PART 3
SOLID WASTE CHARACTERISTICS

1-VOLUME OF WASTE

This section provides information on the assessment of total waste quantities over time.

1-1 Discharge Waste at each Section in Hayatabad

i) Waste from residential area

To know the total quantity of discharged waste in Hayatabad, model residents were selected in the residential area. Also commercial, Public and road areas were selected for this purpose. Industrial area was not touched during this survey because industries do not discharge their solid waste to the municipal authorities for collection. By-law industries are bound to have their own arrangement for discharging their solid waste generated by industrial activities. Residential area was categorized as follow:-

TABLE-29

RESIDENTIAL AREA CATEGORIES

Area	Division/Class	Section
Residential Area	Upper	2 Kanal Houses
		1 Kanal Houses
	Middle	10 Marla Houses
	Lower Middle	7 Marla Houses
		5 Marla House
	Lower	3 Marla Houses

To see the volume of discharge waste by each section of the society, the houses were categorized according to their covered area. It is generally understood that the peoples belong to the upper class having their residential house in 2 kanals or 1 kanal area. Table-29 shows the division residential area into four classes. Reason of categorizing the residential area is that refuse quantity and composition can be related to socioeconomic factors.

Two houses of each category were selected for the survey. Survey was conducted for 7 days period in a row, to see the volume of discharged waste over the week. Survey was conducted between January 14, 2004 to January 20, 2004. For this purpose collection vessels were lended to the model residents. Sort-and-weigh methodology was used for assessing the waste composition of each load of waste. This methodology has the advantage of greater accuracy.

Sampling plan was handed over to the staff deputed for the execution of this survey and explained them the activities, they had to undertake. Additional information on load source was collected from model residents by knowing the number of occupants in each model house.

Weight Bridges were used for weighing the refuse generated from each model houses. Scale having the accuracy upto 100g was used, so that the reliable weight of the lightest bins could be measured. The total mass of refuse from each model house was weighted prior to sorting as a cheek against the individual fractions. Then all fractions were weighted and totaled to check against the original mass. The same procedure was adopted daily over the study period.

According to this survey the average waste generated from the various types of houses is summarized in Table-30 below:

TABLE-30

AVERAGE WASTE GENERATED PER PERSON (KG) IN EACH CATEGORY OF HOUSES

Area of the Waste	Number of inhabitants	Average Waste generated (Kg)	Waste generated per person (Kg)
2 Kanals	**17**	**7.1**	**0.42**
1 Kanal	**10**	**4.40**	**0.44**
10 Marlas	**14**	**6.5**	**0.47**
7 Marlas	**10**	**3.9**	**0.39**
5 Marlas	**6**	**6.1**	**1.0**
3 Marlas	**6**	**2.6**	**0.45**

According to the above survey the waste generated per house is about 5.5 Kg. The waste generated from the 5 Maralas house is exceptionally high (1 Kg per person). One explanation for this may be that there were no children in the house and all were adults and thus the average may be high as compared to all other houses included in the survey. Similarly the greater numbers of inhabitants in bigger plot sizes is either due to the fact that domestic servants also reside there or different portions of the same houses are rented out to more than one family, mostly Afghan refuges.

According to Sub Divisional Officer in-charge for solid waste collection and disposal, the total solid waste generated from the Hayatabad Township is 60 tones. Of this waste 40 tons is collected daily while the remaining 20 tons or one third is left in the street, disposed in the plots on which construction has not yet stared.

Waste generated per capita per day	**0.5 Kg**
Waste generated per household per day	**5.0 Kg**
Total Solid Waste generated per day	**60 Tones**

Source: Micro Municipal Services Proposal

If we take the average of 5.5 or 5 Kg and the number of houses as 12,000 the estimated figure comes to 66,000 Kg which is very near to the estimated figure of Municipal committee

Table-31 shows complete survey data of solid waste in Hayatabad generated from different categories of model houses. Table shows different fractions of solid waste generated daily during the survey period.

TABLE-31

DATA COLLECTION OF SOLID WASTE IN HAYATABAD FROM DIFFERENT CATEGORIES /MODEL HOUSES

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
2 Kanal																	
	Wed 14-01-2004	7	10	**17**	6850	100	-	1050	3500	100	200	350	-	250	300	1000	-
	Thu 15-01-2004				7000	120	250	1000	5000	130	-	250	-	-	200	-	50
	Fri 16-01-2004				5000	100	200	1000	3000	-	250	-	-	100	250	-	100
	Sat 17-01-2004				6000	130	-	1050	4200	70	-	100	250	-	50	-	150
	Sun 18-01-2004				6000	120	110	1050	4250	100	-	50	-	-	250	-	70
	Mon 19-01-2004				10900	120	-	900	7100	250	-	1000	260	70	100	1000	100
	Tue 20-01-2004				8000	100	-	1000	5350	750	250	250	-	50	100	-	150
	Total:				**49750**	**790**	**560**	**7050**	**32400**	**1400**	**700**	**2000**	**510**	**470**	**1250**	**2000**	**620**
	Average:				**7107.14**	**112.86**	**80.00**	**1007.14**	**4628.57**	**200.00**	**100.00**	**285.71**	**72.86**	**67.14**	**178.57**	**285.71**	**88.57**

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
1 Kanal																	
	Wed 14-01-2004	3	7	**10**	4000	120	150	250	2360	150	250	250	250	-	200	-	20
	Thu 15-01-2004				5400	150	-	500	3400	100	-	100	-	100	50	1000	-
	Fri 16-01-2004				3500	170	-	300	2560	150	-	120	-	-	100	-	100
	Sat 17-01-2004				3500	200	-	350	2830	-	-	-	-	50	50	-	20
	Sun 18-01-2004				3000	100	-	250	2300	-	200	50	-	-	100	-	-
	Mon 19-01-2004				6400	120	-	450	3700	100	100	500	280	-	100	1000	50
	Tue 20-01-2004				5000	150	-	300	4350	-	-	50	-	50	100	-	-
	Total:				**30800**	**1010**	**150**	**2400**	**21500**	**500**	**550**	**1070**	**530**	**200**	**700**	**2000**	**190**
	Average:				**4400.00**	**144.29**	**21.43**	**342.86**	**3071.43**	**71.43**	**78.57**	**152.86**	**75.71**	**28.57**	**100.00**	**285.71**	**27.14**

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
10 Marla																	
	Wed 14-01-2004	5	9	**14**	7500	200	-	500	6330	50	-	20	250	50	100	-	-
	Thu 15-01-2004				6000	150	-	300	4900	100	100	250	-	-	150	-	50
	Fri 16-01-2004				5500	150	-	300	4900	50	-	-	-	100	-	-	-
	Sat 17-01-2004				5000	200	-	250	4000	150	-	50	-	150	200	-	-
	Sun 18-01-2004				5000	250	-	250	4030	-	-	20	-	100	250	-	100
	Mon 19-01-2004				9300	200	-	300	7350	-	-	300	-	50	100	1000	-
	Tue 20-01-2004				7500	150	-	250	7050	50	-	-	-	-	-	-	-
	Total:				**45800**	**1300**	**0**	**2150**	**38560**	**400**	**100**	**640**	**250**	**450**	**800**	**1000**	**150**
	Average:				**6542.86**	**185.71**	**0.00**	**307.14**	**5508.57**	**57.14**	**14.29**	**91.43**	**35.71**	**64.29**	**114.29**	**142.86**	**21.43**

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
7 Marla																	
	Wed 14-01-2004	4	6	**10**	4000	250	-	-	3150	100	-	200		150	100	-	50
	Thu 15-01-2004				3000	250	-	-	2480	120	-	150		-	-	-	-
	Fri 16-01-2004				3500	150	-	-	3150	-	-	100		-	-	-	100
	Sat 17-01-2004				3500	100	-	-	3250	-	-	-		-	150	-	-
	Sun 18-01-2004				3000	150	-	-	2350	-	-	-		250	250	-	-
	Mon 19-01-2004				5900	150	-	-	4300	100	-	250		-	100	1000	-
	Tue 20-01-2004				4500	200	-	-	3800	-	-	-	250	-	-	-	250
	Total:				**27400**	**1250**	**0**	**0**	**22480**	**320**	**0**	**700**	**250**	**400**	**600**	**1000**	**400**
	Average:				**3914.29**	**178.57**	**0.00**	**0.00**	**3211.43**	**45.71**	**0.00**	**100.00**	**35.71**	**57.14**	**85.71**	**142.86**	**57.14**

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
5 Marla																	
	Wed 14-01-2004	0	6	**6**	6900	200	-	-	5050	-	250	200	-	-	200	1000	-
	Thu 15-01-2004				6500	150	-	-	5850	150	-	-	-	250	-	-	100
	Fri 16-01-2004				5000	200	250	-	4350	-	-	100	-	-	-	-	100
	Sat 17-01-2004				5500	200	-	-	4450	250	100	250	-	-	250	-	-
	Sun 18-01-2004				4500	150	-	-	4150	100	-	-	-	-	-	-	100
	Mon 19-01-2004				7850	150	-	-	6300	-	-	300	-	-	100	1000	-
	Tue 20-01-2004				6500	200	-	-	6000	100	100	-	-	100	-	-	-
	Total:				**42750**	**1250**	**250**	**0**	**36150**	**600**	**450**	**850**	**0**	**350**	**550**	**2000**	**300**
	Average:				**6107.14**	**178.57**	**35.71**	**0.00**	**5164.29**	**85.71**	**64.29**	**121.43**	**0.00**	**50.00**	**78.57**	**285.71**	**42.86**

Area of House	Date	Inhabitants of House			Amount of Daily Produced Solid Waste in gms	Wastage			Vegetable & Fruits Flakes	Plastic, Rubber	Textile	Paper	Metal	Glass	Bones	Wood	Bread
		Kids	Elders	Total		Tea, Peel of eggs, Shopping Bags etc	Ceramic	Pamper									
3 Marla																	
	Wed 14-01-2004	3	3	**6**	1000	50	-	-	750	-	-	-	-	50	150	-	-
	Thu 15-01-2004				3250	70	-	-	3170	10	-	-	-	-	-	-	-
	Fri 16-01-2004				2500	50	-	-	2430	-	-	20	-	-	-	-	-
	Sat 17-01-2004				2000	50	-	-	1850	-	-	-	-	100	-	-	-
	Sun 18-01-2004				3000	70	-	-	2830	-	-	-	-	-	100	-	-
	Mon 19-01-2004				3500	50	-	-	3430	-	-	20	-	-	-	-	-
	Tue 20-01-2004				2700	50	-	-	2550	-	-	-	-	100	-	-	-
	Total:				**17950**	**390**	**0**	**0**	**17010**	**10**	**0**	**40**	**0**	**250**	**250**	**0**	**0**
	Average:				**2564.29**	**55.71**	**0.00**	**0.00**	**2430.00**	**1.43**	**0.00**	**5.71**	**0.00**	**35.71**	**35.71**	**0.00**	**0.00**

Note: **1). 14 Marlas Plots are only situated in Phase-7 & these are also under process**

2). Vegetables and Fruits Flakes are used for feeding to Animals

3). Textile, Plastic, Rubber, Metal, Paper, Glass, Bones, Wood and Bread are selling items.

ii) Waste from Parks and Commercial areas

Hayatabad is a newly settled town and has three parks and three mini markets. There are no separate arrangements for solid waste collection from parks and commercial markets. On average, there is one donkey cart collecting waste from parks, where the waste is normally plastic packages, tins etc. generated from fast food and drinks.

Solid wastes generated from the commercial areas are mostly papers, paper-boards, packages materials, etc. the overall waste from these areas is estimated to be 1 ton/day. However, there is a weekly market on each Sunday, which adds an additional 1 ton solid waste on week end.

1-2 Daily Dumped Volume

Town-III authorities in Hayatabad are mostly relay on donkey carts as major mode of transportation of solid waste from houses, parks, commercial areas etc. to the authorized dumping site. Beside donkey carts, there are two trucks used for this purpose.

Table-32 gives means of transportation of solid waste to dumping site.

TABLE-32

MEANS OF TRANSPORTATION

Type	Number	Collection frequency	Capacity	Total capacity
Trucks	**2**	**One Trip/day**	**≈ 5 tons per truck**	**10 Tons**
Donkey carts	**100**	**One Trip/day**	**300 Kg per cart**	**30 Tons**

Among 100 donkey carts, 38 have been hired on monthly charge of Rs.1100/= per cart, while the remaining work as volunteers. Volunteer carts sell the saleable items from the waste and dispose off the rest. Table-32 shows the estimated waste quoted by the Municipal Staff of Town-III dealing with collection and disposal of solid waste from Hayatabad. The actual weight of the garbage taken by a donkey cart was measured on computerized weighing machine came to be 720 Kg. However, it seems that the amount of waste taken by the majority carts working as volunteers are very low and they are also selective in choosing the area. They mostly operate in those areas, where they can get maximum load of saleable items. Only 38 hired donkey carts carry 720 kg/cart garbage to the dumping site. Total dumped waste by these hired donkey carts are about 28 tons/day. This figure is very close to the estimated dumped waste per day by donkey carts given in Table-32. Every day these donkey carts collect the waste by going door to door from their nominated areas and then separate on spot saleable and non-saleable items.

Hayatabad Town-III administration has also provided 350 drums having capacity of 1100 liters per drum in commercial and residential areas for garbage disposal. Two garbage collection trucks collect the waste from these drums.

After analyzing the data collected from waste generation and waste disposal, it is estimated that normally 50-60% of the waste is being collected by the Municipal authorities of Hayatabad.

1-3 Total Quantity of Dumped Waste (Topographic Survey)

Topographic survey of the solid waste dumping site in Hayatabad was carried out in December, 2003 by the help of the surveyor from the CD & MD of Hayatabad Town-III. This dumping site is situated in Phase-VII of Hayatabad. A map of Phase-VII Hayatabad, showing the dumping site is enclosed in Annexure-C.

Till December 2003, Phase VII dumping site was used for the disposal of solid waste by both trucks and donkey carts. The site has been abandoned after December, 2003. The exact data, when the Town-III started dumping waste in Phase-VII is not known. However, it seems that the same started in 1997 or later.

To know the total quantity of dumped waste over the period on this site, detail survey data is given in Table-33 to 35. Table-33 shows space capacity of dumping waste and Table-35 gives details about the remaining portions for dumping in the areas marked. Survey diagram is enclosed in Annexure-D.

TABLE-33

CAPACITY OCCUPIED BY WASTE

Area	Length	x	Width	x	Depth	Volume *cft*
1	$\frac{40+45}{2}$	x	$\frac{40+90}{2}$	x	$\frac{16+12}{2}$	8675
2	70	x	$\frac{90+95}{2}$	x	$\frac{4+3}{2}$	22662
3	$\frac{170+115}{2}$	x	90	x	$\frac{2.33+1.16}{2}$	22379
4	$\frac{100+85}{2}$	x	$\frac{80+45}{2}$	x	1.5	8671
5	60	x	$\frac{15+25}{2}$	x	1.5	1800
6	60	x	15	x	2.5	2250
7	150	x	$\frac{20+40}{2}$	x	$\frac{2.74+1.20}{2}$	8865
8	90	x	$\frac{55+70}{2}$	x	$\frac{9+5}{2}$	39375
9	90	x	30	x	1.5	4050
TOTAL						**48727**

TABLE-34

SPARE CAPACITY OF THE DUMPING SITE

Area	Length	x	Width	x	Depth	Volume *cft*
1	$\frac{200+100}{2}$	x	$\frac{90+50}{2}$	x	$\frac{8+14}{2}$	115500
2	$\frac{200+150}{2}$	x	$\frac{75+125}{2}$	x	$\frac{13.90+13.33}{2}$	238175
TOTAL						**353675**

TABLE-35

REMAINING PORTION OF DUMPING IN THE AREAS MARKED

Area	Length	x	Width	x	Depth	Volume *cft*
2	70	x	$\frac{9095}{2}$	x	6	38850
3	$\frac{170+115}{2}$	x	90	x	$\frac{14+7}{2}$	134662
4	$\frac{100+85}{2}$	x	$\frac{80+45}{2}$	x	$\frac{9+4}{2}$	37578
5	60	x	$\frac{15+25}{2}$	x	4	4800
8	90	x	$\frac{55+70}{2}$	x	10	225000
TOTAL						**440890**

Total Capacity of the Site

Waste Occupied volume	48727	1,378.97m^3
Volume of Unused Trenches	353675	10,009.00m^3
Spare Volume of the Used Area	440890	12,477.19m^3
Grand Total	**843292cft**	**23,865.16m^3**

Annual Dumping volume can be calculated from the Equation-A.

$$\textbf{Annual Dumping Volume} = \frac{\textbf{Dumping Volume}}{\textbf{Dumping Periods (Year)}} \longrightarrow \textbf{Equation-A}$$

From the calculation in Table-33, total dump volume is 1,378.97 m^3. So by using Equation-A, Annual dumping volume of the solid waste in Phase-VII is 229.83m^3. Since 1st January 2004, a new site located at a distance of 15 Km from Hayatabad along the ring Road between Bara Chowk and Kohat road is used for waste dumping. This site is far away from the Hayatabad area, so only the waste collected by trucks are disposed off. An estimated 10-15 tons of waste is now being dumped per day.

Since 1st to 28th January 2004, after the abandonment of Phase-VII site, donkey carts use to dump the waste in excavated areas of Kacha Garhi Camp (opposite Hayatabad Township). This particular site has been abandoned too after public complaints. Since 28th January onwards, waste is being disposed by donkey carts in an excavated area within the premises of Sewage Treatment Plant in Phase-III.

As per discussion with the Sub Divisional Officer, In-charge for Solid waste collection and disposal in Town-III, there are all temporary arrangements and they are trying to find some permanent site for waste disposal.

Following Table-36 below summarizes the main distinguishing characteristics of the dumping site in Phase-VII, Hayatabad.

TABLE-36

KEY CHARACTERISTICS OF SOLID WASTE DUMPING SITE IN HAYATABAD

Characteristics	Advantages	Disadvantages
• Poorly site	• Easy access	• Environmental contamination
• No planning	• Low initial cost	• Noxious site
• Little or no site preparation	• Low initial cost	• Unsightly, needs remediation
• No leachate management	• Low initial cost	• Ground water or surface water contamination
• No gas management	• Low initial cost	• Risk of explosion, Green House Gases
• Only occasional cover	• Aerobic decomposition	• Vector/disease, unsightly
• No/Little compaction of waste	• Aerobic decomposition	• Shorter, lifetime little
• No fence	• Access to waste pickers	• Indiscriminate use
• No record keeping	• Low initial cost	• No record of landfill contents
• Waste picking/selling	• Material recovery/income	• Risk to Scavengers health

2- QUALITY OF WASTE