SOLID WASTE MANAGEMENT SYSTEM OF PESHAWAR – A CASE STUDY

By

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ABSTRACT

This paper is a case study and sheds light on the generation, collection, storage, transportation and ultimate disposal of the solid waste generated in Peshawar city. City District Government Peshawar has been divided into four towns (I, II, III & IV). In addition to that, Hayatabad and Cantonment areas also fall in the city jurisdiction, however, only the Hayatabad area is included in the scope of the study. At present, there is indiscriminate disposal of solid waste in low lying areas of the city which creates inevitable health hazards and pose unhygienic conditions in the city. To minimize the risks associated with such situation, a proper solid waste management system is required for the city which is discussed in this paper.

1.1 STRUCTURE OF CITY DISTRICT GOVERNMENT, PESHAWAR (CDGP)

The City District Government Peshawar has been divided into four Towns namely Town-I, Town-II, Town-III and Town-IV. In addition to that, the City's urban areas also include the Cantonment and new housing schemes of City District Municipal Department (CDMD) such as Hayatabad and Regi Lalmah. Town-I and Town-III mostly composed of city/urban area, while Town-II and Town-IV primarily consist of rural suburbs. Accordingly, the management of solid waste in the city's urban area is being handled by TMA's for Town-I and Town-III and for Hayatabad and Regi Lalmah Township by the CDMD. Unfortunately, there is no solid waste collection, storage system in Town II & IV. The Peshawar Cantonment is being managed independently by the Cantonment Board.

The disposal of waste is done by dumping it along the roads, in low lying areas and in the plots and fields offered by owners on voluntary basis and on payment of some amount. No formal landfill arrangements exist. There are two sites in the city and its suburbs which are presently being used by TMA's of Town-I, Town-III of Peshawar and Hayatabad and are known as Hazar Khwani and Lundi Akhune Ahmed. Those sites are located at distances of 4-5 kms and 5-6 kms, respectively from the City on G.T Road along Ring Road.

The most alarming and environmentally undesirable practice is the burning of the solid waste in open dumps by scavengers so that they can easily pick-up glass and tin pieces etc. **(Photo 1)**. The scavenger's activities though reduce the quantities of wastes to a certain extent but is not a desirable solution for the management of the wastes, as it jeopardize the health of the residents.



Photo 1 – Burning of dumped waste at Lundi Akhune Ahmed

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1. Senior Engineer - NESPAK

1.2 STORAGE AND COLLECTION

Table 1 shows the current storage, collection, transfer and solid waste disposal facilities in Peshawar.

Present arrangements for storage and collection of waste in different sections of the City are as follows:

Table - 1 Present Solid Waste Management System for Peshawar

Peculiar Treatment Areas	Storage at the Premises	Collection from Premises	Storage on Street sides	Collection from Streets	Transfer Station	Transfer Vehicle	Disposal
City	Make shift containers	Manually	Street side heaps	Hand carts/ donkey carts/small Tractor trolleys	7 m^3 containers/ filth depots	Hoist trucks/ tractor trolleys/ open body trucks	Open Dumping
		Hand Carts	→		7 m^3 containers/ filth depots	Hoist trucks/ tractor trolleys/ open body trucks	Open Dumping
	Street sweeping/Nullah cleaning		Street side heaps	Hand carts donkey carts/small tractor trolley	7 m^3 containers/ filth depots	Hoist trucks/ tractor trolleys/ open body trucks	Open Dumping
Hayatabad	Make shift containers	Manually	1.1 m^3 containers	Tractor Trolley/ compactor trucks	→		Open Dumping
		Hand carts	→		1.1 m^3 containers	Compactor trucks/ tractor trolley	Open Dumping
	Street sweeping/Nullah cleaning		Street side heaps	Hand Cart	1.1 m^3 containers	Compactor trucks/ tractor trolley	Open Dumping

1.2.1 Main City

The residents throw their solid waste on sides of the streets making small heaps. These small street side heaps are cleared by sweepers using handcarts, donkey carts and taken to the filth depots or 7 m^3 metallic containers or the filth depots **(Photo 2)**.



Photo 2 – Solid Waste Container (7 m^3) in Town-III

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From the filth depots, the waste is again transferred manually or with mechanical loader into tractor trolleys and dumper trucks, which take it to the disposal sites which are in the form of open dumps. The 7 m^3 metallic containers are taken to the disposal site by means of hoist trucks, emptied at the dumping sites and brought back at their respective storage locations. The wastes from these heaps are collected by Suzuki vans etc. or small tractor trolleys and taken to the disposal site or transferred into 7 m^3 containers. **(Photo 3)** placed along the banks of drains/nullahs.



Photo 3 – Small Tractors for Town-III

1.2.2 Hayatabad

In Hayatabad, 1.1 m^3 containers are provided **(Photo 4)**. The waste from the premises is brought to those containers manually by the residents or with the help of hand carts by the sanitary workers. These containers are then serviced by compactor trucks, which shift the wastes to the open dumping site. Donkey carts are also used to collect the wastes from house to house on payment by private workers and shift the wastes to metallic containers or thrown in low lying areas along the Hayatabad bridge.



Photo 4 – Waste Bin in Hayatabad

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1.2.3 Recycling

The recovery and recycling of materials like glass, paper, plastics and metals takes place at all stages of the waste management system encompassing households, roadside heaps, filth depots, communal containers and finally at disposal sites. Nevertheless, the major portion is separated at source. The segregation of recyclables at disposal site is shown in **Photo 5**.



Photo 5 – Segregation of plastic and glass bottles
at Lundi Akhune Ahmad

1.3 FINAL DISPOSAL

Presently, there are two sites namely Hazar Khwani and Lundi Akhune Ahmed which are being used for the purpose of open dumping **(Photos 6 and 7)**. Both of those sites are located along the Ring Road within a distance of 4-6 kms from G.T. Road.



Photo 6 – Container being emptied at Hazar Khwani Site



Photo 7 – Front End Loader at work at Lundi Akhune Ahmed

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1.4 MANAGEMENT OF SPECIAL WASTES

a) Hospital Wastes

There are three Government Hospitals in Peshawar i.e. Khyber Hospital, Lady Reading Hospital and Hayatabad Medical Complex alongwith a few private hospitals. All the three Government

hospitals have been equipped with incinerators to take care of the hazardous wastes. Those incinerators are working properly. Non-hazardous wastes are shifted to the municipal collection system and disposed of at the dumping sites.

b) Slaughter House Wastes

In Peshawar City, collection of slaughter house wastes is done by a tractor trolley designated for the purpose which makes one trip daily and disposes of at Hazar Khwani open dumping site.

c) Dead Animals

Disposal of dead animals is being done by the sanitary workers alongwith other municipal solid waste. Carcasses are sometimes carried away by private workers and taken to such places where skins, bones and fats are separated and marketed. Meat is used in preparing feed for poultry **(Photo 8)**.



Photo 8 – Meat being dried to be used in poultry feed

d) Demolition and Construction Wastes

Most of the demolition and construction wastes are reused. Only a very small portion finds its way to street side dumps; from where they are disposed of alongwith other municipal solid waste.

e) Industrial Wastes

There is no major industry within the City except Khazana Sugar Mills on Charsadda Road. The Industrial Estates on Kohat Road and Jamrud Road are almost located on the outskirts of the City. There are few carpet weaving, industries in Afghan Colony. The chemical waste and rug pieces are being thrown in the drains which cause choking of the drains and results in overflowing thus, posing unhygienic risks to the community. The solid waste generated in the Sugar Mills is taken care of by the factory's administration through their own arrangement.

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1.5 ORGANIZATION

The TMAs Chief Officer is the incharge of Solid Waste and Effluent Management System in Town-I & Town-III. They are assisted by Transport Officer, Assistant Transport Officers, Chief Sanitary Inspector, Sanitary Inspectors, Sanitary Supervisors and Sanitary Workers, Drivers, Loaders as shown in **Figure-1.**

1.6 SOLID WASTE LIFTING CAPACITY AND COLLECTION EFFICIENCY

Total daily lifting capacity of Town-I, Town-III and CDMD vehicles used for the collection of solid waste, (shown in **Table 2, A, B, C & D)** is approximately 398 metric tons. According to an estimate, the solid waste generation rate is 0.5 kg/capita/day. This figure appears appropriate on the basis of the Consultant's experience in other cities of Pakistan which lies within the World Bank's guidelines of 0.3 - 0.6 kg/capita/day for developing countries.

The present population of 1.2 million in Town-I, Town-III and CDMD, thus, generates 602 metric tons daily. The collection efficiency on the basis of the above data comes out to be 66%.

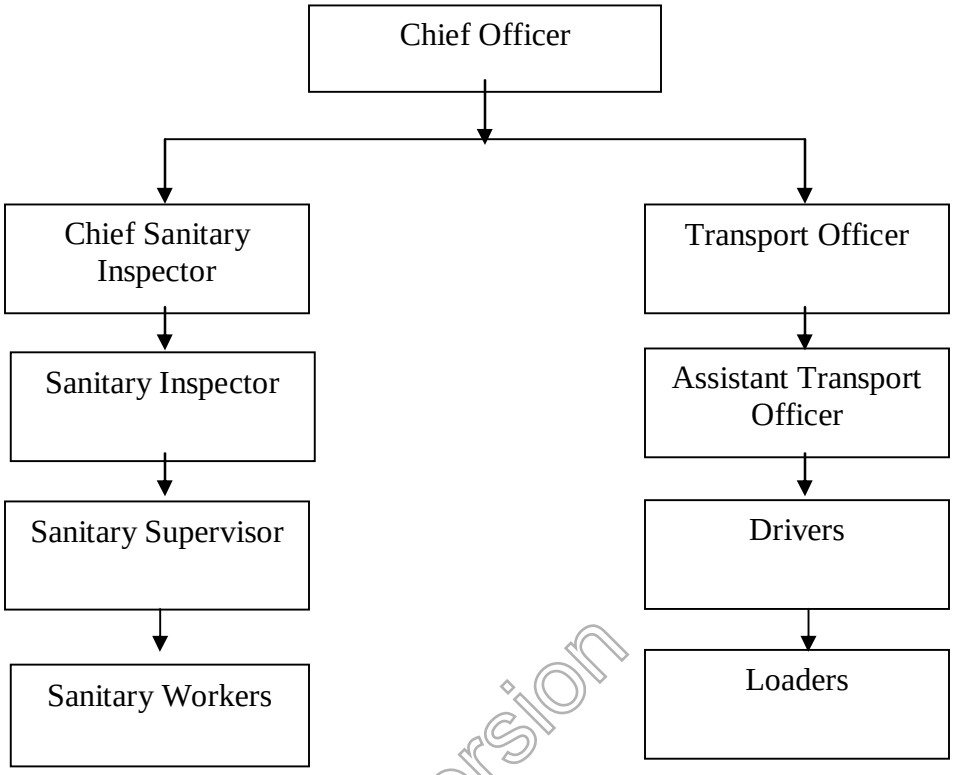


Figure 1 – Existing Organizational Structure of Sanitation

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Department, Peshawar (Town-I & Town-III)

Table 2 Solid Waste Lifting Capacity of TMAs, CDMD

A. TMA Town-I, Peshawar

Sr. No	Type of Vehicle	Number		Trips/ Day	Volume of Vehicle (m^3)	Density (Tons/m^3)	Weight/ Trip (Tons)	Total Weight (Tons/ day)	Age/ Year	Working Condition
		Total	On Road							
1	Multi loaders	10	9	6	5.6	0.5	2.8	151	11+	Satisfactory
2	Open body trucks	12	12	2	5.5	0.5	2.75	66	20+	Satisfactory
3	Suzuki vans	2	2	5	1	0.3	0.3	3	11+	Satisfactory
							Sub-Total:	220		

B. TMA Town-III, Peshawar

Sr. No	Type of Vehicle	Number		Trips/ Day	Volume of Vehicle (m^3)	Density (Tons/m^3)	Weight/ Trip (Tons)	Total Weight (Tons/day)	Age/ Year	Working Condition
		Total	On Road							
1	Multi loaders	5	4	6	5.6	0.5	2.8	67.2	15+	Satisfactory
2	Open body trucks	4	4	2	5.5	0.5	2.75	22	15+	Satisfactory
3	Tractor Trolleys (large)	5	5	3	4.4	0.5	2.2	33	20+	Poor
							Sub-Total:	122		

C. CDMD, Peshawar

Sr. No.	Type of Vehicle	Number		Trips/ Day (Tons)	Weight/ Trip (Tons/ Day)	Total Weight	Age/ Years	Working Conditions
		Total	On Road					
1	Compactor trucks (each serving 17-18 garbage bins)	3	2	4	6 Tons	48	15+	Satisfactory
2	Tractor trolleys collect garbage from markets	2	2	4	1 Ton	8	15+	Satisfactory
					Sub-Total:	56		

D. Total Lifting Capacities and Collection Efficiency

Adding the three, the total lifting capacity is as under:

a) Town-I 220 metric tons/day
b) Town-III 122 metric tons/day
c) Hayatabad 56 metric tons/day
Total Weight **398 metric tons/day**

Total Generation/Day = 1204594 x 0.5 kg/capita/day/1000 kg/ton
= 602 tons

Collection Efficiency = 398/602 = 66%

1.7 COST ANALYSIS OF THE EXISTING SYSTEMS AND OTHER RATIOS

Cost analysis for the existing system is provided in the following paragraphs. It shows that cost/ton of waste collected is Rs. 545/- and the cost/inhabitant/year is Rs. 66/-. Staff to population ratio is 1.44/1000. Those results are shown in **Table 3**.

Total waste collected per year = Total weight collected x No. of days in a year
metric tons
398×365 = 145270 (for year 2006)

Total cost in year 2005-06 = Rs. 79,204,000/-

- Expenses for Town-I = Rs. 44,000,000
- Expenses for Town-III = Rs. 28,000,000
- Expenses for CDMD = Rs. 7,204,000

= Rs. 79,204,000

Cost/Ton = Total cost incurred = 79,204,000/145,270 = Rs. 545
Total waste collected year

Population in year 2006 = 1.2 million
Cost/inhabitant/year = Total Cost in year 2005-06
Population in year 2005-06
79,204,000/1,200,000 = Rs. 66/-
Present Staff for SWM = 1,744

Town-I = 970
Town-II = 600
Town-III = 174

= 1,744

Staff/1000 population = 1,744 x 1000/1,204,594 = 1.44

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Table 3 – Cost Analysis of the Existing System

Collection Efficiency %	Cost/Ton, Rs.	Cost/Inhabitant/ Year, Rs.	Staff/1000 Population
66%	545	66	1.44

1.8 SHORTCOMINGS IN THE EXISTING SYSTEM & PROPOSED REMEDIAL MEASURES

The short comings in the existing system alongwith the mitigation measures are deliberated in the following paragraphs;

a) Street Side Heaps/Filth Depots

Shortcomings:

1) Rodents become quite active in these street side open dumps. These are also breeding places for flies and source of other disease causing organisms.
2) Open heaps are the constant sources of obnoxious odors and unhygienic conditions.
3) The wastes in open heaps scatter all over the surrounding areas as a consequence of scavenging activity and wind action and clog the open drains and sewers.

Remedial Measures: The filth depots need to be replaced by metallic containers and where possible street-side heaps should also be replaced by containers.



Photo 9 – Open body Truck for Town-I

b) Hand Carts

A modified form of the hand cart is shown in **Figure 2**.

Shortcomings

i) It is very small and is cumbersome for the user.
ii) The wastes carried in the hand cart can only be tipped on the ground. There is no arrangement for direct discharge into the containers.
iii) It does not have bearings with the wheels which renders it hard for pushing/pulling.

Remedial Measures

i) The design of the hand cart needs to be modified to increase its capacity to manageable size of about 200 liters.
ii) Bearings need to be added for ease of pulling.
iii) The arrangements should be made to directly unload the wastes into the container.

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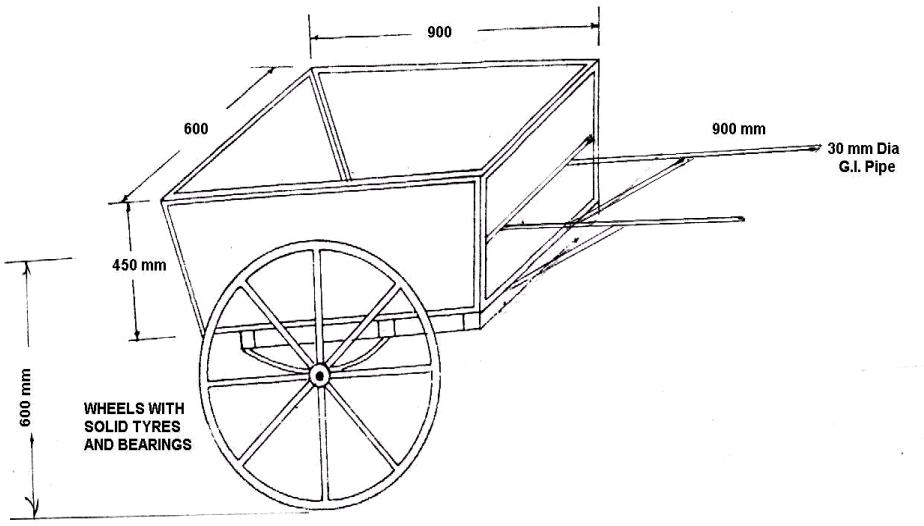


Figure 2 - Modified Hand Cart

c) Tractor Trolleys and Open Body Trucks

Shortcomings	i)	These tractor trolleys are performing the collection job perfectly as per their design, but being small in size these are not suitable for direct haul to the disposal site
Remedial Measures	i)	These should be used for their life, and phased out, when the new system is introduced gradually.

d) Open Dumping

Shortcomings	i)	Disposal of solid wastes is in the form of haphazard open dumps, and is a constant source of environmental pollution.
Remedial Measures	i)	The practice needs to be replaced by proper sanitary landfilling and composting.

2.0 PROPOSED SYSTEM STRATEGY

To effectively manage the solid waste problems, the collection system should consist of communal containers to which the inhabitants may bring their wastes. However, to be effective, the containers must be located within easy reach of each premises and must be low enough to facilitate the loading process.

2.1 GENERATION, COLLECTION AND DISPOSAL RATES - FUTURE PROJECTION

A rough estimate for generation rate has been made as 0.5 kg/capita/day for Peshawar on the basis of the experience of the TMA staff and of the Consultants in other cities of the Country.

With this basic philosophy and the fact that all the wastes could neither be collected nor taken to the designated landfill sites, it is estimated that almost 80% of the total wastes generated will be collected by the municipal vehicles. The other details and calculations are provided in **Table 4** with reference to the future projections in Peshawar City, Hayatabad and Regi Lalmah.

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TABLE 4 - SOLID WASTE GENERATION, STORAGE, COLLECTION, DISPOSAL RATES

PROJECTIONS FOR THE CITY OF PESHAWAR (EXCLUDING CANTONMENT)

Year	Population[1]	Generation		Collection [2]		Composting [3]	Sanitary Landfilling		
		per Day Capita per Day (kg)	Daily (Tons)	Daily Tons	Yearly (Tons)	(Tons/day)	Yearly[4] (Tons)	Yearly[5] (m^3)	Cumulative (m^3)
2006	1,204,594	0.500	602	482	175,871	289	52,761	43,968	43,968
2007	1,246,875	0.500	623	499	182,044	299	54,613	45,511	89,479
2008	1,290,641	0.500	645	516	188,434	310	56,530	47,108	136,587
2009	1,335,942	0.505	675	540	196,998	324	59,099	49,250	185,837
2010	1,382,834	0.505	698	559	203,913	335	61,174	50,978	236,815
2011	1,431,371	0.505	723	578	211,070	347	63,321	52,767	289,582
2012	1,481,612	0.510	756	604	220,642	363	66,193	55,160	344,743
2013	1,533,617	0.510	782	626	228,386	375	68,516	57,097	401,839
2014	1,587,447	0.510	810	648	236,403	389	70,921	59,101	460,940
2015	1,643,166	0.515	846	677	247,099	406	74,130	61,775	522,715
2016	1,700,841	0.515	876	701	255,773	420	76,732	63,943	586,658
2017	1,760,541	0.515	907	725	264,750	435	79,425	66,188	652,845
2018	1,822,336	0.520	948	758	276,703	455	83,011	69,176	722,021
2019	1,886,300	0.520	981	785	286,416	471	85,925	71,604	793,625
2020	1,952,509	0.520	1,015	812	296,469	487	88,941	74,117	867,742
2021	2,021,042	0.525	1,061	849	309,826	509	92,948	77,456	945,199
2022	2,091,981	0.525	1,098	879	320,701	527	96,210	80,175	1,025,374
2023	2,165,409	0.525	1,137	909	331,957	546	99,587	82,989	1,108,363
2024	2,241,415	0.530	1,188	950	346,881	570	104,064	86,720	1,195,084
2025	2,320,089	0.530	1,230	984	359,057	590	107,717	89,764	1,284,848

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Note:
1. Rate of population growth = 3.51%
2. Collection of solid waste is estimated at 80% of generated waste.
3. 60% of collected waste is to be composted
4. 30% of collected waste is expected to reach land fill.
5. Density in landfill is expected to be 1.2 tons/m^3.
6. 10% of collection gets recycled

2.2 SELECTION CRITERIA FOR CONSTRUCTION OF LANDFILL SITE

Following parameters should be considered while selecting the disposal site(s);

- The location/distance of the dumping site from the central/urban activity, so that economy could be maintained by cutting down the fuel consumption.
- The land(s) identified should be derelict such as depressions due to extraction of soil or stones (for construction purposes). The solid waste dumped should fill up those depressions with passage of time and when those dumps are filled upto 100% of their capacity; they can be covered up with soil cover taken from within or adjoining areas and eventually used as parks or playgrounds.
- Depth of the ground water table in the area should not be shallow to avoid ground water contamination.
- There should be no private or public irrigation, or livestock water supply wells down-grade of the landfill boundaries because they will be at risk of contamination.
- The landfill area should not be in close proximity of major surface water bodies.
- Landfill site(s) shall be away from airports. Necessary approval of airport or airbase authorities like Civil Aviation Authority prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 10 km of an airport.
- No major electrical transmission lines or other infrastructure (e.g. sewer, water pipes) should be crossing the landfill site area.
- There should not be fault lines or significantly fractured geological structures that would allow unpredictable movement of gas or leachate within 0.5 km of the perimeter of the proposed landfill development.
- Biomedical wastes should be disposed of in accordance with the "Guidelines for Hospital Waste Management, 2002" issued by the Environmental Health Unit, Ministry of Health, Government of Pakistan.

2.3 PROPOSED ORGANIZATIONAL STRUCTURE

To manage the solid waste system effectively, the organizational structure proposed in this regard is presented in **Figure 3**.

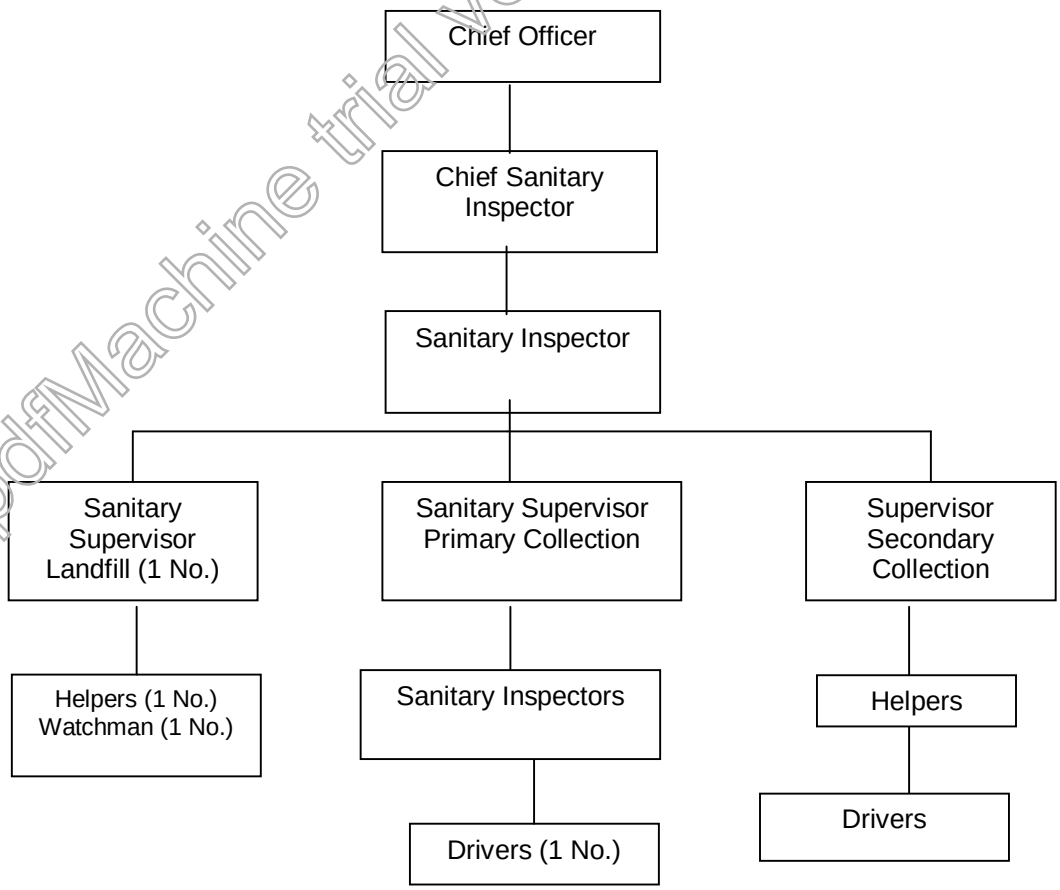


Figure 3 - Proposed Organization Chart of SWM Peshawar (Towns)

2.4 STORAGE AND COLLECTION

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The storage and collection of solid waste in Peshawar is planned to be split up in two stages i.e., primary and secondary. These are presented in **Table 5**.

Table 5 - Proposed Solid Waste Management system for Peshawar

Areas	Storage at the Premises	Primary Collection			Secondary Collection		Disposal
		Collection from Premises	Storage on Street Sides	Collection from Streets	Transfer Station	Transfer Vehicle	
Hayatabad	Make shift containers	Manually			1.1 m^3 Container	Compactor /Hoist Trucks	Sanitary landfill/ composting plant
		Hand carts			1.1 m^3 Container	-do-	-do-
	Street Sweeping/ Nullah cleaning		Street side heaps	Animal Carts/Auto Rickshaw	1.1 m^3 Container	-do-	-do-
Main City	Make Shift container	Manual			7 m^3 Container	Hoist Trucks	-do-
		Hand Carts/ Donkey Carts			7 m^3 Container	-do-	-do-
	Street Sweeping	Manual	Street side heaps	-do-	-do-	-do-	-do-
		Mechanical			7 m^3 Container	-do-	-do-

2.5 PRIMARY STORAGE AND COLLECTION OF SOLID WASTES

a) House to House Collection

Primary storage at the individual premises is proposed to be carried out in the make-shift containers (canisters, baskets, plastic bags etc). House to house/shop to shop collection is proposed to be introduced in the entire city.

b) Use of Hand Carts

A hand cart with a minimum capacity of 200 liters will be used for door to door collection by each sanitary worker. The proposed handcart is also of pulling type and structuring of the human body makes pulling action easier than pushing. The sanitary worker performing the job will ring a hand bell at fixed intervals at approximately fixed timings in each area. Each sanitary worker is expected to serve on the average about 100 houses or 150 shops.

c) Use of Donkey Carts

In case of areas where the distance to reach the communal container increases beyond the capacity of the handcart (i.e., 250 meters), the donkey-carts as being used presently will be allowed to be continued on rental basis.

d) Use of Small Tractor Trolleys

Small tractor trolleys are supposed to replace the donkey carts in the long run, as the animal carts are slow moving and foul the roads with animal dung.

Two different systems are suggested one being used in Hayatabad and the other in the Main City which are recommended to be kept intact. Their details are discussed herewith:

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a) Storage in 1.1 m^3 containers, collection by Compactor Trucks

This is a stationary container system and is being used in Hayatabad. The 1.1 m^3 containers are emptied into 13 m^3 compactor trucks. The compactor trucks are taken to the disposal site and emptied there by mechanical means.

b) Storage in 7m^3 containers, collection by hoist truck

This is a hauled container system. The 7 m^3 containers as shown in **Figure 4**, when loaded with waste will be lifted and taken to the disposal site by a Hoist Truck as shown in **Figure 5** emptied there and brought back to the original position. This system is being used in Peshawar since year 1995 and has proven its workability.

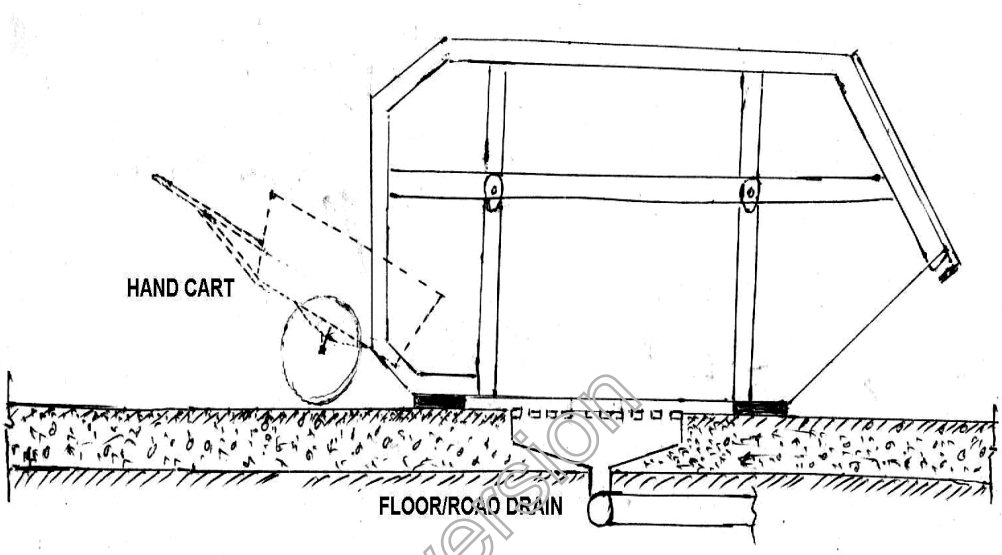


Figure 4 - 7 m^3 Container at Site and Unloading by Hand Cart

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Figure 5 - Hoist Truck

2.6 VEHICLES AND EQUIPMENT REQUIREMENT

The requirements of vehicles and equipment have been worked out only for a period of 5 years upto year 2010. Population distribution of Peshawar in the main city and Hayatabad is shown in **Table 6**. This population figure has been used to calculate the physical requirements.

Table 6 - Population Distribution of Peshawar City (2006-2025)

Type of Area	Year 2006		Year 2010		Year 2025	
	Total	**%age of grand total**	**Total**	**%age of grand total**	**Total**	**%age grand total**
City area	1,074,594	89.20	1,233,598	89.20	2,069,704	89.20
Hayatabad	130,000	10.80	149,236	10.80	250,384	10.80
Grand Total	**1,204,594**	**100.00**	**1,382,834**	**100.00**	**2,320,088**	**100.00**

The summary of collection, storage and disposal is presented in **Table 7 (A & B)**.

Table 7 – Vehicles and Equipment Requirements

A. Primary Storage and Collection (for Year 2010)

Vehicles	Number* Required
Hand carts	687
Donkey carts	116
Litter Bins	200
Brooms	687
Water Sprinklers	3
Mechanical Sweepers with Tractors	2
Motor Cycles	2
Small Tractor Trolleys	50

* From Annexure 1.

B. Secondary Storage and Collection (for year 2010)

Area	Vehicles and Containers	No. required
City	Hoist trucks 7 m^3 containers	22 214
Hayatabad	Compactor Trucks 1.1 m^3 containers	3 274

* Donkey carts will be hired and not purchased.

2.7 STAFFING REQUIREMENTS FOR STORAGE AND COLLECTION

The staffing requirements for the primary and secondary stages for the year 2010 have been worked out independently as presented in **Table 8 (A to D)**. **Table 8 E** compares the existing staff with the required staff.

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Table 8 - Staff Requirement and Salaries for the year 2010 for Collection system (Year 2006 costs)

A. Primary Collection

Position	Vacancies (Number)
Chief Sanitary Inspectors	2
Supervisors	48
Sweepers-cum-Collectors	1292
Total:	1342

B. Secondary Collection

Position	Vacancies (Number)
Sanitary Inspectors	12
Supervisors	4
Drivers	28
Helpers	28
TOTAL	72

C. Sanitary Landfilling

Position	Vacancies (Number)
Supervisor	1
Tractor Drivers	2
Watchmen	2
Helpers	2
TOTAL	7

D. Grand Total

Collection Type/Disposal	Vacancies (Number)
Primary	1342
Secondary	72
Landfilling	7
TOTAL	1421

E. Additional Staff Requirements upto year 2010 and their phased Induction

Sr. No.	Position	Total Number required upto 2010	Number Present in Year 2005	Additional Require-ment
1.	Chief Sanitary Inspector	2	2	-
2.	Sanitary Inspectors	12	25	-13
3.	Supervisors	53	45	8
4.	Drivers	30	40	-10
5.	Helpers/Loaders	30	80	-50
6.	Sanitary Workers	1292	1344	-52
7.	Watchmen	2	-	2
TOTAL		1421	1536	-115

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2.8 HANDLING OF SPECIAL WASTE

a) Hospital Waste

Provision of an incinerator for dealing with the infectious waste from the hospitals and clinics is proposed **(Figure 6)**. For source segregation of the infectious waste, the hospital staff needs to be properly trained. Further information about the same can be obtained by contacting Shalimar Hospital Administration in Mughalpura, Lahore which provides similar training to their staff.

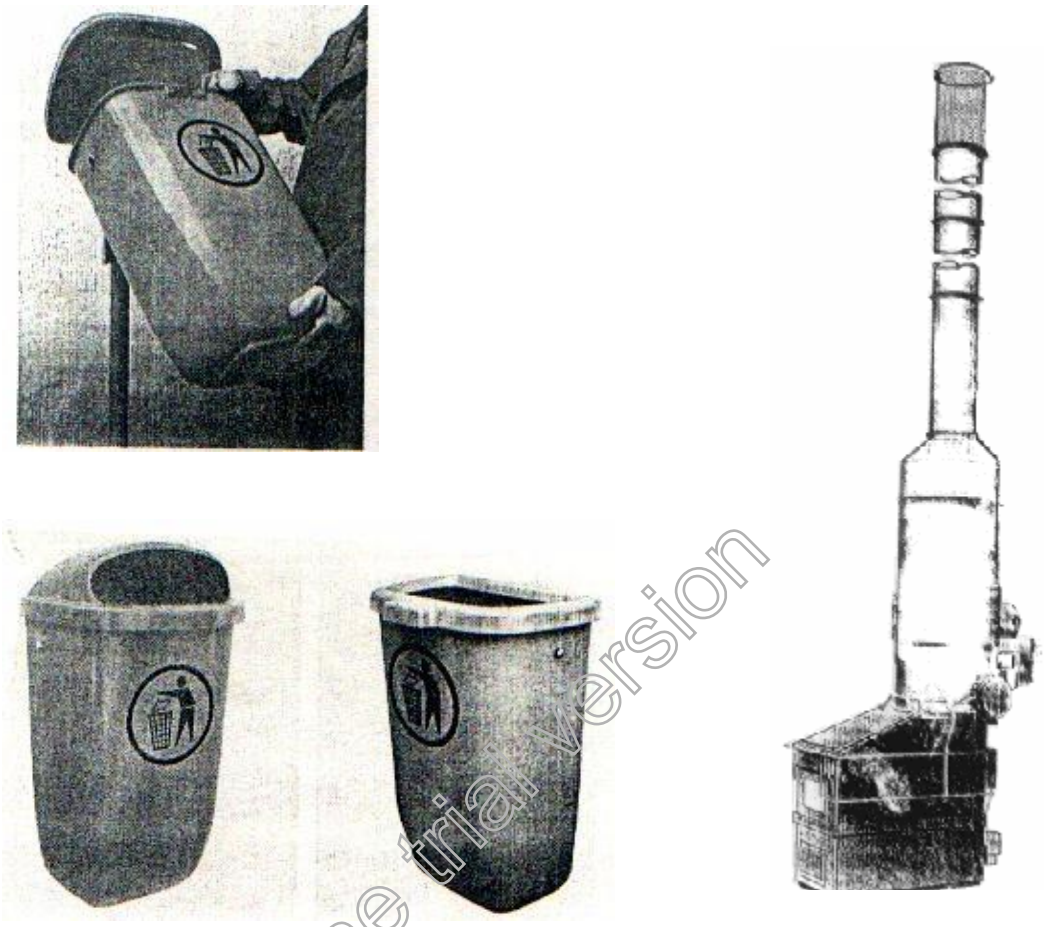


Figure 6: INCINERATOR AND LITTER BINS

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b) Slaughterhouse Waste

Special arrangements are required for disposal of such waste by land-filling at the proposed sanitary landfill site.

c) Dead Animals

Sanitary disposal of dead animals is carried out either by incineration or by burial. Incineration is a costly affair. Efficient burial is, therefore, recommended in a separate specific area of the sanitary landfill site.

d) Demolition and Construction Wastes

Storage and collection of such waste should not be the liability of the town/city government and the generators should be bound to make their own arrangements for transportation to disposal sites or recycling facilities.

e) Polyethylene Bags

For getting rid of littered polyethylene shopping bags from city roads and streets, the inhabitants need to be educated to dispose them of in the form of tight bundles and place them into containers for final disposal so that they may not litter the environment.

2.9 DISPOSAL

There are three alternatives to deal with the disposal of solid wastes in an environmental friendly and sustainable manner, these are;

i) Composting
ii) Sanitary landfilling
iii) Incineration

Composting is a viable alternative which provides recycling of the putrescible content. But cost of a modern plant is prohibitive under local conditions. Windrow composting will be tried on pilot scale if non-putrescible waste can be segregated easily. It will be more useful when sewage can be added by installing the composting plant near sewage disposal stations.

Sanitary landfilling is the cheapest of all if suitable land is available at reasonable distance and cost. This is being used almost in 80% of the cases throughout the modern world. But due to problems in getting suitable land within economical haul distances, this option is to be employed after composting.

Incineration is an extremely expensive option and not suitable under local conditions. Central facility is to be developed to cater the needs for hospital wastes as has been recently taken care by Nishtar Hospital management.

Selected Option

It would therefore be appropriate to adopt composting as the major treatment alternative and to dispose of residual wastes in a sanitary landfill, after picking up recyclables like paper, plastics, glass and metals, if any.

2.10 SANITARY LANDFILL SITE

Total amount of solid wastes generated, collected and that reaching the future designated landfill sites, have been estimated in **Table 9**. It is assumed that 60% of the wastes collected will be composted, 30% landfilled and 10% recycled. Using an average density in the landfills as 1.2 tons per m^3, the total capacity requirements have also been worked out for 20 years.

To look for the potential sites to be used in both the steps, a search program for suitable landfill sites was conducted in May, 2006. It was based on the field trips to sites suggested by Director, EPA as well as to some other areas, which the Consultant considered as potential suitable sites from a geographical point of view. The sites visited were; Hazar Khwani, Lundi Akhune Ahmed, Chinney Pindd, Hayatabad site, Ring Road Bridge, Jahangirabad site (Bahadar Killey), Kaganwala (Bazikhel stop) and Nasir Bagh Road site. These sites have been presented in **Table 9.**

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Table 9 – Evaluation of Sanitary Landfill Sites

Parameters	Landfill Site						
	Hayatabad Ring Road Bridge	Near Cheeney Pind	Bahadar Killey	Hazar Khawani	Lundi Akhune	Kagawla	Nasir Bagh Road
Capacity	6	1	4	4	5	-	6
Distance	5	4	4	6	5	3	4
Access	5	3	3	6	4	3	5
Surface Water	3	5	5	2	5	5	4
Ground Water	5	5	5	5	5	5	5
Nuisance	3	4	3	3	3	2	5
Operation	4	3	3	5	4	1	5
Infrastructure	4	3	3	4	3	2	4
Total Number of Scores	35	28	30	35	35	21	38

The selected sites in order of their use are therefore Hazar Khawani, Lundi Akhune Ahmed, Nasir Bagh Road, and Hayatabad Ring Road Bridge sites.

The first two sites are selected for immediate use for the years 2010, 2011, while the other two sites are to be prepared for use from the starts of 2012. It is proposed that Nasir Bagh Road landfill site, lying north of the City, may be put into operation in 2012 to serve the northern zones. It is estimated that it can cater the northern city needs for 7 years. Hayatabad Bridge site is proposed to take care of solid waste from the southern zones.

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