TECHNICAL ANNEX 5

Future Development Trends and Emissions in the Pearl River Delta Region

List of Tables

List of Figures

1 INTRODUCTION

1.1 Constraints and Assumptions

1.1.1 There had been limited references on future year economic and production activities for PRDEZ when the future development scenarios were projected. A number of studies were in progress, however, intermediate findings were not recognised as appropriate references for the purpose of this Study. All data quoted in this Study were either collected from official or published sources such as reports and yearbooks as listed in the reference sections.

1.1.2 It is understood that various planning and infrastructure studies are on-going for both HKSAR and PRDEZ which may have bearing on the development trends in the coming decade. However, due to the time frame of this Study, only reports available officially as of June 2000 were considered.

1.1.3 Certain Mainland references presented future projections up to year 2010 were prepared during 1994-95. The data had been reviewed based on historical trends and modification has been made if necessary. Year 2015 projection data for PRDEZ has not available as Mainland has still preparing the 10th Five-Year Plan. The 2015 figures therefore were based on the 2010 figures with appropriate modification or extrapolation to cater for the future growth.

2 SOCIO-ECONOMIC CHARACTERISTICS

2.1 Economic Structure

Regional Economy

2.1.1 The pace of growth in many Asian economies has been impressively fast before the financial crisis in October 1997. In the period between 1992 and 1996, gross domestic product (GDP) in Asia has been growing at an average annual rate of 9.1% in real terms (see Table 2-1). This growth rate was three times as fast as for the world economy. Mainland China was the largest contributor to this growth. The average annual real GDP growth in mainland China was 12.1% in that period of time.

2.1.2 As a result of the 1997 regional financial turmoil, the economies in Asia were in severe recession in 1998. Real GDP in many Asian countries/regions, including HKSAR, experienced negative growth, reversing a robust growth trend. Mainland China, in contrast, did not fall into recession. Despite the financial crisis, the Chinese economy posted a growth of 7.8% in 1998. The resulting overall GDP growth in Asia was slowed to 3.8% in 1998, down from 6.7% of the previous year. The Asian economic outlook at that time was generally pessimistic.

2.1.3 The financial crisis was quickly resolved in 1999. The recovery was also much stronger than expected. A sharp rebounce in economic growth was recorded in many crisis affected countries. Overall real GDP growth in Asia has resumed to 6% in 1999 – a rate twice as fast as for the world economy. The growth in Korea and mainland China was particularly strong. The outlook of Asian economies also changed dramatically. The robust recovery in 1999 was anticipated to continue in 2000 and 2001. GDP growth was forecast to be 6.2% in 2000 and 5.9% in 2001 by the International Monetary Fund.

Table 2-1 Real GDP Growth in Selected Countries/Regions (%)

	1982-91 Average	1992-01 Average	1992	1993	1994	1995	1996	1997	1998	1999	2000*	2001*
World	3.3	3.4	2.0	2.3	3.7	3.6	4.1	4.1	2.5	3.3	4.2	3.9
Asia	6.9	7.4	9.4	9.4	9.6	9.0	8.3	6.7	3.8	6.0	6.2	5.9
HKSAR	6.1	3.9	6.3	6.1	5.4	3.9	4.5	5.0	-5.1	2.9	6.0	4.7
Japan	4.1	1.0	1.0	0.3	0.6	1.5	5.0	1.6	-2.5	0.3	0.9	1.8
S. Korea	8.9	5.6	5.4	5.5	8.3	8.9	6.8	5.0	-6.7	10.7	7.0	6.5
Taiwan	8.1	6.0	6.8	6.3	6.5	6.0	5.7	6.8	4.7	5.5	6.2	6.0
Singapore	6.8	7.2	6.6	12.8	11.4	8.0	7.5	8.4	0.4	5.4	5.9	6.0
Mainland China	9.6	9.7	14.2	13.5	12.6	10.5	9.6	8.8	7.8	7.1	7.0	6.5
Philippines	1.3	3.4	0.3	2.1	4.4	4.7	5.8	5.2	-0.5	3.2	4.5	4.5
Malaysia	6.3	6.4	8.9	9.9	9.2	9.8	10.0	7.5	-7.5	5.4	6.0	5.8
Thailand	8.1	4.0	8.1	8.4	9.0	8.9	5.9	-1.8	-10.4	4.2	4.5	5.0
Vietnam	5.9	6.9	8.6	8.1	8.8	9.5	9.3	8.2	3.5	3.5	4.5	5.5
India	5.4	6.0	4.2	5.0	6.7	7.6	7.1	5.8	4.7	6.8	6.3	6.1
Indonesia	5.5	3.4	7.2	7.3	7.5	8.2	8.0	4.5	-13.2	0.2	3.0	3.5

**forecast*
Source: International Monetary Fund World Economic Outlook Spring 2000

HKSAR

2.1.4 In 1999, GDP in HKSAR was US$159 billion and GDP per capita reached US$23,640 (see Table 2-2). This level of GDP per capita was among the highest in the world, comparable to the United Kingdom (US$24,632), France (US$24,594), Canada (US$20,874) and Australia (US$20,696). In Asia, GDP per capita in HKSAR was the third-highest, next to Japan and Singapore.

2.1.5 In the period from 1992 to 1997, the average GDP growth in HKSAR was 5.2% per annum in real terms. This growth rate outperformed the world economy significantly. In 1998, HKSAR experienced a deep recession – the economy contracted by 5.1%. However, the economy of HKSAR adjusted promptly to provide a solid base for continued recovery. In 1999 HKSAR enjoyed a robust recovery, the economy grew at about 3% in real terms. The official forecast of real GDP growth is 6% in 2000.

Table 2-2 GDP and GDP per capita in Selected Asian Countries/Regions

Country	GDP (billion US$ at current prices)			GDP per capita (US$ at current prices)		
	1997	1998	1999	1997	1998	1999
HKSAR	171	164	159	26,624	24,894	23,640
Japan	4,212	3,808	4,349	33,470	30,177	34,402
S. Korea	476	317	407	10,382	6,840	8,712
Taiwan	283	261	282	13,032	11,857	12,700
Singapore	95	83	85	28,970	24,496	24,808
Mainland China	898	959	991	730	772	791
Philippines	82	65	74	1,136	882	975
Malaysia	100	72	79	4,801	3,411	3,640
Thailand	151	112	124	2,475	1,826	1,994
Vietnam	27	27	28	350	349	350
India	402	416	443	422	430	449
Indonesia	216	94	152	1,079	461	729

Source: International Monetary Fund World Economic Outlook Spring 2000

Mainland China

2.1.6 In 1999, GDP in the Mainland was US$991 billion and GDP per capita was US$791 (Table 2.3). This level of GDP was the seventh-highest in the world, next to the United States (US$9,256 billion), Japan (US$4,349 billion), Germany (US$2,115 billion), the United Kingdom (US$1,437 billion), France (US$1,435 billion) and Italy (US$1,173 billion). In Asia, GDP in Mainland China was the second-highest, next only to Japan.

2.1.7 Real GDP growth in mainland China was among the highest in the world. The average annual figure was 10.5% in the period from 1992 to 1999. This growth rate was three times as fast as for the world economy. The economic outlook is also optimistic. Many analysts placed great faith in China's ongoing integration into the global economy. It was anticipated that China's entry into the World Trade Organisation (WTO) and the resultant implementation of market opening reforms would stimulate economic growth particularly in the medium to long term. The State Development Planning Commission of China targeted continuous rapid economic expansion at a rate of no less than 7% per annum to year 2015. The Chinese economy inevitably has plenty of room to grow, considering its GDP per capita was as low as US$791 in 1999.

2.2 Local Economy

Gross Domestic Product

2.2.1 In 1998, GDP in HKSAR and PRDEZ totalled HK$1,798 billion (see Table 2-3). The shares of HKSAR and PRDEZ were 30% and 70% respectively. GDP per capita in HKSAR was HK$189,443 in 1998. Within PRDEZ, Zhaoqing recorded the lowest GDP per capita figure of HK$8,771, representing less than 5% of that in HKSAR while Shenzhen recorded the highest GDP per capita of HK$29,871, which was equivalent to about 15% of that in HKSAR. In 1998, the GDP in the PRDEZ area contributed to about 70% of GDP in Guangdong Province. This was equivalent to about 7% of the national total.

2.2.2 In 1998, HKSAR fell into severe recession, their economies contracted by 5.1% and 4.6% respectively. The economies in the PRDEZ area, in contrast, grew by 9.1% to 19.8% despite the regional financial crisis. This level of growth was significantly higher than the national growth of 7.8%.

Table 2-3 GDP and GDP per capita in the Region

Study Area	1997				1998			
	Production Based	Real Growth	Expenditure Based	Real Growth	Production Based	Real Growth	Expenditure Based	Real Growth
GDP (at current prices, million HK$)								
HKSAR	1,318,035	4.5%	1,323,862	5.0%	1,244,965	-8.1%	1,266,840	-5.1%
PRDEZ	480,993	--	477,063	--	536,807	--	531,183	--
Guangzhou	147,752	13.4%	146,510	--	165,285	13.1%	163,710	--
Shenzhen	101,419	16.0%	98,145	--	115,690	14.5%	111,973	--
Zhuhai	21,109	11.2%	21,109	--	23,649	11.9%	23,594	--
Huizhou	28,592	17.0%	28,519	--	31,952	15.7%	31,878	--
Dongguan	26,450	17.8%	26,450	--	31,907	19.8%	31,907	--
Zhongshan	19,830	14.0%	19,830	--	22,351	13.2%	22,351	--
Jiangmen	41,094	7.2%	43,729	--	43,249	9.1%	44,374	--
Foshan	65,030	15.3%	63,672	--	70,235	13.1%	68,908	--
Zhaoqing	29,716	14.4%	29,099	--	32,489	13.2%	32,489	--
GDP per capita (at current prices, HK$)								
HKSAR	--	--	203,605	1.9%	--	--	189,443	-7.8%
PRDEZ	--	--	--	--	--	--	--	--
Guangzhou	22,343	11.7%	--	--	24,658	11.6%	--	--
Shenzhen	27,481	10.6%	--	--	29,871	9.1%	--	--
Zhuhai	19,068	5.5%	--	--	20,057	5.1%	--	--
Huizhou	10,859	14.7%	--	--	11,912	13.5%	--	--
Dongguan	18,094	16.4%	--	--	21,568	18.4%	--	--
Zhongshan	15,540	12.6%	--	--	17,297	11.8%	--	--
Jiangmen	10,938	6.5%	--	--	11,442	8.4%	--	--
Foshan	20,416	13.5%	--	--	21,747	11.5%	--	--
Zhaoqing	8,143	12.5%	--	--	8,771	11.5%	--	--

-- not available
Source: HK Census & Statistics Department
1998 Statistical Yearbook of Guangdong P92 Table 2-18 P93 Table 2-19 P95 Table 2-22 P97 Table 2-25
1999 Statistical Yearbook of Guangdong P104 Table 2-19 P105 Table 2-20 P107 Table 2-23 P109 Table 2-26

Employment

2.2.3 In 1998, the working population in HKSAR and the PRDEZ totalled 21.7 million (see Table 2-4). The shares of HKSAR and PRDEZ were 15% and 85% respectively. Within the PRDEZ area, the working population was the lowest in Zhuhai (0.7 million), the highest figure was recorded in Guangzhou (4.5 million).

2.2.4 Official unemployment rates in HKSAR and mainland China were 5.7% and 3.5% respectively in 1998. The official unemployment rate in Guangzhou was about 1%. It was however believed that unemployment rates in mainland China were understated and actual figures could be a lot higher because many did not register their unemployment status with the government.

Table 2-4 Employment Figure in the Region

Study Area	1997	1998
HKSAR	3,150,000	3,210,000
PRDEZ	17,985,124	18,440,035
Guangzhou	4,347,469	4,511,295
Shenzhen	2,720,145	2,863,680
Zhuhai	689,980	702,878
Huizhou	1,809,463	1,830,317
Dongguan	876,053	877,489
Zhongshan	1,027,725	1,050,530
Jiangmen	2,233,189	2,230,946
Foshan	2,306,500	2,385,600
Zhaoqing	1,974,600	1,987,300

Source:
HK Census and Statistics Department (Composite Employment Estimates)
1999 Guangzhou Statistical Yearbook P96 Table 3-33, 1998 Shenzhen Statistics and Information Yearbook P122 Table 2-4,
1999 Shenzhen Statistics and Information Yearbook P118 Table 2-4, 1999 Zhuhai Statistical Yearbook P91 Table 3-9,
1998 Huizhou Statistical Yearbook P50 Table 1-5, 1999 Huizhou Statistical Yearbook P181 Table 1-5,
1999 Dongguan Statistical Yearbook P78 Table 2-7, 1998 Zhongshan Statistical Yearbook P62,
1998 Jiangmen Statistical Yearbook P58 Table 2-3, 1999 Jiangmen Statistical Yearbook P72 Table 2-3,
1999 Foshan Statistical Yearbook P285 Table 10-1, 1999 Zhaoqing Statistical Yearbook P164 Table 4-1

Income of Workers

2.2.5 In 1998, the average monthly income of workers (excluding managerial staff and professionals) in HKSAR was HK$11,384 (see Table 2-5). The average monthly income of workers in the PRDEZ area ranged from HK$531 in Zhaoqing to HK$1,356 in Shenzhen. In Guangdong Province, the income of workers engaged in primary industry was significantly lower than that of workers engaged in other employment sectors.

Table 2-5 Average Monthly Salaries of Employees (HK$) in the Region

Study Area	1997	1998
HKSAR*	11,113	11,384
PRDEZ***	--	--
Guangzhou	981	1,071
Shenzhen	1,236	1,356
Zhuhai	957	1,010
Huizhou	521	555
Dongguan	800	837
Zhongshan	826	872
Jiangmen	609	595
Foshan	807	818
Zhaoqing	533	531

-- not available
** for employees up to supervisory level (managerial and professional employees are not included)*
*** Median figures*
****figures exclude bonuses and subsidies*
1 HK$ = 1.1142 yuan
Source:
HK Census and Statistics Department, 1998 Statistical Yearbook of Guangdong P144 Table 5-29, 1999 Statistical Yearbook of Guangdong P160 Table 5-24

2.3 Economic Sectors

2.3.1 The relative importance of the various economic sectors can be reflected in their contributions to the GDP and to total employment. Four economic sectors are discussed in this section. These four sectors are primary industry, secondary industry, tertiary industry and tourism.

2.4 Primary Industry

2.4.1 The contribution of the agriculture and fishery sector to GDP and employment is negligible in HKSAR due to the absence of natural resources (see Table 2-6). The area of cultivated land in HKSAR was only 6,100 ha in 1998. In contrast, the PRDEZ area has a strong agriculture and fishery industry, the area of its cultivated land was about 760,000 ha in 1998. Primary industry contributed 8% of GDP and 24% of employment in 1998. Real GDP growth ranged from 1% in Dongguan and Jiangmen to 12% in Huizhou.

Table 2-6 Contribution to GDP from Primary Industry in the Region

Study Area	1997	1998	% of Total		Real Growth Rate	
			1997	1998	1997	1998
GDP (million HK$, at current prices)						
HKSAR	1,464	1,530	0%	0%	-4%	2%
PRDEZ	39,926	40,630	8%	8%	--	--
Guangzhou	7,693	7,977	5%	5%	6%	4%
Shenzhen	1,418	1,477	1%	1%	1%	3%
Zhuhai	1,099	1,126	5%	5%	4%	5%
Huizhou	5,013	5,121	18%	16%	11%	12%
Dongguan	2,693	2,747	10%	9%	5%	1%
Zhongshan	2,069	2,117	10%	9%	11%	3%
Jiangmen	5,790	5,654	14%	13%	6%	1%
Foshan	5,635	5,672	9%	8%	8%	2%
Zhaoqing	8,517	8,739	29%	27%	9%	8%
Employment						
HKSAR	15,200	14,400	0%	0%		
PRDEZ	4,358,048	4,399,371	24%	24%		
Guangzhou	937,230	941,717	22%	21%		
Shenzhen	44,756	45,643	2%	2%		
Zhuhai	121,011	111,077	18%	16%		
Huizhou	674,500	686,200	37%	37%		
Dongguan	208,524	206,000	24%	23%		
Zhongshan	211,258	219,209	21%	21%		
Jiangmen	859,669	873,225	38%	39%		
Foshan	432,700	425,400	19%	18%		
Zhaoqing	868,400	890,900	44%	45%		

-- not available, 1 HK$ = 1.1142 yuan

Source:

HK Census and Statistics Department

1998 Statistical Yearbook of Guangdong P92 Table 2-18 P93 Table 2-19 P94 Table 2-20

1999 Statistical Yearbook of Guangdong P104 2-18 P 105 Table 2-19 P106 Table 2-20

1999 Guangzhou Statistical Yearbook P96 Table 3-33, 1998 Shenzhen Statistics and Information Yearbook P122 Table 2-4,

1999 Shenzhen Statistics and Information Yearbook P118 Table 2-4, 1999 Zhuhai Statistical Yearbook P91 Table 3-9,

1998 Huizhou Statistical Yearbook P50 Table 1-5, 1999 Huizhou Statistical Yearbook P181 Table 1-5,

1999 Dongguan Statistical Yearbook P78 Table 2-7, 1998 Zhongshan Statistical Yearbook P62,

1998 Jiangmen Statistical Yearbook P58 Table 2-3, 1999 Jiangmen Statistical Yearbook P72 Table 2-3,

1999 Foshan Statistical Yearbook P285 Table 10-1, 1999 Zhaoqing Statistical Yearbook P164 Table 4-1

2.5 Secondary Industry

2.5.1 In HKSAR, secondary industry (comprising industry and construction) contributed 14% of GDP and 19% of employment in 1998 (see Table 2-7). In PRDEZ, secondary industry was the largest contributor to GDP (49%) and the largest employer (39%). Real GDP growth ranged from 13% in Guangzhou, Zhuhai and Jiangmen to 21% in Dongguan.

Table 2-7 Contribution to GDP from Secondary Industry in the Region

Study Area	1997	1998	% of Total		Real Growth Rate	
			1997	1998	1997	1998
GDP (million HK$, at current prices)						
HKSAR	181,184	179,390	14%	14%	-2%	-4%
PRDEZ	236,852	263,351	49%	49%	--	--
Guangzhou	68,763	74,173	47%	45%	13%	13%
Shenzhen	49,958	57,852	49%	50%	16%	17%
Zhuhai	10,982	12,367	52%	52%	12%	13%
Huizhou	15,826	18,177	55%	57%	22%	17%
Dongguan	13,989	17,169	53%	54%	19%	21%
Zhongshan	10,122	11,687	51%	52%	18%	15%
Jiangmen	19,371	21,053	47%	49%	9%	13%
Foshan	35,556	37,021	55%	53%	15%	14%
Zhaoqing	12,286	13,853	41%	43%	17%	16%
Employment						
HKSAR	636,900	616,600	20%	19%		
PRDEZ	7,122,137	7,237,830	40%	39%		
Guangzhou	1,628,759	1,703,752	37%	38%		
Shenzhen	1,675,690	1,711,204	62%	60%		
Zhuhai	284,985	284,782	41%	41%		
Huizhou	508,600	509,800	28%	28%		
Dongguan	395,479	392,182	45%	45%		
Zhongshan	413,335	424,916	40%	40%		
Jiangmen	676,489	641,694	30%	29%		
Foshan	1,091,900	1,120,100	47%	47%		
Zhaoqing	446,900	449,400	23%	23%		

-- not available

1 HK$ = 1.1142 yuan, Data source same as Table 2-6

Industry

2.5.2 The industry sector comprises three sub-sectors:

- manufacturing;
- mining and quarrying and;
- electricity, gas and water.

2.5.3 The key sub-sector is manufacturing. The other two sub-sectors contributed only less than 1% of employment in HKSAR and PRDEZ and about 3% of GDP in HKSAR in 1998.

2.5.4 In HKSAR, the contribution of the manufacturing sector to GDP and employment has declined significantly over the years. Since the mid 1980s, lower value added and less skill intensive manufacturing processes have been relocated across the boundary to the PRDEZ area and other areas of China. An appraisal of all recent planning studies revealed that industrial activities in HKSAR are largely non-production activities. The production activities staying in HKSAR are generally more knowledge based and with a higher value added content. The contribution of the industrial sector was 6% of GDP and 9% of employment in 1998 (see Table 2-8).

Table 2-8 Contribution to GDP from Secondary Industry in the Region

Study Area		1997	1998	% of Total		Real Growth Rate	
				1997	1998	1997	1998
GDP (million HK$, at current prices)							
HKSAR		80,049	73,080	6%	6%	-9%	-11%
PRDEZ		207,952	233,043	43%	43%	--	--
	Guangzhou	59,789	64,107	40%	39%	15%	13%
	Shenzhen	40,173	46,441	40%	40%	17%	17%
	Zhuhai	9,106	10,292	43%	44%	13%	14%
	Huizhou	14,630	16,995	51%	53%	25%	18%
	Dongguan	13,038	16,027	49%	50%	19%	21%
	Zhongshan	9,515	11,687	48%	52%	18%	15%
	Jiangmen	18,029	21,053	44%	49%	12%	14%
	Foshan	33,375	34,807	51%	50%	16%	14%
	Zhaoqing	10,296	11,634	35%	36%	18%	16%
Employment							
HKSAR		324,300	280,100	10%	9%		
PRDEZ		6,175,964	6,245,044	34%	34%		
	Guangzhou	1,340,561	1,388,358	31%	31%		
	Shenzhen	1,572,446	1,603,368	58%	56%		
	Zhuhai	267,524	263,724	39%	38%		
	Huizhou	459,100	457,200	25%	25%		
	Dongguan	360,647	354,524	41%	40%		
	Zhongshan	379,503	388,664	37%	37%		
	Jiangmen	488,183	456,506	22%	20%		
	Foshan	985,100	1,010,700	43%	42%		
	Zhaoqing	322,900	322,000	16%	16%		

-- not available
1 HK$ = 1.1142 yuan
Data source same as Table 2-6

2.5.5 PRDEZ has a strong industrial sector in contrast. The sector contributed 43% of GDP and 34% of employment in 1998. The total industrial output in Guangdong Province was ranked the highest among all provinces in China in 1998. Light industries accounted for 60% of the total industrial output in Guangdong Province. Major industrial production bases included Guangzhou, Shenzhen and Foshan. About 65% of the foreign investment utilised in Guangdong Province was directed to the manufacturing sector where almost 70% of the investment came from HKSAR. In the PRDEZ, the most important industrial segments in output terms were electronic and telecommunications equipment and electric equipment and machinery. The two segments accounted for over one third of industrial output in 1998 (see Table 2-9); they were also the largest employer within the industrial sector.

Table 2-9 Key Industrial Sectors in PRDEZ (in terms of gross output value)

Industry	Contribution to Gross Output Value	
	1997	1998
Electronic and telecommunications equipment	22%	24%
Electric equipment and machinery	12%	11%
Garments and other fiber products	5%	5%
Metal products	5%	5%
Nonmetal mineral products	4%	5%
Raw chemical materials and chemical products	5%	4%
Transport equipment manufacturing	5%	4%
Textile industry	5%	4%
Plastic products	4%	4%

Note: include industrial enterprises at township and higher levels and their affiliated units only
Source: 1998 Statistical Yearbook of Guangdong P318 Table 12-10,
1999 Statistical Yearbook of Guangdong P333 Table 12-11

Construction

2.5.6 The shares of the construction sector in GDP in HKSAR and PRDEZ were 6% and 6% respectively, the shares in employment were 10% and 5% respectively (see Table 2-10).

Table 2-10 Contribution to GDP from Construction in the Region

Study Area		1997	1998	% of Total		Real Growth Rate	
				1997	1998	1997	1998
GDP (million HK$, at current prices)							
HKSAR		71,650	72,459	5%	6%	4%	-2%
PRDEZ		28,898	32,301	6%	6%	--	--
	Guangzhou	8,971	10,065	6%	6%	0%	10%
	Shenzhen	9,785	11,410	10%	10%	11%	15%
	Zhuhai	1,875	2,075	9%	9%	6%	8%
	Huizhou	1,196	1,182	4%	4%	-10%	1%
	Dongguan	950	1,143	4%	4%	7%	15%
	Zhongshan	607	725	3%	3%	17%	22%
	Jiangmen	1,342	1,269	3%	3%	-20%	-1%
	Foshan	2,181	2,214	3%	3%	11%	2%
	Zhaoqing	1,990	2,219	7%	7%	6%	15%
Employment							
HKSAR		312,600	336,500	10%	10%		
PRDEZ		946,173	992,786	5%	5%		
	Guangzhou	288,198	315,394	7%	7%		
	Shenzhen	103,244	107,836	4%	4%		
	Zhuhai	17,461	21,058	3%	3%		
	Huizhou	49,500	52,600	3%	3%		
	Dongguan	34,832	37,658	4%	4%		
	Zhongshan	33,832	36,252	3%	3%		
	Jiangmen	188,306	185,188	8%	8%		
	Foshan	106,800	109,400	5%	5%		
	Zhaoqing	124,000	127,400	6%	6%		

-- not available HK$ = 1.1142 yuan, Data source same as Table 2-6

2.6 Tertiary Industry

2.6.1 Since the mid 1980s, the economy in HKSAR has become more service-oriented. In 1998, the shares of the service sector in GDP and employment were as high as 80% and 80% respectively in HKSAR (see Table 2-11). The contribution in the PRDEZ was significantly lower at 43% of GDP and 29% of employment. Real GDP growth of the service sector in PRDEZ ranged from 5% in Jiangmen to 23% in Dongguan despite the regional financial crisis. GDP in HKSAR in contrast contracted by 7% in real terms.

Table 2-11 Contribution to GDP from Tertiary Industry in the Region

Study Area		1997	1998	% of Total		Real Growth Rate	
				1997	1998	1997	1998
GDP (million HK$, at current prices)							
HKSAR		1,050,386	1,001,507	80%	80%	4%	-7%
PRDEZ		204,215	232,826	42%	43%	--	--
	Guangzhou	71,297	83,136	48%	50%	15%	15%
	Shenzhen	50,043	56,362	49%	49%	16%	12%
	Zhuhai	9,028	10,157	43%	43%	11%	12%
	Huizhou	7,753	8,654	27%	27%	8%	13%
	Dongguan	9,769	11,991	37%	38%	20%	23%
	Zhongshan	7,640	8,547	39%	38%	9%	13%
	Jiangmen	15,933	16,541	39%	38%	5%	5%
	Foshan	23,839	27,542	37%	39%	17%	14%
	Zhaoqing	8,914	9,897	30%	30%	16%	13%
Employment							
HKSAR		2,498,200	2,575,000	79%	80%		
PRDEZ		5,196,579	5,410,810	29%	29%		
	Guangzhou	1,602,182	1,665,231	37%	37%		
	Shenzhen	893,599	960,466	33%	34%		
	Zhuhai	254,911	277,692	37%	40%		
	Huizhou	361,500	356,400	20%	19%		
	Dongguan	222,559	225,783	25%	26%		
	Zhongshan	321,048	327,011	31%	31%		
	Jiangmen	500,580	521,627	22%	23%		
	Foshan	675,800	700,600	29%	29%		
	Zhaoqing	364,400	376,000	18%	19%		

-- not available
1 HK$ = 1.1142 yuan; Data source same as Table 2-6

2.7 The Tourism Sector

2.7.1 The tourism sector is a very important economic sector in HKSAR and PRDEZ although its direct contributions to GDP and employment have not been measured. In 1998 visitors to HKSAR reached 9.6 million (see Table 2-12). Mainland China (30%) and Taiwan (20%) were the largest source markets for HKSAR. The amount of tourism receipts in HKSAR was similar to that in the PRDEZ. Different from HKSAR, visitors to the PRDEZ were largely domestic visitors from different areas of China. Domestic travel income constituted to about 70% of total travel income in 1998.

Table 2-12 Contribution to GDP from the Tourism Sector in the Region

Study Area		1997	1998
Visitor Arrivals			
HKSAR SAR		10,406,261	9,574,711
PRDEZ*		--	--
	Guangzhou	1,450,661	1,333,213
	Shenzhen	1,404,100	1,484,700
	Zhuhai	609,000	697,200
	Huizhou	116,412	125,469
	Dongguan	--	--
	Zhongshan	440,811	483,081
	Jiangmen	--	--
	Foshan	245,100	320,900
	Zhaoqing	--	--
Tourism Receipts (million HK$, at current prices)			
HKSAR SAR		69,900	55,300
PRDEZ		61,333	67,335
	Guangzhou	25,315	29,006
	Shenzhen	16,736	17,482
	Zhuhai	5,242	5,419
	Huizhou	1,626	1,646
	Dongguan	2,790	2,799
	Zhongshan	1,537	2,132
	Jiangmen	2,668	2,746
	Foshan	3,507	3,982
	Zhaoqing	1,911	2,122

-- not available
**international visitors only*
1 HK$ = 1.1142 yuan
Source:
HKSAR Tourist Association, 1999 Guangzhou Statistical Yearbook P465 Table 15-1, 1999 Shenzhen Statistics and Information Yearbook P275 Table 10-13, 1999 Zhuhai Statistical Yearbook P256 Table 8-13, 1998 Guangdong Statistical Yearbook P5517 Table 16-37, 1999 Guangdong Statistical Yearbook P536 Table 16-35

2.8 Future Development Scenario

Key Economic Issues

2.8.1 Economic related issues include:

- the trading and transport sectors are key economic sectors in HKSAR, any new air pollution control measures on freight transport might impact on the HKSAR economy directly;
- considering the close and increasing economic links between HKSAR and the PRDEZ, any new air pollution control measures on cross boundary traffic might impact on the two economies directly;
- the agriculture and manufacturing sectors are key economic sectors in the PRDEZ, any new air pollution control measures on agriculture and industrial production activities might impact on its economy directly;
- the tourism sector is a key economic sector in HKSAR and PRDEZ, any new pollution control measures might improve air quality which in turn would promote tourism growth and benefit the economy;

- considering the unemployment situation in the PRDEZ might have been understated, any air pollution control measures related to the closure of enterprises might result in high levels of unemployment;
- any new air pollution control measures on manufacturing activities that would improve the quality of products might promote Mainland's further integration with the world economy. HKSAR is also likely to be among the main beneficiaries of the Mainland's entry into the WTO.

Future GDP Growth

2.8.2 The economic recovery in HKSAR is anticipated to continue over short term. An annual GDP growth rate of 5% in real terms is assumed (see Table 2-13). This is similar to the level of growth over the last 20 years. The growth is expected to slow to 4.5% in the medium term and further to 4% in the long term when the economy approaches maturation.

Table 2-13 Prediction Projection of GDP Growth in the Region

Study Area	1999	2000	2001-2005	2006-2010	2011-2015
HKSAR	3%*	6%*	5%	4.5%	4%
PRDEZ	13%	13%	12%	12%	11%
Primary Industry	3.5%	3.5%	3.5%	3.5%	3%
Secondary Industry	14%	14%	12%	12%	11%
Tertiary Industry	14%	14%	13%	13%	12%

**official forecast*

2.8.3 In mainland China, economic reform strategy over the last two decades has centred on the agriculture and manufacturing sectors. It is anticipated that the service sector will be liberated and spur growth in the medium to long term as a result of mainland China's entry into the WTO. It is also anticipated the PRDEZ would remain a focus of economic development in the Mainland. According the Guangdong's strategies for the coming decade, Guangzhou, Shenzhen, Zhuhai, Foshan, Dongguan and Zhongzhan will be developed into a commercial, trade and hi-tech manufacturing centre, Huizhou will become a key production centre and Zhaoqing will focus on the development of tourism. Based on official forecasts, we therefore anticipate the economy in the PRDEZ to grow continuously at a rate of 12% over the short to medium term and 11% over the long term. This level of growth is somewhat higher than the national total targeted at 7% per annum to year 2015. It is anticipated that primary industry would grow slowly at a rate of 3% to 3.5% whilst secondary and tertiary industries would maintain a robust growth at 11% to 13%. This level of growth is slightly higher than what was anticipated by the Guangdong Provincial Government in 1996 (see Table 2-14), considering the potential positive impact of mainland China's entry into the WTO. The share of the tertiary industry would progressively increase to over 50% in 2015, a level similar to what was targeted by the Government in 1996 as shown in Table 2-15.

Table 2-14 Projected GDP Growth in the PRDEZ in 1996

	Overall	Primary Industry	Secondary Industry	Tertiary Industry
1996-2000	17.4%	11.5%	13.5%	22.9%
2001-2010	11.9%	3.6%	10.1%	13.8%

Source: Researches on Perspective Plan for the Pearl Rive Delta Economic Region (1996), Vol 1

Table 2-15 Target GDP Composition in the PRDEZ

	Primary Industry	Secondary Industry	Tertiary Industry
2000	8%	48%	44%
2010	5%	35%	60%

Source: Guangdong Construction Commission (1996) The Planning for Urban Agglomeration of Pearl River Delta

2.8.4 It is interesting to note that at these projected levels of GDP growth, by 2002/3, the GDP per capita for the PRDEZ would reach about US$3,500 per annum, this would place the PRDEZ at about the level of development that Shanghai stands today, by 2007/8 the figure would reach about US$5,000 per annum (similar to Bangkok today) and by 2012/3 the figure would reach approximately US$7,500 per annum (similar to Kuala Lumpur today).

2.9 Population and Labour Force

HKSAR

2.9.1 As population of HKSAR continues to grow, it exerts a large pressure for future development. To prepare a guide for future development taking into account of longer-term visions of HKSAR's changing roles in a wider regional context, Territory Development Study Review (TDSR) formulated the following two broad regional development scenarios for consideration: (PD, 1998)

- Scenario A: PRDEZ will be the major economic hinterland of HKSAR over the long term and 2011 territorial population is assumed to be 7.5 million;
- Scenario B: Guangdong Province and other inner provinces of the Mainland will be the major economic hinterland of HKSAR and 2011 territorial population is assumed to be 8.1 million

2.9.2 Based on the result of the 1996 Population By-census, Census and Statistics Department has prepared a set of population projection which gives a common basis in business development and future planning in HKSAR. Year 1997 actual population and projected population for 2000-2015 are summarised in Figure 2-16 below. For strategic planning purposes, the Scenario B with assumption of 8.1 million in 2011 should be used. (C&SD, 1997; PD, 1998)

Table 2-16 Summary Statistics on the Projected Populations

Mid-Year	1997	2000	2005	2010	2015
Total population	6,487,500	6,860,000	7,299,200	7,713,600	8,124,600

2.9.3 In 1998, approximately 65% of territorial population lives in the Metro Area. Population of the Metro Area is expected to be increased to about 4.29 million by 2006 and possibly up to about 4.56 million by 2011, compared to a 1996 figure of 4.04 million. (PD, 1998)

2.9.4 At present, economic and community-related activities are highly concentrated in the Metro Area where provides a high proportion (about 82%) of all jobs in HKSAR. Along with improvement of accessibility to other parts of the Territory, especially by rail, the proportion of jobs in the Metro Area is expected to decline to around 74% by 2006 but absolute numbers will still grow significantly. (PD, 1998)

2.9.5 In the long run, new strategic growth areas are needed for urban use. TDSR proposed to give priority to the following three areas for meeting long-term housing needs: (PD, 1998)

- the North Western New Territories;
- the North Eastern New Territories; and
- Hong Kong Island South and Lamma Island.

2.9.6 In the South West New Territories Development Strategic Review (SWNT DSR), North Lantau New Town is planned to be the major population centre in the sub-region with the Hong Kong International Airport. Considering traffic capacity of the internal and external road networks and in balancing the development opportunities and constraints, the "Tung Chung and Tai Ho CFS" has proposed a maximum population capacity of 335,000 for the New Town. (PD, 2000a)

PRDEZ

2.9.7 The PRDEZ can be broadly divided into two regions: core region and peripheral region according to their economic development and geographical location. The core region is the relatively well-developed region while the peripheral region is those area developing later than other areas. These two regions include the following areas: (GDPD et al, 1995)

- Core Region: Guangzhou Urban Area, Shenzhen Urban Area, Zhuhai Urban Area, Foshan Urban Area, Nanhai, Shunde, Zhongshan, Dongguan, Panyun, Doumen and Baoan.
- Peripheral Region: Huizhou Urban Area, Zhaoqing Urban Area, Jiangmen Urban Area, Huidong, Huiyang, Bolo, Huadu, Conghua, Zengcheng, Sanshui, Gaoming, Xinhui, Taishan, Enping, Kaiping, Heshan, Gaoyao and Shihui.

2.9.8 Within the study area, approximately half of the area is located at the core region and another half are in the peripheral region.

2.9.9 In 1997, total population of Guangdong Province is approximately 70.5 million, of which 99.5% is population with residence card and 0.5% is temporal movement population. Also in 1997, total labour force is 45.9 million and the proportion of primary, secondary and tertiary industry are 41%, 33% and 26% respectively. (GDSB, 1998)

2.9.10 Projected population is one of the major indicators for future planning development. Future population is projected based on existing and the historical trend. It is defined that total population equal to sum of population with residence card and temporal movement.

2.9.11 In 1994/95 a detailed planning study "Research on Perspective Plan for the Pearl River Delta Economic Region (GDPD&PRDEPO, 1995)" was initiated by the Guangdong Provincial Government to study the future development scenarios in the area. The study provided the most comprehensive review on the existing and future development potential of the major cities within the PRDEZ. A set of the future development scenarios up to 2010 was presented in this study including the natural growth and temporal movement population.

Future Population Projection with Residence Card

2.9.12 In mid-90s, marriage and contraception rate in PRDEZ reached a maximum. During the same period, immigration population from other provinces are also in the age of marriage. It was therefore estimated that before 2000, the natural growth rate will keep at the same level of 1993 or 1994. After 2000, people born in the 70s will gradually enter the marriage period. However, due to the implementation of planned marriage policy, it is estimated that natural growth rate will have a significant decline. (GDPD et al, 1995)

2.9.13 Under the planned economy, PRDEZ required many professionals or experts from other provinces for its fast track industrial and commercial development. For Shenzhen city in particular, it planned to give residence cards to those temporal movement population living there for a long time and having stable jobs. As such, it is anticipated that the annual mechanical growth will be increased significantly from 2000 onward. (GDPD et al, 1995)

2.9.14 Research on Perspective Plan for the PRDEZ (GDPE&PRDEPO, 1995) presented a set of growth factor for population with residence card including the natural birth and mechanical movement in the PRDEZ and they are summarised in Table 2-17.

Table 2-17 Estimated Growth Factor in the PRDEZ

Event	Case A. Provincial Projection		Case B. Projection estimated by individual cities	
Year	1996-2000	2001-2010	1996-2000	2001-2010
Total population	2.0%	-0.5%	1.2%	1.3%
Population with residence cards	2.0%	1.8%	2.0%	1.6%
Population with temporary residence cards	2.2%	-9.4%	-0.7%	0.3%

Ref: Research on Perspective Plan for the Pearl River Delta Economic Region

2.9.15 For year 2000 residence population projection, a growth factor of 2.0% is used for both case A and B. For year 2001-2010 population projection, a growth factor 1.8% instead of 1.6% is used in this study. This is because year 1998 actual residence population data extracted from various cities statistical yearbooks is already close to that of 2000 projected data in 1995 as shown in Table 2-17. A relative higher growth projection factor (case A) therefore considered to be more appropriate for this study for the prediction of the resident population.

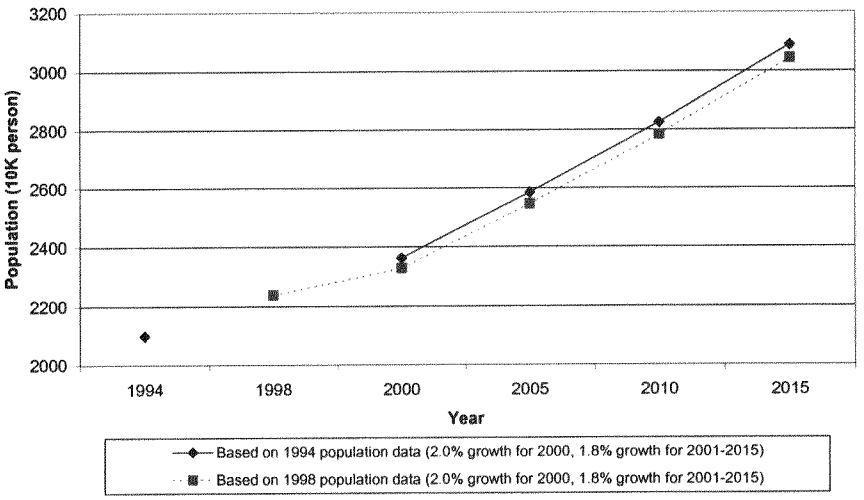
2.9.16 1994 population data presented in the 'Research on Perspective Plan for the Pearl River Delta Economic Region' was used as a reference information for the projection of population in PRDEZ. The latest available factual population for 1998 was also extracted from individual cities statistical yearbooks to verify the 1994 figures. The projected residence population in PRDEZ is summarised in Table 2-18 and Figure 2-1 for different years.

Table 2-18 Proposed Residence Population in the PRDEZ

Residence Population	Total	Guangzhou	Shenzhen	Zhuhai	Foshan	Zhongshan	Jiangmen	Dongguan	Huizhou	Zhaoqing
1994 actual population	2,098	637	94	62	306	123	369	141	222	145
1998 actual population	2,238	674	115	69	325	130	379	149	239	157
2000 population projected from 1998 figure (Case A)	2,328	702	119	72	338	135	394	155	249	164
2005 population projected from 1998 figure (Case A)	2,546	767	130	79	370	148	431	169	272	179
2010 population projected from 1998 figure (Case A)	2,783	839	143	86	404	162	471	185	298	196
2015 population projected from 1998 figure (Case A)	3,043	917	156	94	442	177	515	202	325	214

N.B. Figures are in 10,000 person.

Figure 2-1 Projected Future Years Population with Residence Card in the PRDEZ



Future Projections for Temporal Population

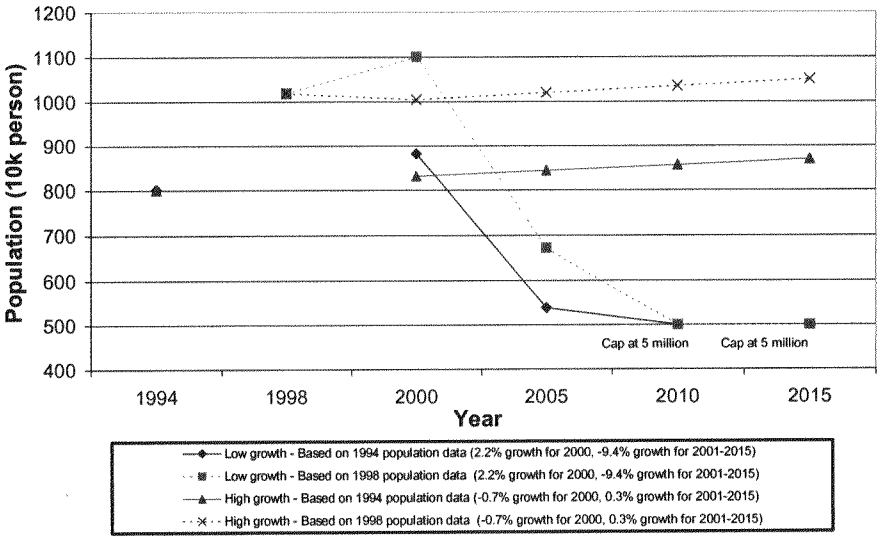
2.9.17 Temporal population includes residents owning temporary residence cards, but not including those population passing by from other provinces or tourists. In PRDEZ, the temporal population occupies a relatively high percentage of total population due to extremely high work factor demand for industry and manufacturing sector within the region.

2.9.18 In the 90s, PRDEZ put a lot of effort in developing open economy which required extensive labour force. With the introduction of open door economic policy, each province tends to shift away from labour intensive industries to high technology production sectors which result in less temporal population movement with the Pearl River Delta region in the future years. It is estimated that total labour demand for primary, secondary and tertiary industries would be 20.50 million in 2000 and 18.51 million in 2010. (GDPD et al, 1995)

2.9.19 Two different growth factors as presented in Table 2-18 are assumed for the prediction of future temporal movement. For Case A, 2.2% and -9.4% growth rate are used for 2000 and 2001-2010 respectively. For Case B, -0.7% and 0.3% growth rate are used for 2000 and 2001-2010 respectively. These two cases growth rate will reference to 1994 and 1998 actual statistics as base year for 2000-2015 projection.

2.9.20 A recent study (GDPD et al, 1995) indicated that the temporal movement population in PRD will be capped at 5 million from 2010 onward. The projected temporal movement population is shown in Figure 2-2.

Figure 2-2 Projected Future Years Temporal Population Movement in the PRDEZ



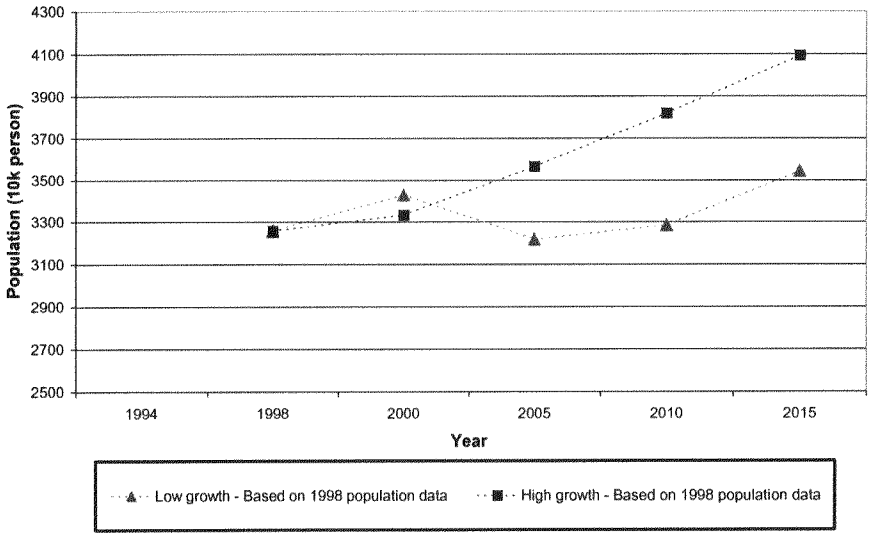
Total Population Projection for Future Years

2.9.21 Total population in PRDEZ is simply the summation of the residence card population and temporal movement population as shown in Figure 2-3. The future population scenarios for various assessment years are as follow.

Year	Growth	Residence Pop. + Temporal Pop. = Total Population
Year 2000	High Growth	23.28 + 11.00 = 34.28
	Low Growth	23.28 + 10.04 = 33.32
Year 2005	High Growth	25.46 + 10.19 = 35.65
	Low Growth	25.46 + 6.72 = 32.17
Year 2010	High Growth	27.83 + 10.35 = 38.18
	Low Growth	27.83 + 5.00 = 32.83
Year 2015	High Growth	30.43 + 10.50 = 40.93
	Low Growth	30.43 + 5.00 = 35.43

(N.B. Figures are in million person.)

Figure 2-3 Total Projected Future Years Population in the PRDEZ



3 LANDUSE PATTERN

3.1 Introduction

3.1.1 Major changes to HKSAR's economy have arisen from the impacts of mainland China's "Open Door Policy", under which a substantial number of HKSAR's manufacturing enterprises have moved wholly or partly to South China. Some activities have also moved to other parts of South East Asia. That, in turn, has encouraged the expansion of HKSAR's hub function as a port, in parallel with which there has been major growth in HKSAR's role as a regional and international centre for business, services and finance.

3.1.2 It is expected that HKSAR's tertiary services sector will continue to grow in scale and diversity to provide a mainstay for employment, requiring a more structured view with regard to the development of new office-based employment centres. The TDSR thus proposes a broad land development strategy to encourage the growth of new employment nodes around major rail-based transport interchanges so as to help achieve a better population-to-job balance.

3.1.3 According to the State Development Standard of Guangdong Province, total development area shall be 105-120m^2 and 90-105 m^2 per person for planned economic zone and other cities respectively for year 1995. To achieve this and to build up a high quality living environment with good service, land area shall be saved and utilised, and the green area shall be increase in parallel for enhance the living standard.

3.2 HKSAR Existing Landuse

3.2.1 Recently completed study (PD, 1998) indicates that there is a potential surplus of between 115 and 140 ha of land zoned for general industrial use. This opens up opportunities for the rezoning of such areas for other employment-generating development, as well as for housing.

3.2.2 Whilst manufacturing production activities in HKSAR have diminished considerably, it is perceived that there are opportunities for investment in new types of enterprises involving the application of higher technology and the production of higher-value-added products. In that context, a more liberal approach needs to be taken to encourage new investment by, for example, allowing private developers to play a more proactive role in the comprehensive planning and development of new multi-purpose industrial/business estates and science parks.

3.2.3 At present, about 65% of the territorial population lives in the Metro Area in which there also is a high concentration of economic and community-related activities that provide a high proportion (about 82%) of all jobs in HKSAR. 1997 land use in HKSAR is summarised in Table 3-1.

Table 3-1 1997 Landuse in HKSAR

Land Use	Area (Hectares)	Percentage (%)
Commercial	200	0.2%
Residential	5,700	5.2%
Industrial	1,100	1.0%
Open space	1,600	1.5%
Government, institution and community facilities	1,900	1.7%
Vacant development	4,100	3.7%
Roads/ railways	2,900	2.6%
Woodlands	22,000	20.1%
Grass and scrub	51,900	47.4%
Badlands, swamp and mangrove	4,400	4.0%
Arable	6,200	5.7%
Fish ponds	1,500	1.4%
Other uses	6,000	5.5%

3.3 PRDEZ Existing Landuse

3.3.1 In 1993, the total land area of PRDEZ is about 4.16 million hectares which accounts for 23.38% of total land area of Guangdong Province The land area per person is 0.2 hectares, which is slightly lower than that of Guangdong Province (0.3 hectares/ person). In PRDEZ, 3.76 million hectares land has been utilised and this occupies 90.35% of total land area. (GDPD et al, 1995a) The distribution of land use for 1997 is summarised Table 3-2.

Table 3-2 2010 and 1993 Land Use in PRDEZ

	2010		1993	
Land Use	Area (Hectares)	Percentage (%)	Area (Hectares)	Percentage (%)
Total Land Area	4,118,004	100.0	4,118,000	100
Cultivated Land	660,000	16.0	706,000	17.15
Landscaped Area	280,500	6.8	210,000	5.1
Forestry	1,716,000	41.7	1,742,000	42.3
Animal Husbandry	13,200	0.3	0	0
Residential	398,640	9.7	334,000	8.12
Inland Water	484,440	11.8	481,000	11.69
Mari-culture Zone	158,400		109,000	
Transportation	125,400	3.1	73,000	1.77
Undeveloped Area	439,824	10.7	571,000	13.87

Source: GDPD et al, 1995a

3.4 Future Landuse in HKSAR

3.4.1 There are a few on-going planning feasibility studies being carried out by the Planning Department of the HKSAR Government. These current planning studies are Planning and Development Studies on North East and North West New Territories, South West New Territories Development Strategy Review and South East New Development Strategy Review.

3.4.2 Objectives of these planning studies are employed to identify new development areas within HKSAR to accommodate the future population growth. These new development areas be planned and developed comprehensively to meet the community's increasing aspirations for a better living environment. Preliminary design principles for these planning areas have been formulated and public have been consulted with the proposed development plans.

3.5 Future Landuse in PRDEZ

3.5.1 Based on spatial distribution of PRDEZ, urban land use will be classified into four different types of areas, namely ecological sensitive area, open area, city dense area and metropolis. This planning classification aims to balance the harmonic development which finally led to good practice and management of individual city and county.

3.5.2 In ecological area, ambient air quality shall comply with National Level I standard in accordance with State and Province regulations. In terms of development, neither industrial enterprise nor real estate is allowed to be developed.

3.5.3 In open area, the planning purpose for farming industry is to increase its overall benefit and to keep the scale and number of enterprise under certain level. For non-farming industry, it shall be located close to urban city as far as possible to increase the development quality. Overall, the landuse reserved for county development shall be kept under 8% of total land area and landuse for non-farming development shall be controlled under 150m^2 per village people.

3.5.4 In the city dense area, city and county development shall be strictly control to prevent illegal continuous development. Landuse in this area aims to balance landuse structure, regional service facility, especially infrastructure development. Within each individual county, buffer green area shall be constructed. As a general rule, landuse for city or county development shall be controlled under 25% of total land area which non-farming development shall be kept under 150m^2 per village people.

3.5.5 Major industries planned to be developed in metropolis include finance, trading, and technology and information industry. Planning purpose of this area is to develop high technology and large infrastructure to enhance its radiation function to its surrounding area.

3.5.6 In terms of overall planning, farm area for population with residence card shall be 0.4 MOU per person. Including protected farm area, total farm area shall be reserved to 10 million MOU. On the other hand, total woodland area shall be 25 million MOU or above and coverage of forest shall be more than 40%. In the urban area, green area coverage percentage shall be 30% and green buffer area shall be built between cities or counties. Total natural protection area shall be 3-5% of total land area.

3.5.7 Land is an non-reuse resource and therefore in landuse planning, need for different types of land shall be met, and land protection and reservation for long term development shall also be considered. In the future 15 years, the key problem of landuse planning is to keep certain amount of farmland for stable development of farming industry which can be served to fulfil the need of ecological development.

3.5.8 Apart from farm area, landuse for other type of land shall also be planned based on the principle of reasonable usage to get the maximum benefit which is the backbone to keep stable, sustainable and speedy development of PRDEZ. The Research on Perspective Plan for the Pearl River Delta Economic Region Study (GDPD et al, 1995) has classified the cities into three major level of significance and two developing axis accordance to their influence to the overall economic development in the PRDEZ.

Guangzhou - Primary Centre of Urban Cities

3.5.9 Guangzhou is the political, economic and culture centre of PRDEZ. Now Guangzhou is one of the important cities in Mainland in terms of foreign trading, transportation and light industry. Within PRDEZ, Guangzhou is the largest commercial and technology centre. The overall economic power of Guangzhou is the third in mainland China, just behind Beijing and Shanghai. However, the tertiary industry of Guangzhou is more than 50% of the city which is the highest in mainland China. In this regard, Guangzhou will inevitably become an international city in the PRDEZ.

Shenzhen and Zhuhai - Secondary Centre of Urban Cities

3.5.10 Both Shenzhen and Zhuhai are classified as special economic zone located at the estuary of Pearl River. Given its special location and economic type, Shenzhen has become one of the most important financial, foreign trading, commercial and international trading centres in the Mainland. In future, Shenzhen will play a role of open window with intensive capital investment.

3.5.11 Zhuhai is located at the west estuary of Pearl River which forms an triangle with HKSAR and Guangzhou. Given the excellent port infrastructure and sufficient reserve land, Zhuhai will develop its strong port industry and trading in future.

Third Level of City Centre

3.5.12 Small cities in the PRDEZ including Zhaoqing, Foshan, Huizhou, Jiangmen, Zhongshan and Dongguan and counties.

Eastern Development Axis

3.5.13 Based on the function and natural environment of PRDEZ, cities in PRD can be classified into two different types of axis: developing axis and potentially developing axis. Guangzhou - Shenzhen - HKSAR will be the developing axis for the west side of Pearl River. In this axis, infrastructure connecting Guangzhou and Shenzhen and many ports are found.

Western Development Axis

3.5.14 Guangzhou - Zhuhai would be another developing axis. Processing, electronic and light food industry are well developed in the area. With the completion of Humen Bridge, Lingdinyang Bridge, west and east Side of Pearl River will be connected closer.

4 INFRASTRUCTURE

4.1 Introduction

4.1.1 In this section, infrastructure development for various assessment years of the Study were generated for estimating future emission inventory. These forecasts included road, marine, air, rail traffic and electricity generation. The study area covers HKSAR and the nine cities in the PRDEZ. These nine cities are: Dongguan, Foshan, Guangzhou, Huizhou, Jiangmen, Shenzhen, Zhaoqing, Zhongshan and Zhuhai. The forecast years are 2000, 2005, 2010 and 2015.

4.1.2 An extensive data collection and information gathering exercise was undertaken to obtain historical trend data and official forecasts. Where official forecasts were available, they were reviewed for reasonableness to the extent possible before they were utilised to generate forecasts for this study. When no official forecasts were available, the forecasts were developed based on analysis of available historical trend data, using accepted practices and procedures and our experience in similar studies.

4.2 Road Traffic Future Development Scenario

Road Traffic in HKSAR

4.2.1 The air quality model requires, as input, vehicle kilometres travelled (VKT) for the following ten vehicle categories:

- Motorcycle
- Car
- Taxi
- Passenger Van
- Public Light Bus
- Non-franchise Bus
- Single-deck Bus
- Double-deck Bus
- Light Goods Vehicle
- Heavy Goods Vehicle

4.2.2 For HKSAR, future development scenarios as described in the recently completed Third Comprehensive Transport Study (CTS-3) were adopted. Traffic forecasts for the following future scenarios taken from the Strategic Environmental Assessment Technical Report of CTS-3 were used:

- 2001 – Low /Budget Toll Scenario
- 2006 – Recommended Transport Strategy – Medium Growth
- 2011 – Recommended Transport Strategy – Medium Growth
- 2016 – Recommended Transport Strategy – Medium Growth

4.2.3 The procedure used to generate VKT estimates by the required vehicle categories for each District Board area was as follow:

i. Extract VKT by vehicle type from the assignment file of the above listed CTS-3 model runs.
ii. Summarise VKT by vehicle type for each District Board area.
iii. Interpolate between the Base Year (1997) and future years traffic forecasts to derive VKT estimates for the years 2000, 2005, 2010 and 2015.

4.2.4 The VKT forecasts for estimating road traffic emission level in 2000, 2005, 2010 and 2015 are summarised in Tables 4-1 through 4-4.

Table 4-1 Estimated 2000 Annual VKT for HKSAR

	HKSAR 2000 Annual Average Vehicle Kilometer Traveled by District (km/yr)										
District	**Motor Cycle**	**Private Car**	**Taxi**	**Pass. Van**	**PLB**	**LGV**	**HGV**	**Non Fr. Bus**	**SD Fr. Bus**	**DD Fr. Bus**	**Totals**
Central & Western	22,099,958	341,386,930	200,905,691	18,934,079	18,549,600	146,470,983	57,620,984	13,415,375	940,932	14,457,006	834,781,539
Wan Chai	15,720,290	242,840,064	183,658,436	11,162,640	14,952,252	64,717,409	22,191,984	7,909,004	768,534	11,806,962	575,727,574
Eastern	20,199,198	312,023,572	209,582,210	11,384,166	14,718,612	90,972,761	34,870,204	8,066,017	746,232	11,467,830	714,030,801
Southern	14,249,300	220,116,796	96,174,118	13,387,862	19,425,042	70,331,460	18,745,284	9,485,777	788,358	12,112,464	474,816,462
Yau Tsim Mong	17,335,380	267,786,398	164,698,500	14,232,570	17,646,546	117,500,565	54,991,245	10,084,133	1,330,686	20,445,624	686,051,646
Sham Shui Po	22,794,503	352,117,163	136,508,153	15,093,233	20,066,136	211,498,185	119,055,953	10,693,898	1,075,098	16,518,702	905,421,021
Kowloon City	21,500,633	332,128,995	220,988,483	12,033,788	21,347,262	142,110,645	52,711,043	8,526,090	1,042,176	16,012,482	828,401,595
Kwun Tong	32,797,658	506,638,605	203,978,783	15,778,665	21,205,308	207,492,675	76,444,530	11,179,320	1,552,644	23,859,954	1,100,928,141
Wong Tai Sin	10,918,688	168,662,415	86,959,658	5,773,740	13,949,370	89,906,708	36,002,243	4,090,913	624,456	9,596,232	426,484,421
Kwai Tsing	35,620,754	550,243,865	162,104,105	29,595,391	24,778,230	336,038,890	272,464,171	20,968,978	1,794,780	27,580,494	1,461,189,658
Tuen Mun	33,431,335	516,424,262	67,191,466	13,565,563	21,567,804	249,117,163	267,985,505	9,611,525	2,348,436	36,088,884	1,217,331,943
Island	11,747,419	181,467,338	67,826,117	8,833,716	0	152,245,771	58,499,208	6,259,003	447,456	6,874,326	494,200,355
Yuen Long	21,953,239	339,116,990	59,500,037	13,013,323	26,714,256	231,693,566	297,577,498	9,220,284	1,057,752	16,251,786	1,016,098,732
Tai Po	20,326,680	313,994,743	39,278,282	8,588,182	8,184,126	176,497,603	108,996,458	6,084,835	563,568	8,661,672	691,176,150
North	9,953,914	153,764,006	25,695,727	5,478,646	9,995,898	125,872,913	119,394,713	3,881,822	435,774	6,693,786	461,167,199
Sha Tin	50,219,856	775,764,238	182,907,835	26,013,053	17,063,508	327,276,965	171,181,231	18,430,798	2,276,220	34,979,448	1,606,113,151
Sai Kung	7,399,591	114,306,034	27,735,192	3,212,762	6,829,368	46,078,481	15,185,750	2,276,503	292,404	4,492,968	227,809,054
Tsuen Wan	16,513,675	255,095,374	45,553,853	9,077,976	21,609,222	149,525,777	154,727,453	6,431,897	1,013,148	15,566,442	675,114,816
Total	384,782,070	5,943,877,788	2,181,246,643	235,159,354	298,602,540	2,935,348,519	1,938,645,455	166,616,171	19,098,654	293,467,062	14,396,844,256

Source: Third Comprehensive Transport Study, October 1999. Hong Kong Transport Department.

Table 4-2 Estimated 2005 Annual VKT for HKSAR

	HKSAR 2005 Annual Average Vehicle Kilometer Traveled by District (km/yr)										
District	**Motor Cycle**	**Private Car**	**Taxi**	**Pass. Van**	**PLB**	**LGV**	**HGV**	**Non Fr. Bus**	**SD Fr. Bus**	**DD Fr. Bus**	**Totals**
Central & Western	32,542,993	502,701,587	265,432,407	28,302,689	21,082,470	118,796,347	52,795,319	20,053,095	1,110,144	17,061,030	1,059,878,082
Wan Chai	17,218,319	265,974,601	203,425,491	12,292,091	16,503,126	58,358,613	20,086,774	8,709,250	807,828	12,411,594	615,787,687
Eastern	23,726,064	366,504,292	235,435,778	13,034,938	14,681,088	88,964,795	37,304,619	9,235,789	774,552	11,903,604	801,565,521
Southern	15,513,469	239,642,877	99,296,830	13,739,363	22,145,178	61,789,659	16,463,138	9,734,816	808,536	12,427,170	491,561,037
Yau Tsim Mong	22,235,625	343,481,775	188,727,135	18,853,598	19,676,736	129,753,833	67,919,768	13,358,190	1,439,364	22,117,212	827,563,235
Sham Shui Po	29,152,343	450,330,038	162,825,840	20,508,548	23,074,428	216,231,165	126,928,028	14,530,815	1,175,280	18,058,602	1,062,815,085
Kowloon City	24,970,718	385,729,020	238,080,488	14,440,545	22,772,820	142,819,088	55,157,625	10,231,485	1,101,648	16,930,758	912,234,194
Kwun Tong	36,884,588	569,772,735	224,497,950	18,367,733	21,595,416	188,214,278	73,777,583	13,013,925	1,657,428	25,468,530	1,173,250,164
Wong Tai Sin	11,083,298	171,205,905	92,363,025	5,825,955	16,239,396	72,544,335	27,531,465	4,127,640	659,148	10,127,232	411,707,399
Kwai Tsing	44,056,008	680,547,866	197,662,838	37,543,824	22,438,644	338,715,554	297,134,431	26,600,976	1,879,032	28,875,426	1,675,454,600
Tuen Mun	43,087,889	665,591,933	87,716,527	23,048,374	26,828,952	265,889,542	360,088,092	16,330,586	2,534,994	38,956,284	1,530,073,172
Island	22,049,669	340,611,437	195,543,936	13,744,829	0	188,360,993	130,939,078	9,738,540	1,116,870	17,161,920	919,267,271
Yuen Long	35,516,678	548,641,519	93,610,627	23,308,776	30,408,600	267,676,250	496,617,113	16,514,950	1,346,970	20,700,150	1,534,341,634
Tai Po	23,937,055	369,762,062	41,722,157	12,807,720	9,976,074	160,869,211	114,371,878	9,074,578	632,244	9,717,300	752,870,279
North	10,773,778	166,427,294	29,726,230	8,214,358	10,097,496	101,849,623	164,557,750	5,820,185	562,506	8,643,264	506,672,483
Sha Tin	55,436,400	856,349,647	195,011,662	31,197,312	16,698,534	289,327,457	156,723,588	22,104,043	2,350,206	36,114,018	1,661,312,867
Sai Kung	12,704,918	196,257,600	53,128,037	4,007,988	7,872,960	74,759,702	28,445,458	2,839,788	299,484	4,604,124	384,920,059
Tsuen Wan	24,934,486	385,172,532	71,516,779	15,413,868	30,074,424	161,551,440	167,974,841	10,921,183	1,683,978	25,875,276	895,118,807
Total	485,824,297	7,504,704,721	2,675,723,737	314,652,507	332,166,342	2,926,471,884	2,394,816,545	222,939,833	21,940,212	337,153,494	17,216,393,573

Source: Third Comprehensive Transport Study, October 1999. Hong Kong Transport Department.

Table 4-3 Estimated 2010 Annual VKT for HKSAR

	HKSAR 2010 Annual Average Vehicle Kilometer Traveled by District (km/yr)										
District	**Motor Cycle**	**Private Car**	**Taxi**	**Pass. Van**	**PLB**	**LGV**	**HGV**	**Non Fr. Bus**	**SD Fr. Bus**	**DD Fr. Bus**	**Totals**
Central & Western	56,934,585	879,490,004	387,049,298	48,955,849	23,938,542	202,263,783	113,836,438	34,686,152	1,350,510	20,750,772	1,769,255,934
Wan Chai	18,875,733	291,580,554	210,371,545	12,297,309	18,073,470	70,986,077	24,285,335	8,713,044	880,752	13,534,836	669,598,653
Eastern	28,367,202	438,198,114	264,508,828	13,956,620	15,097,038	105,986,255	43,943,762	9,888,509	835,086	12,832,500	933,613,914
Southern	17,021,934	262,943,440	107,091,039	14,626,891	23,563,656	69,974,267	17,873,410	10,363,343	852,786	13,105,080	537,415,846
Yau Tsim Mong	24,141,030	372,913,778	210,689,738	18,712,440	20,974,500	140,065,853	70,267,230	13,258,185	1,497,066	23,004,336	895,524,155
Sham Shui Po	30,775,433	475,402,973	176,017,650	19,919,580	24,870,270	234,409,508	133,458,000	14,113,538	1,242,540	19,094,406	1,129,303,896
Kowloon City	28,547,445	440,982,668	269,834,288	15,380,415	24,300,684	153,396,165	59,586,165	10,897,448	1,148,022	17,638,758	1,021,712,057
Kwun Tong	40,219,268	621,284,603	247,818,585	17,808,413	23,430,552	193,663,223	67,518,863	12,617,888	1,717,608	26,396,364	1,252,475,364
Wong Tai Sin	11,678,018	180,397,515	100,375,815	5,535,675	17,318,742	72,696,555	25,164,090	3,921,878	678,972	10,433,442	428,200,701
Kwai Tsing	44,505,871	687,500,993	209,450,189	34,611,005	23,874,114	380,367,619	345,774,456	24,522,854	2,037,978	31,314,486	1,783,959,565
Tuen Mun	47,154,074	728,405,834	104,038,193	29,316,722	27,754,308	321,757,963	542,714,710	20,771,446	2,814,300	43,247,118	1,867,974,668
Island	33,930,475	524,135,232	235,312,438	21,282,480	0	294,858,353	269,574,257	15,079,126	1,459,188	22,425,192	1,418,056,740
Yuen Long	40,218,790	621,273,398	121,534,006	24,093,382	32,606,586	265,820,299	587,444,875	17,070,588	1,497,774	23,016,372	1,734,576,070
Tai Po	26,998,589	417,059,294	47,940,804	15,401,549	11,709,258	158,845,889	104,161,810	10,912,262	680,742	10,462,824	804,173,021
North	11,724,480	181,112,206	35,907,494	9,529,963	11,467,830	87,012,209	160,867,087	6,752,196	599,676	9,214,620	514,187,761
Sha Tin	60,411,658	933,199,366	211,688,035	34,203,197	17,587,428	286,285,464	139,921,049	24,233,566	2,388,084	36,695,640	1,746,613,486
Sai Kung	16,939,750	261,675,526	70,027,430	4,796,417	8,460,246	92,151,439	34,962,314	3,398,400	299,484	4,602,000	497,313,006
Tsuen Wan	24,698,722	381,529,022	82,285,034	13,956,379	32,608,356	156,481,027	168,300,238	9,888,494	1,799,028	27,644,922	899,191,223
Total	563,143,055	8,699,084,518	3,091,940,409	354,384,285	357,635,580	3,287,021,946	2,909,654,088	251,088,915	23,779,596	365,413,668	19,903,146,060

Source: Third Comprehensive Transport Study, October 1999. Hong Kong Transport Department.

Table 4-4 Estimated 2015 Annual VKT for HKSAR

	HKSAR 2015 Annual Average Vehicle Kilometer Traveled by District (km/yr)										
District	**Motor Cycle**	**Private Car**	**Taxi**	**Pass. Van**	**PLB**	**LGV**	**HGV**	**Non Fr. Bus**	**SD Fr. Bus**	**DD Fr. Bus**	**Totals**
Central & Western	65,354,475	1,009,557,619	459,377,814	51,884,548	26,196,000	245,328,556	145,018,493	36,761,477	1,466,622	22,535,640	2,063,481,243
Wan Chai	22,499,844	347,561,675	231,561,680	14,608,865	19,182,552	85,093,543	28,178,881	10,350,535	929,250	14,281,776	774,248,601
Eastern	27,895,689	430,911,945	264,537,764	12,682,489	15,164,652	103,983,507	41,279,282	8,985,801	872,256	13,403,148	919,716,532
Southern	18,654,681	288,169,431	116,001,892	15,771,047	25,117,362	78,720,042	19,748,556	11,174,024	904,116	13,893,438	588,154,589
Yau Tsim Mong	23,337,008	360,492,360	220,130,033	16,013,190	22,156,152	135,121,358	65,994,008	11,345,700	1,561,848	23,999,784	880,151,439
Sham Shui Po	30,535,155	471,690,840	184,634,453	18,102,675	25,412,952	237,280,890	132,398,655	12,826,305	1,271,922	19,545,402	1,133,699,249
Kowloon City	38,246,160	590,805,645	321,076,673	22,682,993	25,072,404	178,222,185	66,332,963	16,071,158	1,195,812	18,376,140	1,278,082,131
Kwun Tong	47,516,535	734,008,823	269,522,325	22,055,528	25,778,988	213,824,408	75,736,088	15,626,888	1,763,274	27,097,284	1,432,930,139
Wong Tai Sin	11,949,713	184,593,300	106,303,988	5,964,015	17,659,644	71,835,008	23,514,008	4,225,433	683,928	10,508,844	437,237,879
Kwai Tsing	44,852,083	692,845,402	222,147,461	32,200,690	23,758,002	407,332,649	369,420,523	22,814,734	2,046,828	31,453,254	1,848,871,625
Tuen Mun	50,882,969	786,008,290	129,796,366	30,533,350	29,378,106	329,061,550	597,793,853	21,633,790	2,928,996	45,006,852	2,023,024,120
Island	37,450,368	578,507,083	256,175,640	23,556,859	0	337,047,790	353,858,400	16,690,392	1,597,248	24,542,466	1,629,426,246
Yuen Long	55,145,837	851,855,688	181,945,663	31,595,350	44,586,300	348,111,706	807,035,040	22,386,110	1,745,574	26,825,058	2,371,232,326
Tai Po	32,900,760	508,231,570	57,810,607	20,793,535	13,079,238	199,880,719	132,129,792	14,732,914	770,658	11,840,946	992,170,739
North	13,316,206	205,699,205	46,259,021	12,006,122	14,524,266	101,371,298	186,886,937	8,506,620	683,574	10,506,720	599,759,969
Sha Tin	64,036,476	989,193,103	226,748,894	39,042,943	18,480,924	323,863,272	160,347,557	27,662,976	2,508,798	38,549,892	1,890,434,836
Sai Kung	22,742,942	351,320,645	80,903,160	8,638,733	9,479,766	114,190,063	46,174,486	6,120,518	395,772	6,079,950	646,046,035
Tsuen Wan	25,205,933	389,368,282	95,560,884	13,617,814	33,622,566	152,804,808	164,243,398	9,648,482	1,791,594	27,531,288	913,395,048
Total	632,522,832	9,770,820,902	3,470,494,316	391,750,744	388,649,874	3,663,073,350	3,416,090,916	277,563,856	25,118,070	385,977,882	22,422,062,743

Road Traffic in PRDEZ

4.2.5 Official VKT forecasts was not available for PRDEZ. The consultant estimated future VKT based on the following:

- Analysis of historical trends of number of registered vehicles;
- Analysis of relationship between GDP growth and growth in vehicle fleet size;
- Base Year (1997) VKT information for PRDEZ provided by GPEMC; and
- Assumptions on annual VKT per vehicle in the future.

4.2.6 Based on the GDP growth forecasts discussed in Section 2 and the relationship between GDP growth and the growth in vehicle fleet size, future vehicle fleet sizes in PRDEZ were estimated.

4.2.7 Information on typical VKT per vehicle for various vehicle types in PRDEZ was provided by GPEMC. The consultant assumed that in the future typical VKT for motor vehicles will remain similar. The typical VKT for motorcycles, small petrol vehicles, large petrol vehicles and diesel goods vehicles are assume at 10,000; 38,500; 30,000 and 33,000 km/vehicles respectively. The estimated annual VKT by vehicle category in PRDEZ is shown in Table 4-5.

Table 4-5 Assumed Annual Vehicle Kilometre Travelled in PRDEZ (in million Kilometres)

Vehicle Type	1997	2000	2005	2010	2015
Motorcycle	27,260	38,300	61,680	78,720	78,720
Small Petrol Vehicle (1)	18,051	26,466	48,774	85,965	138,435
Large Petrol Vehicle (2)	6,720	8,010	10,230	12,450	14,430
Diesel Goods Vehicle	10,357	10,665	11,204	11,781	12,359

(1) Include passenger vehicles up to 20 seats (2) Include passenger vehicles with more than 20 seats

4.3 Marine Traffic Future Development Scenario

Marine Traffic in HKSAR

4.3.1 Three types of marine traffic were studied:

- Internal ferry passenger traffic
- Cross-boundary ferry passenger traffic
- Cargo traffic

4.3.2 Year 1997, 2001, 2006, 2011 and 2016 internal ferry passenger forecasts from the CTS-3 Travel Model were extracted. Through interpolation, internal ferry passenger forecasts for 2000, 2005, 2010 and 2015 were estimated. These forecasts are shown in Table 4-6. CTS-3 also provides forecasts for cross-boundary ferry passenger. Table 4-7 summarises the cross-boundary ferry passenger forecasts derived from CTS-3 forecasts.

Table 4-6 HKSAR Internal Ferry Passenger Forecasts for Daily One-way Person Trips

	1997	2000	2005	2010	2015
Ferry Trips	113,945	96,549	96,549	96,549	96,549

Table 4-7 HKSAR Cross-Boundary Ferry Passenger Forecasts for Daily One-way Person Trips

	1997	2000	2005	2010	2015
Ferry Trips	49,400	54,200	63,500	57,700	72,800

4.3.3 The latest marine cargo forecasts for HKSAR were taken from the Hong Kong Port Cargo Forecasts 1997/98 published by the HKSAR Port Development Board. The report included forecasts for 2001, 2006, 2011 and 2016. Through interpolation, overall port cargo traffic and container traffic forecasts for ocean going vessels and river vessels were developed. These are summarised in Tables 4-8 and 4-9 respectively.

Table 4-8 HKSAR Overall Port Freight Traffic Forecasts (in Million Tonnes)

	1997	2000	2005	2010	2015
Ocean Going Traffic	134.8	158.2	201.2	250.7	299.9
River Traffic	34.5	44.6	62.9	79.2	86.6

Source: HKSAR Port Cargo Forecasts 1997/98, Port Development Department

Table 4-9 HKSAR Port Container Traffic Forecasts (in million TEUs)

	1997	2000	2005	2010	2015
Ocean Going Traffic	12.2	14.1	17.3	21.3	24.9

Source: HKSAR Port Cargo Forecasts 1997/98, Port Development Department

Marine Traffic in PRDEZ

4.3.4 Historical marine passenger and cargo statistics between 1991 and 1998 for the nine cities in the PRDEZ were assembled from various statistical yearbooks. Table 4-10 summarises the trends for passenger and cargo traffic.

Table 4-10 Historical Marine Traffic Trends in PRDEZ

	1991	1992	1993	1994	1995	1996	1997	1998
Passenger (in thousand person)	22,330	22,550	25,070	20,530	34,710	26,500	12,230	10,780
Freight (in million tonnes)	108	137	154	153	148	145	150	144

Source: Guangdong Statistical Yearbook, 1992 - 1999

4.3.5 Based on a review of the historical trends in marine traffic and GDP for each of the nine cities, relationships between the growth in marine traffic and GDP growth were identified. Based on the future GDP forecasts discussed in Section 2, future marine passenger and cargo traffic were estimated. These are summarised in Table 4-11.

Table 4-11 Marine Traffic Forecasts for PRDEZ

	2000	2005	2010	2015
Passenger (in thousand person)	9,845	6,667	4,515	3,141
Freight (in million tonnes)	164	192	225	261

4.4 Air Traffic Future Development Scenario

HKSAR International Airport

4.4.1 For estimating emissions from air traffic, forecasts of number of landing and taking off (LTO) by aircraft type. However, official forecasts of LTOs for Hong Kong International Airport were not available.

4.4.2 Passenger and freight forecasts were developed as part of CTS-3 for the years 2001, 2006, 2011 and 2016. Using these forecasts, passenger and freight forecasts was developed for 2000, 2005, 2010 and 2015.

4.4.3 Various types of aircraft were grouped into the following categories based on their weight:

- Small – 51 to 100 tons/150 seats
- Medium – 101 to 200 tons/200 seats
- Large – over 200 tons/400 seats

4.4.4 Based on the information on flight schedule and aircraft types for one week in 1999 provided by the Civil Aviation Department, the flight movements were grouped into these three categories. The result shows 83 percent of the LTOs were made by 'Large' aircraft, 11 percent were 'Medium' and only 6 percent were 'Small'.

4.4.5 The LTO forecasts are calculated based on a mix of aircraft that, on average, equate with the assumptions of average number of passenger per aircraft. The aircraft mix for 1999 and each forecast year is summarised in Table 4-12. Based on these assumptions, passenger forecasts are then converted into LTOs. The resulting LTO forecasts are summarised in Table 4-13.

Table 4-12 Assumed Future Aircraft Mix for Hong Kong International Airport

Aircraft Type	1999	2000	2005	2010	2015
Large	85%	85%	87%	90%	90%
Medium	12%	10%	9%	7%	7%
Small	3%	5%	4%	3%	3%

Table 4-13 Estimated Future Annual Landing and Take Off by Aircraft Type for Hong Kong International Airport

Aircraft Size	1997	2000	2005	2010	2015
Large	71,434	74,800	96,800	118,500	134,700
Medium	10,181	8,800	10,000	9,200	10,500
Small	2,426	4,400	4,400	3,900	4,500
Total	84,041	88,000	111,200	131,600	149,700

Guangzhou Airport

4.4.6 By 2005, the existing Guangzhou Baiyun Airport will be closed and replaced by a new airport in Huadu. Official 2005 and 2010 LTO of this new airport were obtained from the recently Mainland State Council approved "Environmental Impact Assessment of the New Guangzhou Huadu Airport" report. These forecasts were referenced when developing LTO estimates for the year 2000, 2005, 2010 and 2015.

4.4.7 Similar to HKSAR Airport, the 1999 LTOs at this airport were grouped into 'Small', 'Medium' and 'Large', based on the information on flight schedule and aircraft types for one week in 1999 provided in OAG Executive Flight Planner April 1999.

4.4.8 The LTO forecasts are calculated based on a mix of aircraft that, on average, equate with the assumptions of average number of passenger per aircraft. The aircraft mix for 1999 and each forecast year is summarised in Table 4-14. Based on the above assumptions, passenger forecasts are then converted into LTOs. The resulting LTO forecasts are summarised in Table 4-15.

Table 4-14 Assumed Future Aircraft Mix for Guangzhou Airport

Aircraft Type	1999	2000	2005	2010	2015
Small	58%	58%	30%	27%	25%
Medium	12%	12%	40%	43%	45%
Large	30%	30%	30%	30%	30%

Table 4-15 Estimated Future Annual Landing and Take Off by Aircraft Type for Guangzhou Airport

Aircraft Type	2000	2005	2010	2015
Small	39,600	22,200	27,600	36,900
Medium	8,200	29,600	44,000	66,500
Large	20,500	22,200	30,700	44,300
Total	68,300	74,000	102,300	147,700

Shenzhen Airport

4.4.9 Total annual LTO forecasts for the years 2002, 2007, 2012, 2017 and 2022 for Shenzhen Airport were obtained from the web site of the Shenzhen Airport Company. Based on these forecasts and historical trend data, the future total LTOs for the years 2000, 2005, 2010 and 2015 was estimated.

4.4.10 The 1999 LTOs at this airport were grouped into 'Small', 'Medium' and 'Large', based on the information on flight schedule and aircraft types for one week in 1999 provided by OAG Executive Flight Planner April 1999. The aircraft mix for 1999 and each forecast year is summarised in Table 4-16. Based on the above assumptions, the total LTO forecasts were dis-aggregated into 'Small', 'Medium' and 'Large' aircraft categories. The resulting LTO forecasts are summarised in Table 4-17.

Table 4-16 Assumed Future Aircraft Mix for Shenzhen Airport

Aircraft Type	1999	2000	2005	2010	2015
Small	88%	88%	85%	85%	85%
Medium	8%	8%	10%	10%	10%
Large	4%	4%	5%	5%	5%

Table 4-17 Estimated Future Annual Landing and Take Off by Aircraft Type for Shenzhen Airport

Aircraft Type	2000	2005	2010	2015
Small	29,400	42,200	54,100	64,100
Medium	3,400	4,800	6,400	7,500
Large	1,800	2,700	3,200	3,800
Total	34,600	49,700	63,700	75,400

Zhuhai Airport

4.4.11 Official LTO forecasts for Zhuhai Airport were not available. Passenger and freight forecasts were first developed based on historical trends and relationship with GDP growth trend.

4.4.12 The 1999 LTOs at this airport were grouped into 'Small', 'Medium' and 'Large', based on the information on flight schedule and aircraft types for one week in 1999 provided by OAG Executive Flight Planner April 1999. The LTO forecasts are calculated based on a mix of aircraft that, on average, equate with the assumptions of average number of passenger per aircraft. The aircraft mix for 1999 and each forecast year is summarised in Table 4-18. Based on the above assumptions, passenger forecasts are then converted into LTOs. The resulting LTO forecasts are summarised in Table 4-19.

Table 4-18 Assumed Future Aircraft Mix for Zhuhai Airport

Aircraft Type	1999	2000	2005	2010	2015
Small	90%	90%	90%	90%	90%
Medium	10%	10%	10%	10%	10%
Large	0%	0%	0%	0%	0%

Table 4-19 Estimated Future Annual Landing and Take Off by Aircraft Type for Zhuhai Airport

Aircraft Type	2000	2005	2010	2015
Small	6,000	6,900	8,100	9,300
Medium	700	800	900	1,000
Large	0	0	0	0
Total	6,700	7,700	9,000	10,300

4.5 Rail Traffic Future Development Scenario

Diesel Locomotive Operations

4.5.1 The emissions from rail traffic derive mainly from the consumption of diesel fuel by diesel locomotives. Therefore, only the operation of diesel locomotives is studied.

4.5.2 Only a limited number of diesel-fuel locomotives are operated in HKSAR. These are mostly used for track maintenance and/or depot operation. The level of diesel locomotive operation is not expected to increase in the future.

4.5.3 Emissions from diesel locomotives accounted for an insignificant share (less than 0.2 percent) of the Base Year (1997) mobile source emission of HKSAR. This share is not expected to increase in the future.

4.5.4 In PRDEZ, diesel locomotives' contribution toward the Base Year (1997) mobile source emission of PRDEZ is negligible (less than 0.001 percent). As the economy continues to growth, the use of diesel locomotive is expected to decline so its emission contribution should reduce further.

4.6 Electricity Generation

Hongkong Electric Co. Ltd (HEC)

4.6.1 HEC operates eight coal-fired units and seven gas turbine units at Lamma Island with a total capacity of 3305MW. Coal continues to be the major fuel of HEC and 3.8 million tonnes of low sulphur coal were consumed. As a result of competitive sourcing of coal supply and operation cost, the average coal price incurred by HEC in 1999 was 11.3% lower than that of 1998. Given fuel cost is a major expense category for the plant's operation, the significant saving in fuel cost is of great benefit to end-users (HEC, 1999).

4.6.2 In February 1999, HEC proposed to construct a 1800 MW gas-fired power station at Lamma Island Extension. An EIA report for this application was completed and approved by EPD (ERM, 1999). The implementation schedule for the construction of the new generators shall be subjected to an agreement with the Government as listed in Table 4-20. 3,305MW shall be used for the future years generating capacity.

Table 4-20 Forecasted Electricity Generating Capacity of HEC

Power Plant	Generating Unit	Total Capacity	Commissioned Year
Hong Kong Electric Limited Lamma Power Station	L1-L3	750 MW	1984
	L4-L6	1050 MW	1991
	GT1	55 MW	1991
	GT2-GT7	750 MW	1991
	L7-L8	700 MW	1997
	L9	300MW	2004 for first 300MW
	New Extension	1800 MW	

4.6.3 Over the past years, HEC adopted a series of measures and devices for environmental protection, which includes: (HEC, 2000)

- Electrostatic precipitators for cleaning furnace gas before it is discharged from the chimney;
- Low sulphur content coal is used to reduce the SO_2 emission. Also, newer generating units are each installed with a Flue Gas Desulphurization system which is capable to remove at least 90% of the sulphur dioxide in the flue gas;
- Low NO_x tangential firing techniques are adopted for all coal-fired boilers and newer boilers are fitted with the latest technology low NO_x burning systems to further reduce the NO_x emissions

CLP Power HKSAR Ltd (CLP Power)

4.6.4 CLP Power operates the following generating plants for Castle Peak Power Company Limited:

- Gas-fired combined-cycle plant at Black Point (1,875 MW)
- Coal-fired steam plant at Castle Peak (4,108 MW)
- Diesel Oil-fired simple-cycle gas turbine plant at Penny's Bay (300 MW).

4.6.5 Through a 49% ownership of HKSAR Pumped Storage Development Company Ltd, CLP Power has the right to use 50% of the 1,2000 MW hydro generating capacity of Phase 1 of the Guangzhou Pumped Storage Power Station.

4.6.6 In terms of nuclear power stations, CLP Power owns 25% of the Guangdong Nuclear Power Station and is contracted to buy 70% of the annual output of the nuclear plant at Daya Bay. The nuclear power station comprises two 985MW pressurized water reactor generating units. Approximately one of each of CLP Power's electricity output is generated by coal, gas and nuclear.

4.6.7 In protecting the environment, CLP Power has implemented the following control measures and also get some achievement in the past years (CLP Power, 2000)

- Early decommissioning of the power plant at Tsing Yi which ran on heavy fuel oil with higher emission
- Introduced natural gas as a fuel for power generation with lower emission
- Emission of SO_2 and nitrogen oxides per unit of electricity generated reduced by about 70% between 1990-1999
- Emission of CO_2 per unit of electricity generated reduced by about 29% between 1990-1999
- Implemented air pollution emission abatement measures such as low NO_x burners at Castle Peak Power Station

4.6.8 The overall electricity generation efficiency of CLP Power was improved by about 8% between 1990 and 1999. This gain was primarily because of the introduction of combined cycle technology at Black Point Power Station. In addition, total loss during transmission has been improved to below 5%. (CLP Power, 2000)

4.6.9 In the approved EIA report for the new Black Point Power Plant completed in 1991, an implementation schedule of its electricity generating capacity up to 6000MW was proposed based on different fuel use scenarios. The proposed implementation schedule is listed in Table 4-21. 8,263MW shall be used for as the future generating capacity for CLP Power from 2008 onward.

Table 4-21 Forecasted Electricity Generating Capacity of CLP Power

Power Plant	Generating Unit	Total Capacity	Commissioned Year
China Light & Power Limited Black Point Power Station	1	312.5 MW	1996
	2	312.5 MW	1996
	3	312.5 MW	1996
	4	312.5 MW	1996
	5	312.5 MW	1997
	6	312.5 MW	1998
	7	312.5 MW	2005
	8	312.5 MW	2006
China Light & Power Limited Castle Peak Power Station	A	1400 MW	1982
	B	2710 MW	1985

PRDEZ

4.6.10 In Guangdong Province, thermal power station is still the dominant sources of electricity supply. According to the latest statistics from relevant electricity department, in 1997 the capacity of total thermal power generator in Guangdong Province is 21.33 MKW, which accounts for 75.8% of generator capacity in Guangdong Province. (SEPA et al, 1999)

4.6.11 With the rapid economic growth in the PRDEZ, the number of new power plants operated in PRDEZ increase significantly in the past few years. In 1998, 4 out of 8 major power stations were located in PRDEZ. Similarly, in 1995, 45 out of 82 thermal power stations were operated in PRDEZ. Total coal and oil consumption of these 45 power stations are 10.28 Mtons and 2.48 Mtons, which accounted for 68.1% and 62.48% of coal and oil consumption in the Guangdong Province respectively. The biggest operating power plants in PRDEZ with their electricity generating capacity are presented in Table 4-22.

Table 4-22 Major Power Plants in the PRDEZ (excluding Nuclear Power Plant)

Name	Capacity (MW)	Coal Used (Tonnes)	Oil Used (Tonnes)
Guangzhou Power Plant	200	795,782	24,073
Guangzhou Huangpu Power Plant	1,100	1,836,897	863,406
Guangzhou Zhujiang Power Co.	600	1,362,115	7,148
Mawan Power Co.	1,200	989,217	12,073
Foshan Shakou Power Plant	283	0	80,000
Shunde Desheng Power Plant	273	0	120,000
Shajiao B Power Plant	700	1,385,129	2,455
Shajiao A Power Plant	1,200	3,255,700	32,200
Zhongshan Power Plant	250	0	78,474

Source: SEPA, 1999

4.6.12 Due to the adverse environmental impacts caused by the existing thermal power plants in PRDEZ, there were policy directions issued by the Provincial government for the power generation industry. The dual principle of new power plant emphasis not only for regional economic development benefit but also encourage energy saving. Only those, high efficiency, low pollution emission and large peak adjustment power generator shall be developed. On the other hand, those middle to small capacity power stations with high pollution emission, low economic benefit shall be phased out.

4.6.13 PRDEZ is the heart of electricity network in the Guangdong province. Before 2000, a 500 KV double circuit electricity network would be completed and gradually extend to Shantao and Maoming. 10 years later, 500 KV transformer station shall be constructed to convey electricity to peripheral cities including Zhaoqing, Shihui and Huadu etc. After 2010, the electricity network will then be extended further to Huizhou which completed with 500 KV network construction. On the basis of formation of a safer, reliable and high efficiency PRDEZ electricity network, west electricity to east project shall be speeded up.

4.6.14 Energy saving is also one important future goal in electricity generation. Energy usage shall be utilised and energy consumption rate shall be lowered as far as possible. Large capacity and high efficiency power generator shall be developed based on high technology. At the same time, middle to small-scale power generators shall be modified or eliminated. Also high-energy loss transform shall be eliminated to improve the quality of electricity network.

4.6.15 Energy shortage is serious in Guangdong province and the case is even serious than that of the whole Mainland. It is estimated that total coal consumption of Guangdong province is 76.82 Mtons of which 70.00 Mtons are imported or transferred from other provinces. In 2010, annual coal consumption of Guangdong province is estimated to be 124.10 Mtons, of which 118.10 Mtons are imported or transferred from other provinces. Given limited coal in Guangdong province, it is essential and important to develop new energy sector and to save energy at the same time. Nuclear power would be a new energy sector and Shenzhen Lingou Nuclear Power Plant has been built with total capacity is 4 million KW.

4.6.16 Future planned power generation are listed in Table 4-23 below. For coal-fired power plant of any scales, it is not allowed to be constructed after year 2000 in accordance with the latest Guangdong Provincial Government announcement. Hence there will not have an increase in power generation from coal-fired power plants after year 2000. (GDPD et al, 1995b)

Table 4-23 Planned Power Generation (MW) in PRDEZ for Specific Power Plants

Name	Fuel	Single Unit Capacity	Total Capacity	1995 Capacity	1996-2000 Capacity	2000-2010 Capacity
Dongguan Shajiao Power Plant C	Coal	3 x 660	1,980	1,980		
Zhuhai Power Plant	Coal	2 x 660 4 x 660	3,720		2,520	1,200
Jiangmen Taishan Power Plant	Coal	4 x 660 4 x 600	5,040		1,920	3,120
Guangzhou Shuiming Power Plant	Coal	1 x 125	125	125		
Guangzhou Zhujiang Power Plant	Coal	2 x 300	600	300	300	
Dongguan Binsha Power Plant	Coal	1 x 125	125		125	
Shenzhen Mawan Power Plant	Coal	4 x 300	1,200		600	600
Other Coal Fired Power Plants	Coal		430	50	380	
Shenzhen Chianwan Power Plant	Natural Gas	3 x 340	1,020			1,020
Huizhou Bijia Power Plants	Natural Gas	12 x 340	4,080			4,080
Guangzhou Panyun Power Plant	Natural Gas	8 x 340	2,720			2,040
Shenzhen East Power Plant	Natural Gas	8 x 340	2,720			1,360
Shenzhen Auling Power Plant	Nuclear	4 x 1000	4,000			4,000
Guangzhou Chunen Power Plant	Buffer	4 x 300	1,200		1,200	
Guangzhou Hengyun Power Plant C	Oil	1 x 210	210		210	
Foshan Nanhai Power Plant A	Oil	2 x 210	420		420	
Zhongshan Power Plant A	Oil	2 x 125	250		250	
Dongguan Oil Power Plant	Oil	2 x 200	400		400	

5 DETERMINATION OF FUTURE YEAR EMISSIONS

5.1 Introduction

5.1.1 In general, there were two possible methods to derive the future year emissions. For an emission source, the future year emissions could be directly computed based on the future activity data presented in previous chapters and relevant emission factors.

Emission = Future year activity data × emission factor

5.1.2 For emission sources where activity data were neither applicable nor available, the future year emissions were estimated with projection surrogates such as GDP and population growths, which could suitably represent the trade, service or industry.

Emission = Base year emission × growth rate of relevant surrogate (i.e. the growth factor), where

Growth factor of a projection surrogate = Future year activity level ÷ Base year activity level

5.1.3 The methods applied to determine the future year emissions are widely accepted in other inventory development projects worldwide that are comparable to this study. USEPA has published several papers on this subject which serve as reference in the projection of future year emissions.

5.2 Overall Methodology

5.2.1 This report presents the projected future year (2000, 2005, 2010, and 2015) emission inventories for the Hong Kong Special Administration Region (HKSAR) and the Pearl River Delta Economic Zone (PRDEZ).

5.2.2 Future year emission inventory is compiled by projecting base year emissions with the relevant growth scenarios. During the course of the study, certain control measures were committed to reduce pollutant emissions from particular activities. The effects of those control measures on future year emissions were considered together with the future development of the emitters.

5.2.3 Growth surrogates used in the projection included Gross Domestic Product (GDP), population, the number of on-road vehicles, vehicle kilometre travelled (VKT), airport landing and take-off cycles (LTOs), marine freight and passenger volume, and energy consumption/generation. The application of growth surrogates in different jurisdictions (HKSAR, MSAR, PRDEZ) may vary. Details are to be given in latter sections.

5.3 Future year emissions in HKSAR

Motor Vehicles

5.3.1 The annual emissions from a motor vehicle type can be expressed in terms of total vehicle-kilometres-travelled (VKT) and the fleet emission factors. The on-road vehicles in HKSAR are categorised into ten different types:

- Motor Cycle
- Private car
- Taxi
- Passenger van
- Public light bus
- Light goods vehicle
- Heavy goods vehicle
- Non franchised bus
- Single-deck franchised bus
- Double-deck franchised bus

5.3.2 Therefore the total emission from on-road vehicles is the sum of the emissions contributed by individual vehicle types. The base year and future year annual VKT used in the future year emission projection is reference to the recently completed Third Comprehensive Transport Study (CTS-3). Table 5-1 shows the future annual VKT by vehicle types in HKSAR in the study period. The estimated emission is presented in Table 5-2 and illustrated in Figure 5-1 for 2015 scenario.

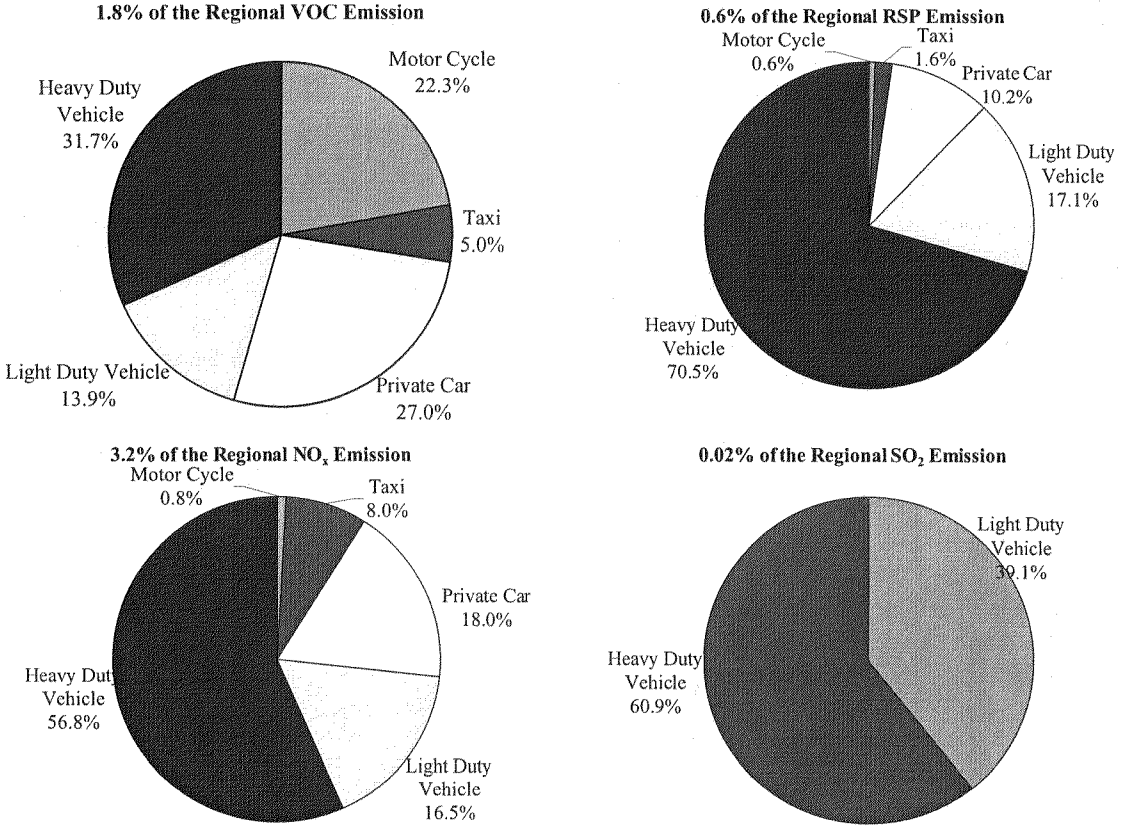
Table 5-1 Future Annual VKT by vehicle types in HKSAR (km/yr)

Vehicle Type	1997	2000	2005	2010	2015
Motor Cycle	273,586,425	384,782,070	485,824,297	563,143,055	632,522,832
Private Car	4,226,190,303	5,943,877,788	7,504,704,721	8,699,084,518	9,770,820,902
Taxi	1,702,038,231	2,181,246,643	2,675,723,737	3,091,940,409	3,470,494,316
Pass. Van	176,599,244	235,159,354	314,652,507	354,384,285	391,750,744
PLB	310,507,690	298,602,540	332,166,342	357,635,580	388,649,874
LGV	2,309,923,402	2,935,348,519	2,926,471,884	3,287,021,946	3,663,073,350
HGV	1,395,306,154	1,938,645,455	2,394,816,545	2,909,654,088	3,416,090,916
Non Fr. Bus	125,125,075	166,616,171	222,939,833	251,088,915	277,563,856
SD Fr. Bus	17,880,339	19,098,654	21,940,212	23,779,596	25,118,070
DD Fr. Bus	274,760,236	293,467,062	337,153,494	365,413,668	385,977,882
Total	10,811,917,098	14,396,844,256	17,216,393,573	19,903,146,060	22,422,062,743

Table 5-2 Estimated emission from motor vehicles (tonnes/year)

Pollutant	1997	2000	2005	2010	2015
VOC	13,395	12,917	11,765	10,097	11,428
RSP	5,498	4,710	2,943	2,029	2,315
NO_x	31,360	31,309	26,157	22,384	25,354
SO_2	1,471	1,303	129	149	169

Figure 5-1 2015 VOC, RSP, NOx and SO_2 Emissions from Motor Vehicles in the HKSAR



Light Duty Vehicle includes Pass. Van, PLB & LGV
Heavy Duty Vehicle includes HGV, Non Fr Bus, SD Fr Bus & DD Fr Bus

5.3.3 The emissions of paved and unpaved road dust were projected using the total VKT as growth surrogate. It is assumed that road dust increases as more vehicles ride on the road longer. Table 5-3 presents the amount of RSP sourced from road dust. Another emission source related to total VKT growth is petrol distribution and handling where VOC is emitted from the process. The amount of VOC emissions from service stations is also included in Table 5-3.

Table 5-3 Emissions associated to the growth of total VKT in HKSAR (tonnes/year)

Emissions	Pollutant	1997	2000	2005	2010	2015
Transportable paved road dust	RSP	1,000	1,332	1,593	1,841	2,074
Transportable unpaved road dust	RSP	68	90	108	124	140
Service Station Refuelling	VOC	1,145	1,525	1,824	2,108	2,375

Airports

5.3.4 Future emission from the landing and takeoff of aircrafts at the airport is the product of forecasted landing and takeoff cycles and relevant emission factors. With the emission factors of different plane types derived from computer modelling results, the future year emissions are computed and presented in Table 5-4.

Table 5-4 Estimated emissions from airport in HKSAR (tonnes/year)

Pollutants	1997	2000	2005	2010	2015
VOC	677	189	240	287	327
NO_x	2,787	2,561	3,286	3,963	5,091
SO_2	288	298	383	463	526

Marine Vessels

5.3.5 There is a long list of marine vessels that go in and out of HKSAR harbours and waters everyday. These marine vessels can be categorised in to 5 vessel types, namely:

- Ocean-going vessels
- River trade vessels
- Container vessels
- Domestic ferries
- International ferries

5.3.6 The future activity information of these 5 vessel types is mainly obtained from HKSAR Port Development Board and HKSAR Annual Digest of Statistics. The changes in activity levels of the 5 vessels types are treated as growth surrogates for other vessels types in corresponding categories to project future emissions from base year emissions. Table 5-5 shows the future activity growth of marine vessels. Table 5-6 shows the projected emissions.

5.3.7 The activity of all classes of vessels is expected to be in an increasing tread through 2015 except for domestic ferries. The passenger-trips for domestic ferries are kept constant since 2000. In view of the passenger trend presented in the HKSAR Annual Digest of Statistics and the present transportation infrastructure, the use of domestic ferries is not expected to grow significantly and would level out.

Table 5-5 Future activity growth of marine vessels

Class of Vessel	1997	2000	2005	2010	2015
Ocean-Going Vessels Freight Carried (million tonnes)	134.8	158.2	201.2	250.7	299.9
Growth factor from 1997	1.00	1.17	1.49	1.86	2.22
River Traffic Vessels Freight Carried (million tonnes)	34.5	44.6	62.9	79.2	86.6
Growth factor from 1997	1.00	1.29	1.82	2.30	2.51
Container Vessels Freight Carried (million TEUs)	12.2	14.1	17.3	21.3	24.9
Growth factor from 1997	1.00	1.16	1.42	1.75	2.04
Domestic Ferry (daily one-way person trips)	113,945	96,549	96,549	96,549	96,549
Growth factor from 1997	1.00	0.85	0.85	0.85	0.85
International Ferry (daily one-way person trips)	49,400	54,200	63,500	57,700	72,800
Growth factor from 1997	1.00	1.10	1.29	1.17	1.47

Table 5-6 Projected emissions from marine vessels in HKSAR waters and harbours (tonnes/year)

Pollutant	1997	2000	2005	2010	2015
VOC	443	428	478	529	579
RSP	485	505	597	684	769
NO_x	14,395	15,953	19,618	23,093	26,478
SO_2	3,234	3,694	4,623	5,507	6,369

Power Generation

5.3.8 The electricity generation data was extracted from the annual reports of individual power & electric companies in HKSAR. The fuel mix was also considered in the calculation of future emissions as the emission factors of different fuel types vary. The emission factors applied here are referenced to overseas and local papers including Corinair, USEPA AP-42 and EIA reports (ERL, 1991 & ERM, 1998). Table 5-7 presents the electricity generated from different fuels and Table 5-8 presents the future emissions.

Table 5-7 Projected fuel mix for HKSAR (million kWh)

Fuel Type	1997	2000	2005	2010	2015
Coal/Oil Fired	14,829	16,460	17,498	18,388	19,426
Gas fired	9,500	10,545	11,210	11,780	12,445
Nuclear	7,000	7,770	8,260	8,680	9,170
Total Generation	31,329	34,775	36,968	38,848	41,041

Table 5-8 Projected emissions from power generation in HKSAR (tonnes/year)

Pollutant	1997	2000	2005	2010	2015
VOC	296	329	350	367	388
RSP	3,747	4,159	4,421	4,646	4,908
NO_x	56,084	62,253	66,179	69,544	73,470
SO_2	54,434	60,422	64,232	67,498	71,308

Textile Industry

5.3.9 Growth factor for textile industry was estimated using the employment trend, i.e. the historic employment size of the textile industry as surrogate. The growth for textile industry projected in a downward trend as shown in Table 5-9 and the projected emissions shown in Table 5-10. However, the emission from textile industry is a relatively minor source in the emission inventory.

Table 5-9 Growth factor for textile industry

Year	1997	2000	2005	2010	2015
No. of Employees	43,901	29,161	21,801	19,271	18,816
Growth Factor	1.00	0.66	0.50	0.44	0.43

Table 5-10 Projected emissions from textile industry in HKSAR (tonnes/year)

Pollutant	1997	2000	2005	2010	2015
VOC	9	6	4	4	4
RSP	63	42	31	28	27
NO_x	1,423	946	707	625	610
SO_2	4,983	3,310	2,474	2,187	2,136

Human emissions

5.3.10 For those emission sources where no additional or source specific information is available, the projection is based on growth surrogates that could suitably represent the emission sources.

5.3.11 Emissions cause by human sweat and exhalation are projected using the population trend presented in the HKSAR Annual Digest of Statistics as growth surrogates. The growth factors are presented in Table 5-11.

Table 5-11 Population Projection Factors for HKSAR

Population	1997	2000	2005	2010	2015
Mid-Year Population Forecast	6,487,500	6,860,000	7,299,200	7,713,600	8,124,600
Growth factor from 1997	1.00	1.06	1.13	1.19	1.25

Other industries

5.3.12 There is a variety of trade, service and industrial sectors that uses the GDP growth as projection surrogate in projecting future emissions. The GDP growth presented in Table 5-12 represents the growth of the following sectors or sources in HKSAR:

- Domestic solvent use
- Other fuel combustion
- Dry cleaning
- Fuel terminals
- Other industries
- Paint application
- Paint manufacture
- Printing
- PVC manufacture
- Transportable Construction Dust

Table 5-12 GDP Projection Factors for HKSAR

Year	1997-2000	2001-2005	2006-2010	2011-2015
GDP annual growth	3.0%	5.0%	4.5%	4.0%
Number of years in period	3	5	5	5
Period growth	1.093	1.276	1.246	1.217
Compounded growth factor from 1997	1.093	1.395	1.738	2.114

5.4 Future year emissions in PRDEZ

5.4.1 The emission projections for PRDEZ are handled in a way that is similar to the projections for HKSAR for consistency. However the projection methods may vary in cases where more relevant information is available for PRDEZ. This section will elaborate any exceptions and the emissions projected for different sources.

Motor Vehicles

5.4.2 Motor vehicles in PRDEZ were classified into four classes:

- Motorcycle
- Small petrol vehicle
- Large petrol vehicle
- Diesel goods vehicle

5.4.3 In calculating the future year fleet distribution, the following assumptions were made with reference to vehicular emission studies in mainland China and overseas.

- The life spans for motorcycle, small petrol vehicle, large petrol vehicle, and diesel goods vehicle were 9 years, 8 years, 10 years, and 10 years respectively. (Qinghua University and Peking University, 1999)
- In the United States, average lifetime emissions degradation due to deterioration and malfunction for VOC and NOx is approximately 65% in 9 years, i.e. a degradation rate of ~6% per year (J. Air & Waste Manage. Assoc. / Ross, Goodwin, Watkins, Wenzel, and Wang, 1993). Assuming the degradation rate in PRDEZ is 50% greater than that in the United States due less advanced technologies in maintenance and lower inspection frequency, the estimated degradation rate of vehicles in PRDEZ is around 10% per year.
- The future motor vehicle emissions at EURO standards within the scheduled time frame (SEPA, 1999) as presented in Table 5-13.

Table 5-13 Euro emissions standards implementation plan

Year of commencement	1997	2000	2001	2004	2005	2010
Motorcycle	Pre-Euro		Euro 1		Euro 2	Euro 3
Small Petrol Vehicle	Pre-Euro	Euro 1		Euro 2		Euro 3
Large Petrol Vehicle	Pre-Euro		Euro 1		Euro 2	Euro 3
Diesel Goods Vehicle	Pre-Euro	Euro 1		Euro 2		Euro 3

5.4.4 Table 5-14 shows the projected growth of motor vehicles in PRDEZ. With consideration of the projected growth and design life span of motor vehicles, the penetration rate of new Euro standard vehicles and the phase out rate of used vehicles were estimated. Figure 5-2 shows the change in fleet mix of the four vehicle types in terms of number of vehicles. The information on VKT travelled in different cities is provided by GPEMC and an average value among major PRDEZ cities is assumed for each vehicle type for projections of vehicular emissions.

Table 5-14 The Annual Vehicle Kilometre Travelled in PRDEZ (in million kilometres) assumed for the calculation of vehicular emissions

Vehicle Type	1997	2000	2005	2010	2015
Motorcycle	27,260	38,300	61,680	78,720	78,720
Small Petrol Vehicle (1)	18,051	26,466	48,774	85,965	138,435
Large Petrol Vehicle (2)	6,720	8,010	10,230	12,450	14,430
Diesel Goods Vehicle	10,357	10,665	11,204	11,781	12,359

(1) Include passenger vehicles up to 20 seats (2) Include passenger vehicles with more than 20 seats

5.4.5 As mentioned in 5.3.2, the total emission from motor vehicles is the sum of the emissions contributed by individual vehicle types. For a given study year, the vehicular emissions are calculated in terms of the projected VKT by vehicles of different Euro standards, the emission factors of Euro standards, and the age of vehicles. The results are presented in Table 5-15. The VOC and NO_x emitted from different vehicle types of different Euro standards are further presented in Figure 5-3 and 5-4. A summary of the predicted emissions for 2015 scenario is further illustrated in Figure 5-5.

Table 5-15 Projected emissions from motor vehicles in PRDEZ (tonnes/year)

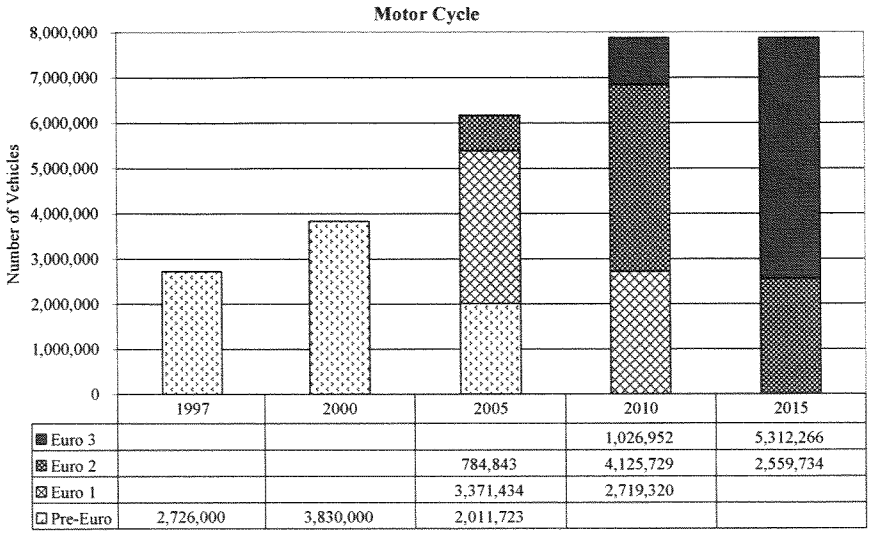
Pollutant	1997	2000	2005	2010	2015
VOC	240,726	375,116	347,821	169,897	104,967
RSP	31,470	55,083	53,202	35,009	22,147
NO_x	140,791	240,581	239,502	171,564	129,841
SO_2	21,143	27,748	36,887	33,573	20,886

5.4.6 For other emission sources related to total VKT growth in PRDEZ, the projection of their future emissions was analogous to that of the projection for HKSAR as described in 5.3.3. The total VKT in PRDEZ is the sum of VKT of different vehicle types in the 9 individual cities within the study area. The estimated emissions of other sources related to VKT growth in PRDEZ are presented in Table 5-16.

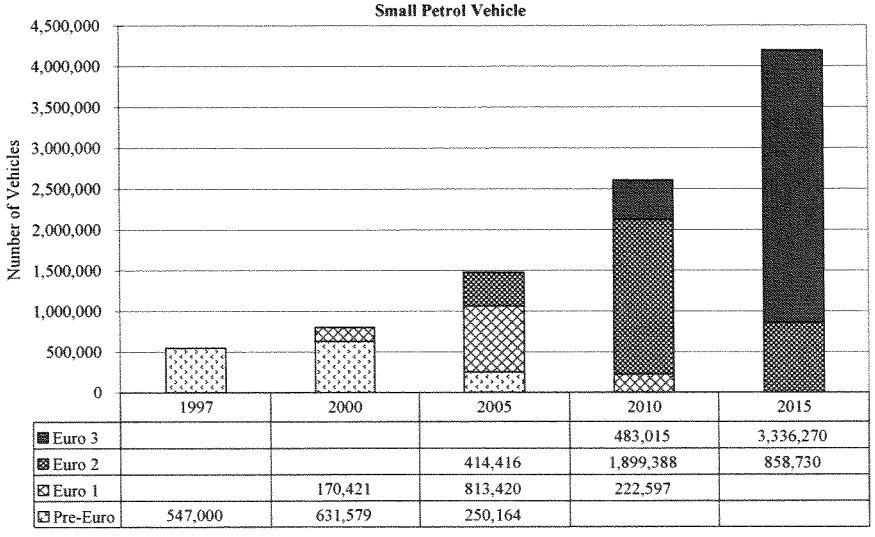
Table 5-16 Emissions associated to the growth of total VKT in PRDEZ (tonnes/year)

Emissions	Pollutant	1997	2000	2005	2010	2015
Transportable paved road dust	RSP	4,004	5,504	8,802	11,907	13,684
Transportable unpaved road dust	RSP	3,684	5,063	8,098	10,954	12,589
Petrol distribution and handling	VOC	4,992	6,860	10,972	14,842	17,057

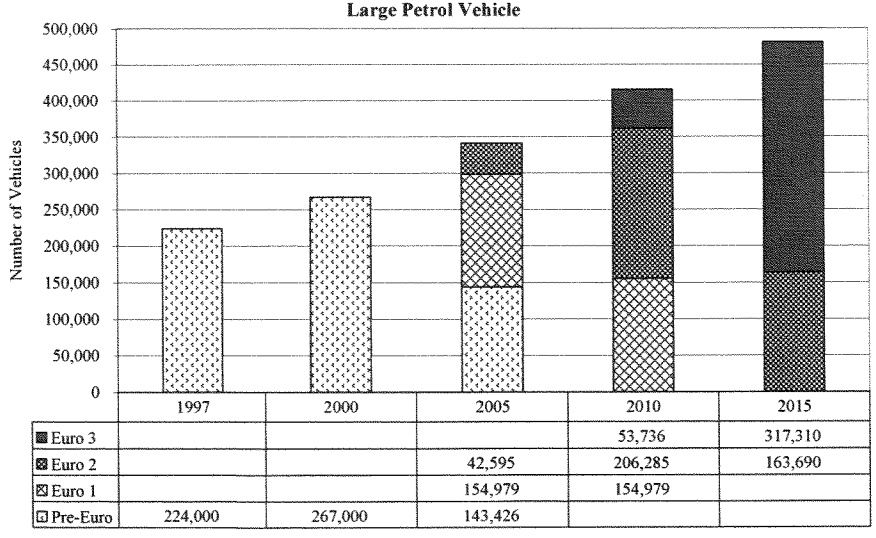
Figure 5-2 Emission Standard Distribution of Motor Vehicles in the PRDEZ



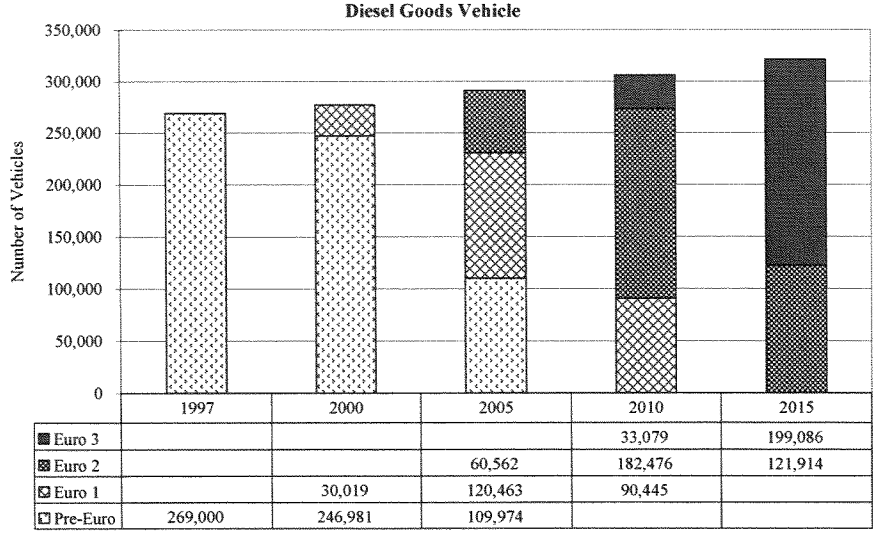
	1997	2000	2005	2010	2015
Euro 3				1,026,952	5,312,266
Euro 2			784,843	4,125,729	2,559,734
Euro 1			3,371,434	2,719,320	
Pre-Euro	2,726,000	3,830,000	2,011,723		



	1997	2000	2005	2010	2015
Euro 3				483,015	3,336,270
Euro 2			414,416	1,899,388	858,730
Euro 1		170,421	813,420	222,597	
Pre-Euro	547,000	631,579	250,164		

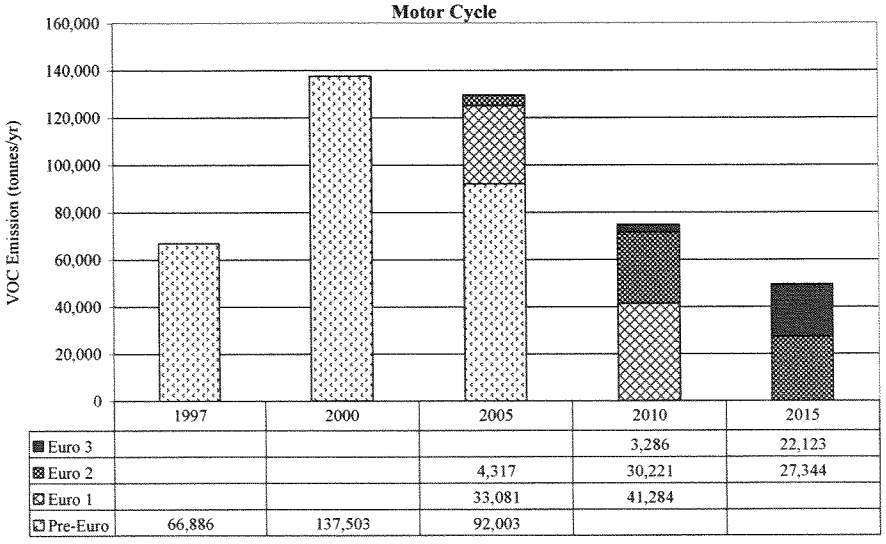


	1997	2000	2005	2010	2015
Euro 3				53,736	317,310
Euro 2			42,595	206,285	163,690
Euro 1			154,979	154,979	
Pre-Euro	224,000	267,000	143,426		

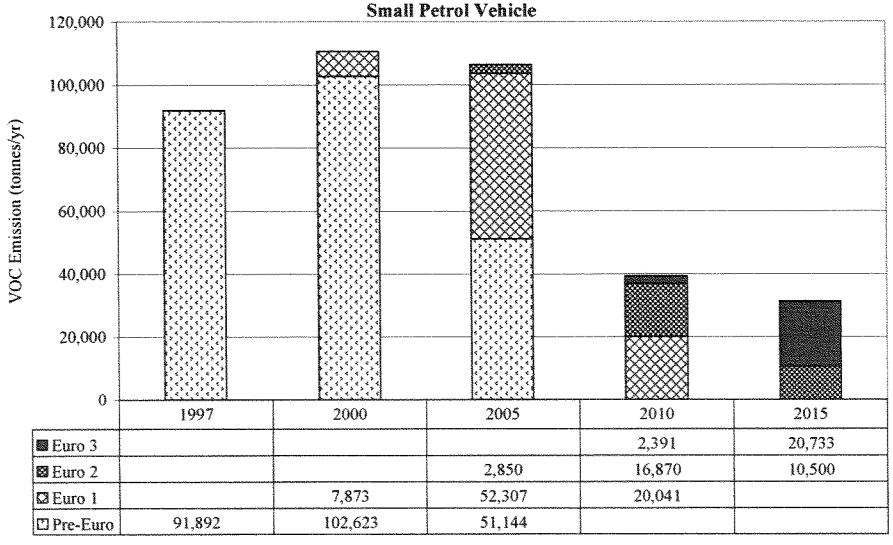


	1997	2000	2005	2010	2015
Euro 3				33,079	199,086
Euro 2			60,562	182,476	121,914
Euro 1		30,019	120,463	90,445	
Pre-Euro	269,000	246,981	109,974		

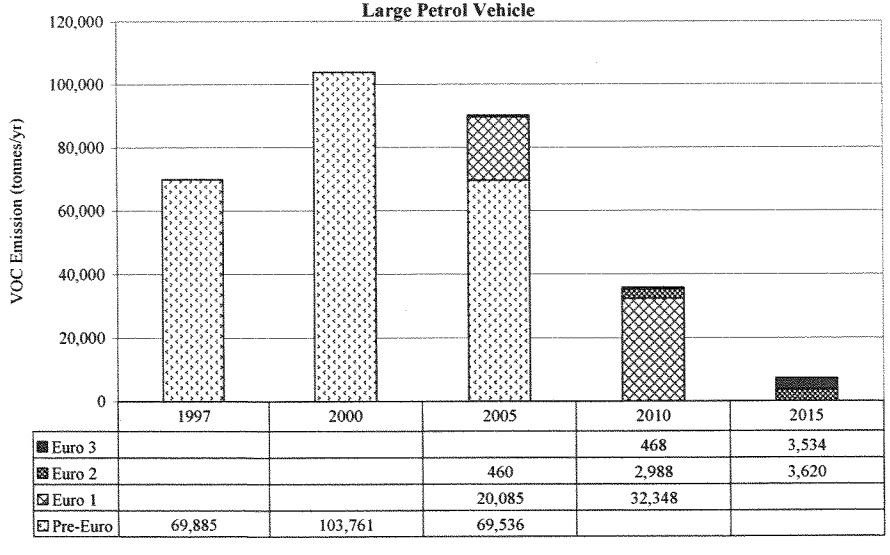
Figure 5-3 VOC Emission Distributions of Motor Vehicles in the PRDEZ



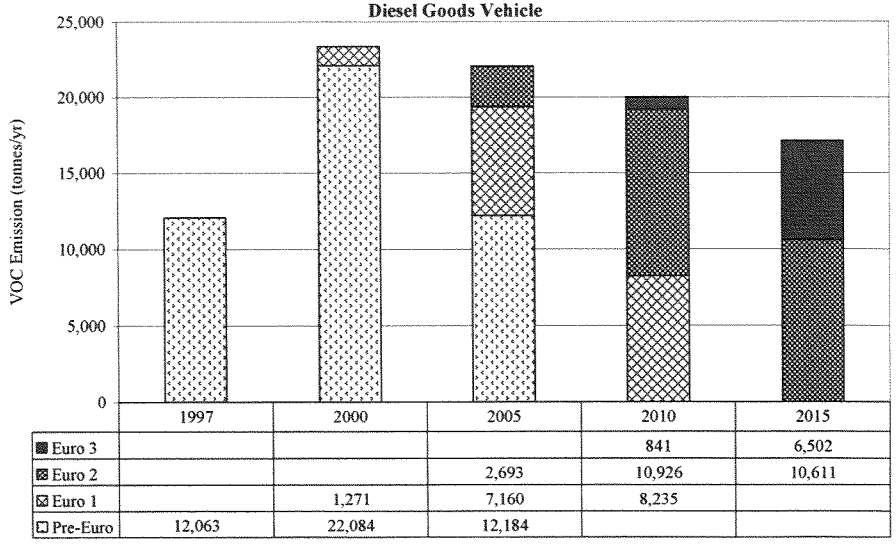
	1997	2000	2005	2010	2015
Euro 3				3,286	22,123
Euro 2			4,317	30,221	27,344
Euro 1			33,081	41,284	
Pre-Euro	66,886	137,503	92,003		



	1997	2000	2005	2010	2015
Euro 3				2,391	20,733
Euro 2			2,850	16,870	10,500
Euro 1		7,873	52,307	20,041	
Pre-Euro	91,892	102,623	51,144		

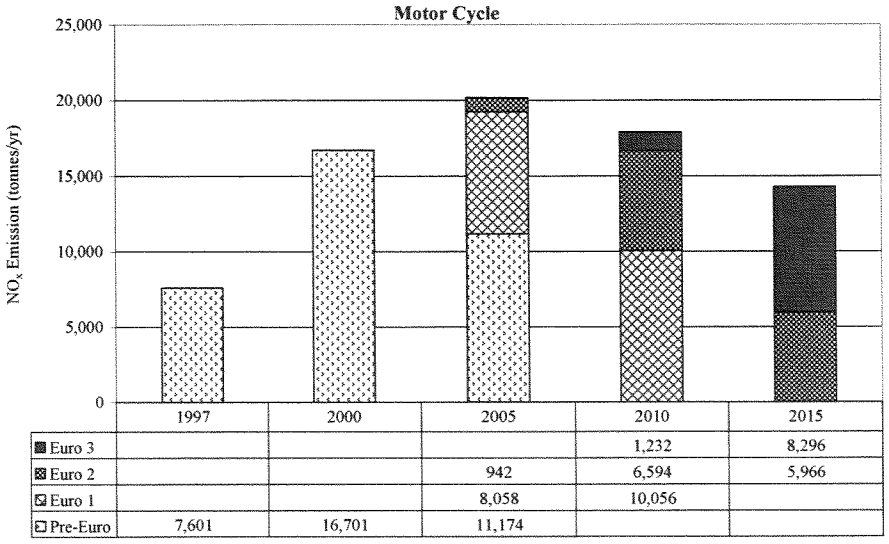


	1997	2000	2005	2010	2015
Euro 3				468	3,534
Euro 2			460	2,988	3,620
Euro 1			20,085	32,348	
Pre-Euro	69,885	103,761	69,536		

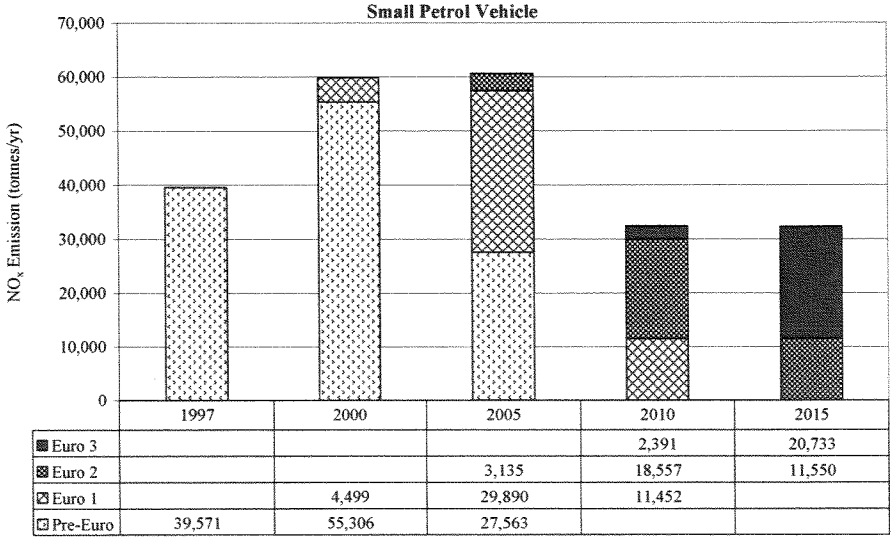


	1997	2000	2005	2010	2015
Euro 3				841	6,502
Euro 2			2,693	10,926	10,611
Euro 1		1,271	7,160	8,235	
Pre-Euro	12,063	22,084	12,184		

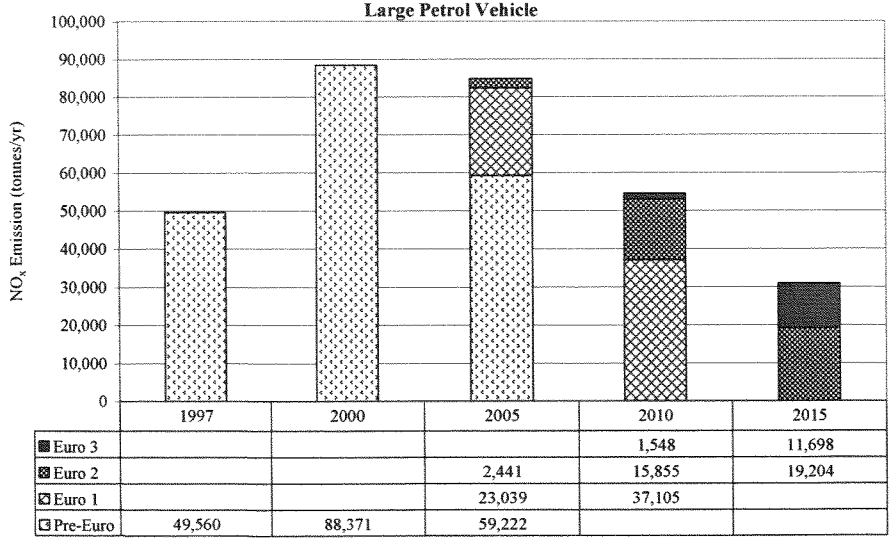
Figure 5-4 NOx Emission Distributions of Motor Vehicles in the PRDEZ



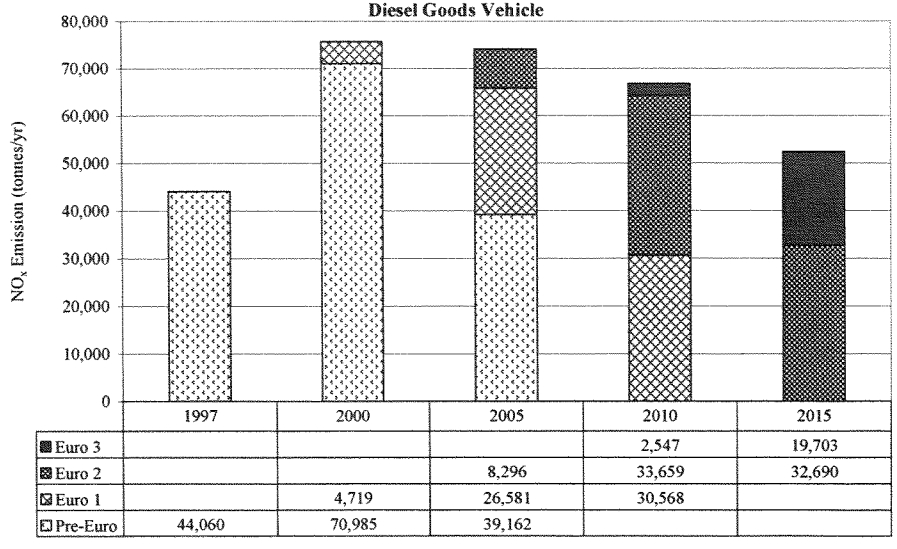
	1997	2000	2005	2010	2015
Euro 3				1,232	8,296
Euro 2			942	6,594	5,966
Euro 1			8,058	10,056	
Pre-Euro	7,601	16,701	11,174		



	1997	2000	2005	2010	2015
Euro 3				2,391	20,733
Euro 2			3,135	18,557	11,550
Euro 1		4,499	29,890	11,452	
Pre-Euro	39,571	55,306	27,563		

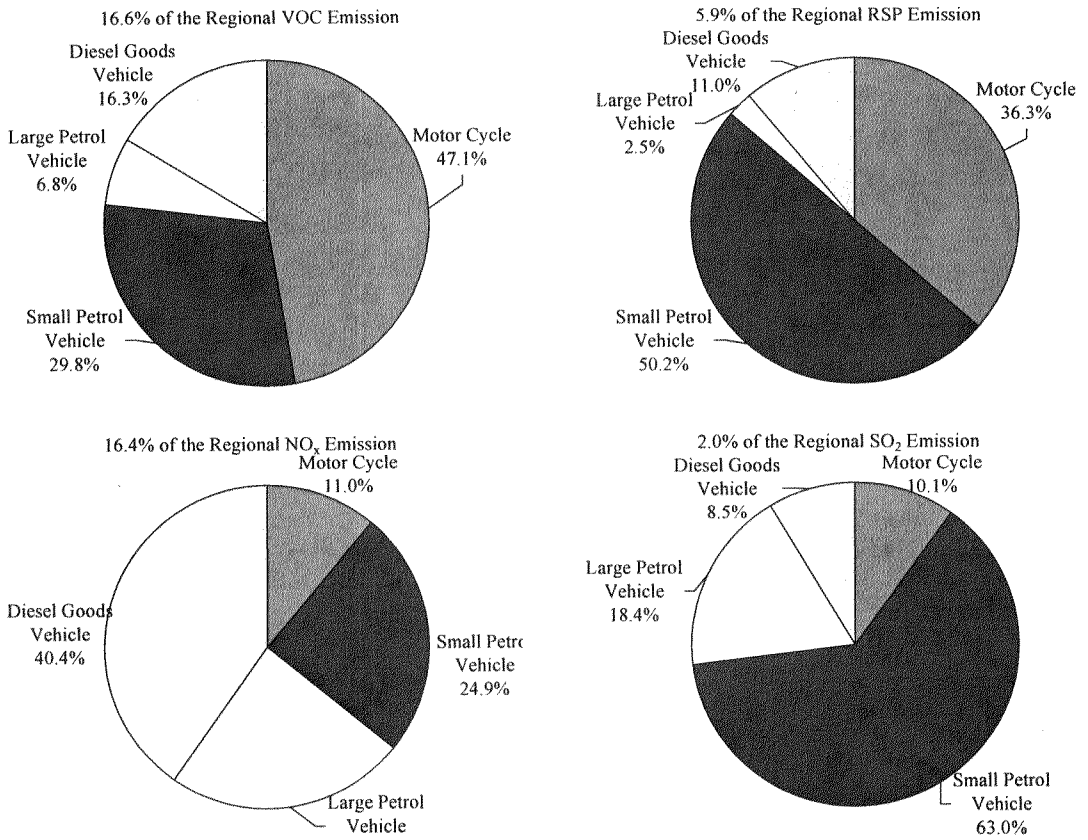


	1997	2000	2005	2010	2015
Euro 3				1,548	11,698
Euro 2			2,441	15,855	19,204
Euro 1			23,039	37,105	
Pre-Euro	49,560	88,371	59,222		



	1997	2000	2005	2010	2015
Euro 3				2,547	19,703
Euro 2			8,296	33,659	32,690
Euro 1		4,719	26,581	30,568	
Pre-Euro	44,060	70,985	39,162		

Figure 5-5 2015 VOC, RSP, NOx and SO_2 Emissions from Motor Vehicles in PRDEZ



Small Petrol Vehicle includes passenger vehicles up to 20 seats; Large Petrol Vehicle includes passenger vehicles with more than 20 seats

Airports

5.4.7 Future emission from the landing and takeoff of aircrafts at the airport is the product of forecasted landing and takeoff cycles and relevant emission factors. The emission from airports in PRDEZ is projected in an analogous method as HKSAR. Projected LTOs are presented in Table 5-17 and the estimated emissions from airports in PRDEZ are presented in Table 5-18.

Table 5-17 The forecasted LTO cycles in PRDEZ

Airport	1997	2000	2005	2010	2015
Guangzhou	55,701	68,300	74,000	102,300	147,700
Shenzhen	26,000	34,600	49,700	63,700	75,400
Zhuhai	6,136	6,700	7,700	9,000	10,300

Table 5-18 Estimated emissions from airport in PRDEZ (tonnes/year)

Airport	Pollutants	1997	2000	2005	2010	2015
Guangzhou	VOC	193	236	256	354	511
	NO_x	1,804	2,212	2,396	3,313	4,783
	SO_2	75	92	100	138	199
Shenzhen	VOC	82	109	156	200	237
	NO_x	362	482	692	887	1,050
	SO_2	27	36	52	66	78
Zhuhai	VOC	12	13	15	18	20
	NO_x	72	78	90	105	121
	SO_2	6	6	7	9	10

Marine Vessels

5.4.8 There is very limited information in future activity level for PRDEZ vessels. The vessels in PRDEZ can generally be divided into 2 categories, one for carrying passengers and the other for carrying freight. The future activity levels for the two categories of vessels were presented in Table 5-19. With the base year emissions presented in the main report, the future emissions from PRDEZ vessels were projected and shown in Table 5-20.

Table 5-19 Future activity levels for PRDEZ vessels

Activity	1997	2000	2005	2010	2015
Freight Carried (million tonnes)	150	164	192	225	261
Growth factors from 1997	1.000	1.093	1.280	1.500	1.740
Passengers Carried (thousand persons)	12,230	9,845	6,667	4,515	3,141
Growth factors from 1997	1.000	0.805	0.545	0.369	0.257

Table 5-20 Future emissions from PRDEZ vessels (tonnes/year)

Pollutants	1997	2000	2005	2010	2015
VOC	484	415	327	276	252
RSP	1,387	1,187	937	790	721
NO_x	55,925	47,879	37,775	31,862	29,073
SO_2	13,988	11,976	9,448	7,969	7,272

Power Generation

5.4.9 The electricity generation data was mainly extracted from the fuel consumption projections in the Research on Perspective Plan for the PRD Economic Region in Guangdong (GDPD 1995) and was also referenced to Guangdong Acid Rain Report (GDEPB 1998). Regression and interpolation were performed with the data where necessary to complete the activity level for future years. Same as the calculation for HKSAR, the fuel mix in the future was also considered as the emission factors of different fuel types vary. The emission factors applied here are referenced to overseas papers including Corinair and USEPA AP-42. Table 5-21 presents the electricity generated from different fuels and Table 5-22 presents the future emissions. Electricity generation from coal causes the most pollutants.

Table 5-21 Projected fuel mix for PRDEZ (million kWh)

Fuel Type	1997	2000	2005	2010	2015
Coal/Oil Fired	67,350	93,100	99,050	105,000	110,950
Gas fired	2,550	5,100	23,800	42,500	61,200
Nuclear	3,800	3,800	3,800	29,500	29,500
Hydro	1,000	1,000	1,000	1,000	1,000
Western Provinces	5,200	7,500	23,450	39,400	55,350
Total Generation	79,900	110,500	151,100	217,400	258,000

Table 5-22 Projected emissions from power generation in PRDEZ (tonnes/year)

Pollutant	1997	2000	2005	2010	2015
VOC	1,150	1,577	1,926	2,275	2,624
RSP	16,580	22,971	24,627	26,284	27,940
NO_x	137,642	191,355	216,185	241,015	265,846
SO_2	215,169	297,462	316,569	335,677	354,784

Agriculture-related sources

5.4.10 The agriculture related emissions were made up of various sources:

- Agricultural waste burning
- Agriculture activity
- Ammonia production

- Animal waste ammonia
- Grain drying
- Nitrogen fertiliser production
- Nitrogen fertiliser usage
- Pesticide application

5.4.11 The agriculture GDP of Guangdong obtained from the Statistical Yearbook of Guangdong was used as surrogate to project the growth of the various sources listed above. The agricultural growth factors are presented in Table 5-23.

Table 5-23 Future Agriculture Growth Factor

Year	1997	2000	2005	2010	2015
Agriculture GDP (RMB 100 million)	1,656	1,783	1,828	1,652	1,312
Growth Factor	1.00	1.08	1.10	1.00	0.79

Industrial sources

5.4.12 The projections of future emissions from an array of industries were based on secondary and tertiary GDP growth. These industrial sources include:

(Projected by secondary GDP growth)

- Alcoholic beverage production
- Chemicals/rubber/plastic
- Coke production
- Electronic manufacture
- Gas, water and sanitary work
- Manufacture-heavy
- Manufacture-light/medium
- Mining/mineral extraction
- Oil refinery
- Paint application
- Printing
- Pulp and paper industries
- Solvent application

(Projected by tertiary GDP growth)

- Food and beverage
- Transportation

5.4.13 It is understood that emissions from secondary and tertiary industries are closely related to fuel combustion and a growth in GDP normally indicates a growth in the industrial sector. Therefore the growth factors were estimated based on GDP growths adjusted with the elasticity of energy consumption for the two tiers of industries, Secondary (manufacturing and construction industries), and Tertiary (other activities). The elasticity adjustment was based on provincial statistics given in the Statistical Yearbook of Guangdong and the assumed average is 0.53. Adjusted GDP growth factors are presented in Table 5-24.

Table 5-24 Adjusted GDP Projection Factors by Industry Type for PRDEZ

Industry	2000	2005	2010	2015
Secondary Industry				
GDP Annual Growth	14.0%	12.0%	12.0%	11.0%
Times of growth relative to preceding study year	3	5	5	5
Adjusted growth factor	1.186	1.617	2.305	3.209
Tertiary Industry				
GDP Annual Growth	14.0%	13.0%	13.0%	12.0%
Times of growth relative to preceding study year	3	5	5	5
Adjusted growth factor	1.145	1.545	2.227	3.202

Construction-related sources

5.4.14 The construction related emissions were sourced from construction activity and transportable construction dust. The construction growth factors were derived from the regression of historic trend given in the Statistical Yearbook of Guangdong and are presented in Table 5-25.

Table 5-25 Future Construction Growth Factor

Year	1997	2000	2005	2010	2015
Construction GDP (100 million yuan)	733	1,109	1,851	2,453	2,551
Growth factor from 1997	1.000	1.513	2.525	3.346	3.480

Non-metallic mineral industry

5.4.15 Cement production is a major sector in the non-metallic mineral industry and considered an indicator in estimating non-metallic mineral industry growth. The non-metallic industry growth was estimated based on past cement production trend given in the Statistical Yearbook of Guangdong. The growth factors for non-metallic mineral industries are presented in Table 5-26.

Table 5-26 PRDEZ Non-metallic mineral Growth Factors

Year	1997	2000	2005	2010	2015
Cement Production (10000 tons)	5148	5043	4941	4878	4833
Growth factor from 1997	1.000	0.980	0.960	0.948	0.939

Other emissions

5.4.16 Part of the emissions to the atmosphere is associated with the daily life of human or their lifestyle. Therefore the population growth is selected as the projection surrogate for the following source items in the emission inventory:

- Human sweat and exhalation
- Human waste urban without sanitary facilities
- Industrial waste incineration
- Waste incineration
- Commercial fuel use
- Domestic coal consumption
- Domestic LPG consumption
- Domestic other fuel consumption

5.4.17 The projected population growth in the PRDEZ was presented are given in Table 5-27. The growth factors have accounted both resident and temporary worker populations.

Table 5-27 Population Projection Factors for the PRDEZ

Population Growth	1997	2000	2005	2010	2015
Resident (millions)	21.94	23.28	25.46	27.83	30.43
Temporal (millions)	10.25	10.04	10.19	10.35	10.50
Total (millions)	32.19	33.32	35.65	38.18	40.93
Population growth factors from 1997	1.000	1.035	1.108	1.186	1.272

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