Monitoring of Municipal Solid Waste

1993 and 1994

Hong Kong

Environmental Protection Department

MONITORING OF MUNICIPAL SOLID WASTE

1993 & 1994

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Waste Facilities Planning Group
Environmental Protection Department
HONG KONG GOVERNMENT

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Monitoring of Municipal Solid Waste for 1993 & 1994, Hong Kong

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Summary of Findings

(1) A total of 20,000 tonnes per day of wastes was disposed of at landfills and incineration plants in 1993. In 1994, this quantity increased to about 24,000 tonnes per day, the rise was attributed to a 34% increase in intake of construction waste at landfills(11,500 tonnes per day in 1993 compared with 15,500 tonnes per day in 1994). Intake of municipal solid waste at disposal facilities increased by 7% in 1993 (8,450 tonnes per day) but there was no further growth in 1994(8,430 tonnes per day).

(2) Municipal solid waste was mainly comprised of paper, putrescible matter and plastics. They constituted about 70% by weight of domestic waste and about 60% by weight of commercial and industrial waste. Putrescible matter dominated the domestic waste stream while paper was dominant in commercial and industrial waste. In both 1993 and 1994, more than 60% by weight of construction waste landfilled were inert materials suitable for land reclamation purpose provided that they have been sorted and separated from other waste at source.

(3) The average moisture content of domestic and commercial/industrial waste was 52% and 29% respectively in 1993, and 45% and 30% respectively in 1994. Bulk density of domestic waste was 203 kg/m^3 in 1993 and 197 kg/m^3 in 1994. The bulk density of commercial/industrial waste was 81 kg/m^3 in 1993 and 91 kg/m^3 in 1994.

(4) On top of the landfill disposal figures, another 1.8 million tonnes of municipal solid waste were recovered in 1993 while about 1.9 million tonnes were recovered in 1994. This represents more than 35% of total municipal solid waste arisings in Hong Kong. About 1.3 million tonnes of these recovered waste were exported for recycling in 1993 which was worth HK$ 2.2 billion while 1.4 million tonnes were exported in 1994 with a value of about HK$ 2.4 billion.

(5) The domestic waste generation rate remained relatively stable in 1993 and 1994 at a level of around 1 kg/person/day. The generation rate for commercial/industrial waste also maintained at about 1.4 kg/employee/day in these two years. The survey data continue to demonstrate a close relationship between municipal waste arising and the Gross Domestic Product (GDP) .

(6) If the present trend continues without any limit on growth, the domestic waste generation rate will reach 1.5 kg/person/day by year 2006. Similarly, the commercial/industrial waste generation rate will reach 2.1 kg/employee/day by year 2006. Under such situation, it is estimated that the quantity of municipal waste to be disposed of would be about 13,000 tonnes per day in the year 2006.

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Abbreviations

tpd	-	tonnes per day
TKOL	-	Tseung Kwan O Landfill
SENT	-	South East New Territories Landfill
WENT	-	West New Territories Landfill
SWL	-	Shuen Wan Landfill
PPVL	-	Pillar Point Valley Landfill
RTS	-	Refuse Transfer Stations
KBTS	-	Kowloon Bay Refuse Transfer Station
IETS	-	Island East Refuse Transfer Station
STTS	-	Shatin Refuse Transfer Station
KCIP	-	Kwai Chung Incineration Plant
CWTC	-	Chemical Waste Treatment Centre
EPD	-	Environmental Protection Department
USD	-	Urban Services Department
RSD	-	Regional Services Department
CED	-	Civil Engineering Department
EMSD	-	Electrical and Mechanical Services Department
C & SD	-	Census and Statistics Department

1. Introduction

1.1 Hong Kong is a densely populated metropolitan city with an area of about 1076 square kilometres but a population of about 6 million. Such a large population together with the growing economy of Hong Kong have led to many environmental problems. One of these problems is the management and disposal of large amount of solid waste generated from the various activities of the community.

1.2 To tackle the solid waste problem, the government had published in 1989, a Waste Disposal Plan for Hong Kong which sets out the solid waste disposal strategy for the territory to ensure that wastes are disposed of in an environmentally acceptable and cost effective manner. This includes the development of three very large landfills in remoter parts of the New Territories together with a network of refuse transfer stations located in the urban areas and new towns.

1.3 As the Waste Disposal Authority, the Environmental Protection Department is required under the Waste Disposal Ordinance (Cap 354) to implement the Waste Disposal Plan through provision of waste disposal facilities and the administrative system for managing the disposal of solid waste. In this connection, waste surveys have been carried out annually by this department to obtain comprehensive information on the local waste stream.

1.4 The findings of the waste survey provide important information for management of solid waste, including

(a) planning of new waste disposal facilities;

(b) assigning solid waste to waste disposal facilities;

(c) planning for waste reduction measures;

(d) forecast arisings of the major types of waste and their geographical distribution and;

(e) establishing waste management models for development of a cost-effective waste management plan.

1.5 This report presents the results of the waste surveys carried out in 1993 and 1994, which includes :

(a) waste quantities ;

(b) waste composition;

(c) waste characteristics;

(d) geographical distribution of waste;

(e) recyclable waste;

(f) waste recovery and recycling;

(g) forecast on waste arisings.

2. Methodology

2.1 Waste classification and terminology

In this report, waste type is classified with reference to the source of waste arisings and also to the institutional arrangements for waste collection and disposal. The major waste types are municipal waste, construction waste, chemical waste and special waste.

2.1.1 **Municipal waste** includes domestic waste, commercial waste and industrial waste.

2.1.2 **Domestic waste** refers to waste generated from residential premises in the course of daily activities and also waste from public cleansing activities. Public cleansing waste includes dirt and litter from street cleansing, beaches and litter bins collected by the municipal councils; marine refuse collected by Marine Department and waste from country parks collected by Agriculture and Fisheries Department.

2.1.3 **Bulky waste** refers to large furniture and domestic appliances which cannot be handled by conventional compactor type refuse collection vehicle. They are usually collected separately.

2.1.4 **Commercial waste** is waste arisings from commercial activities taking place in markets, shops, restaurants, hotels and offices etc. It is collected mainly by private waste collectors. However, there are some commercial wastes which are mixed with domestic waste and are collected by the municipal councils.

2.1.5 **Industrial waste** is waste arisings from industrial activities, but excluding chemical waste and construction waste. Industrial waste is collected by private waste collectors. However, some industries may deliver their own waste directly to landfills for disposal.

2.1.6 **Construction waste** includes waste arisings from construction and demolition activities as well as renovation works of shops and apartments.

2.1.7 **Chemical waste** is defined under the Chemical Waste Regulations as follows : Any substance or thing being scrap material, effluent, or an unwanted substance or by-product arisings from the application of or in the course of any process in a trade activity, and which is or contains any substance or chemical specified in the prescribed schedule if such substance or chemical occurs in such form, quantity or concentration so as to cause pollution, constitute a danger to health or pose a risk of pollution to the environment is considered as chemical waste.

2.1.8 **Special waste** includes animal carcasses, high security waste, abattoir waste, condemned goods, waterworks sludge, sewage sludge, sewage works screenings,

excremental waste, livestock waste and clinical waste.

2.1.9 **Other waste** in this report refers to waste types not covered by definitions mentioned above, such as coal ash, incinerator ash, stabilised residues from Chemical Waste Treatment Centre, waste for marine dumping, and dredged and excavated marine spoil.

2.2 Survey method

2.2.1 Two similar waste arising surveys covering both the wet and dry seasons were carried out each year in 1993 and 1994, one in June/July and the other in November/December. The surveys included visits to operating landfills, incinerator and refuse transfer stations to collect information through weighbridge monitoring, on-site waste sorting analysis on domestic and commercial/ industrial waste, and load-count on construction waste.

2.2.2 Weighbridge monitoring refers to the collection of information on waste arrival at weighbridges of waste facilities. The information collected included arrival time, vehicle type, vehicle registration number, waste type, waste quantity, and source of waste arisings. All information except arrival time and waste quantity was obtained by asking the vehicle drivers. A typical form used for logging the information is shown in Appendix I.

2.2.3 Waste samples were collected from five or more loads of different refuse collection vehicles on each day when the waste sorting analysis was carried out. These vehicles were selected in such a way that they contained a good balance of domestic, commercial and industrial wastes. One cubic meter of each sample was sorted manually according to waste components and then weighed separately to determine its composition and bulk density. In the November/December survey, the quantities and percentage of recyclable materials of municipal waste were also determined from the sorting exercise with special reference to plastic content. For moisture content determination, waste sample size of 1 to 2 kg was used.

2.2.4 The load-count on construction waste was performed by two survey teams staying at the landfill tipping face. Construction waste was divided into five major categories based on the waste content. Observations on the volumetric percentage of the various components by each team were recorded independently based on their own judgement. The composition of construction waste was then worked out by averaging the results so obtained.

2.2.5 The results of the waste arising surveys provided detailed information on waste composition and geographic distribution. Such information together with the waste intake records at landfills and incinerators provided by CED and EMSD respectively, form the

basis in working out the geographical distribution and composition of solid waste arisings in Hong Kong.

3. Waste Quantities

3.1 Solid Waste Statistics

3.1.1 Table 1 summarizes the quantities of municipal solid waste, construction waste and special waste disposed of in 1993 and 1994. The quantity of municipal solid waste had increased by 7% from 1992 to 1993 and then remained unchanged in 1994. This is because in 1994, the decrease in industrial waste offset the increase in domestic /commercial waste. The phenomenon reflects a continual shifting of economic activities in Hong Kong from the manufacturing industry to the financial and servicing industries. Construction waste disposal at landfills had increased by 34% from 1993 to 1994.

3.1.2 Table 1 shows that commercial and industrial waste were only collected by private waste collectors, however, the municipal councils, for historical reasons, have been collecting commercial waste to a limited extent. For instance, in the old mixed commercial and residential buildings, commercial waste is mixed with domestic waste when they are delivered to refuse collection points. Wastes from markets are very often collected by the municipal councils, and, the councils still continue to provide collection service to many commercial establishments particularly those in the older urban areas. This has complicated the estimation on the quantity of publicly collected commercial waste. Nevertheless, it has been roughly estimated in the waste reduction consultancy study that about 1,000 tonnes per day of publicly collected waste were generated from commercial and industrial activities. Further work needs to be carried out to obtain more information in this area.

3.1.3 For the purpose of monitoring the source distribution of municipal waste, the whole territory of Hong Kong was divided into 19 Waste Arisings Districts (WAD) which were further subdivided into 54 Waste Arisings Areas (WAA). The boundaries of the WADs were generally in accordance with the District Board boundaries and the areas covered by the WAAs were aggregates of tertiary planning units with similar socio-economic characteristics. The distribution of solid waste arisings in 1993 and 1994 by district in the whole territory are shown in Table 2.

3.1.4 From Table 2, it can be seen that municipal waste from Hong Kong Island and Kowloon actually decreased while there was a 11% growth for the New Territories. This could be an indication of the rapid increase of residential premises in the New Territories over the past two years. With the development of new towns and

Waste Quantities

Waste Type	1993			1994		
	Collection Agents		Total	Collection Agents		Total
	Public[1]	Private[2]	(tonnes/ day)	Public[1]	Private[2]	(tonnes/ day)
a. Domestic Waste						
-household mixed/public cleansing	4,297	934	5,231	4,663	771	5,434
-junk and bulky	705	63	768	580	55	635
Sub-total	5,002[4]	997	5,999 (+4%)	5,243[4]	826	6,069[4] (+1%)
b. Commercial Waste						
-commercial mixed	-	497	497	-	579	579
-junk	-	39	39	-	57	57
-markets	-	20	20	-	5	5
-paper	-	16	16	-	6	6
-wood[3]	-	-	-	-	49	49
Sub-total			572 (+24%)			696 (+22%)
c. Industrial Waste						
-manufacturing mixed	-	1,548	1,548	-	1,196	1,196
-junk[3]	-	-	-	-	125	125
-plastic/rubber	-	33	33	-	31	31
-wood/sawdust	-	179	179	-	203	203
-rags	-	11	11	-	12	12
-glass	-	9	9	-	11	11
-tannery	-	5	5	-	2	2
-paper	-	95	95	-	82	82
Sub-total			1,880 (+10%)			1,662 (-12%)
d. Municipal Solid Waste received at disposal facilities (a+b+c)			**8,451** (+7%)			**8,427** (-0.3%)
e. Construction Waste (landfilled)						
-mixed/site clearance	-	6,668	6,668	-	7,495	7,495
-soft material/rubble	-	4,437	4,437	-	6,327	6,327
-wood/bamboo	-	418	418	-	455	455
-wet soil/slurry[3]	-	-	-	-	1,200	1,200
Sub-total			11,523 (-4%)			15,477 (+34%)
f. Special waste (landfilled)	99	154	253 (+5%)	80	310	390 (+54%)
g. All waste received at waste facilities (d+e+f)	5,101	15,126	**20,227** (+0.5%)	5,323	18,971	**24,294** (+20%)

Remarks:
(1) Waste collected by RSD and USD, R/USD contractors and other government vehicles
(2) Waste collected by private cleansing/waste management companies
(3) Data for 1993 is not available
(4) Publicly collected waste included some commercial waste (please refer to para 3.1.2 for details).
(±%) Percentage change from previous year

Table 1 Quantities of Solid Waste received at waste disposal facilities in 1993 and 1994

Waste Arising District	Waste Quantities (Tonnes per Day)											
	Domestic Waste				Commercial & Industrial Waste		Municipal Solid Waste		Construction Waste (Landfilled)		All Solid Waste [4]	
	Publicly Collected [1],[2] (a)		Privately Collected (b)		(c)		(d)=(a+b+c)		(e)		(f)=(d)+(e)	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
Central & Western	348	345	73	54	119	92	540	491	766	813	1,306	1,304
Wanchai	249	247	101	76	72	80	422	403	546	453	968	856
Eastern	371	388	142	99	151	127	664	614	814	575	1,478	1,189
Southern	233	230	36	26	64	59	333	315	489	427	822	742
HK ISLAND Sub-total	1,201	1,210	352	255	406	358	1,959	1,823	2,615	2,268	4,574	4,091
Yau Tsim	326	324	53	41	116	112	495	477	534	684	1,029	1,161
Mong Kok	160	164	74	44	33	33	267	241	207	624	474	865
Sham Shui Po	309	321	66	60	129	83	504	464	528	894	1,032	1,358
Kowloon City	327	321	78	54	178	154	583	529	429	839	1,012	1,368
Wong Tai Sin	282	277	10	12	63	49	355	338	249	712	604	1,050
Kwun Tong	417	417	50	44	373	285	840	746	941	1,148	1,781	1,894
KOWLOON Sub-total	1,821	1,824	331	255	892	716	3,044	2,795	2,888	4,901	5,932	7,696
Kwai Tsing	297	313	23	13	195	160	515	486	544	1,144	1,059	1,630
Tsuen Wan	211	195	128	85	243	262	582	542	925	1,651	1,507	2,193
Tuen Mun	312	331	27	33	119	195	458	559	660	925	1,118	1,484
Yuen Long	217	268	15	24	128	127	360	419	190	214	550	633
North	143	165	13	25	43	70	199	260	744	838	943	1,098
Tai Po	190	226	31	49	156	197	377	472	1,370	859	1,747	1,331
Shatin	381	452	55	54	236	201	672	707	1,161	1,572	1,833	2,279
Sai Kung	117	147	22	30	34	72	173	249	426	1,091	559	1,340
NEW TERRITORIES Sub-total	1,868	2,097	314	313	1,154	1,284	3,336	3,694	6,020	8,294	9,356	11,988
Cheung Chau	37	38	-	-	-	-	37	38	-	-	37	38
Mui Wo	31	28	-	-	-	-	31	28	-	-	31	28
Discovery Bay	13	12	-	-	-	-	13	12	-	-	13	12
Lamma Island	15	14	-	-	-	-	15	14	-	-	15	14
Peng Chau	11	15	-	-	-	-	11	15	-	-	11	15
Hei Ling Chau	5	5	-	-	-	-	5	5	-	-	5	5
OUTLYING ISLANDS Sub-total	112	112	-	[3]3	-	-	112	115	-	[3]14	112	129
TERRITORIAL TOTAL	5,002	5,243	997	826	2,452	2,358	8,451	8,427	11,523	15,477	19,974	23,904

Remarks : (1) includes public cleansing waste
(2) publicly collected waste included some commercial waste (please refer to para 3.1.2 for details).
(3) data collected from Waste Arisings Survey and breakdown into individual islands is not available
(4) special waste not included in this table

Table 2 Distribution of Solid Waste Disposed of in 1993 and 1994

most of the large scale demolition works being in Kowloon, construction waste arisings in the New Territories and Kowloon had increased by 38% and 70% respectively from 1993 to 1994.

3.1.5 The quantities of different types of special waste, chemical waste and other waste are shown in Table 3. Due to historical reasons, the information contained in the table are provided from different sources, as listed in Appendix II. Whenever possible, the figures on the actual intake at waste facilities are presented. If such information is not available, estimates were used.

3.1.6 The significant increase in the quantity of chemical waste in 1994 was due to the commissioning of the CWTC in mid 1993 and the associated legislative control on disposal of chemical waste.

3.2 Waste intake at disposal facilities

3.2.1 In 1993 and 1994, four new waste facilities were commissioned. These include two strategic landfills, WENT and SENT, one refuse transfer station at Shatin (STTS) and the CWTC.

3.2.2 The total quantities of waste, including municipal solid waste, special waste and construction waste delivered to each waste facility such as refuse transfer station, incinerator, and landfill, are presented in Figure 1. TKOL remained as the major waste disposal site in 1993 and 1994.

3.2.3 A comparison of the solid waste arisings by region and their disposal at the regional landfills and incinerators are shown in Figure 2. TKOL remained as the major outlet for municipal waste arisings from Hong Kong Island and Kowloon in 1993. In 1994, most of the publicly collected domestic waste from these regions was diverted to WENT via RTS and so there was a sudden drop of domestic waste intake at TKOL. For the past two years, the amount of construction waste delivered to SWL and TKOL were slightly larger than those generated in the region whereas PPVL received a smaller amount of construction waste than the actual arisings from West New Territories. This suggests that a proportion of construction waste arisings from West New Territories (mainly Kwai Tsing) was delivered to facilities in other regions for disposal.

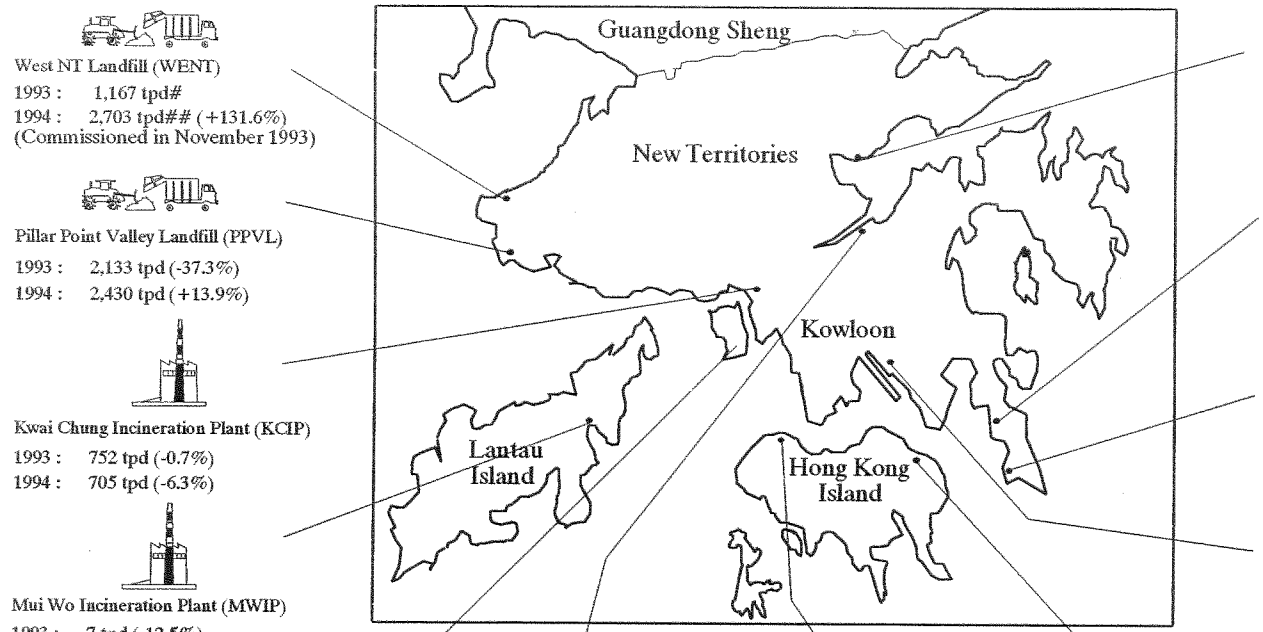
3.3 Construction waste disposal at public dumps and landfills

3.3.1 Inert construction waste (e.g. sand, soil, rubble etc.) are suitable materials for land reclamation and a majority of such waste can be disposed of at public dump, an area designated in a land reclamation project to receive such waste. The quantities of construction waste disposed of at landfills and public dumps over the past three years are shown in Figure 3. There was a reduction in delivery of suitable construction waste to public dumps in both

Description of Waste		Quantity per day		
		1993	1994	
Chemical waste[1]		82	248	tonnes
Special waste				
- waterworks sludge[2]		3,970	4,330	tonnes
- sewage sludge [3]		370	410	tonnes
- sewage works screenings		40	33	tonnes
- excremental waste [4]		80	25	tonnes
- livestock waste		1,100	800	tonnes
- abattoir waste		9	12	tonnes
- animal carcasses		7	8	tonnes
- condemned goods		7	2	tonnes
- high security waste		9	11	tonnes
- clinical waste		29	21	tonnes
	Sub-total	5,621	4,086	tonnes
Marine dumping/Dredged & excavated marine spoil		284,370	132,679	cu.m
Coal ash				
- pulverised fuel ash		3,040	2,230	tonnes
- furnace bottom ash		420	290	tonnes
	Sub-total	3,460	2,520	tonnes
Secondary waste[5]				
- incinerator ash		188	155	tonnes
- CWTC stabilized residue		18	56	tonnes
	Sub-total	206	211	tonnes

Remarks :
1. included waste received by Chemical Waste Treatment Centre (CWTC)
2. with average 2.5% dry solid by weight
3. with average 15% dry solid by weight
4. assumed bulk density at 1.2 tonnes/cu.m.
5. waste resulted from waste treatment facilities

Table 3 Quantities of Chemical, Special and Other Wastes in 1993 and 1994



West NT Landfill (WENT)
1993 : 1,167 tpd#
1994 : 2,703 tpd## (+131.6%)
(Commissioned in November 1993)

Pillar Point Valley Landfill (PPVL)
1993 : 2,133 tpd (-37.3%)
1994 : 2,430 tpd (+13.9%)

Kwai Chung Incineration Plant (KCIP)
1993 : 752 tpd (-0.7%)
1994 : 705 tpd (-6.3%)

Mui Wo Incineration Plant (MWIP)
1993 : 7 tpd (-12.5%)
1994 : 8 tpd (+14.3%)
(Decommissioned in June 1994)

Shuen Wan Landfill (SWL)
1993 : 6,414 tpd (+13.1%)
1994 : 7,570 tpd (+18.0%)

Tseung Kwan O Landfills (TKOL)
1993 : 10,656 tpd* (+7.7%)
1994 : 10,493 tpd** (-1.5%)

South East NT Landfill (SENT)
1994 : 1161 tpd
(Commissioned in September 1994)

Kowloon Bay Transfer Station (KBTS)
1993 : 1,715 tpd (+7.1%)
1994 : 1,762 tpd (+2.7%)

Chemical Waste Treatment Centre (CWTC)
1993 : 90 tpd
1994 : 222 tpd
(Commissioned in April 1993)

Sha Tin Transfer Station (STTS)
1994 : 592 tpd
(Commissioned in October 1994)

Kennedy Town Incineration Plant (KTIP)
1993 : 419 tpd (-38.4%)
(Decommissioned in March 1993)

Island East Transfer Station (IETS)
1993 : 1,142 tpd
1994 : 1,248 tpd (+9.3%)

Remarks: TKOL *Recevied waste transferred from KBTS till November 1993.
**Recevied waste transferred from IETS till September 1994.
WENT #Received waste transferred from KBTS from November 1993.
##WENT received waste from KBTS (throughout 1994), IETS (starting from September 1994) and STTS (starting from October 1994).
(%) --Percentage increase / decrease over previous year.

Figure 1 Quantity of waste delivered to waste facilities in 1993 and 1994

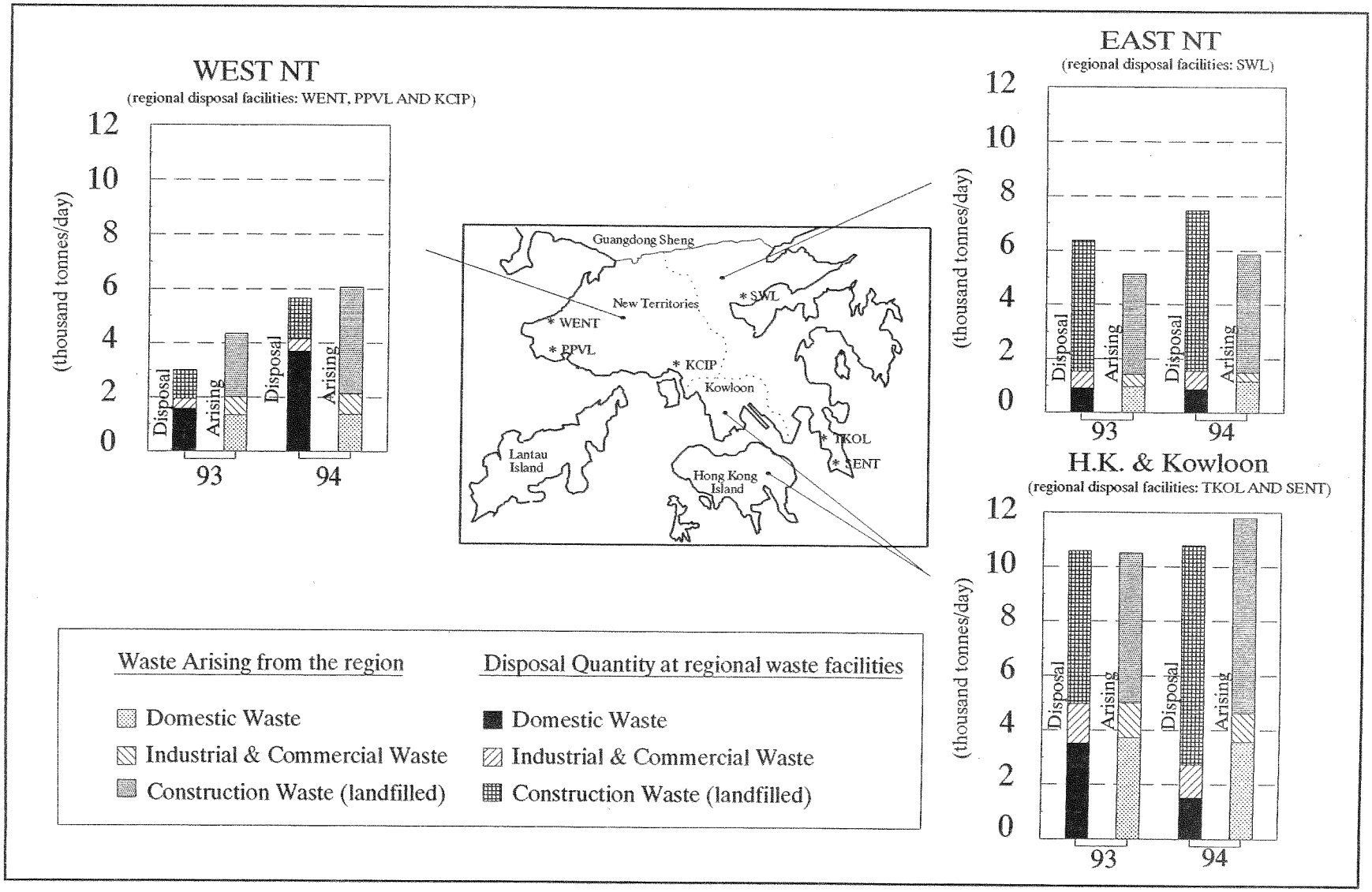


Figure 2 Comparison of Waste Arisings and Disposal Quantity by sub-region in 1993 and 1994

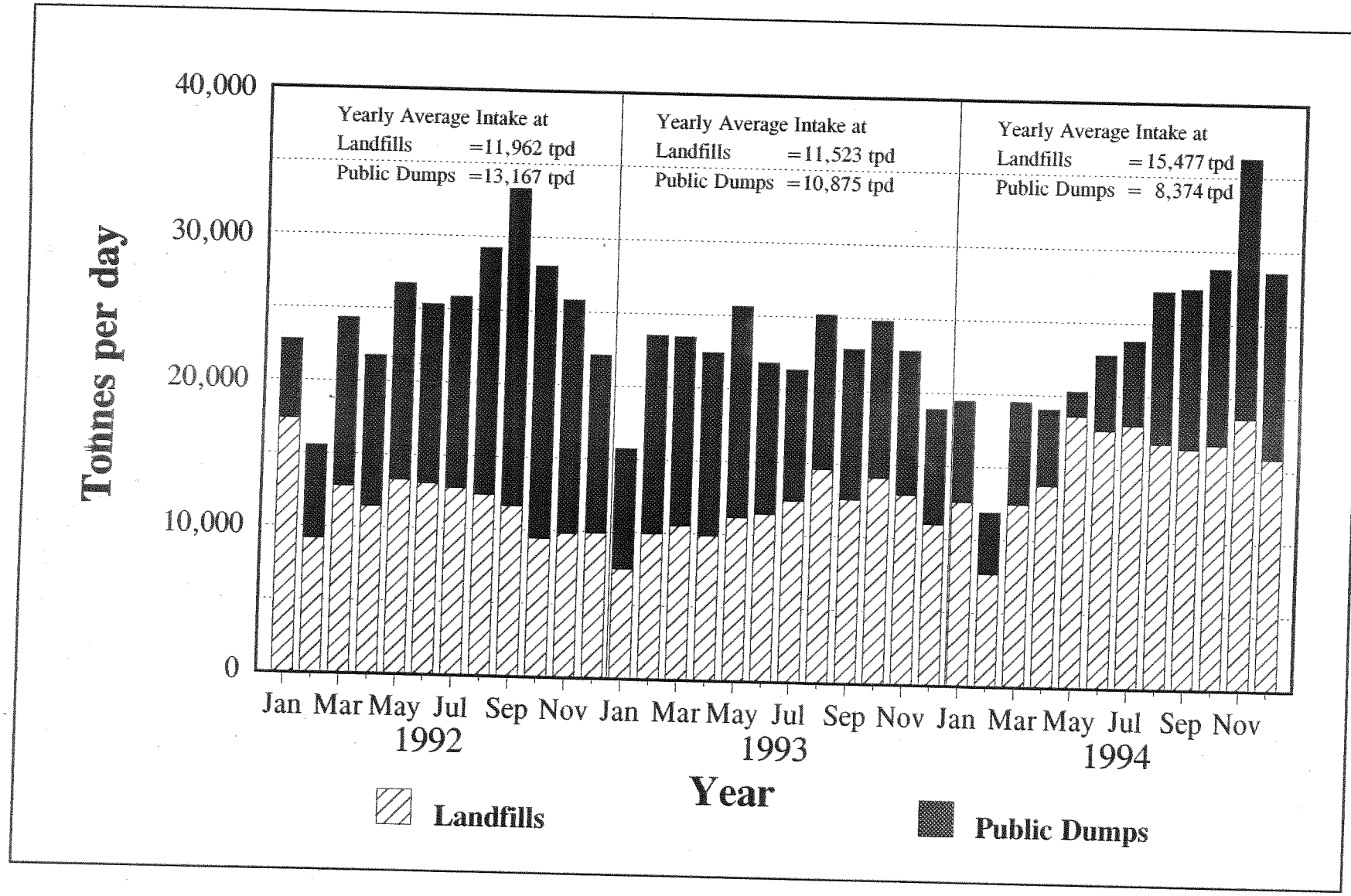


Figure 3 Quantity of Construction Waste delivered to Landfills & Public Dumps for 1992-1994

1993 and 1994, but an increase in delivery of construction waste to landfills in 1994. This could be attributed to the significant growth in the construction activities and the lack of sufficient public dumps in the Territory.

3.3.2 Figure 4 presents the quantity of construction waste disposed of at each landfill from 1992-94 and the percentage of construction waste in the total waste intake. In 1994, construction waste comprise more than half of the total waste intake at all landfills. TKOL received most of the construction waste while PPVL received the smallest amount. This could be attributed to the proximity of TKOL to urban areas and the traffic conditions of the Tuen Mun Highway. As a phasing-out arrangement, the TKOL received only construction waste as from October, 1994. Other municipal waste which used to be delivered to TKOL were diverted to the new SENT landfill.

4. Waste Characteristics

4.1 Composition of domestic waste

4.1.1 The composition of domestic waste in 1993 and 1994 are shown in Figure 5. As in the past, paper, putrescibles and plastics were the major components of domestic waste . They constituted about 70% by weight of the domestic waste in both 1993 and 1994. There was no significant change in the composition of domestic waste except that the percentage of wood had dropped to less than 1%.

4.1.2 The composition of municipal waste varies among cities and countries where social habits, climatic conditions, public awareness on environment, economical factors and the extent of waste recovery are different. Some information on the composition of municipal waste in various cities and countries is shown in Table 4 for comparison. The waste in Hong Kong had a low glass content but a high plastic content. This may be attributed to the extensive use of plastic bags and packaging, and also to the declining popularity and the high recovery rate of glass bottles.

4.2 Composition of commercial and industrial waste

Figure 6 presents the composition of commercial and industrial waste in 1993 and 1994. Paper and plastics remained the two major components of commercial and industrial waste and constituted about 50% of all the commercial and industrial waste. The percentage of paper had increased from about 20% in 1992 to around 30% in 1994. The significant increase in disposal of paper could be attributed to the rapid growing commercial and financial activities in Hong Kong and also the fluctuating paper recycling market world wide. In contrast, the percentage of textiles waste

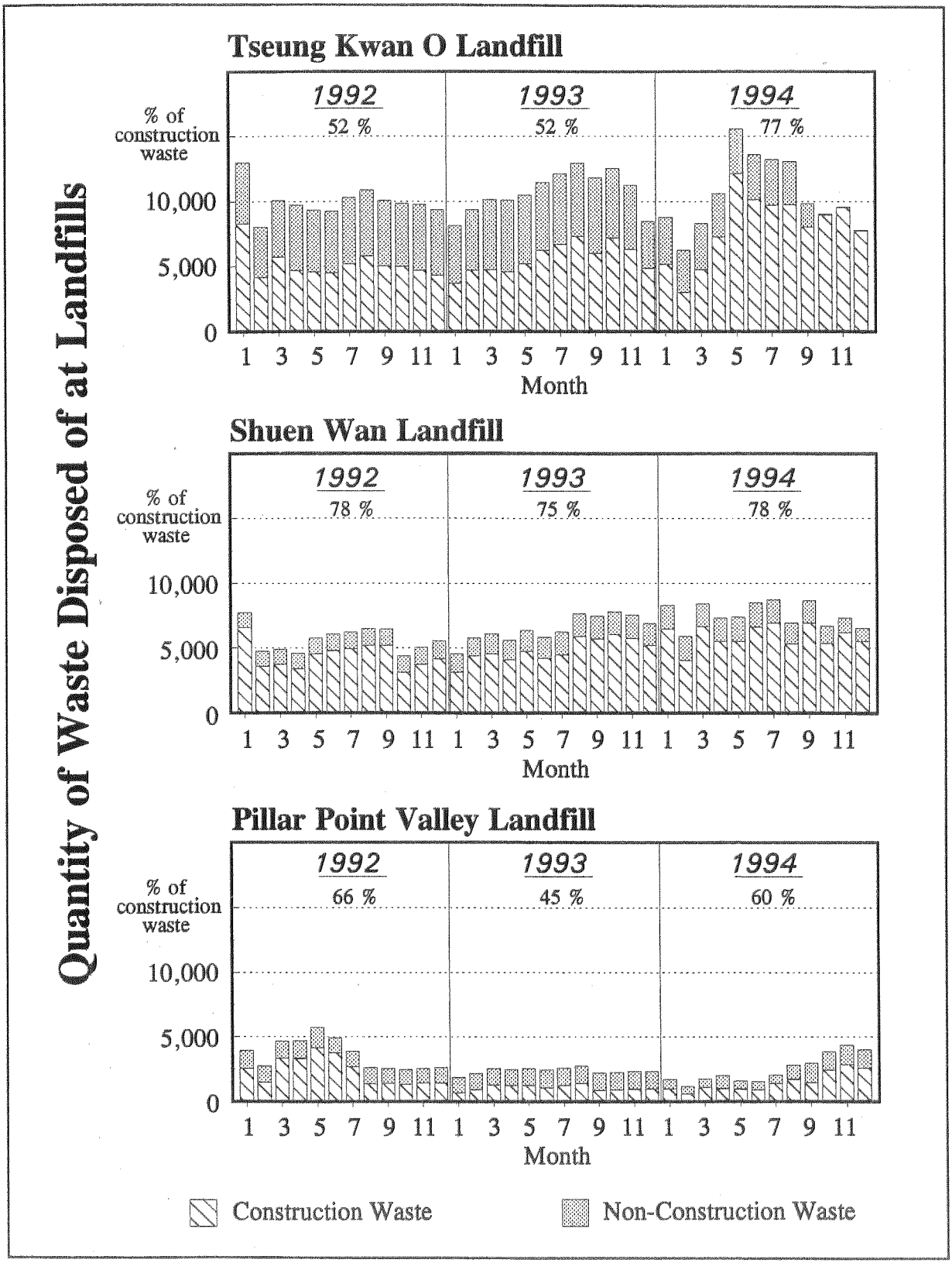


Figure 4 Construction Waste Disposal at Tseung Kwan O, Shuen Wan and Pillar Point Valley Landfills from 1992 to 1994

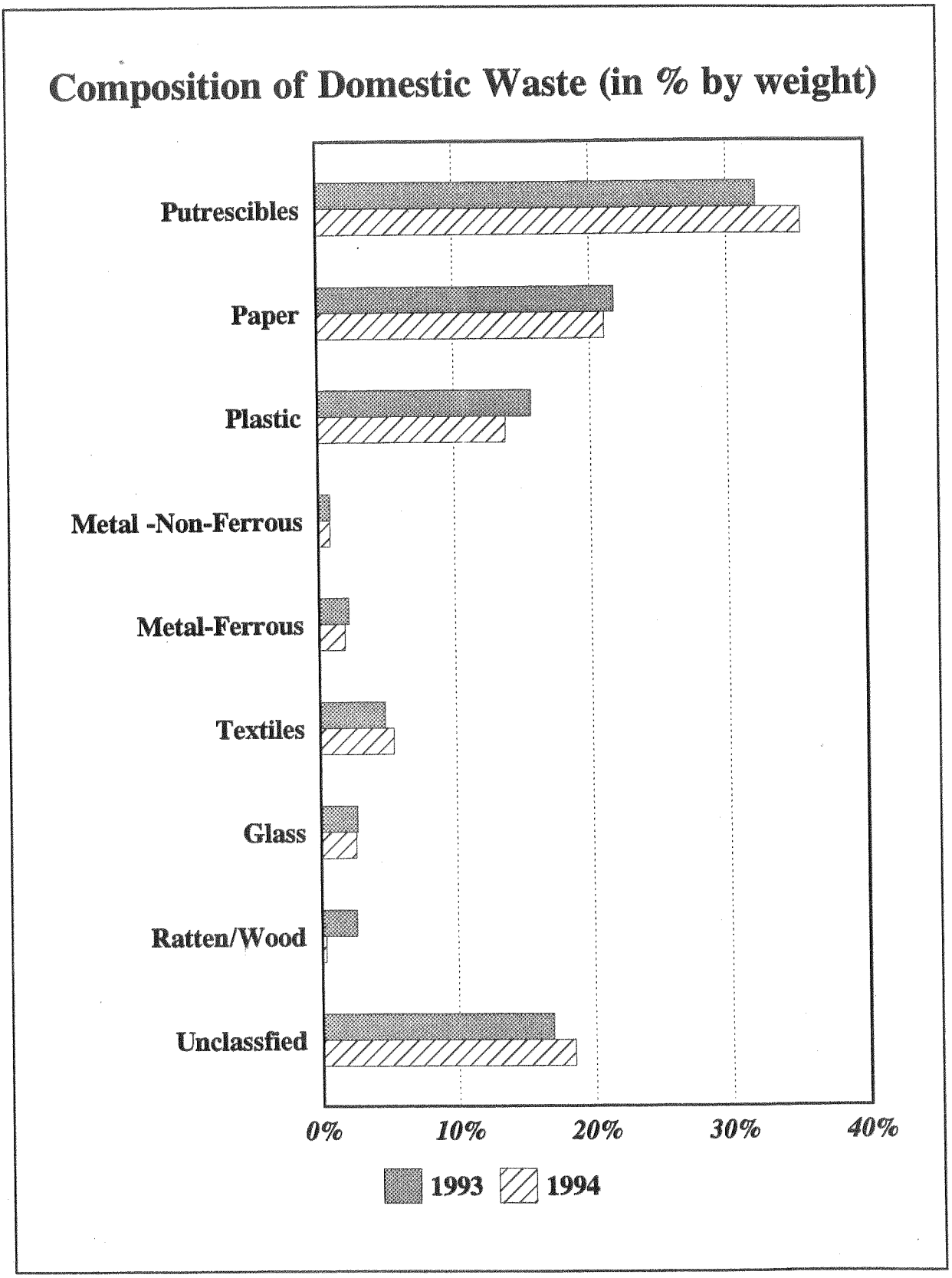


Figure 5 Composition of Domestic Waste in 1993 and 1994.

		Percentage (by Fresh Weight) of Components									
Location	Year	Paper	Putrescibles and Yard Waste	Textiles	Leather, Rubber & Wood	Plastics	Metals	Glass	Fine Material	Miscellaneous	Source
Hong Kong	1994	21.1	35.4	5.4	0.3	13.8	2.8	2.6	-	18.6	-
Macau	1991	21.8	35.9	14.6	-	11.2	2.2	3.3	-	11.0	n
Singapore	1990	28.3	44.4	3.0	-	11.8	4.8	4.1	-	3.6	b
Taipei	1989	22.6	31.5	7.5	1.3	14.3	6.2	8.4	-	8.2	a
Kaoshung	1989	19.3	28.8	4.2	2.0	18.6	6.3	4.6	-	6.2	a
Sydney	1987	20.9	48.0	2.3	2.1	7.6	6.3	9.3	-	3.5	c
Greater Melbourne	1985	20.9	42.9	1.6	0.3	9.9	5.9	16.1	-	2.4	d
Paris	1985	39.5	18.6	-	-	7.6	4.6	8.9	14.1	6.7	e
Tokyo	1985	38.4	35.6	4.0	1.0	11.9	5.7	-	-	3.4	f
United Kingdom	1990	33.0	20.0	4.0	-	8.0	8.0	10.0	-	17.0	g
Taiwan	1989	14.0	34.8	8.6	4.5	12.9	6.0	4.9	-	14.3	a
Switzerland	1989	30.6	29.4	3.1	4.3	13.4	5.9	8.7	-	4.6	h
United States	1988	34.2	28.4	2.4	7.0	9.2	8.1	7.1	-	3.6	i
France	1988	30.0	25.0	4.0	-	6.0	5.0	12.0	18.0	-	j
New Zealand	1988	30.5	24.0	4.9	-	8.3	7.8	11.2	-	13.3	k
Germany (FRG)	1985	16.0	29.9	2.0	-	5.4	3.2	9.2	10.1	24.2	m

Table 4 Composition of Municipal Waste in Other Cities and Countries

Source of Information :

a : "WEIC 0013 - Waste Information Exchange" (in Chinese), Mar 1990, pp 32-34, Information Centre of Waste Exchange, Taiwan.

b : Quoted from Engineering Services Department, Singapore.

c : "Metropolitan Waste Disposal Authority, Annual Report 1988-1989", pp 63, Metropolitan Waste Disposal Authority, Australia (NSW)

d : "Publication no. 239 - Municipal Waste Services in Victoria", Dec 1985, pp5-6, 25, Environment Protection Authority, Australia (NSW)

e : Quoted from Agence Nationale pour la Recuperation et l'Elimination des Dechets, France

f : "Recycling of Household Waste in Japan", pp6-9, Clean Japan Centre, Japan

g : "Recycling-Can Local Authority Make It Pay", Paper to National Society for Clean Air and Environmental Protection, Apr 1991. John Barton, Warren Spring Laboratory, United Kingdom.

h : "Waste Management in Switzerland", pp 5, Department of Environment, Switzerland.

i : "Characterization of Municipal Solid Waste in United States : 1990 Update - Executive Summary", June 1990, pp ES-11, USEPA

j : "Les Chiffres cles des Dechets" (in French), Jan 1989, pp 4-5, Agence Nationale pour la Recuperation et l'Elimination des Dechets, France

k : "The Interdata Environmental Resource Management Handbook" published in 1992, Institute of Waste Management, New Zealand.

m : "Environmental Figures 1988/89" (in German), pp 422, Federal German Environmental Protection Agency, FRG.

n: "Central de Incineracao dos Residuos solidos de Macau", 1992 , Macau.

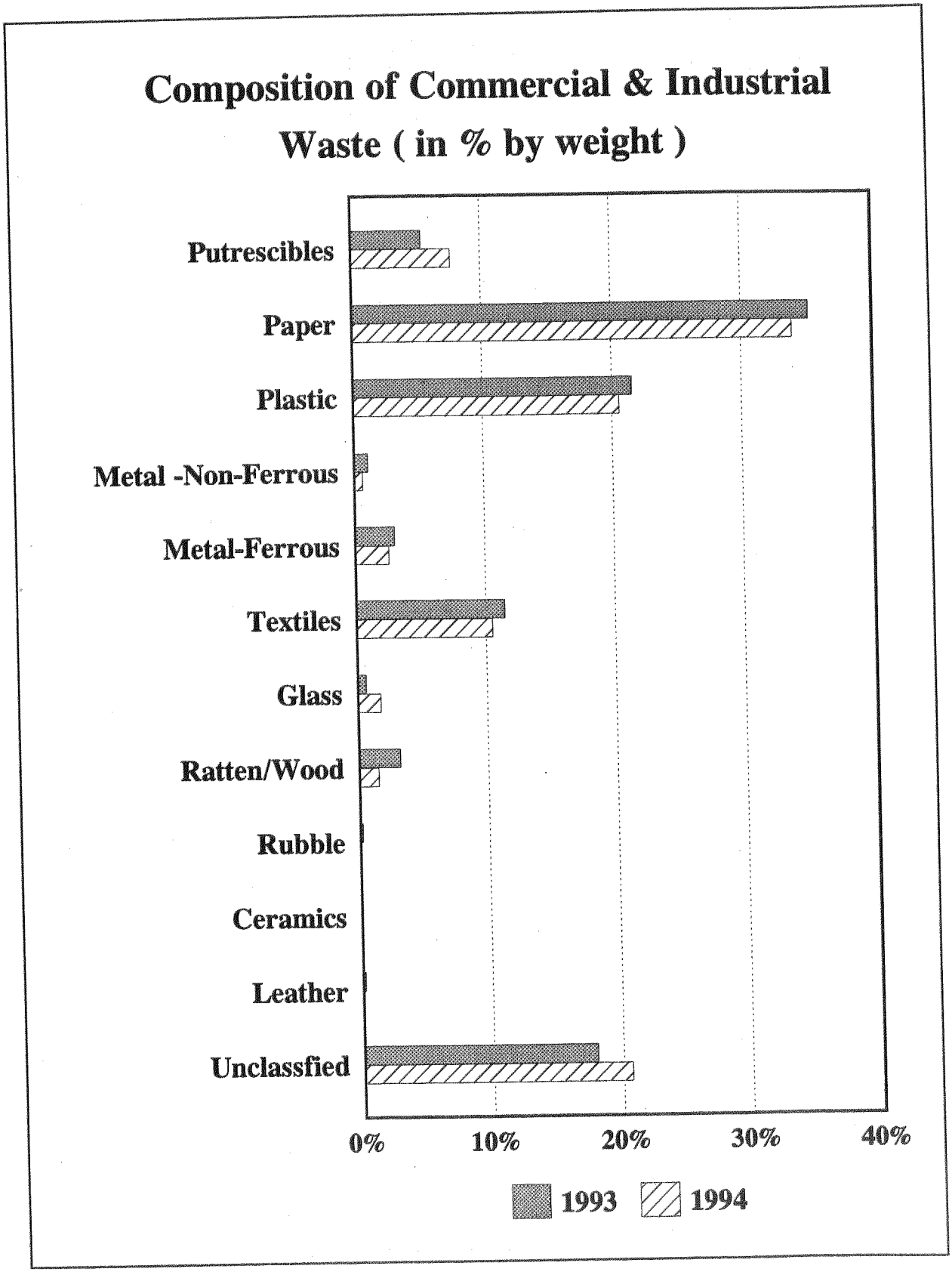


Figure 6 Composition of Commercial and Industrial Waste in 1993 and 1994

dropped for about 10% from 1992 to 1994.

4.3 Composition of construction waste

4.3.1 Composition of five main categories of construction waste, namely roadwork material, excavated soil, demolition waste, site clearance and renovation waste received at landfills, as determined by the method described in section 2.2.4 of this report is shown in Table 5.

4.3.2 In 1993, most of the construction waste disposed of at landfills were generated from site clearance operation (about 48%) and they were very mixed in nature. However, in 1994, the largest proportion of construction waste landfilled was excavated soil (about 33%). This shows that construction waste generation could vary significantly over time due to various reasons and it is extremely difficult to establish a trend for such changes. This in turn leads to difficulties in making reliable prediction on construction waste generation and hence effective management of construction waste.

4.3.3 As shown in Table 6, there was about a 14% increase of the quantity of inert materials disposed of at landfills from 1993 to 1994. Soil and sand were the major components of construction waste disposed of at landfills in 1993 and 1994 (about 39% and 55% respectively).

4.4 Waste moisture content and bulk density

4.4.1 The average moisture content of domestic and, commercial and industrial waste in 1993 and 1994 are shown in Table 7. In 1993 and 1994, the mean moisture content of domestic waste was 52% and 45% respectively. For commercial and industrial waste, the average moisture content was 29% in 1993 and 30% in 1994.

4.4.2 The average bulk densities of domestic and commercial & industrial waste in 1993 and 1994 are also shown in Table 7. The average bulk density of domestic waste (203 kg/m^3 in 1993 and 197 kg/m^3 in 1994) was higher than the bulk density of commercial and industrial waste (81 kg/m^3 in 1993 and 91 kg/m^3 in 1994) in both years. This may be due to the higher moisture content of domestic waste. There was no significant change in bulk density of domestic waste as well as commercial and industrial waste.

5. Waste Recovery and Recycling

5.1 Recyclable content of waste

5.1.1 Based on the winter survey on recyclable materials and data obtained from the waste composition analysis, the percentage and quantity of major recyclables were worked out and are shown in Table 8.

5.1.2 As shown in Table 8, paper and

COMPONENT	WASTE CATEGORY									
	Roadwork Material		Excavated Soil		Demolition Waste		Site Clearance		Renovation Waste	
	93	94	93	94	93	94	93	94	93	94
Soil/Sand	23.3	54.0	61.5	83.8	17.5	40.0	32.9	43.1	14.4	28.9
Concrete/Mortar	51.1	16.0	1.2	3.5	21.1	7.6	10.0	3.6	16.1	5.0
Rock/Rubble	23.3	8.8	10.3	7.6	12.6	9.1	5.5	5.5	4.2	3.8
Reinforced Concrete	0.0	8.2	0.8	0.3	4.7	13.0	0.1	4.2	0.6	1.8
Bricks/Tiles	0.0	1.0	1.4	0.5	20.1	10.9	3.0	3.0	19.2	6.1
Slurry & Mud	0.0	0.5	22.9	1.4	0.0	0.2	1.5	0.5	0.0	1.6
Asphalt	1.6	3.8	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0
Wood	0.0	5.1	1.0	1.4	15.1	11.5	17.0	13.0	24.8	32.1
Ferrous Metal	0.0	0.3	0.1	0.1	2.8	0.6	3.8	2.0	3.2	1.6
Non-ferrous Metal	0.0	0.0	0.0	0.0	0.5	0.1	0.2	0.2	1.1	0.1
Other (include bamboo, trees, glass, plastics, junk/fixtures, organics & garbage)	0.7	2.3	0.8	1.4	5.6	6.9	26.0	24.4	16.4	19.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% to total quantity observed	4.3%	12.0%	31.3%	33.3%	6.5%	22.1%	47.6%	14.5%	10.3%	18.1%

Table 5 Composition of Construction Waste Received at Landfills by Weight Percentage under 5 Waste Categories in 1993 and 1994

COMPONENT	AT EACH DISPOSAL SITE (PERCENTAGE BY WEIGHT)						Total	
	Pillar Point Valley Landfill		Tseung Kwan O Landfill		Shuen Wan Landfill			
	93	94	93	94	93	94	93	94
Soil/Sand *	42.0	53.7	22.1	45.7	43.4	65.1	38.6	54.7
Concrete/Mortar *	9.6	4.0	13.8	7.7	9.3	4.7	10.3	6.2
Rock/Rubble *	13.4	7.4	6.0	5.3	7.1	9.2	8.1	7.1
Reinforced Concrete *	1.4	2.0	0.0	7.3	0.7	2.4	0.7	4.9
Brick/Tile *	2.7	0.7	9.8	4.8	4.3	3.9	5.2	4.2
Slurry & Mud	1.0	3.7	1.2	0.2	12.5	1.5	7.9	0.9
Asphalt	0.2	0.0	0.0	0.2	0.1	1.0	0.1	0.6
Wood	13.0	12.7	17.2	16.0	9.7	5.7	11.9	11.3
Ferrous Metal	2.5	0.4	2.7	0.8	2.1	0.8	2.3	0.8
Non-ferrous Metal	0.5	0.0	0.2	0.1	0.2	0.1	0.2	0.1
Other (include bamboo, trees, glass, plastics, junk/fixture, organics & garbage)	13.7	15.4	27.0	11.9	10.6	5.6	14.7	9.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Inert materials which are considered suitable for public dumping.

Table 6 Composition of Construction Waste Received at Landfills by Weight Percentage in 1993 and 1994

Waste Type	1993		1994	
	Average Bulk Density (kg/m^3)	Average Moisture Content (%)	Average Bulk Density (kg/m^3)	Average Moisture Content (%)
Domestic	203	52	197	45
Commercial and Industrial	81	29	91	30

Table 7 Bulk Density and Moisture Content of Domestic, Commercial and Industrial Waste in 1993 and 1994

	Domestic				Industrial & Commercial			
	1993		1994		1993		1994	
	% by weight	Quantities (tonnes per day)	% by weight	Quantities (tonnes per day)	% by weight	Quantities (tonnes per day)	% by weight	Quantities (tonnes per day)
Paper - Writing Paper	3.02	158	4.47	243	8.35	171	10.23	182
Paper - Newsprint	12.45	651	10.57	574	7.14	146	5.94	106
Paper - Others	7.73	404	6.06	330	16.81	344	17.73	315
Glass - Colour Bottle	1.33	70	1.17	64	0.40	8	0.85	15
Glass - Clear Bottle	1.52	80	1.44	78	0.20	4	0.92	16
Plastic	17.00	889	13.81	750	19.02	389	20.58	366
Ferrous Metal	2.36	123	1.93	105	2.98	61	2.60	46
Non-ferrous Metal	0.54	28	0.86	47	0.77	16	0.65	12
Miscellaneous	54.05	2828	59.69	3243	44.33	906	40.5	721
Total:	100.00	5231	100.00	5434	100.00	2045	100.00	1779

Table 8 Recyclable Content of Domestic, Commercial and Industrial Waste in 1993 and 1994

plastics were the two major components of municipal solid waste in 1993 (51% of commercial and industrial waste, 40% of domestic waste) and 1994 (55% of commercial and industrial waste, 35% of domestic waste). It is noted that the percentage of plastics in domestic waste has dropped from 17% in 1993 to about 14% in 1994. This may be an indication of the success of the "Use less plastic bags" campaign.

5.1.3 Details of the recyclable plastics in municipal solid waste are shown in Table 9. While plastic bags remain the major component of all recyclable plastics, the actual quantity of plastic bags disposed of at landfills had actually decreased. It is also noteworthy that there was a substantial increase of EPS (Expanded Polystyrene) food/drink containers and vacuum packaging in 1994 but the quantity of plastic household utensil had dropped significantly in 1994.

5.2 Recovery and recycling of municipal solid waste.

5.2.1 In 1993 and 1994, over 35% by weight of the municipal solid waste generated in the territory had been recovered. The recovered waste were either recycled locally (0.5 million tonnes in both years) or exported for recycling in overseas countries (1.3 million tonnes in 1993 and 1.4 million tonnes in 1994) as shown in Figure 7.

5.2.2 The composition of municipal solid waste recovered in 1993 and 1994 are presented in Figure 8. The majority of the waste recovered was metal while paper was the second predominant component. A breakdown of the values of the exported recyclable materials is presented graphically in Figure 9 while a detailed breakdown from 1991-94 is shown in Table 10.

5.2.3 A number of local constraints limit the present extent of waste recovery and recycling activities. Examples include:

a) space constraint in domestic, commercial or industrial premises which affects the viability of waste separation and sorting activities;

b) high land premiums and labour cost which affect the economic viability of setting up local recycling facilities;

c) lack of local markets for recovered materials and recycled products, etc.

5.2.4 According to findings shown in Table 11, there were around 500 private waste collectors and 100 recyclers in Hong Kong dealing with recovered waste.

5.2.5 In view of a well established export market for waste paper as well as the availability of local

Component	Domestic Waste				Commercial and Industrial Waste			
	% by weight		Quantities(tpd)		% by weight		Quantities(tpd)	
	1993	1994	1993	1994	1993	1994	1993	1994
EPS Food/Drink Container	0.33	0.64	17	35	0.28	1.50	6	27
Other Polyfoams	0.95	0.32	50	17	1.07	1.76	22	31
Beverage Bottles	0.42	0.30	22	16	0.28	0.09	6	2
Colour Bag	11.18	9.13	585	495	4.23	4.31	86	77
Clear Bag	1.52	1.11	79	60	2.99	3.23	61	57
Toys & Appliances	0.11	0.34	6	19	0.58	0.62	12	11
Household Utensil	1.96	0.73	102	40	0.71	0.52	15	9
Trim-Off & Scrap	0.00	0.01	0	1	0.85	3.87	17	69
Vacuum Packaging	0.05	0.24	3	13	0.00	0.66	0	12
Others	0.48	0.99	25	54	8.03	4.02	164	71
Total	17.00	13.81	889	750	19.02	20.58	389	366

Table 9 Composition of Plastic Components in Domestic, Commercial and Industrial Waste in 1993 and 1994

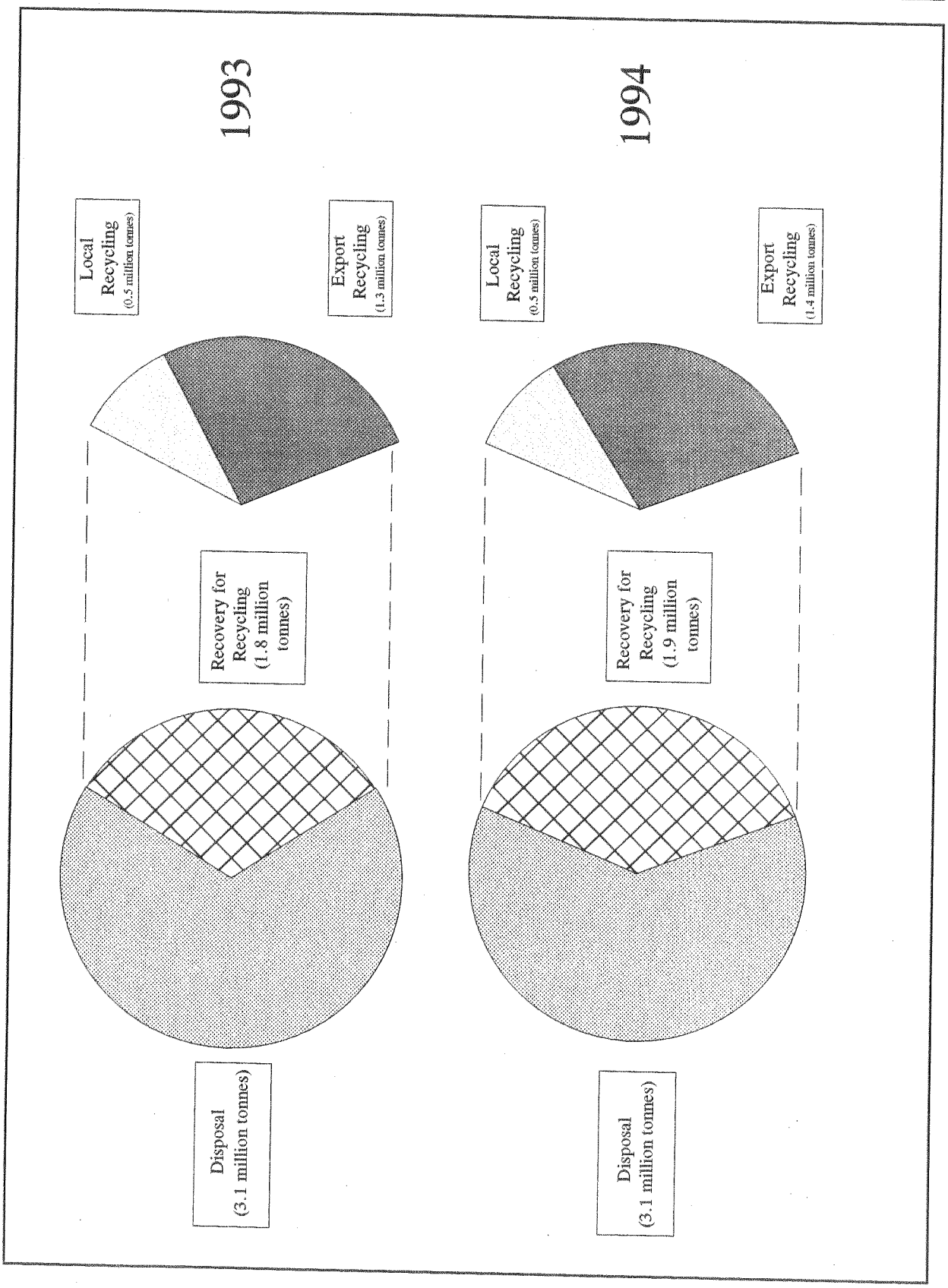


Figure 7 Recovery of Municipal Solid Waste in 1993 and 1994

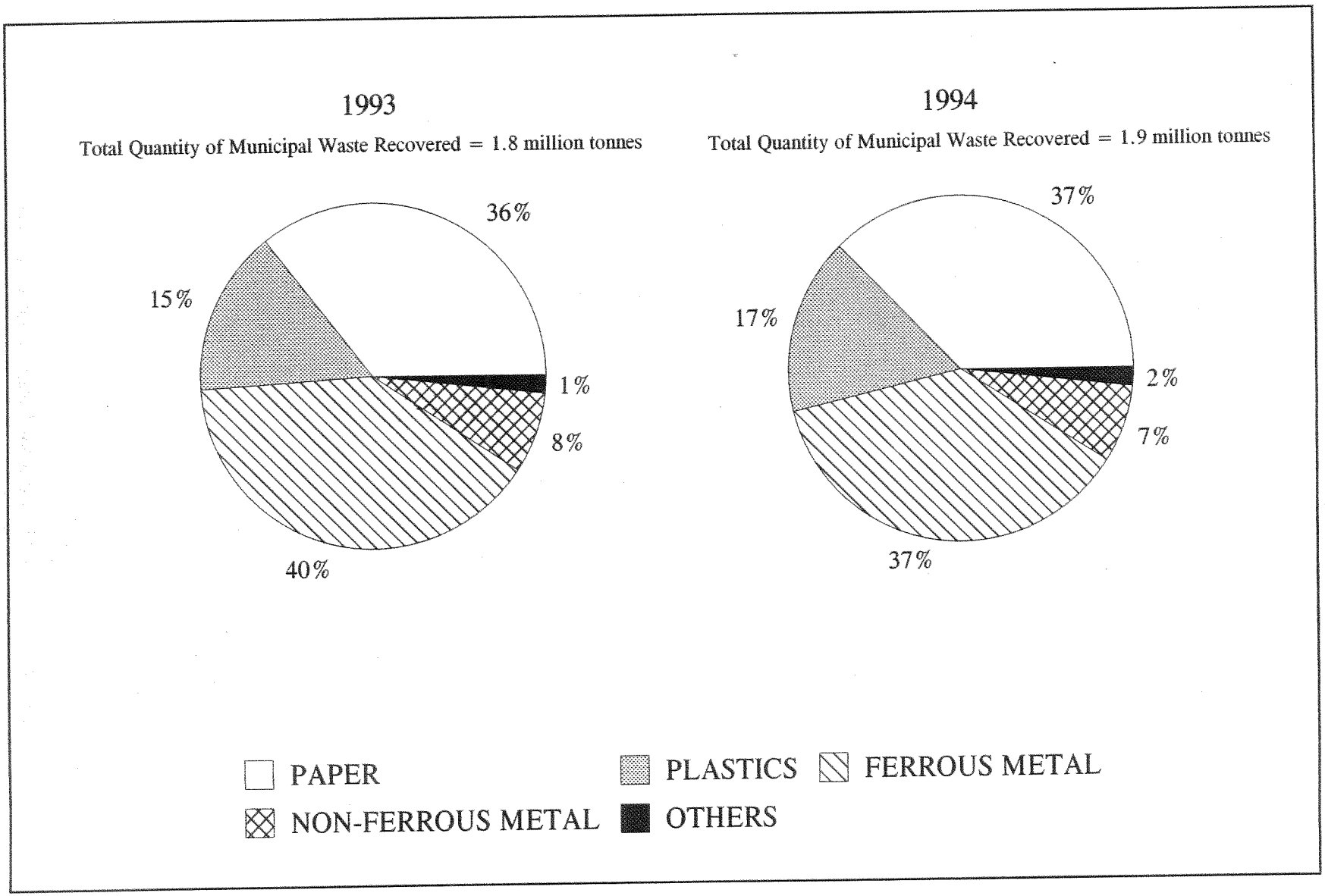


Figure 8 Composition of Municipal Waste Recovered in 1993 and 1994

Categories of Waste Materials	1991		1992		1993		1994	
	Quantity (tonnes)	Value ($,000)	Quantity (tonnes)	Value ($,000)	Quantity (tonnes)	Value ($,000)	Quantity (tonnes)	Value ($,000)
A) Wood & Paper								
- Wood (incl. sawdust)	21,096	10,988	18,085	9,551	5,252	2,834	5,922	3,721
- Paper	580,399	441,780	496,902	371,840	382,660	248,398	441,516	328,625
Sub-total :	601,495	452,768	514,987	381,391	387,912	251,232	447,438	332,346
B) Glass								
Sub-total :	1,055	991	853	997	1,066	1,072	546	526
C) Plastics								
- Polyethylene	34,946	97,788	50,870	137,709	64,385	156,512	61,440	148,234
- Polystyrene & Copolymers	45,761	139,855	67,447	168,324	80,121	184,376	90,221	230,795
- Polyvinyl Chloride	32,379	69,969	33,812	78,841	47,797	107,280	48,658	107,769
- Others	31,442	80,887	89,835	217,878	65,225	137,897	98,521	181,398
- Unhardened Rubber	14	23	0	0	1	2	1	22
Sub-total :	144,542	388,522	241,964	602,752	257,529	586,067	298,841	668,218
D) Ferrous Metals & Steel								
- Pig or cast iron	243	200	7,432	7,158	1,584	1,536	7,940	6,963
- Alloy steel	394,514	517,690	475,186	486,688	475,627	558,535	475,049	560,241
- Tinplate	0	0	0	0	34	18	148	482
Sub-total :	394,757	517,890	482,618	493,846	477,245	560,089	483,137	567,686
E) Non-Ferrous Metals								
- Copper & alloys	73,136	570,709	115,036	646,087	89,173	550,847	77,902	521,787
- Nickel	35	786	43	1,455	114	2,048	134	2,779
- Aluminum	26,407	188,122	33,399	182,694	30,407	123,739	46,209	188,630
- Lead	3,102	7,586	1,840	2,502	1,577	2,140	277	1,368
- Zinc	2,006	4,898	2,015	8,705	798	2,830	928	2,535
- Tin	40	566	44	693	68	758	57	713
- Metal ash & residues	997	3,957	479	1,553	593	14,025	293	4,159
- Magnesium	0	0	0	0	0	0	0	0
- Silver	0	1	1	1,086	4	4,591	7	8,889
- Platinum	0	0	*0	2,193	*0	939	0	0
- Other base metals	0	0	0	0	0	0	0	0
Sub-total :	105,723	776,625	152,858	846,968	122,734	701,917	125,808	730,860
F) Textile Fibres								
- Silk	5	417	27	1,942	0	0	0	0
- Cotton	14,343	47,624	14,214	36,040	10,835	29,208	10,360	38,576
- Man-made fibres	126	558	265	874	100	476	51	185
- Wool/other animal hair (not pulled)	178	3,810	196	6,863	177	5,009	141	8,498
- Wool/other animal hair (pulled)	0	0	0	0	0	0	0	0
- Old clothing & other old textile articles, rags, etc.	16,392	49,624	14,922	43,239	11,917	32,976	9,539	34,120
Sub-total :	31,044	102,033	29,624	88,958	23,029	67,669	20,091	81,379
Total :	1,278,616	2,238,829	1,422,904	2,414,912	1,269,516	2,168,046	1,375,861	2,381,015

* figures round off to nearest 1

Table 10 Export of Recovered Waste Materials from 1991 to 1994

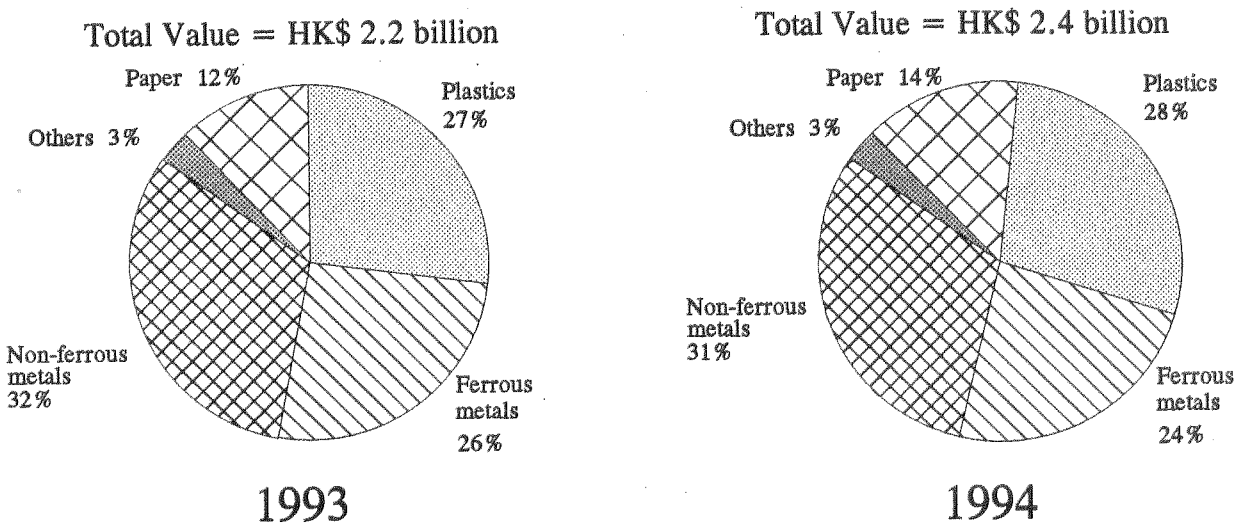


Figure 9 Values of the Exported Recyclable materials in 1993 and 1994

		1993	1994
Number of Private waste Collectors[1]		500	500
Number of Waste Recyclers[1]		100	100
Quantity of Waste Handled by Recyclers	Local waste[1] ('000 Tonnes)	500	500
	Imported waste[1] ('000 Tonnes)	30	50
Waste Exported to Overseas	('000 Tonnes)[2]	1,300	1,400
	HK$ ('000)[2]	2,200,000	2,400,000
Total Quantity of Waste Recycled[3] ('000 Tonnes) (a)		1,800	1,900
Total Quantity of Waste Disposed of ('000 Tonnes) (b)		3,100	3,100
Percentage of Waste Recovered (a/a+b)		37%	38%
Data Source: (1) Annual Surveys to Local Waste Recycling Industry (2) Census and Statistics Department data (3) not include imported waste handled by recyclers			

Table 11 Summary of Recycling Statistics in 1993 and 1994

recycling plants, the government had taken the lead in initiating a separation scheme for waste paper. So far some 40 housing estates, over 500 private establishments covering schools, commercial offices, banks, hotels and utility companies and over 90% of government departments had organised their own waste paper separation and collection programmes.

5.3 **Recovery and recycling of construction waste**

5.3.1 Construction waste consists much inert material which is suitable for land reclamation. However, the indiscriminate disposal of construction waste at landfills has been using up the scarce and costly landfill capacity which was designed primarily for the disposal of municipal waste. From Table 5, it can be seen that the construction waste disposed of at landfills contains more than 60% of inert materials which were potentially suitable for public dumps if proper separation was done at source.

5.3.2 The government is working closely with the construction industry to encourage proper segregation and sorting of construction waste at source. The landfill charging scheme would provide a financial incentive for the contractors to improve on the site management practices and to reduce the amount of construction waste generated. A construction waste sorting facility has been established at SENT for sorting out inert construction waste materials for reuse and to reduce the amount of construction waste disposed of at the landfills.

6. Waste Generation Rates and Arisings Forecasts

6.1 Waste generation rates

6.1.1 Waste generation rates are common basis for waste arisings forecast. In this report, the domestic waste generation rate is expressed as the quantity of waste disposed of per capita. The commercial and industrial waste arisings are expressed as waste disposed of per employee. The employees constitute people engaged in economic activities grouped under Division 3, 6 and 8 of the International Standard Industrial Classification which include manufacturing, wholesale, retail, import and export trades, restaurants, hotels, finance, insurance, real estate and business services. Calculations were based on population and employment size distribution data provided by C & SD.

6.1.2 The waste generation rate for each Waste Arisings District are shown in Table 12. The areas constituting each Waste Arisings District are shown in Appendix III. Domestic waste generation rate of Kwai Tsing district was the lowest for 1993 and 1994 (0.71 and 0.74kg/person/day respectively) while that of Yau

CODE NAME	DISTRICT	DOMESTIC WASTE (kg/person/day)		COMMERCIAL & INDUSTRIAL WASTE (kg/employee/day)	
		1993	1994	1993	1994
1010	Central & Western	1.65	1.54	0.50	0.37
1020	Wanchai	1.97	1.80	0.52	0.55
1030	Eastern	0.90	0.87	1.34	1.07
1040	Southern	0.99	1.00	1.81	1.65
1000	Hong Kong Island	1.22	1.17	0.77	0.65
2010	Yau Tsim	2.99	2.89	0.64	0.62
2020	Mong Kok	1.48	1.35	0.37	0.37
2030	Sham Shui Po	1.05	1.14	1.04	0.69
2040	Kowloon City	1.06	1.03	1.65	1.44
2050	Wong Tai Sin	0.80	0.78	0.98	0.79
2060	Kwun Tong	0.81	0.82	2.13	1.63
2000	Kowloon	1.09	1.09	1.20	0.97
1000/2000	Urban Area	1.14	1.12	1.02	0.83
3010	Kwai Tsing	0.71	0.74	1.47	1.22
3020	Tsuen Wan	1.22	1.07	2.63	2.87
3030	Tuen Mun	0.78	0.85	2.44	4.08
3040	Yuen Long	0.89	0.99	3.72	3.75
3050	North	0.83	0.97	2.56	4.11
3060	Tai Po	0.86	1.05	4.79	6.08
3070	Sha Tin	0.82	0.93	3.75	3.20
3080	Sai Kung	0.88	1.01	4.19	8.51
3000	New Territories	0.85	0.93	2.69	3.02
4000	Outlying Islands	2.18	2.39	0.00	0.00
	Territorial Average	1.02	1.04	1.44	1.38

Table 12 Geographical Variation in Waste Generation Rate

Tsim District was the greatest in both 1993 and 1994 (2.99 and 2.89 kg/person/day). An explanation for such a wide range of domestic waste generation rates within a small territory is that a considerable amount of commercial waste in the business districts (particularly in the old urban districts like Yau Tsim, Central and Western) was mixed with domestic waste and was then collected by USD. In contrast, domestic waste arisings in new towns were mainly from public or private housing estates where domestic waste was less likely to be mixed with commercial and industrial waste.

6.1.3 The commercial and industrial waste generation rates in the Central and Western Districts were very low while the Tai Po and Sai Kung Districts hold very high generation rates for the same kind of wastes. The low generation rates in the Central and Western Districts could be another indication that a significant proportion of the commercial waste generated from commercial and mixed developments in Central and Western Districts was already collected by USD's domestic waste collection service. The high generation rates of Tai Po and Sai Kung could be due to the large number of industrial estate/ buildings in these regions which generated waste of high densities (e.g. metal scrap etc.). Furthermore, as many of the manufacturing processes had been automated, the number of industrial workers would decline. Hence, its generation rate, which is expressed as waste produced per worker, may become inflated further.

6.1.4 The waste generation rate for construction waste together with the intake of construction waste at landfills, public dumps and marine spoil grounds are shown in Table 13. There has been a significant increase in construction waste generation rate per site worker recently from 1991 to 1993 but a slight drop in 1994. The generation rate was 0.46 tonne/site worker/day in 1993 and 0.42 tonne/site worker/day in 1994. There was no construction waste disposed of at Hong Kong marine spoil grounds in 1994 and this may be the explanation for the slight drop of construction waste generation rate.

6.2 Correlation between waste arisings and Gross Domestic Product (GDP)

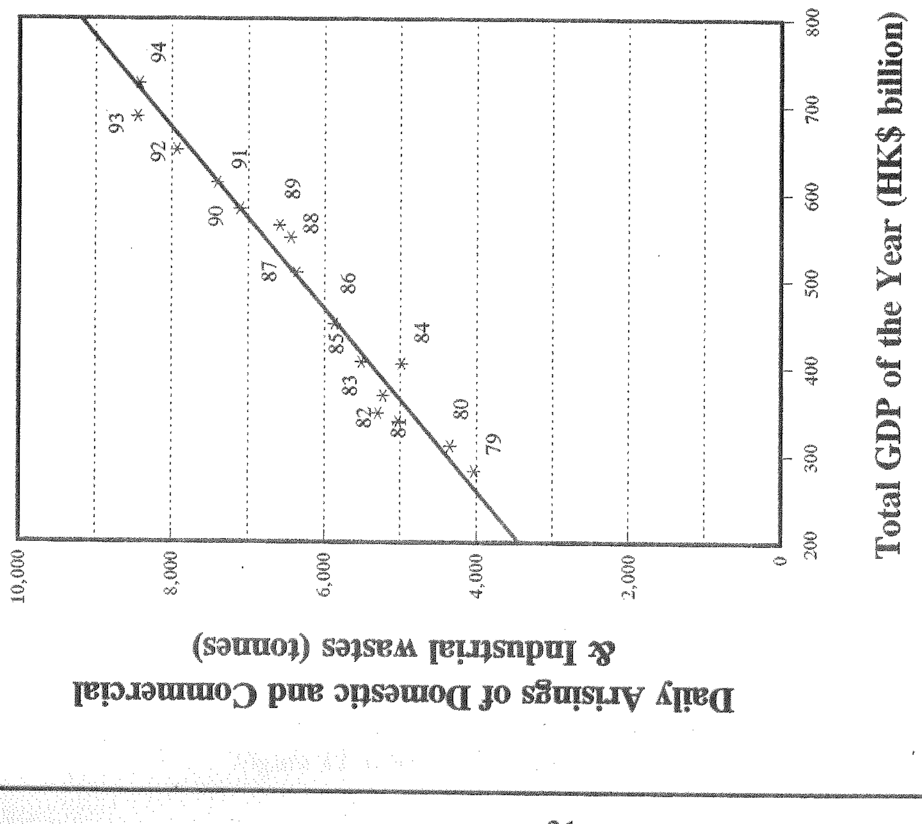
It has been established in previous reports that municipal waste generation has a close relationship with the economic activities measured by the Gross Domestic Product (GDP). Such correlation was further reinforced by the additional data for year 1993 and 1994. The relationship is shown in Figure 10.

6.3 Forecast on domestic waste arisings

6.3.1 In this report, it was assumed that

Year	Quantity (tonnes per day)				No. of construction workers	Waste generation rate (tonne/site worker/day)
	Landfills	Public Dumps	Marine Spoil Grounds	Total		
1986	2,850	15,781	486	19,117	67,443	0.28
1987	4,224	13,068	1,125	18,417	71,615	0.26
1988	6,521	13,315	98	19,934	73,456	0.27
1989	5,584	12,822	879	19,285	70,504	0.27
1990	8,446	8,901	4,780	22,127	71,114	0.31
1991	16,374	4,882	4,835	26,091	63,418	0.41
1992	11,962	13,167	3,875	29,004	62,232	0.47
1993	11,523	10,875	3,141	25,539	54,960	0.46
1994	15,477	8,374	0	23,851	56,244	0.42

Table 13 Construction Waste Intake and Generation Rate



Note: GDP at 1990 constant market price

Figure 10 Correlation of Waste Arisings with Total Gross Domestic Product from 1979 to 1994

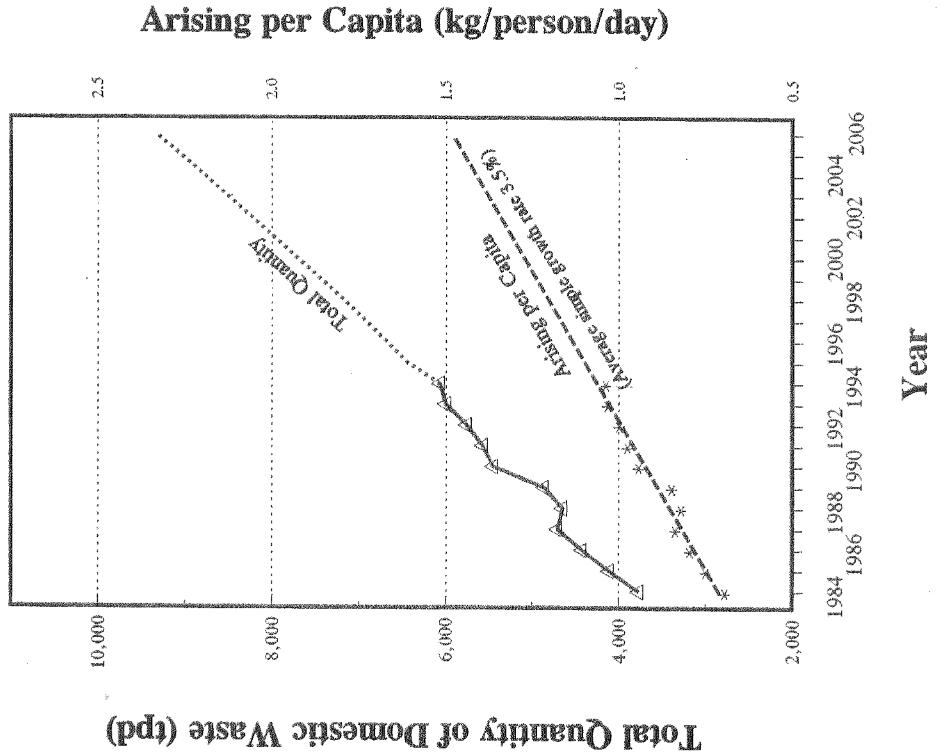


Figure 11 Domestic Waste Arisings Forecast

there would be no limit to growth of domestic waste generation rate for predicting domestic waste arisings. In Figure 11, the waste generation rate was growing steadily. Over the past fifteen years, the average increase in waste generation rate was 3.5% per annum.

6.3.2 Based on the linear projection on domestic waste as shown in Figure 11, the domestic waste generation rate increases from the current rate of about 1 kg/person/ day to about 1.5 kg/person/day in 2006.

6.4 Forecast on commercial and industrial waste arisings

Similarly, the forecast on commercial and industrial waste was made and shown in Figure 12. A linear regression approach was adopted and an average simple growth rate of 6.3% per annum was obtained. Based on the projection shown in Figure 12, the commercial and industrial waste arising per employee per day in year 2006 will be about 2.1 kg.

6.5 Forecast on construction waste arisings

6.5.1 The actual quantity of construction waste disposed of up to 1994 and the estimated quantity of construction waste arisings up to 2006 are shown in Figure 13. As can be seen from Fig. 13, the quantity of construction waste disposed of fluctuated over the past few years. This makes an accurate forecast on construction waste quantity rather difficult as no clear trend can be established based on past data. In this report, quantities of construction waste disposed of at landfills, public dumps and marine spoil grounds were all taken into account in the forecast. A waste generation rate of 0.44 tonne/site worker/day (based on average of 1991-1994) by linear projection is used in the forecast. Such rate is then multiplied by the estimated number of construction site workers which was based on data provided by C & SD.

6.5.2 From Figure 13, it can be seen that there would be a decrease of construction waste arisings from 1997 to 2000. This is because the projected number of construction site workers was found to decline during this period.

6.6 Forecast on waste arisings in each Waste Arisings District

6.6.1 Table 14 is the forecast on domestic, commercial and industrial waste arisings in each district up to 2011. The results were obtained by using the waste generation rate on each Waste Arisings District and the population distribution as predicted by the Working Group on Population Distribution. Table 15 summarizes the forecast on municipal and construction waste arisings in each district up to 2011. Details of calculations are shown in Appendix IV.

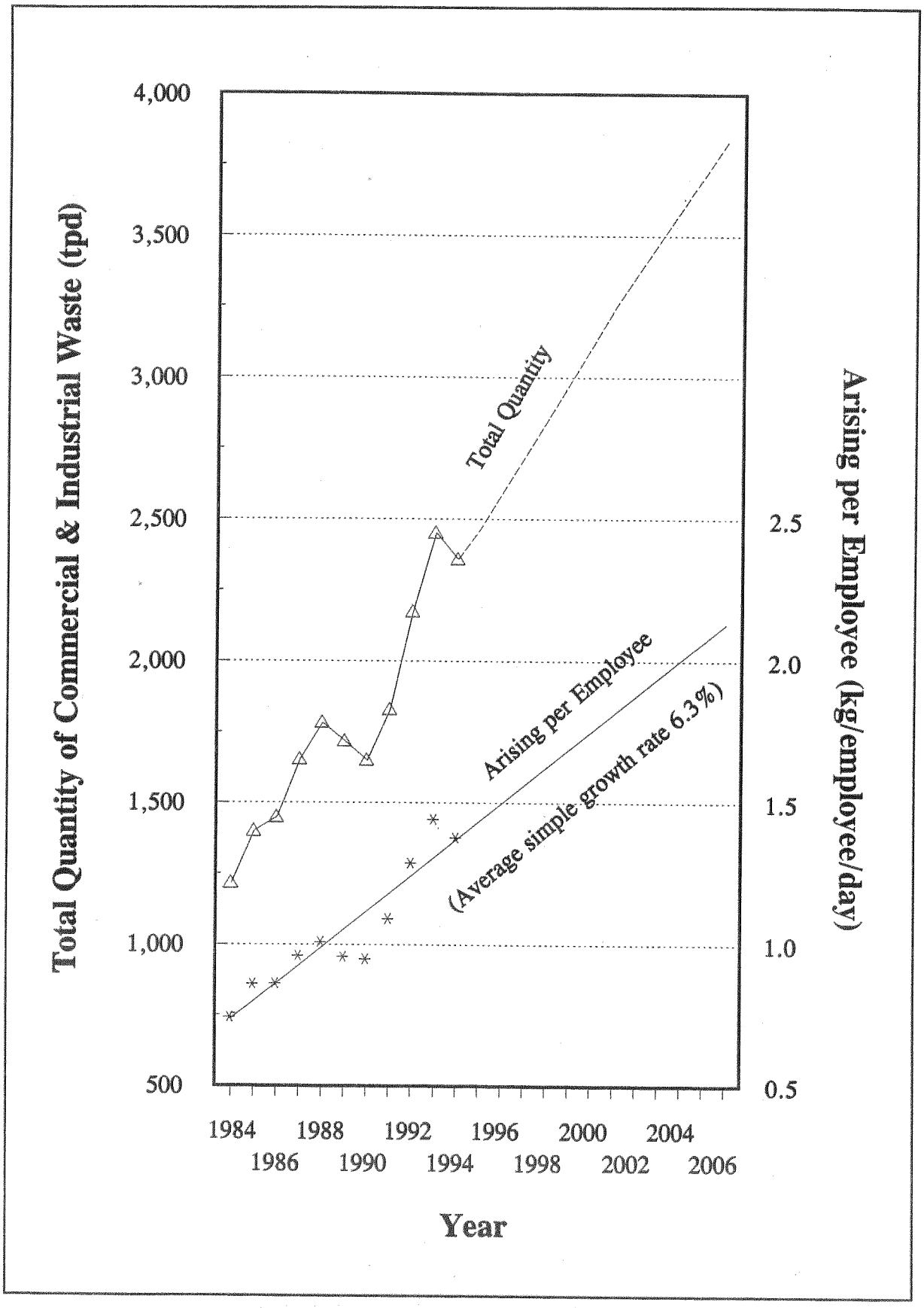


Figure 12 Commercial & Industrial Waste Arisings Forecast

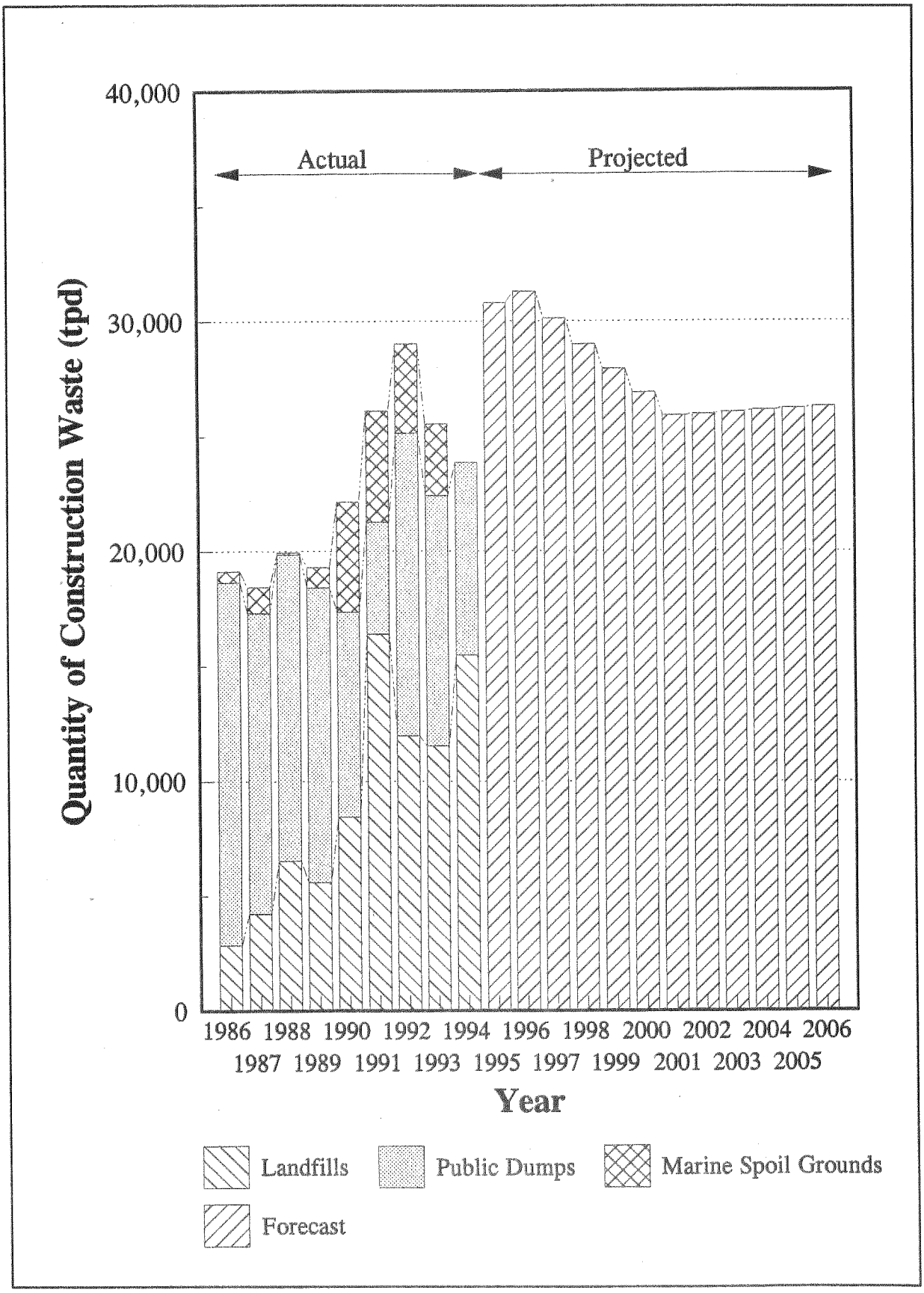


Figure 13 Construction Waste Disposal and Arisings Forecast

Waste Quantities (tonnes per day)	Domestic Waste								Commercial & Industrial Waste				Total Municipal Waste			
Year	Pubilc				Private											
District	1996	2001	2006	2011	1996	2001	2006	2011	1996	2001	2006	2011	1996	2001	2006	2011
Central & Western	384	414	490	565	60	65	77	88	101	92	150	169	545	571	716	822
Wanchai	266	287	310	358	82	88	95	110	88	80	131	147	436	456	536	615
Eastern	431	480	522	602	110	122	133	153	139	127	206	233	680	729	861	988
Southern	250	270	338	390	28	30	38	43	65	59	96	109	343	359	472	542
HONG KONG ISLAND	1,331	1,451	1,660	1,915	280	305	343	394	394	358	582	658	2,004	2,115	2,585	2,967
Yau Tsim	365	607	561	646	47	78	72	83	124	55	183	207	536	740	816	936
Mong Kok	172	229	212	244	47	62	57	66	36	45	53	60	255	336	322	370
Sham Shui Po	333	337	464	535	62	63	87	100	91	73	135	153	486	473	686	788
Kowloon City	340	375	632	728	57	63	105	122	169	90	251	283	566	528	988	1,133
Wong Tai Sin	308	357	325	375	14	16	15	17	54	137	80	91	376	510	420	483
Kwun Tong	430	465	545	628	46	50	58	67	314	1,203	464	524	790	1,718	1,067	1,219
KOWLOON	1,948	2,370	2,739	3,156	273	332	394	455	788	1,604	1,166	1,318	3,009	4,305	4,299	4,929
Kwai Tsing	341	366	370	426	14	15	15	18	176	160	261	295	531	541	646	739
Tsuen Wan	203	216	236	272	90	96	105	121	289	263	428	483	582	575	769	876
Tuen Mun	377	424	556	641	37	42	55	63	215	195	318	359	629	661	929	1,063
Yuen Long	301	359	430	496	26	32	38	44	140	127	207	234	467	518	675	774
North	209	222	283	327	31	33	42	49	77	70	114	128	317	325	439	504
Tai Po	252	266	309	356	55	58	67	77	217	198	322	364	524	522	698	797
Sha Tin	499	546	653	753	60	65	78	90	222	202	328	370	781	813	1,059	1,213
Sai Kung	178	348	418	482	36	70	84	97	79	72	117	132	293	490	619	711
NEW TERRITORIES	2,360	2,747	3,255	3,753	349	411	484	559	1,415	1,287	2,093	2,365	4,124	4,445	5,832	6,677
OUTLYING ISLANDS	138	344	447	515	4	10	13	15	0	0	0	0	142	354	460	530
TERRITORIAL TOTAL	5,777	6,912	8,101	9,339	906	1,058	1,234	1,423	2,596	3,250	3,841	4,341	9,279	11,219	13,176	15,103

Table 14 Forecast Quantities of Municipal Waste by Waste Arisings Districts in 1996, 2001, 2006 and 2011

Waste Quantities (tonnes per day)	Municipal Waste				Construction Waste				Grand Total			
Year / District	1996	2001	2006	2011	1996	2001	2006	2011	1996	2001	2006	2011
Central & Western	545	571	716	822	2,128	1,259	1,278	1,237	2,674	1,830	1,995	2,059
Wanchai	436	456	536	615	879	750	762	737	1,315	1,206	1,298	1,352
Eastern	680	729	861	988	2,371	2,597	2,637	2,558	3,051	3,326	3,497	3,546
Southern	343	359	472	542	1,246	1,333	1,354	1,310	1,588	1,692	1,826	1,852
HONG KONG ISLAND	2,004	2,115	2,585	2,967	6,625	5,939	6,030	5,842	8,629	8,054	8,616	8,809
Yau Tsim	536	740	816	936	1,954	842	855	827	2,489	1,582	1,671	1,763
Mong Kok	255	336	322	370	733	657	667	646	988	993	990	1,016
Sham Shui Po	486	473	686	788	3,345	1,903	1,933	1,871	3,831	2,376	2,618	2,659
Kowloon City	566	528	988	1,133	2,015	2,992	3,038	2,966	2,581	3,520	4,026	4,099
Wong Tai Sin	376	510	420	483	1,620	1,567	1,591	1,540	1,996	2,077	2,011	2,023
Kwun Tong	790	1,718	1,067	1,219	2,252	2,556	2,595	2,513	3,042	4,274	3,662	3,732
KOWLOON	3,009	4,305	4,299	4,929	11,917	10,517	10,680	10,363	14,926	14,822	14,979	15,292
Kwai Tsing	531	541	646	739	1,631	1,812	1,840	1,807	2,162	2,353	2,486	2,546
Tsuen Wan	582	575	768	876	1,840	1,141	1,159	1,123	2,422	1,716	1,926	1,999
Tuen Mun	629	661	929	1,063	1,801	1,331	1,352	1,370	2,430	1,992	2,281	2,433
Yuen Long	467	518	675	774	1,244	1,154	1,172	882	1,711	1,672	1,847	1,656
North	317	325	439	504	1,081	608	617	629	1,398	933	1,056	1,133
Tai Po	524	522	698	797	1,019	657	667	679	1,543	1,179	1,365	1,476
Sha Tin	781	813	1,059	1,213	2,386	1,399	1,420	1,452	3,167	2,212	2,479	2,665
Sai Kung	293	490	619	711	900	906	920	937	1,193	1,396	1,539	1,648
NEW TERRITORIES	4,124	4,445	5,832	6,677	11,902	9,008	9,147	8,879	16,026	13,453	14,979	15,556
OUTLYING ISLANDS	142	354	460	530	837	415	422	430	979	769	882	960
TERRITORIAL TOTAL	9,279	11,219	13,176	15,103	31,281	25,879	26,279	25,514	40,560	37,098	39,456	40,617

Table 15 **Forecast Quantities of Municipal Waste and Construction Waste by Waste Arisings Districts in 1996, 2001, 2006 and 2011**

6.6.2 The forecast could be affected by the followings :-

(a) Waste reduction programme to be developed by the Government;

(b) Impact on waste generation due to implementation of the landfill charging scheme;

(c) Degree of recycling activities and potential markets for recovered materials;

(d) Forecast made on future demographic trends;

(e) Progress on new town developments and urban redevelopments;

(f) Changes in social patterns, environmental awareness, population density, industrial and commercial activities, manufacturing and product packaging technology; and

(g) Limits to the growth of waste generation rates.

SAMPLE SURVEY FORM USED FOR WEIGHBRIDGE MONITORING

ENVIRONMENTAL PROTECTION DEPARTMENT

Sheet ____

Monitoring of Waste Arisings

Record of Incoming Lorries at Disposal Site

Disposal Site : _____ Survey Date : _____

Surveyor : _____

TIME	Vehicle No.	Waste Cat.	Waste Content	Arising Area /District/	Owner-ship	Payload	Area Code

Sources of Data on Chemical, Special and Other Wastes in 1993 and 1994

Description of Waste	Source of Data	Actual data	Estimation
Chemical Waste	Environmental Protection Department	✓	
Waterworks Sludge	Based on the Integrated Sludge Disposal Strategy Interim Report, Dec 1991		✓
Sewage Sludge			
Sewage Works Screenings	Civil Engineering Department (Weighbridge Record)	✓	
Excremental Waste	Environmental Protection Department	✓	
Condemned Goods			
Abattoir Waste			
Animal Carcasses			
Livestock Waste	Environmental Protection Department		✓
High Security Waste	Electrical and Mechanical Services Department (Weighbridge Record)	✓	
Clinical Waste	Based on the Centralised Incineration Facility for Special Waste - Phase I Feasibility Report 1992		✓
Marine Dumping/Dredged & excavated marine spoil	Environmental Protection Department	✓	
Pulverised Fuel Ash and Furnace Bottom Ash	Hong Kong Electric Co. Ltd. China Light and Power Co. Ltd.	✓	
Incinerator Ash	Electrical and Mechanical Services Department	✓	
Stabilised Residues from CWTC	Environmental Protection Department	✓	

System of Waste Arisings Districts/Areas Used in Waste Arising Survey

District identity code	District name	Source Area identity code	Source Area name
1010	Central & Western	1011	Central
		1012	Sheung Wan
		1013	Mid Levels
		1014	Peak
		1015	Kenndey Town
1020	Wanchai	1021	Wanchai
		1022	Tai Hang/ Happy Valley
1030	Eastern	1031	North Point
		1032	Quarry Bay
		1033	Sha Kei Wan
		1034	Chai Wan
1040	Southern	1041	Pok Fu Lam
		1042	Aberdeen
		1043	Stanley
2010	Yau Tsim	2011	Tsim Sha Tsui East
		2012	Tsim Sha Tsui West
		2013	Yau Ma Tei
2020	Mongkok	2021	Mongkok North
		2022	Mongkok South
2030	Sham Shui Po	2031	Sham Shui Po
		2032	Shek Kip Mei
		2033	Cheung Sha Wan
		2034	La Chi Kok
2040	Kowloon City	2041	Hung Hom
		2042	Ho Man Tin
		2043	Kowloon Tong
2050	Wong Tai Sin	2051	Wong Tai Sin
		2052	Ngau Chi Wan

District identity code	District name	Source Area identity code	Source Area name
2060	Kwun Tong	2061	Kwun Tong East
		2062	Kwun Tong West
		2063	Sau Mau Ping
		2064	Lam Tin
3010	Kwai Tsing	3011	Kwai Chung
		3012	Tsing Yi
3020	Tsuen Wan	3021	Tsuen Wan
3030	Tuen Mun	3031	Tuen Mun
		3032	Lam Tei
3040	Yuen Long	3041	Yuen Long
		3042	Tin Shui Wai
		3043	Kam Tin/Shek Kong
		3044	San Tin
3050	North	3051	Sheung Shui/Fanling
		3052	Shau Tau Kok
3060	Tai Po	3061	Tai Po
		3062	Shuen Wan
		3063	Tai Po Rural
		3064	Sai Kung North
3070	Shatin	3071	Shatin West
		3072	Shatin East
		3073	Shatin South
		3074	Ma On Shan
3080	Sai Kung	3081	Sai Kung South
		3082	Clear Water Bay
		3083	Junk Bay
4000	Islands		

Details on waste arisings forecast

(a) Select the planning years for which the waste arisings in each WAD are required. (In this report, the years selected are 1996, 2001, 2006 and 2011.)

(b) For each year selected, obtain the forecasted territorial arisings (control total) of each waste category based on the projection in the previous sections.

(c) For each waste category, assume an initial single growth rate for the different waste generation factors (per capita/employee) of all WADs. This gives the future waste generation factors at district level, which will give the forecasted waste quantities in each WAD after multiplying by the respective predicted population (or employee population).

(d) Sum up the waste arisings of all WADs and compare it with the control total obtained in (b).

(e) Adjust the initial growth rate and repeat steps (c) & (d) above until the sum of the waste arisings from all WADs agrees with the control total obtained in (b).

BREAKDOWN OF WASTE DELIVERED TO INCINERATION PLANTS, REFUSE TRANSFER STATIONSAND LANDFILLS IN 1993

Disposal Facility	Average Daily Waste Intake by Category in 1993 (tpd)					Incinerator Ash
	MSW		Construction	Special	Total	
	Public	Private				
Kennedy Town Incineration Plant (KTIP) *	70	-	-	-	70	20
Kwai Chung Incineration Plant (KCIP)	747	5	-	-	752	166
Mui Wo Incineration Plant (MWIP)	7	-	-	-	7	
Island East Transfer Station (IETS) **	1,126	15	-	1	1,142	
Kowloon Bay Refuse Transfer Station (KBTS) #	1,709	-	-	6	1,715	
Tseung Kwan O Landfill (TKOL)	126	2,167	5,618	83	7,994 ##	
Shuen Wan Landfill (SWL)	686	827	4,843	58	6,414	
Pillar Point Valley Landfill (PPVL)	531	435	1,062	105	2,133	
Total :	5,002	3,449	11,523	253	20,227	186
	8,451					
	19,974					

* KTIP was decommissioned in March 93
** Waste from IETS was delivered to TKOL by barge.
# Waste from KBTS was disposed of at TKOL before Nov. 93. After Nov. 93, these waste were diverted to WENT.
The quantity shown here does not include the waste from the two RTS.
Note : Average Daily Intake shown here is calculated by dividing the total waste intake in 1993 by 365 days irrespective of the operational period of the site.

BREAKDOWN OF WASTE DELIVERED TO INCINERATION PLANTS, REFUSE TRANSFER STATIONS AND LANDFILLS IN 1994

Disposal Facility	Average Daily Waste Intake by Category in 1994 (tpd)					Incinerator Ash
	MSW		Construction	Special	Total	
	Public	Private				
(a) Kwai Chung Incineration Plant (KCIP)	705	-	-	-	705	155
(b) Mui Wo Incineration Plant (MWIP) **	4	-	-	-	4	
Island East Transfer Station (IETS) *	1,248	-	-	-	1,248	
(c) Kowloon Bay Refuse Transfer Station (KBTS) #	1,762	-	-	-	1,762	
Shatin Transfer Station (STTS) #	146	-	-	-	146	
Tseung Kwan O Landfill (TKOL)	91	1,415	8,039	99	9,644 ##	
(d) Shuen Wan Landfill (SWL)	624	917	5,928	101	7,570	
Pillar Point Valley Landfill (PPVL)	226	517	1,501	186	2,430	
(e) SENT Landfill	40	335	9	4	388	
WENT Landfill	397	-	-	-	397 ##	
Total :	5,243	3,184	15,477	390	24,294	155
	8,427					
	23,904					

*Waste from IETS was delivered to TKOL until September 94 and the waste was diverted to WENT by barge after September 94.
** MWIP was decommissioned in June 1994.
# Waste from STTS was delivered to WENT.
The quantity shown here does not include the waste from the RTS.
Note : Average Daily Intake shown here is calculated by dividing the total waste intake in 1994 by 365 days irrespective of the operational period of the site.