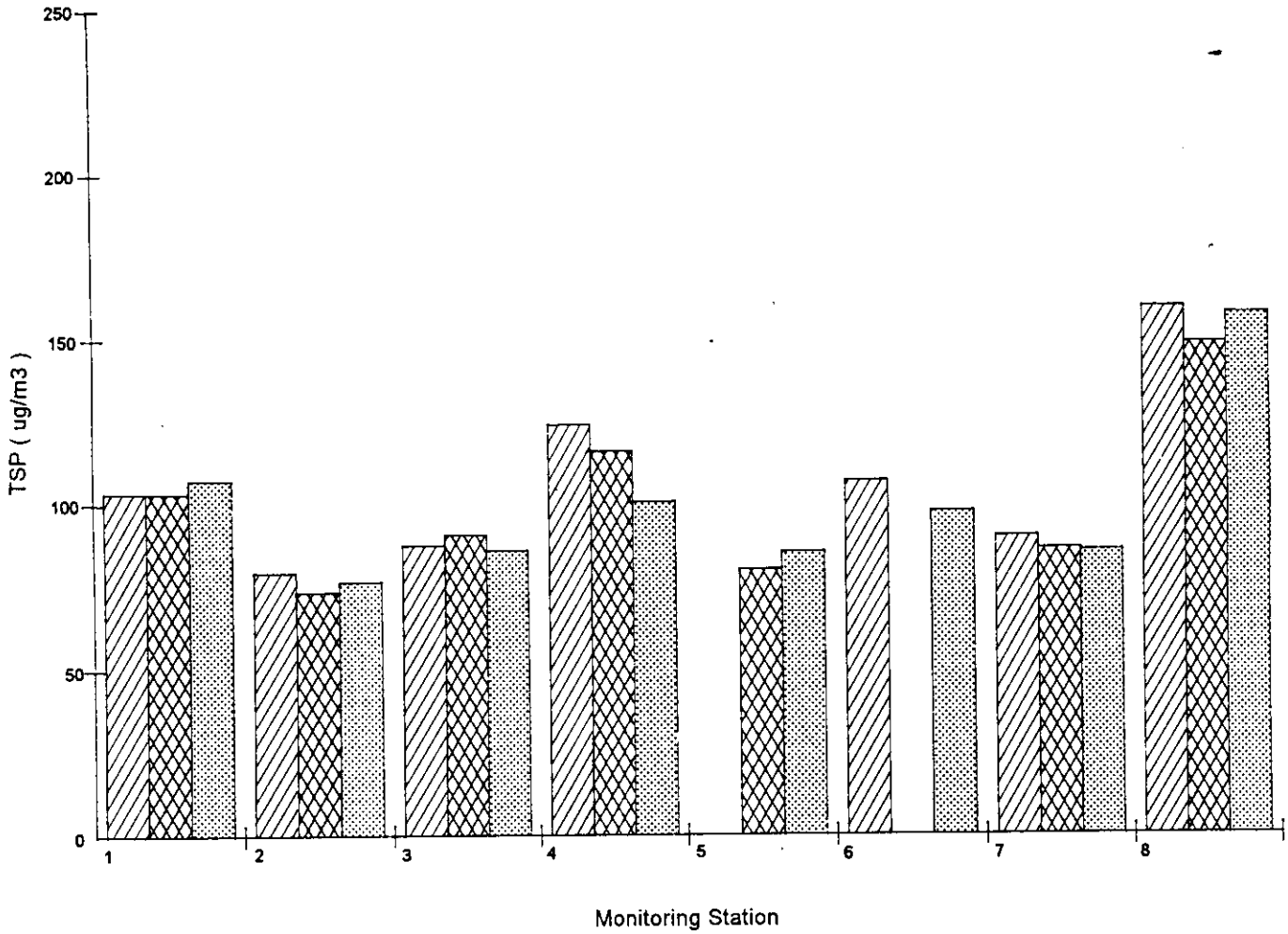


Legend : Monitoring Stations

1 : Kwun Tong
2 : Sha Tin
3 : Tai Po
4 : Sham Shui Po
5 : Central and Western
6 : Tsuen Wan
7 : Kwai Chung
8 : Mong Kok

1992
1993
1994

Figure 6.1 Results of Monitoring RSP at Fixed Stations



Legend : Monitoring Stations

1 : Kwun Tong
2 : Sha Tin
3 : Tai Po
4 : Sham Shui Po
5 : Central and Western
6 : Tsuen Wan
7 : Kwai Chung
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1992
1993
1994

Figure 6.2 Results of Monitoring TSP at Fixed Stations