INTEGRATED SOLID WASTE MANGEMENT APPROACH FOR ENVIRONMENTAL IMPROVEMENT: A CASE STUDY OF SYLHET CITY

A Thesis by

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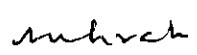
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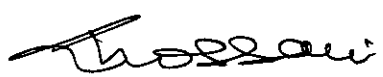(Supervisor)
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DECLARATION

I hereby declare that the thesis work submitted herewith was performed by me as a research work in partial fulfillment of the requirements for the degree of Master of Science and Engineering in Civil from Bangladesh University of Engineering and Technology (BUET)

This thesis contains no material, which has been accepted for the award of any other degree from any other institutions. Further to the best of my knowledge and belief, the thesis contains no material previously published or written by any other persons, except where specific references are made.

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ABSTRACT

One of the most pressing demands on services of Sylhet City Corporation of Bangladesh from urban dwellers is better waste management. The conservancy section is responsible for sweeping the streets, collecting rubbish and disposing to a landfill, drain clearing. Sweeping is carried out by 129 permanent sweepers located in main streets of the city. The City Corporation estimates it collects between 60 and 80 tonnes of rubbish from its bins (152 dust bins) and open points (60) for disposal daily where as around 180-200 tonnes of rubbish is produced every day. The landfill is located a short distance outside (about 7km) of the city, on 17 acres of land owned by the city corporation. The land is approximately 3 metres below the level of the road. The site is not engineered and has been used for 5 years. The City Corporation has no Waste Strategy to improve the cleanliness of the city and reduce the effect of the city's rubbish on the environment.

During the research programme a household survey was done to explore the city dwellers opinion in tackling the conservancy problems. The survey was cancer survey and done in three electoral words of the city. Total 3036 households were surveyed. The waste generation rate is 0.34 kg/cap/day. Most of the households (73%) produced 1-2kg daily. Among the household waste, 34.7% is coming from cooking, 27% is coming from homestead activities and the rest covers cosmetics, toilet, education and cloth. The survey shows that 68.3% of total household waste is compostable, 11.7% is recyclable and the rest 20% is disposable.

Only little of the total households (11%) preserve waste for recycling. About half of the total population (51%) in the surveyed area is enjoying additional facilities from some Community Based Organizations (CBOs). The households have been bearing Tk. 10 to tk 200 monthly for the CBO who works for waste collection in their locality. Most of the residents (93.4%) of the surveyed area are quite ignorant about the waste management policy of Sylhet City Corporation.

The conservancy activities should include the 100% primary collection of the waste, optimum utilization of waste through intensive recycling, awareness raising on waste education as well as waste reduction.

The conservancy activities of Sylhet City Corporation should be decentralised in five blocks rather than one centralised area. In order to ensure 100% primary collection of the waste, City Corporation should encourage the participation of NGOs and CBOs, and facilitate these organisations to dispose their collected waste in some designated secondary transfer points timely rather than a number of small dustbins.

Recycling and reclamation should be strongly promoted for conservation of resources and prevention of environmental degradation. The city corporation will relive from the heap of garbage and its huge amount of budget will be saved and recycled product will also increase the fertility of the soil. The reduced quantity of rubbish will also increase the life of the final dumping point.

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1.1   General

Rapid urban population growth is one of the important features of contemporary Bangladesh. Approximately one-fifth of the country's population live in urban area, expected to reach nearly 80 million by 2020 (World Bank 1998). The history of systematic development and management of urban areas of Bangladesh structured through the institution of Municipality/*Pourashava* is a phenomenon of colonial era. The cities and towns of Bangladesh lack the necessary capacities in providing municipal services like water supply, decent housing, health, education facilities, transportation etc. They depend very much on central government for financial support and are poorly equipped to meet the challenges of the rapid urbanisation and the rising demands for urban services and kindred basic urban amenities. The pressure of rapid urbanisation accompanies ecological threats – water and air pollution, abandoned waste. In fact, one of pressing demands on municipal services from urban dwellers, is better of waste management. In most of municipalities, collection of total garbage may not exceed 30-40% of total generation. Although manageable, waste has now become an acute environmental threat in urban areas. The city/municipal waste is an acute problem for environment and public health but it receives little attention compared to the other utility services in all of the municipalities of Bangladesh. The case in Sylhet city is no different.

The Sylhet city corporation estimates it collects around 60-80 tones of rubbish from its rubbish bins each day, but that around 180 – 200 tonnes per day is being produced. The difference between what is collected and what is produced is thought to be lost to drains or other sources. The collected portion is also dumped in open grounds. Solid Waste Management of Sylhet City Corporation can be characterized by inappropriate technology and equipment, institutional inadequacy, inappropriate method of finance, lack of legislation and policy guidelines for environmental monitoring and legislation and enforcement. In recent consultation with local residents and business community, proper waste management has been identified as one of the top priorities. (Baseline Study of Sylhet Municipality, Asia-Urbs Sylhet Partnership 2001).

1.2   Objectives of the study

The study is aimed to explore the weakness of conservancy services of Sylhet city corporation and to develop a alternative integrated approach for community based solid waste management which is both economically sustainable and environmentally sound.

The following are the major objectives of this thesis

- To study the current activities of conservancy section of Sylhet City Corporation to identify its weakness.
- To undertake a household survey to assess the opinions of the city dwellers to ensure a safe and clean city.
- To collect and analyse the information on community based composting techniques in Bangladesh
- To suggest an integrated approach to solid waste management system which is both economically sustainable and environmentally sound.

1.3   Outline of Methodology

The methodology to be adopted in this study is literature review of previous studies, review of conservancy services of Sylhet City Corporation, assessment of city dwellers opinion in developing a clean city through household survey in three electoral words.

Dargamahallah, Lamabazar and Kajolshah words are selected to undertake the household survey programme as these words are the representative of the city and slums are not concentrated in these words and a main road is included in these words to contain shops and businesses.

Determination of effects in terms of environmental aspects results from current unhygienic waste management practices and to explore the current community based composting techniques in Bangladesh and to represent a success case study of community based composting.

Development a long term city -wide environmentally sound waste management plan in which non governmental organisations, individual and groups can take part with their own interest to implement the plan and which is economically sustainable and environmentally sound.

1.4   Scope and Limitation of the study

The selected study areas constitute high and medium group of people of Sylhet City but in low income slum areas the survey results may vary. No actions were taken to measure the chemical composition of wastes. Chemical analysis of leachete has not been done. As the City Corporation does not maintain a separate accounts in conservancy expenditure so it was not possible to measure the cost effectiveness between current system and the proposed interview approach. The information presented in this study will influence the policy makers of Local Government Engineering Department as well as municipal/city corporation authority to adapt the proposed community based approach in conservancy services.

1.5   Organisations of the thesis

The thesis presents literature review, analysis of household survey, present community based composting practices in Bangladesh, development of framework for community based solid

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waste management in six chapters as shown in below. In addition, a bibliography of related publications has also been presented.

Chapter 1 includes general introduction, objective, outline of methodology, scope and limitations of the study

Chapter 2 includes literature review covering function elements of solid waste management system. Brief reviews of relevant literature are also discussed in this chapter

Chapter 3 presents the profile of municipalities in Bangladesh and profile of Sylhet City Corporation & its conservancy services

Chapter 4 presents household survey findings

Chapter 5 presents waste strategy framework for short, medium and long term

Chapter 6 presents a general discussion on the findings of the study, identifies precise conclusions and provides a number of recommendations for future study

References presents a list of relevant publications and reports, which may be useful for future study in this context

Chapter 2

Literature Review

2.0   Introduction

Solid waste is the term now used internationally to describe non- liquid waste material, which arises from the domestic, trade commercial, industrial, agricultural and mining activities. Solid Waste Comprises countless different materials: dust food packaging in the form of paper, metals, plastics or glass, discarded clothing and furnishings. garden waste, construction waste, factory off cuts and processing wastes, pathological wastes, hazardous and radioactive wastes.

Domestic wastes have three main characteristics: weight generated, density and constituents. This varies not only from country to country but also from town to town and within a town according to the status level of different income groups. Therefore, no rational decision on solid waste system is possible until a representative data of this kind are available.

2.1 Objectives of Solid Waste Management

The key objectives of solid waste management is to minimize the adverse environmental effects caused by indiscriminate disposal of solid wastes. Sound solid waste management system necessary to raise and maintain the standard of cleanliness of the city environment, particularly in respect of rubbish collection and containment, demonstrate the high standards of cleanliness of public land achievable to protect health and the environment and to demonstrate an integrated approach to waste management at a community level and to install a fully resourced integrated infrastructure. In order to achieve these objectives solid waste management system is to be approached in an efficient and orderly fashions through a clear understanding of the fundamental aspects and relationships of the constituent elements of waste management. It is to be recognised however that problems associated with the management of solid wastes particularly in developing countries are complex. This is because of increasing quantity and diverse nature of the wastes along with the development of sprawling urban centres, funding limitations for public services as well as limitations in both energy and raw materials.

2.2 Terminology of Waste Management System

Municipal Solid Waste Management - includes the cleaning and sweeping of public areas and streets, as well as the primary and the secondary collection, transfer and final disposal of solid waste. Primary collection is the collection of solid waste at source (from households, businesses, institutions etc.) or from street containers, and its transportation to point of transfer. Secondary collection is the collection of the waste from transfer

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points for transport to the final disposal site. House - to - house collection of waste at the doorstep.

Recovery - represents the removal or rescue of post-consumer materials for some type of rescue or recycling. This often implies separation, sorting and eventual processing for use in production.

Recycling - is used to mean the transformation of recovered and stored materials into intermediately products for industrial production (Such as crushed glass or ground or extracted plastic) or the making of the new products for final use, such as the production of lanterns from steel cans. Reuse (or product in its original form, for the same or a new purpose within or outside the household. With respect to organic wastes, term recovery or reuse is used rather than recycling: organics may be reused as fuel and may be composted for agriculture and horticulture.

Organic Materials: refers to waste materials, such as food leftovers, vegetable and fruit peelings and garden waste (also called wet or biodegradable waste).

Inorganic materials: refers to recyclable materials, such as plastics, paper and metals (also called dry waste), which have a potential reeling monetary value.

2.3   Functional Elements of a Solid Waste Management System

The activities involved with the management of solid waste from the point of generation to final disposal have been grouped into six functional elements namely (1) Waste generation, (2) On-site handling, Storage and Procession (3) Collection (4) Transfer and Transport (5) Processing and Recovery, and (6) Disposal.

2.3.1   Waste Generation

Waste generation refers to generation of waste at source. Generation of solid waste varies in different types of dwelling in different socio- economic groups.

Waste generation encompasses those activities in which materials are identified as no longer being of value and either thrown away or gathered together for disposal. The primary sources of solid waste include (1) Residential, (2) Commercial, (3) Municipal, (4) Industrial, (5) Open areas, (6) Treatments, and (7) Agricultural, etc.

Factors that affect generation rate

(i)Geographic location, (ii) Season of the year (iii) Frequency of collection (iv) Use of Home Grinders (v) Characteristics of population (vi) Extent of Salvage and Recycling (vii) Legislation and (viii) Public attitudes.

Depending on the above factors, the generation tates of solid wastes in different cities and towns of different countries vary quite considerably. Table 2.1 and 2.2 shows the variation

Table 2.1: Quantities of solid wastes generated and collected in different cities of Asia

Cities	WASTE GENERATION		Waste Collection
	Kg/capita day	10^3 ton/year	10^3 ton/year
Bombay	0.5-0.6	1150	1150
Manila	0.5	1380	1140
Bangkok	0.88	1800	1533
Kualalampur	1.29	730	730
Singapore	0.98	1873	943
Beiging	1.59	3580	2983
Shanghai	0.87	2256	2256
Tokyo	0.54	4491	3417

Source : UNCRD(1988)

Table 2.2: Estimated quantities of solid wastes generated in Bangladesh

Administrative Division	Urban			Rural			Total
	Population	Estimated waste generation rate	Estimated waste generation	Population	Estimated waste generation rate	Estimated waste generation	Estimated waste generation
	million	Kg/cap/day	ton/day	million	Kg/cap/day	ton/day	ton/day
Rajshahi	2.213	0.5	1107	25.287	0.15	3793	4900
Barishal	0.466	0.4	186	7.291	0.15	1094	1280
Khulna	1.609	0.5	805	11.634	0.15	1745	25550
Dhaka	5.966	0.5	2983	27.974	0.15	4196	7179
Chittaganj	2.619	0.5	1310	19.250	0.15	288	4198
Sylhet	0.255	0.4	102	6.892	0.15	1024	1136
Total	13.128		6493	98.328	0.15	14750	2123

Source: (Diaz et al. 1998)

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2.3.2 Types of Solid Waste

The principal types of solid waste originating from a metropolitan area include:

Food Waste: Food wastes are the animal, fruit or vegetable residues resulting form the handling preparation, cooking and eating of food.

Rubbish: Rubbish consists of combustible and non-combustible solid wastes. Typically combustible rubbish consists of materials such as paper cardboard, plastics, textiles, rubber, lather, wood, furniture and garden trimmings. Non-combustible rubbish consists of items, such as glass, aluminium in cans and crockery, ferrous and other nonferrous metal and dirt.

Ashes and Residues: Materials remaining from the burning of wood, coal coke and other combustible waste. Ashes and residues are normally composed of fine powdery materials. Demolition and construction waste includes dirt, stones, concrete, brick plaster, timber, shingles, plumbing, heating and electrical parts.

Special Wastes: Waste such as street sweepings, roadside litter, litter from municipal litter container, catch basin, debris, dead animals and abandoned vehicles are classified as special wastes.

Treatment Plant Waste: The solid and semisolid waste from wastewater and industrial waste treatment facilities are included in this classification.

Agricultural Waste: Wastes are residues resulting from drivers agricultural activities such as the planting and harvesting of row, field and tree and vine, crops, the production of milk, the production of animals for slaughter and operation of feedlots are collectively called agricultural waste.

Hazardous waste:

Chemical, biological, flammable, explosive or radioactive waste that pose a substantial danger, immediately or over time to human, plant or animal life are classified as hazardous waste.

2.3.3 Composition of City Solid Waste

Information on the composition of solid waste is important in evaluating alternative equipment needs, system and management needs, system and management programs and plans.

Physical Composition: Information and data on the physical composition of solid waste are important in the selection and operation of equipment and facilities in assessing the feasibility of resource and energy recovery and the analysis and design disposal facilities.

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The percentage of municipal solid waste components varies with location, season economic conditions and many other factors.

Chemical Composition:

Information on the chemical composition of solid waste is important in evaluating alternative options. Table 2.3 summarizes and compares typical composition of solid wastes from developing and industrialized countries.

Table 2.3: Approximate composition of solid wastes in India, Bangladesh and Europe

Waste Components	India (% by weight)	Bangladesh* (Dhaka) (% by weight)	Europe (% by weight)
Food and Vegetable waste	75	70	30
Paper products	2	4	27
Plastics	1	5	3
Rags	3	-	3
Metals	0.1	0.13	7
Glass and ceramics	0.2	0.25	11
Wood	-	0.16	-
Garden wastes	-	11	4-6
Others (stones, dirt etc)	7	5	3
Moisture content	22-32	65	15-35

Source : (after Cairncross & Feachem, 1993) * IFRD & BCSIR(1998)

2.3.4 Online Handling Storage and Processing

Those activities associated with the handling, storage and processing.

Onsite Handling

Online handling refers to the activities associated with the handling of solid waste until they are placed in the containers used for their storage before collection. Depending on the type of collection service handling may also be required to move the loaded container to the collection point and to return the empty container to the point where they are stored between collections.
Domestic wastes accumulated at several locations in and around low and medium rise residential dwelling are placed in large storage container to await removal by waste collection agency. Where curb collection is used the resident is also responsible for placing the loaded storage container (s) at the curbs and for returning the empty containers(s) to their storage location next to or in the dwelling. In high-rise apartments

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wastes are (picked up by building maintenance personnel or porters form each floor and taken to basement service area, (2) taken to basement service area by the tenants or (3) bagged and placed by the tenants in specially designed chutes with openings located at each floor.

In most office, commercial and industrial buildings solid wastes that accumulate in the office of work locations usually are collected in relatively or large container mounted on rollers. Once filled these containers are removed by means of the s4ervice elevator, if there is one and emptied into (1) large storage container or (2) compactor used in conjunction with the storage containers, or (3) stationery compactor that can compresse4d the material into bales into specially designed containers or (4) other processing equipment such as incinerators.

Onsite Storage

Factors that must be considered in the onsite storage of solid wastes include (1) type of container to be used (2) the container location (3) public health and aesthetic and (4) the collection methods to be used.

The types and the capacity of the container used depend on the characteristics of the solid wastes to be collected, the collection frequency and the space available of the placement of the containers.

Container Location

In newer residential areas containers of the solid wastes usually are placed by the side or rear of the house. In older residential areas containers are located in alleys. In high-rise multifamily apartment large containers are often placed in specially designed enclosure. In high-rise apartment storage containers are located in a basement or ground floor serviced area.

On Site Processing

Grinding, sorting, compaction, shredding and composting are all onsite processing methods used to (1) reduce the volume (2) alter the physical form or (3) recover usable materials from solid wastes.

Off Route

Time spent checking in and out in the morning and at the end of the day + time spent driving to the first pick up point + time spent driving from the last pick up points to the dispatch station + time spent due to unavoidable congestion + time spent on equipment repairs and maintenance + time spent for lunch, talking.

At site (s): time spent at the disposal site = the time spent waiting to unload ± time spent unloading = 30 min.

The time required per trip, which also corresponds to the time required per container is given by the following equations

$$T_{hcs} = (P_{hcs} + s + h)/ (1-W)$$

[Source Sutradhar. R.(2002)]

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2.3.5   Collection

Stationery Container System

These are collection system in which the container used for the storage of waste remain at the point of generation, except for occasional short trips to the collection vehicle.

Stationary container system may be used for the collection of all types of wastes. The system varies according to the type and quantity of waste to be handled, as well as the number of generation points. There are two main types (1) system in which self-loading compactors are used and (2) system in which manually loaded vehicles are used.

Residential Collection Service

Low-Rise Detached Dwellings – the most common. Types of residential services used are (1) curb (2) alley (3) set out – set back (4) set –out and (5) backyard carry.
Where curb service is used, the homeowner is responsible for placing the containers to be emptied at the curbs on collection day and for returning the empty containers to their storage location until the next collection.
Where alleys are part of the basic layout of a city or a given residential area alley storage of containers used for solid wastes is common.
In set out set back service, containers are set out set out from the homeowners property and set back after being emptied by additional crews that work in conjunction with the collection crews responsible for loading the collection vehicle.
Set out service is essentially the same as set out – setback service except that the homeowner is responsible for returning the containers to their storage location.
In backyard carry service, the collection crew is responsible for entering the homeowner's property and removing the waste from the storage location.
Methods of loading the collection vehicle may be classified as either manual or mechanical.   Methods commonly used for residential wastes   includes (1) the direct lifting and carrying of containers, (2) the rolling of loaded containers on their rim, (3) the use   of small lifts for   rolling the containers to the collection vehicle and   (4) the use of large containers   ("toto") or drop cloths into which wastes from small containers are emptied before being carried or rolled to the collection vehicle.

Where collection vehicles with low loading heights are used, wastes are transferred directly from the containers in which they are stored or carried to the collection vehicle by the collection crew. In some cases where open body are used crew members stationed on the truck will lift the loaded container into the truck with the help of the collections on the ground, empty the container, and return it to the collectors on the ground.
Evaluating alternative processing and recovery options.

Commercial –Industrial services

The collection service provided to large apartment buildings and commercial activities typically is centred on the use of large moveable and stationary containers and large stationary compactors.

Communal Collection

In this system householders discharge their waste into the communal bin at specific locations over a considerable distance and refuse collection vehicle collects the accumulated waste at a frequent interval, usually once in a day in most of the third world countries this type of collection system is followed.

2.3.6 Transfer and transport

The functional elements of transfer and transport refers to the means, facilities, and appurtenances used to effect the transfer of waste from relatively small collection vehicle to large vehicles and to transport them over extended distance to either processing centres as disposal sites. Factors that tend to make the use of transfer operations attractive include (1) the presence of illegal dumps and large amounts of litter (2) the location of disposal site relatively far from collection routes (typically more than 10 mile) (3) the use of small capacity collection trucks (generally under 20 Yd3) (4) the existence of low density residential areas (5) the widespread use of medium –sized container for the collection of waste from commercial sources and (6) use of hydraulic or pneumatic collection system. Transfer and transport operations became a necessity when haul distance to available disposal site or processing centres increases to the point that direct hauling is no longer economically feasible.

[Source Sutradhar, R.(2002)]

Transfer stations

Important factor that must be considered in the design of transfer stations includes –

1.type of transfer operation to be used.
2.capacity requirement.
3.equipment and accessory requirement 4.sanitation requirement.

Types of transfer station

Depending on the method used to load the transfer vehicle transfer station may be classified into 4three types –

Direct discharge (2) storage discharge (3) combined direct and storage discharge.

2.3.7   Processing and Resource Recovery

The main purposes of processing are to improve the efficiency of operation, to recover resources and to recover conversion products and energy. Important processing techniques used routinely in municipal solid –waste system includes: compaction, thermal volume reduction (incineration) and manual separation of waste components.

Composting

Community based composting is an integral part of integrated solid waste management.

Composting is the process of bacterial conversion of organic solid and semi solid wastes into compost which can be handled, stored and transported without any adverse environmental effect, and can be used as organic manure for improvement of soil quality and fertility. Composting is an ancient resource recovery process practiced, though less frequently, in both developing and industrialized parts of the world. Composting has taken a beating in some western countries with collapse of markets associated with the high costs sophisticated processing techniques, yet the system appears to presented potential solutions in high population cities of the developing worlds, where waste characteristics are suitable for such method of resource recovery.

Composting plays an important role in reducing the amount of rubbish being disposed to landfill and places value in rubbish as a resource, recycling it into a product that can be used to improve soil texture and crop yields. Composting can reduce the demand on the City's secondary collection, while supplementing the local economy and improving the environment.

Quantity of Rubbish suitable for Composting

There are three main components to household rubbish:

- Organic, made up of food and garden rubbish   (68%)
- Recyclable paper   (11%)
- Inorganic   (21%)

The overall moisture content of collected residential waste may be as high as 50%.

Methods of Community Composting

Community composting can be done in two different methods.

1.   On a small scale, especially developed for slums, but equally applicable to households with a garden, is barrel composting. This is suitable for one to six households and produces suitable compost in around three months. The material can be used on the gardens or sold to growers.

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2. A larger scale, suitable for up to around 2,000 households, is de-centralised composting (Aborjona O Paribesh, Sept. 2000, page 5). Rubbish from the primary collection is delivered to the compost site rather than to a Municipality/city corporation secondary collection point from which it would typically go to landfill. At the composting site the rubbish is sorted into the three waste types described above. The organic fraction is piled up on the compost heap; the operatives typically sell on the recyclable fraction; and the inorganic fraction is taken by rickshaw van to the Municipality/city corporation secondary collection point. Mature compost is typically produced after around seven weeks.

The basic composting process is shown in the figure 2.1

```
        ┌─────────────────┐
        │ Organic Solid   │
        │ Wastes          │
     ┌──┴─────────────────┴──┐
     │ Salvaging/Packaging   │───────────────┐
     └───────────┬───────────┘               ▼
                 │                    ┌───────────────┐
                 ▼                    │ Salvageable   │
     ┌───────────────────────┐       │               │
     │ Screening/Sorting     │       └───────────────┘
     └───────────┬───────────┘
                 │                    ┌───────────────┐
                 ▼                    │ Non-          │
     ┌───────────────────────┐       │ Compostables  │
     │ Shredding/Pulverizing │──────▶│               │
     └───────────┬───────────┘       └───────────────┘
 ┌───────────────┐
 │ Water Additives│──────┐
 └───────────────┘       ▼
     ┌───────────────────────┐
     │ Moisture Adjustments  │
     └───────────────────────┘
      ┌──────┐        ▲
      │ Air  │────────┘
      └──────┘
     ┌───────────────────────┐
     │ Aerobic Composting    │
     └───────────┬───────────┘
                 │              ┌─────────────────────┐
                 ▼              │ CO2, Excess air, NH3 │
        ┌───────────┐          └─────────────────────┘
        │ Maturing  │
        └─────┬─────┘
              ▼
     ┌───────────────────────┐
     │ Processing/Bagging    │
     └───────────┬───────────┘
                 ▼
     ┌───────────────────────┐
     │ Saleable Compost      │
     └───────────────────────┘
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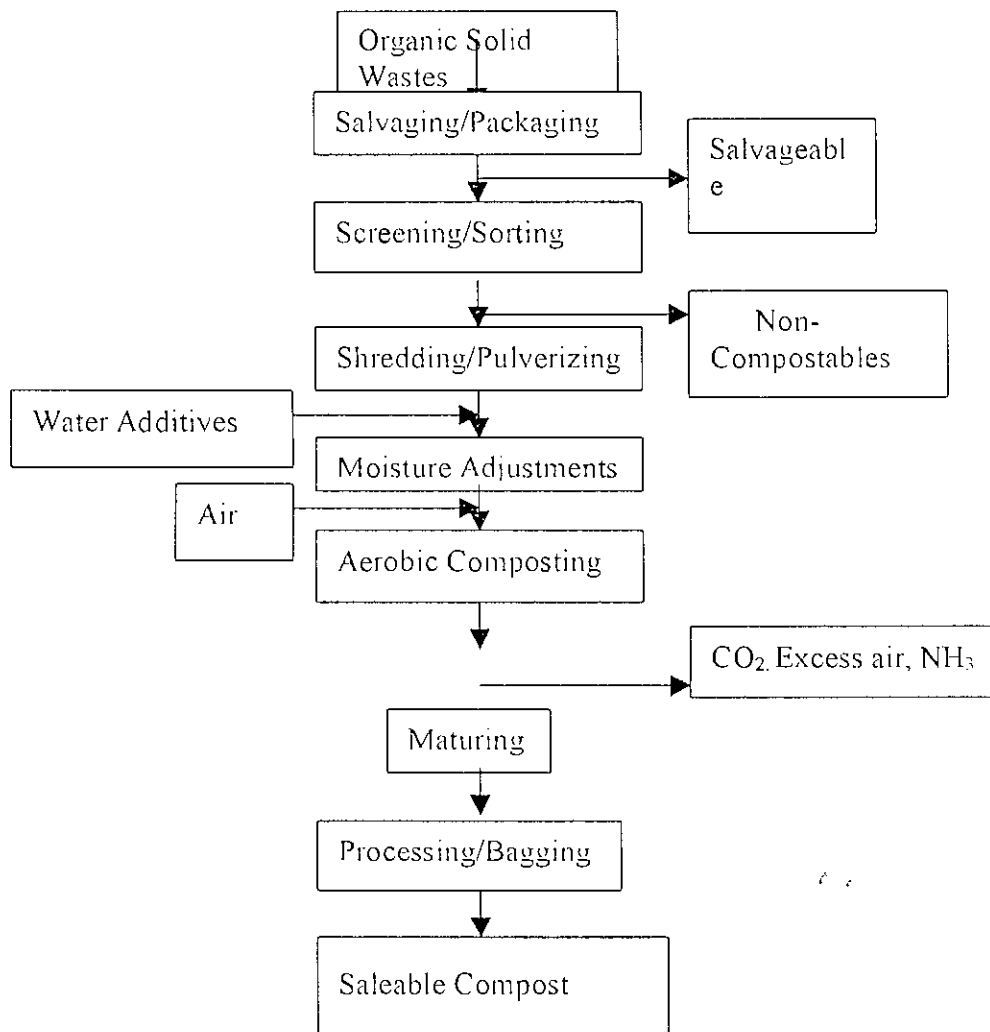
Figure 2.1:   Basic Composting Process

The major considerations for composting of solid wastes in Bangladesh are as follows

- Availability and suitability of wastes
- Socio-economic conditions
- Technological access
- Marketing for compost
- Affordable prices for farmers
- Environmental legislations and enforcement
- Institutional support

2.3.8   Characteristics of compost

Compost is a stable humus-like product and is a very good soil conditioner. It also supplements nutrients to soils. The important chemical characteristics of compost are shown in Table 2.4

Table 2.4:   Chemical constituents of Compost

`Chemical Constituents	Percent by weight
Organic matter	25-50
Carbon	8-50
Nitrogen	0.4-3.5
Phosphorus	0.3-3.5
Potassium	0.5-1.8
Ash	20-60
Calcium	1.5-7.0

The application of compost to agricultural lands brings significant favourable changes in the soil properties. Some important changes are listed below

- Increase organic content of the soil
- Increases moisture retention capacity
- Improves aeration at root zones
- Improves soil texture
- Increases soil fertility
- Replenishes micro nutrient in soils

Methods of Composting

Barrel Composting

Composting Barrel

- The capacity of barrel can be of 45 to 200 litres depends on availability in the market
- To ensure the supply of necessary oxygen in the barrel and to avoid anaerobic condition a number of hole (0.5" dia.) will be made in the base and sides of the barrel.
- The barrel must be covered to avoid rainwater. The cover of the barrel will be slightly larger than the diameter of the ring shaped base
- 1 sft size door system must be kept in the lower portion of the barrel to collect the produced compost
- The barrel should be painted to avoid fungal attack and erosion. The barrel used for composting will be painted in green colour and the barrel used for collecting disposable waste is yellow colour.

Placement of Barrel

In placement of barrel following points should be considered

- ➢ The base of the barrel should be placed on elevated surface (6" from ground level) to avoid rain water or flood
- ➢ The base should be ring shaped and made of bricks, sand and cement.
- ➢ The ring will be hollowed in two positions to ensure the supply of sufficient oxygen and to collect the compost
- ➢ The gap between barrel and ring shape will be minimal

Figure 2.2 : Barrel Composting

Windrow Method

In this method, compostable organic waste is heaped into piles under a covered shed made with steel angle posts and asbestos groping on top which allows the beneficial micro organism to decomposed the organic waste efficiently. The pile is aerated with bamboo aerators. Fig. 2.3 and 2.4 shows lay out of a trial composting facility and sections of a composting plant.

Layout of a trial composting facility

BACK OF PLOT
Sorting Area
Solid ground slab
(Preferably Concrete Construction)

Wall
9 No.
Compost Bays
(Plan)
Removable

A

Solid

Section

DETAIL 1

4' wide Solid slab walkway

4 No.
Maturing Bays
B
Each having
Internal Dimensions
(Plan)

Section

Rickshaw vans
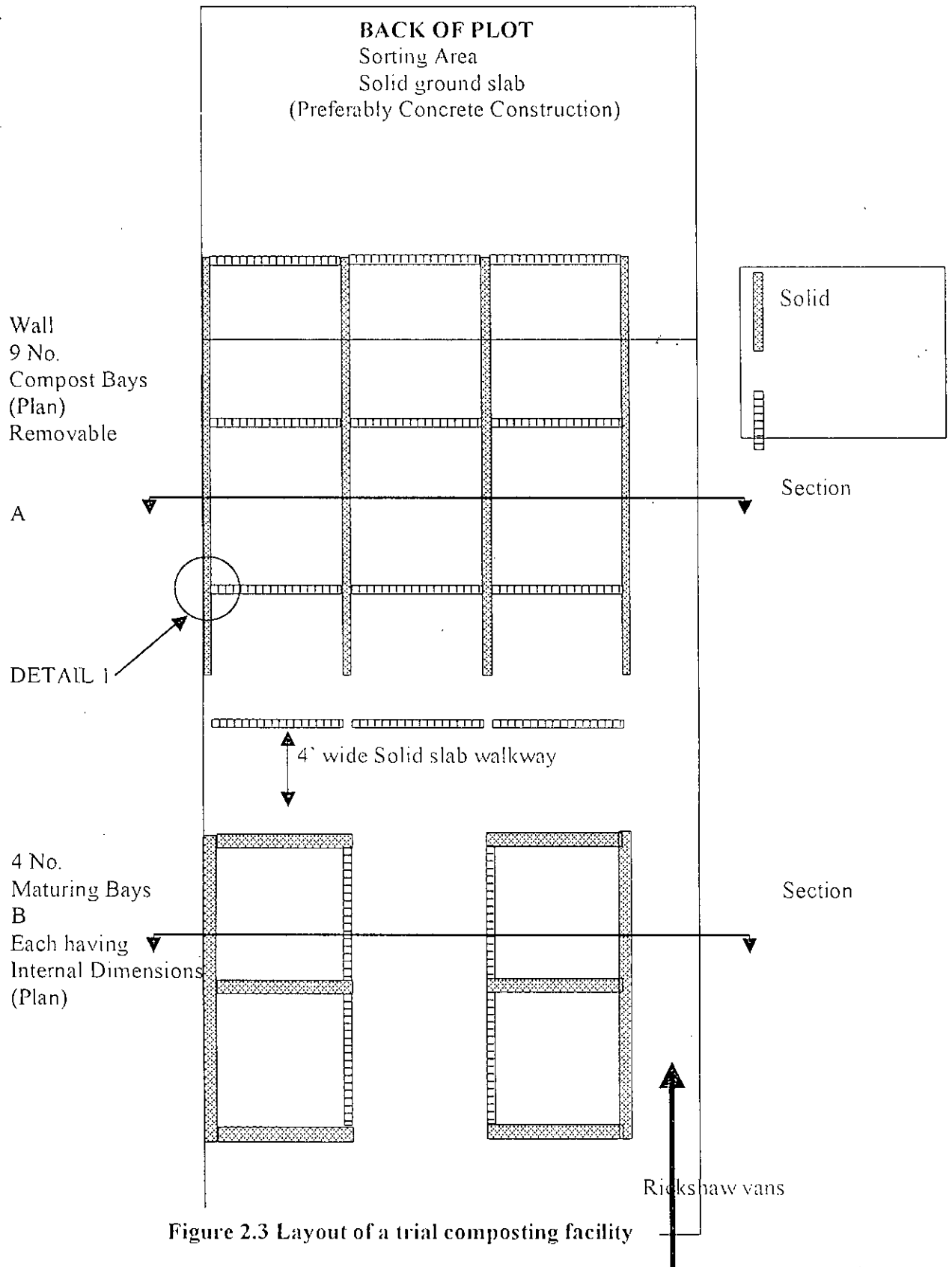
Figure 2.3 Layout of a trial composting facility

SECTION A

7' clear height to roof truss

Width of Site

Walkway

3 Bays internal dimension

6")

(>3'

Solid wall
5' High

Suitable foundations & Walkway slab

SECTION B

6' clear height to roof truss

Width of Site

Walkway

Solid Wall
6' High

Removable
Walls

Solid wall
6' High

Suitable foundations & Walkway slabs
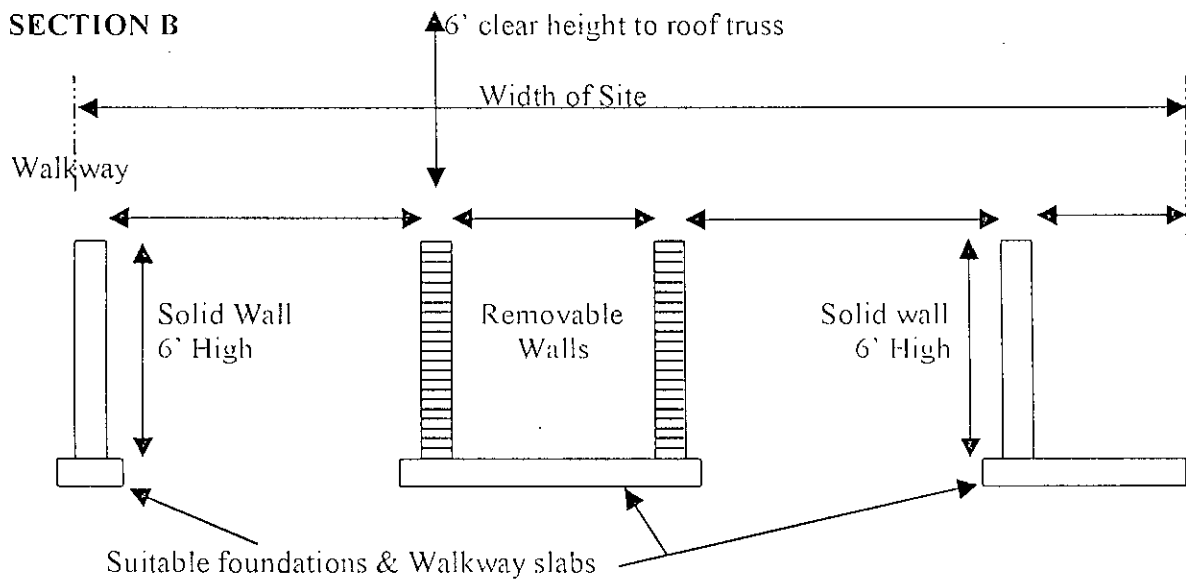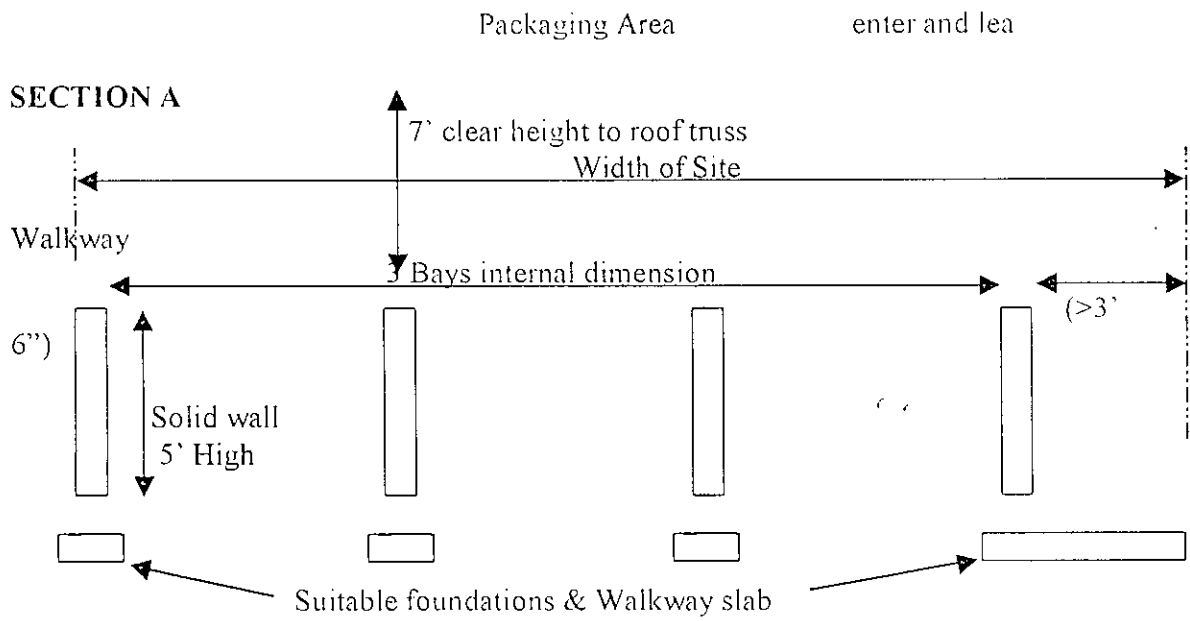
DETAIL 1

This detail is typical for all intersections between solid walls and removable walls.

Removable wall

Solid Walls
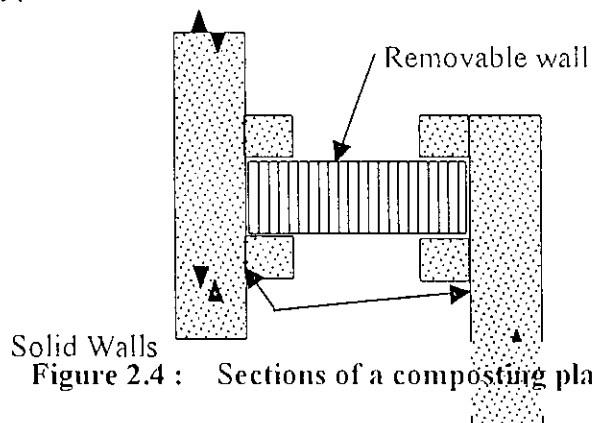
Figure 2.4 :   Sections of a composting plant

Typical Sequence of Operation of Windrow Composting Facility

The following diagrams set out the typical order of progress of a week's compost through the facility.

The sequence is as follows:

Week 1

Each bay in the first row is filled with compostable rubbish over two days .(Figure 2.5)

Week 2

On the first day of the second week, the first bay in the first row is moved to the bay behind, in the second row.
The first bay in the first row is then filled over two days.
Each of the bays in the first row is moved in a similar method

Week 3

On the first day of the third week, the first bay in the second row is moved into the row behind, in the third row. In addition, the process begun in week 2 is repeated.

Week 4

On the first day of the fourth week, the first bay in the third row is moved into one of the maturing bays. The process described in week 3 is repeated.

On the third day, the second bay in the third row is moved into the same maturing bay as was placed the first day. Similarly, on the fifth day the third bay in row three is moved into the same maturing bay. One maturing bay has been filled and will remain in place for 4 weeks.

Week 5

The maturing bay filled in week 4 remains untouched.
The process described in week 4 is repeated.with a different maturing bay being filled over the week.

Week 6 & 7
The process in week 5 is repeated with the two remaining maturing bays.

Week 8

The maturing bay filled in wee4 is removed and packaged for sale. The bay is refilled over the course of the week. .(Figure 2.6)
The process continues in this fashion.

A case study on state window method has been shown in Appendix-1

WEEK 1

Sorting Area

Removable Walls

Days 1 & 2   3 & 4   5&6

Week 1
Compost Bays

Week 2
Walls
Compost Bays

Solid

Week 3
Compost Bays

Weeks 4 to 7
Maturing Bays

Week 8 +
Packaging Area
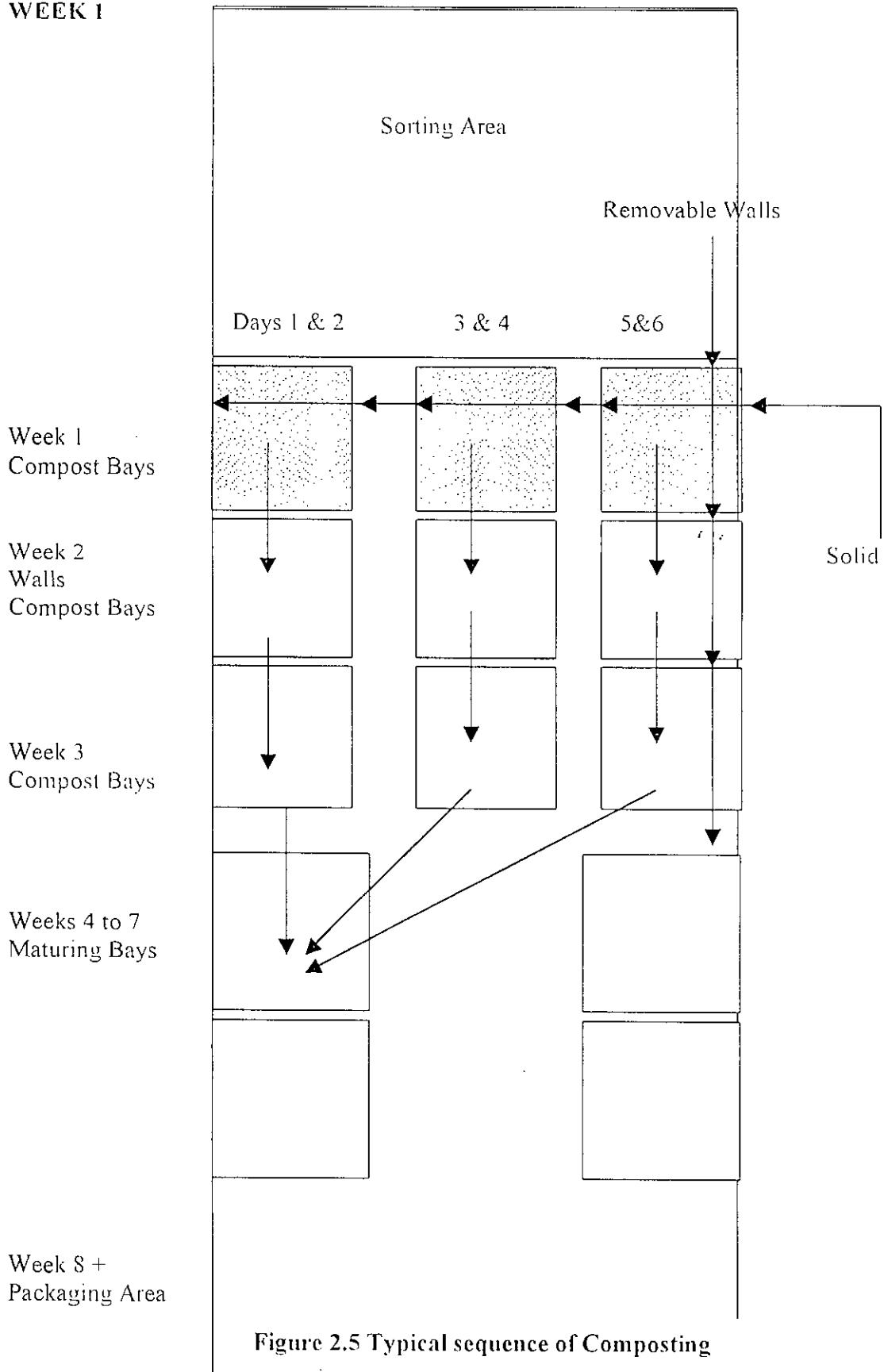
Figure 2.5 Typical sequence of Composting

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WEEK 8

Packaging Area

Sorting Area

Days 1 & 2   3 & 4   5&6

Week 1
Compost Bays

Week 2
Compost Bays

Week 3
Compost Bays

Weeks 4 to 7
Maturing Bays

Week 8 +
Packaging Area
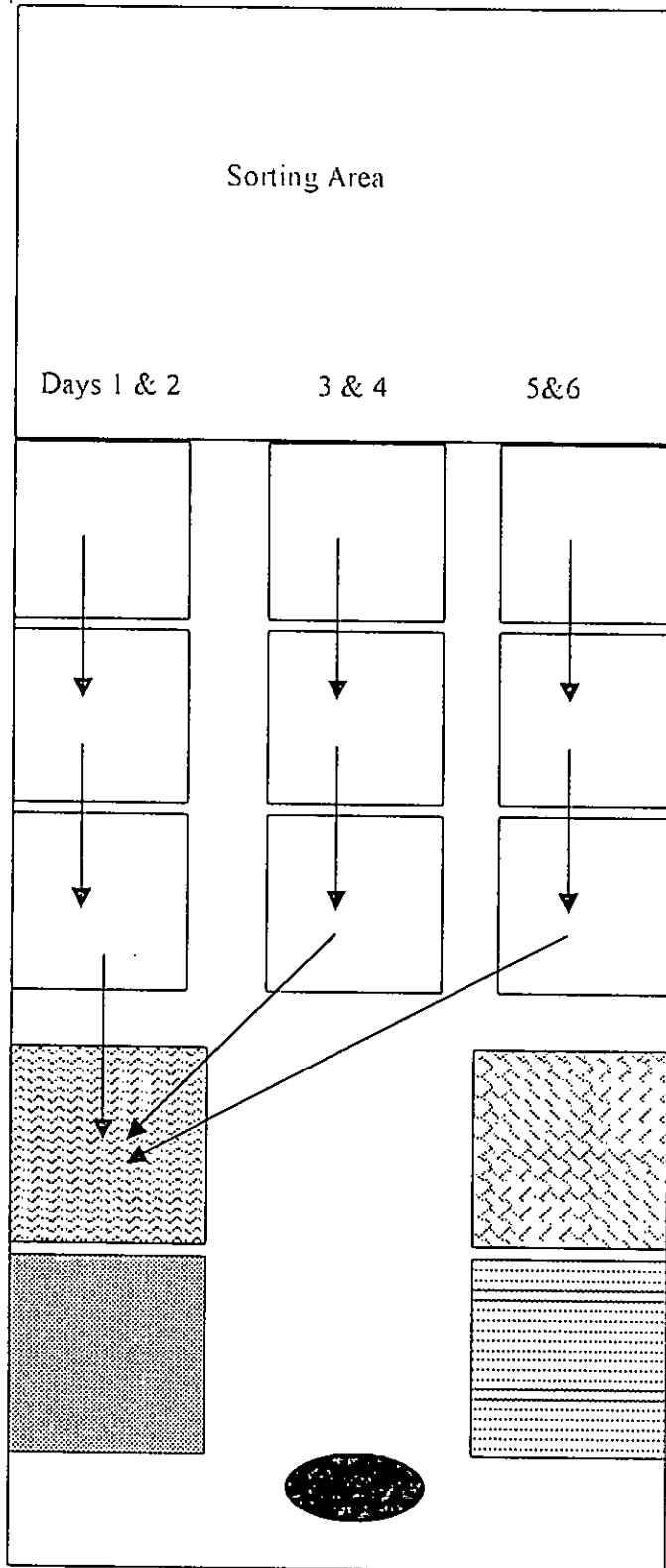
Figure 2.6 Typical sequence of Composting

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2.3.9 Disposal

Waste disposal on land has always been the lowest cost disposal option. Alternative methods such as composting or incineration usually, but not always, involve the use of high cost capital plant and equipment that needs skilled management and labour and are also costly to operate. The term sanitary landfill means an operation in which the waste to be disposed of are compacted and covered with a layer of soil at the end of each days operation.

The factor that must be considered in evaluating potential solid waste disposal site includes (1) available land area (2) impact of processing and resource recovery (3) haul distance (4) soil condition and topography (5) climatological conditions (6) surface water hydrology (7) geologic and hydrologic condition (8)local environmental condition (9) potential ultimate use for the completed site.

Chapter 3

Conservancy Services of Sylhet City Corporation

3.1 Profile of Sylhet City Corporation

Sylhet City Corporation began functioning in 1878 with 5.82 sq.km. area and almost 17 thousand populations. At present its area increased to 26.05 sq.km. and population approximately 5 hundred thousands. Table 1.1 presents the extent of the growth of this city during the last 10 years period.

Table 3.1: Growth of the Sylhet City from 1991 to 2001

Items	In 1991	In 2001	Percentage Change
Area (Sq. km.)	16.92	26.05	54.0
Households	14,068	49,628	252.8
Population	109,000	285,308	161.8
Male	61,000	156,010	155.8
Female	48,000	129,298	169.4
Household size	6.8	5.6	(21.4)
Ward	5	13*	160.00
Mahalla	94	201*	113.8
Density (no. per sq.km.)	6,442	10,952	70.0

Source: Baseline study of Sylhet Municipality, Asia Urbs Sylhet Partnership (2002)

The City widens by more than 50 percent during the 10-year period. Household and population expanded due to horizontal expansion of the City as well as the growth of population. Household size is becoming smaller and is now 5.6. The rate of decrease is about 2.1 percent per annum during the period of 1991 to 2001. Population density was 6,442 in 1991 and increased to about 70 percent in 2001. This indicates that the city is becoming extremely crowded.

3.2 Resources and access to services

Waste generation having depends on no. of population and recourses of the city
The physical resource base of the City Corporation is reported in the table (3.2).

Table 3.2: Resource base/organizations & access to services in the city area

Description	Quantity
Electricity distribution line (km)	1,609.1
Electricity consumer (no.)	54,494
Households having electricity (percent)	90.9
Households with Cable Connection (percent)	27.5

Pucca Roads (km.)	41.83
Pucca drains (km.)	18.09
Kutcha drains (km.)	70.79
Box culvert	35
Bridge	3
Graveyard	4
Crematorium	2
Concrete made bins for waste deposit	160
Normal garbage truck	7
Push cart	20
Schools & colleges	63
Children park	2
Museum	1
Airport	1
Banks	26
Press club	1
Telegraph office	1
Chamber of commerce (business association)	1
District bar association	1
Red crescent organization	1
Freedom fighter association	1
District sports association	1
Female association	1
Sports club	4
Academy for children	1
Cultural academy	1
Circuit house	1
Residential hotels	125
Department rest house	9
Parjatan motel	1
Bus & rail station	2+1 = 3
General hospital	2
Maternity & child care hospital	3
Infectious disease hospital	1
TB hospital	1
EPI centre	29
Post office	19
Co-operative association	85
Restaurants, hotels and community centres	220
Police station	2

Source: Baseline study of Sylhet Municipality. Asia Urbs Sylhet Partnership (2002)

It appears from the table (3.3) that the City Corporation has a number of educational institutes, hotels, community centers, restaurants, banks, pharmacies and health clinics. These offices, business centers and institutions are producing a quantity of waste daily.

Table 3.3: Business outlet in Sylhet city

Description	Quantity
Departmental store	41
Jewellery	155
Whole sale dealer	35
Bakery	40
Rice mill	35
Flour mill	16
Saw mill	3
Hotel & restaurants	185
Tea stalls	5
Grocery shop	944
Bedding store	35
Fruit stall	22
Fish shed	32
Vegetable shop	26
Meat shop	35
Tobacco shop	2
Engineering/consultancy	27
Hardware store	115
Sanitary store	45
Printing/stationary	74
Snacks bar	55
News stall	5
Shoe store	105
Welding shop	102
Sweetmeat	21
Coaching centre	10
Photography	54
Music centre	35
Video centre	52
Cinema hall	6
Community centre	26
Other shops	10,251
Total	

Source: Baseline study of Sylhet Municipality, Asia Urbs Sylhet Partnership (2002)

From the table (3.3) it is clearly seen that the city area has a less no of industry . In this sence Sylhet cities waste is almost free from chemicals except in health care waste.

From the table (3.4 and 3.5) it can be said that the allocation and expenditure in water, health and sanitation sector is increasing. The figure indicates that the policy makers of city corporation are considering the waste management with importance.

Table 3.4:   Item-wise public expenditure in the Sylhet City

Year	Establishment Taka (nominal)	Water, Health & Sanitation Taka (nominal)	Education Taka (nominal)	Infrastructure Taka (nominal)	Other Taka (nominal)
1995-96	13442773.00	2858789.00	97200.00	73134175.00	278586.00
1996-97	14616095.00	3816217.00	384350.00	79455302.00	726395.00
1997-98	15285900.00	10252950.00	846730.00	63372499.00	701652.00
1998-99	15043800.00	13568785.00	1156922.00	27001876.00	105572500
1999-00	15776898.00	34218105.00	2034595.00	76611342.00	1439590.00

* Data include water supply and sanitation projects of 9 district cities.

Table 3.5:   Item-wise distribution of public expenditure in the Sylhet City

Year	Establishment %	Health & Sanitation %	Education %	Infrastructure %	Other %
1995-96	14.97	3.18	0.11	81.43	0.31
1996-97	14.76	3.85	0.39	80.26	0.73
1997-98	16.90	11.33	0.94	70.06	0.78
1998-99	26.02	23.46	2.00	46.69	1.83
1999-00	12.13	26.31	1.56	58.90	1.11

Source: Baseline study of Sylhet Municipality, Asia Urbs Sylhet Partnership (2002)

The components of water, health and sanitation are purchase of bleaching powder, repair of machinery and equipment of the water supply system, cleaning of drainage and garbage, buying of medicine, health equipment, insecticides, immunization programme, other buying and repairs. A major proportion of the City expenditure goes to infrastructure development. This includes land development, repair and construction of bridge, culvert, drain, market, building, roads, park, bus terminals and other construction and repairs.

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3.3 Sylhet City Corporation – Conservancy Section

The Current Situation

The Conservancy Section is responsible for sweeping the streets, collecting rubbish and disposing to a 'landfill'. The section is the responsibility of the Medical Officer and is supported by one inspector and 7 supervisors.

3.3.1 Sweeping

Sweeping is carried out by 129 permanent sweepers located in main street of the city and supported by a number of labourers hired on a daily basis. Main streets are programmed to be swept every day, while the majority of side streets and residential streets are not swept at all by the City Corporation. The sweepers spend some time clearing drains. The duties of the supervisors and inspector are unclear. The inspector stated if he was told of a problem on the streets then he would attend. It is not clear whether the sweepers are checked. The tools used by the sweepers are limited to a brush, having no handle, and a flat wicker basket into which litter is swept.

3.3.2 Rubbish Collection

Rubbish Collection occurs at 152 City provided rubbish bins and there are bo ad -hoe collection points. A concrete box with one side +open and roughly 1.5 metres wide by 1.0 m deep identifies them. Trucks undertake daily rubbish collection from all bins. Men with shovels empty the bins into the truck, and unload the rubbish at the 'landfill' in a similar way. Collection of rubbish appears to occur only six days a week, Fridays being a day off. It is on these days that the streets become considerably dirty and covered with piles of rubbish. The loading of rubbish into the trucks is carried out using flat wicker baskets and a pick type shovel. This takes a long time to clear a bin and contributes significantly to the delay in clearing rubbish across the city

The City Corporation estimates it collects between 60 and 80 tonnes of rubbish from its bins for disposal every day, but that around 180-200 tonnes of rubbish is produced every day. The amount not collected 'disappears', mostly into drains. Consequently the drains are invariably full and have no capacity for carrying rainwater.

There are four main issues associated with rubbish bins.
Bins are located next to or on top of drains
The construction of the bins is insufficient. The bins are too small for the amount of rubbish being placed in them, and in some cases a bin does not exist.
All sites have insufficient hard surfacing for storage of the rubbish and all have insufficient boundaries to contain the rubbish and prevent it falling in to the drains
The bins are not always completely cleared of all rubbish when they are emptied
There are too few bins.

3.3.3 The 'landfill'

The landfill is located a short distance (about 7 k.m) outside of the city, on 17 acres of land owned by the City Corporation. The land is approximately 3 metres below the level of the road that runs along sided it and dumping radiates from an access point on the road. The site is not engineered and is simply rubbish dumped on open land. The land is susceptible to flooding during the rainy season, and was covered in water at the time of the visit. The site is not engineered and has been used for 5 years.

There are no controls over what wastes are being placed in the site. Clinical waste is being dumped here at the same time as other rubbish. The site has approximately a dozen people working on it, primarily sorting the rubbish and removing valuable materials such as paper. There is a clear severe health risk for these people from, not least, the clinical waste. It was unclear whether these people were employed by the City Corporation, or if the City Corporation simply allowed anyone to sift through the rubbish. In any case, the City Corporation has a responsibility to protect people from the hazards it is creating here.

Floodwaters come up to the rubbish. There are complaints from the local farmers about the smell. The site has no engineering and it must be assumed that water and land is being polluted. It is likely that food produced adjacent to this site will contain elements hazardous to health and other elements in quantities in excess of WHO recommended safe levels for human health. The site has no clean water facilities for drinking and washing.

3.3.4 Collection Points

The City Corporation undertakes collections of rubbish from some 200 locations around the city. It is estimated that 135 of these locations are designated areas with rubbish bins provided by the City Corporation . In addition, there are some 60 or so other ad-hoc collection points which are not technically designated as Municipal collection points, although collections are made from these.

City Corporation rubbish bins were originally provided in the form of a concrete structure, but over the years these have disappeared or fallen into a bad state of disrepair, with many locations having rubbish lying on open ground without any form of containment. Many collection points are adjacent to or over drains and invariably the drains are full of rubbish.
The rubbish placed at collection points becomes scattered about mainly as a result of the scavenging that goes on for recyclables, such as paper products. Furthermore, cows are often found at collection points, probably placed there by their owners. Both these practices are detrimental to maintaining a clean area.

3.3.5 Resources – Employees

The Conservancy section employs of permanent labour and day labour, hired on a daily basis, as follows:

	Sweepers	157 No. at Tk 60 per day (to be confirmed)
Dump Labourers (hire)	17 No. at Tk 80 per day
Day Labourers (hire)	21 No. at Tk 60 per day
Night Labourers (hire)	20 No. at Tk 60 per day
Truck drivers	10 No. at Tk 2,700 per month
Supervisors	8 No. at Tk 2,700 per month
Inspector	1 No. at Tk 3,800 per month (inclusive of Bonus)

This calculates to a total labour cost of Tk 66,00,000 per year.

3.3.6 Equipment

The section has two 2 tonne compaction-type vehicle donated as a gift by Hiroshima City in recognition of the two cities being twinned. The City Corporation owns 10 vehicles: 8 No. 3 tonne trucks and 2 No. 2 tonne compaction type vehicles. There are currently 2 trucks out of service with engine problems, one for 16 months and the other for 6 months .

Approximately Tk1,25,000 is spent on fuel for 8 trucks each month.

There does not appear to be any routine maintenance of vehicles carried out such as oil change. It appears that maintenance, or more accurately repair, is carried out when the vehicles break down.

Methodology

There are three shifts during which differing numbers of trucks and labourers are employed on rubbish collection: Table 3.6 shows a typical day activities of our labour

Table 3.6 :   A typical day activities for sweepers & labours

	6am to 12pm	9am to 5pm	5pm to 9pm	9pm to 4am	4am to 6am
Sweepers (no.)	20		NIL		NIL
Day labourers (no.)		12	NIL		NIL
Nightlabourers(no.)			NIL	20	NIL
Trucks	5	5/3	NIL	5	NIL

Source: From Conservancy Section of Sylhet City Corporation

In the period 9am to 12pm, there is a total of 32 employees on rubbish collection, and a maximum of 5 trucks. The number of trucks reduces to 3 at 12pm. The 20 sweepers employed on rubbish collection are drawn from the total 157, so that the number of sweepers carrying out sweeping is reduced.

Of the 21 day labourers employed, it is usual for 12 to carry out rubbish collection and, depending on labour availability, 9 carry out drain clearing.

The conservancy team knows the locations of the rubbish bins, but there is no map or record of their location. Similarly, the routes of the trucks are known but are not recorded. Principally, there are 5 routes covering the centre of the city during the morning, and 5 serving either the centre or main roads around the city at night. In the afternoon, three vehicles are typically assigned to residential areas but in practice, these carry out 'fire-fighting', providing a reactionary service to clear 'demand'. During the night one vehicle services solely the market opposite the post office in the centre of the city. On the whole, each vehicle removes 3 or 4 truckloads of rubbish at night, and 2 truckloads removed by each truck during the day. Maps of day and night collection rounds has been prepared as part of this review with the help of the Chief Inspector of the Conservancy section.

3.3.7   Participation of NGOs & CBOs

Currently a number of NGOs and Community Based Organisations have established Primary Collection Schemes in some four parts of the City.

These schemes have focused on building residents' awareness and participation in putting rubbish out in a more satisfactory method. The schemes have achieved success rates of at least 85%.

It is clear that NGOs and CBOs play a vital role in bridging the gap between residents and the Secondary Collection undertaken by the city, and demonstrates that every sector has a role in taking responsibility for maintaining a clean city.

From discussions with the City Corporation inspector the following observations are clear:

There are nearly always 5 trucks carrying out rubbish collection, except in the afternoon shift. However, the rote of rubbish collections is not set and on any particular day trucks may carry out reactive work to clear rubbish where complaints are being raised, where 'demand' requires, so that 'routine' rubbish collection is serviced by less than 5 trucks.

3.4   Recommendations

Services

The statutory services of city corporations are secondary rubbish collection, provision and maintenance of rubbish collection points, sweeping, Drain clearness, conservancy law enforcement and their additional services are primary rubbish collection, Recycling Composting. Awareness rising & education, Waste reduction.

Collection Points

A programme of collection point rehabilitation must be prepared and implemented. Key issues to address during rehabilitation must be:

Construction or reconstruction of a clearly defined structure of sufficient capacity for the depositing of rubbish with solid foundation and ground slab for the full containment of rubbish

Drains adjacent to rubbish collection points must be cleared of accumulated debris, and protected from further contamination.

Co-ordinated with the construction of collection points and recommendation 2 (c) above, a review of the number of collection points with a view to reduce the number along busy routes. This might be achieved by providing larger collection points at less conspicuous locations, if possible.

Wherever locations allow it, open spaces adjacent to collection points should be landscaped. An example might be to build a planter of sufficient height to discourage placing rubbish on it, planted with robust plants. The purpose of landscaping is partly to disguise the collection point, partly to generally improve the area around the collection point so to avoid a repetition of widespread dumping of rubbish.

Proper scheduling of truck routes and times for rubbish collection.

There are no maps prepared by the city corporation clearly setting out the areas and routes covered by the 8 vehicles in operation. Much of the information relating to the working times and number of loads transported to the dump are anecdotal and are not supported by records of any nature. It is not clear what the supervisors actually do, other than trouble shoot and redirect vehicles to service 'demand'. Nevertheless, the Chief Inspector demonstrates that some intelligent thought has been put into the collection rounds at some time.

All the while the City Corporation fails to commit additional resources to the Conservancy section, the existing routing of the trucks at day and night should not be altered.

At such time as composting capacity allows, organic market waste should be placed for collection separate to other wastes, so that the organic waste may be taken directly to the composting facility without requiring sorting. Market waste must be combined into residential waste for de-centralized community based composting as soon as capacity allows. This will allow a more efficient composting process to take place and produce a higher quality product. The sorting of wastes for recycling will also improve, allowing more waste to be recycled without contamination.

A thorough detailed evaluation of the amount of rubbish being placed at collection points across the city must be undertaken to fully support the scale of additional resources required to fully meet the demand. By way of example, the Pilot Project has instigated such an overwhelming positive response that its demands now require a dedicated vehicle to service the collection point in that area.

Appropriate amount of dedicated resources, labourers and vehicles, should be allocated to clearing drains so that drain clearing and debris removal is properly co-ordinated without calling upon and diminishing the resources fully required for routine secondary collection of rubbish.

3.5 Sylhet Waste Production

The City Corporation estimates it collects around 60 – 80 tonnes of rubbish from its rubbish bins each day, but that around 180 – 200 tonnes per day is being produced. The difference between what is collected and what is produced is thought to be lost to drains or other sources. There are approximately 600,000 people resident in the city.

By these estimates it is calculated that between 55,000 and 75,000 tonnes of rubbish is produced each year in Sylhet, or between 0.3 to 0.4 kgs per person per day. On a daily basis each family produces between 1.65 kg to 2.2 kg (assumes average family size is 5.5 people).

3.6 Types of Waste

Sylhet's solid waste is mainly comprised of general waste and clinical waste. Wastes such as engine oil and chemicals are thought to be present in the general waste but this is difficult to identify.

General Waste comprises mostly household waste and shop waste and consists of organic kitchen waste, plastic bottles and bags, paper, few drinks tins, and some household cleaning fluids. Organic waste is vegetable and meat or fish, though meat and fish are not wasted and this waste is mainly bones.

Clinical waste is all types of health care waste, comprising needles and syringes, discarded medicines, body parts and fluids and general infected and non-infected treatment materials.

These wastes are found mixed together and deposited in the street. Private clinics are the source of clinical waste and there is no separate collection of this waste. These wastes are collected by the City Corporation together and dumped at the corporation's site out of town.

Chapter 4

Survey Analyses

4.1 Objective of the survey

The main objective of the household survey is to collect information on city dweller's opinion in building a safe and clean city.

The specific objectives are:

To study the current conservancy services and to explore it's weakness.
To identify the waste generation rate and the types of wastes produced.
To increase the awareness and responsibilities of the city dwellers in building a safe and clean city.

4.2 Methodology

The household survey has completed by door-to-door survey with an open ended questionnaire in Ward - 1,2,3. The questionnaire was developed by own. The survey was cancer survey. A questionnaire has been attach in Appendix -2

4.3 Findings

Basic Information:

There are 3036 households in ward – 1,2,3 which have surveyed. There are 26 para have been found in the surveyed area. The list of the para along with the number of households is shown in the table no.4.1

Table 4.1:   Name of the surveyed area

		Frequency	Percent
	Old	356	11.7
	Kazi Ilias	35	1.2
	New Medical	383	12.6
	Police line	94	3.1
	C&B Medical	5	.2
	Lamabazar	34	1.1
	Civil Surgeon	10	.3
	Jollarpar	67	2.2
	Munshipara	114	3.8
	Shagordighirpar	20	.7
	Medical Colony	13	.4
	Mirermoida	140	4.6
	Shoroshpur	115	3.8
	Dorgagate	53	1.7
	Dorgamoholl	35	1.2
	Sonali Bank Staff	30	1.0
	Dariapara	378	12.5
	Dorshondewri	192	6.3
	Mia Fazilchist	79	2.6
	Rajargoli	170	5.6
	Amberkhana	23	.8
	Mirjazanga	11	.4
	Zornerpar	180	5.9
	Kazolshah	185	6.1
	Kewapara	303	10.0
	Zindabazar	3	.1
	Total	3028	99.7
Missing	System	8	.3
Total		3036	100.0

4.3.1   Socio-Economic Condition

Family size:

Waste generation per household depends on the number of person in household. From figure 4.1 it is clear that more than half of the families 56% in this area are consists of 4-6 members. About one fifth of the total are small families who have less than 4 members and only 5% are large families of which members are more than 10. It indicates that the number of nuclear family is much more higher than that of joint family.

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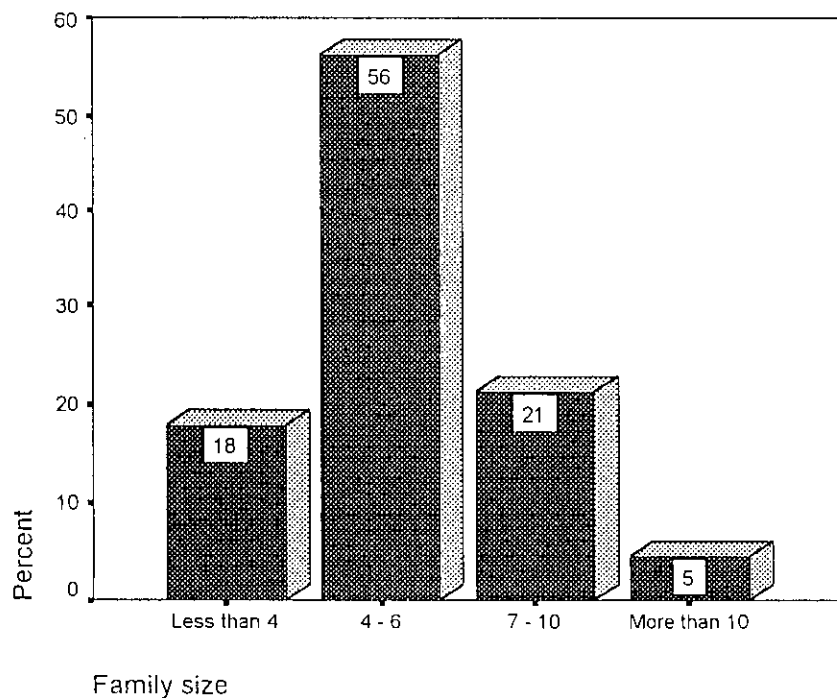
Figure - 4.1: Family Size of the Households

The average family size is 5.55 in this area, which is almost same as the national figure. The range of the family size varies from 1 to 30. Which has been shown in table 4.2

Table 4.2:   Descriptive Statistics of the family size

NN

No of person	Statistics		
	Minimum	Maximum	Mean
Family size	1	30	5.55

When the family size become bigger the quantity of waste become greater. Table 4.3 shows the quantity of waste produced by family size.

Table 4.3:   Quantity of waste produced by family size

% Within Family		Quantity of Waste KG				
		1-2 kg	2-4 KG	4-5 KG	5+ KG	Total
Famil size	Less then	81.7	18.1	.2		100.0
	4 -	75.5	22.9	.9	.6	100.0
	7 -	67.4	30.3	2.2	.2	100.0
	More then	59.9	30.7	8.0	1.5	100.0
Total		74.2	24.0	1.4	.4	100.0

Education level of the family:

Waste generation depends on the education of the family members. Generally business family has a tendency to generate larger quantity of waste than others. In the survey area 51.4% household (table 4.4) are servicer. Most of the people living in this area have literacy skills. 78.9% of the total households are literate of whose family members are educated. Among others 12.4% of the surveyed households family members have basic literacy skills who can only identify the alphabets and the rest 8.7% are illiterate.

Table – 4.4:   Occupation of the household

		Frequency	Percent
	Service	1562	51.4
	Business	935	30.8
	Labour	215	7.1
	Self Emploved	81	2.7
	Expatriate	103	3.4
	Doctor	5	.2
	Teacher	7	.2
	Driver	72	2.4
	Retired	11	.4
	Total	2991	98.5
Missing	Svstem	45	1.5
Total		3036	100.0

Income level of the household:

Waste generation depends on the income status of the household. From the figure (4.2) it is clear that 41% households monthly income varied from Tk.1,000 to Tk. 5,000. 36% are living in the income level of Tk. 5,000–10,000. One fifth (20%) of the total households income is more than Tk. 10,000. Only 3% households income is less than Tk. 1,000.

Monthly income of the household
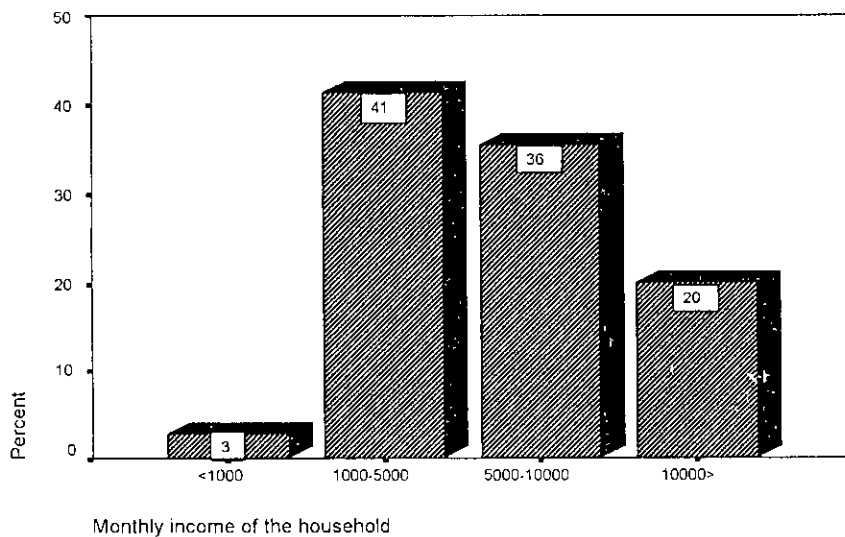
Figure 4.2 Income level

36

Religion of the household:

Physical composition of waste depends on the religion of the household. Among the total household of the area, 77.5% of them are Muslim, 22% are Hindu, 0.3% are Christian and the rest 0.2% are Buddhist..

Christianity
.3%

Buddism
.2%

Hinduism
22.0%

Islam
77.5%
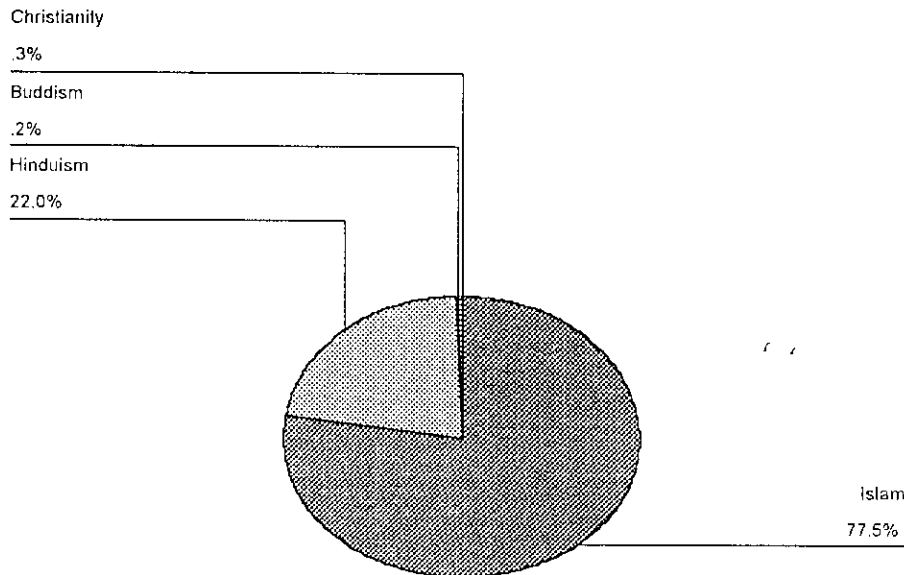
Figure 4.3:   Religion of the family

Trend of living:

Waste generation rate depends on the trend of living systems .Generally the permanent resident has a tendency to generate more waste than others. From the figure (4.4) we can see that a large number of people (44% of the total household) of this area have been living in Sylhet town for more than 20 years. Among the rest of the people 16% of them have been living here for 2–5 years and 5% households are here for less than 1 year, who are living here as a temporary basis.

Years living in Sylhet
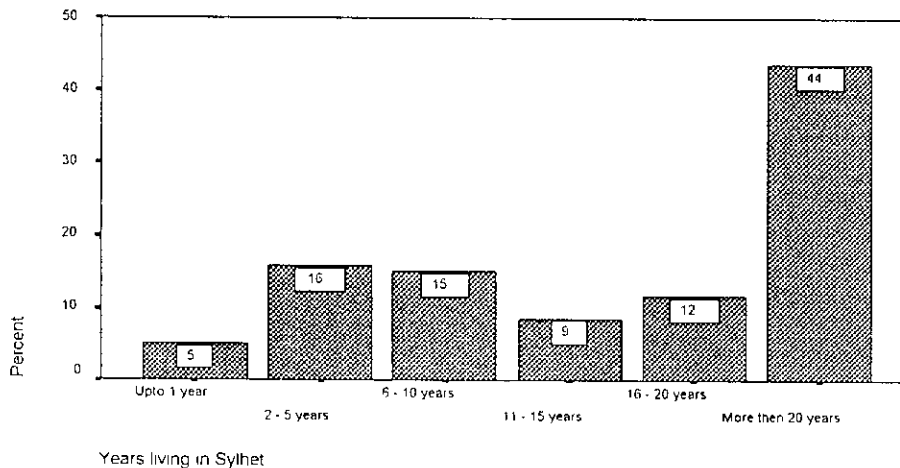
Figure 4.4: Trend of living

37

Category of the house

A large number of people are living in rented houses. From figure 4.5 it can be said that (27.5%) of the respondents are living in their own houses. A few are living in government residence and the others are living in the houses with a condition of taking care of the houses. The owner of those houses living abroad permanently and the pay their visit here temporarily. Rest of the time those houses were looks after by the caretaker.
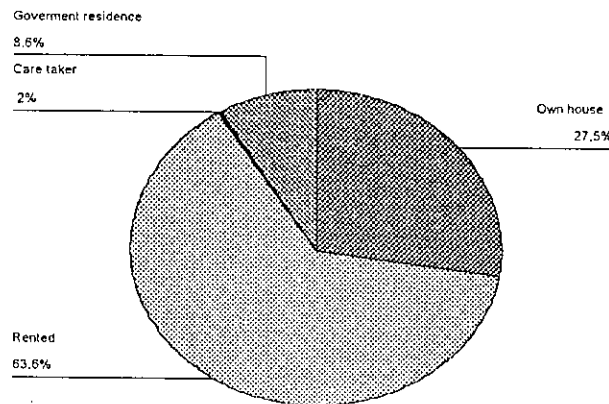
Figure 4.5: Category of the houses

4.3.2   Information about waste

Sources of waste

Household waste generally comes from cooking, toiletries, homestead activities, toilet, educational materials cloth. Fig 4.6 shows that   34.7%   waste is coming from cooking 13.5% comes from cosmetics, 27.0 % is comes from home stated activities 6.5% is toilet 13.2% comes from educational materials 5.1% is coming from cloth.
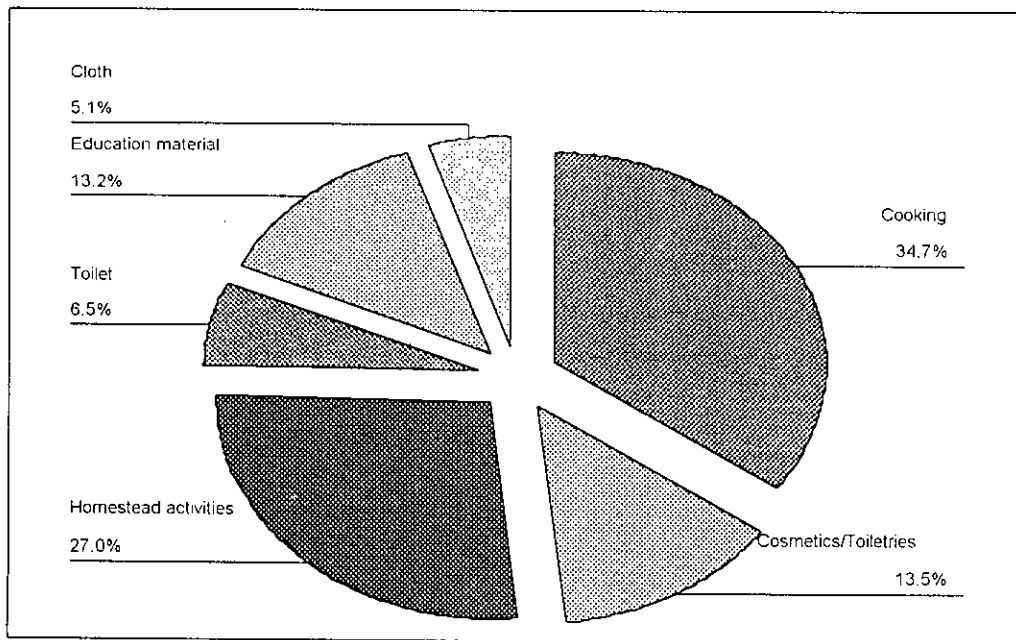
Figure 4.6: Sources of waste

There are varieties in collected wastes. Different types of waste are produced from different sources. Some of them are decomposable, some are recyclable and some are disposable. The waste from cooking purpose, homestead activities and half of the education materials (68.3%) are compost able. Clothes and half of the education materials (11.7%) are recyclable. Waste from cosmetics, toiletries and toilets (20%) are disposable.

Quantity of the waste

Average 5609 kg. waste is produces from these area of the town daily. From the figure (4.7) we can see that most of the households (73%) produced 1-2kg, 2-4kg waste is produced from 24% households, 4-5kg waste is produced from 1.4% households and from 0.4% households produce waste is more than 5kg per day.
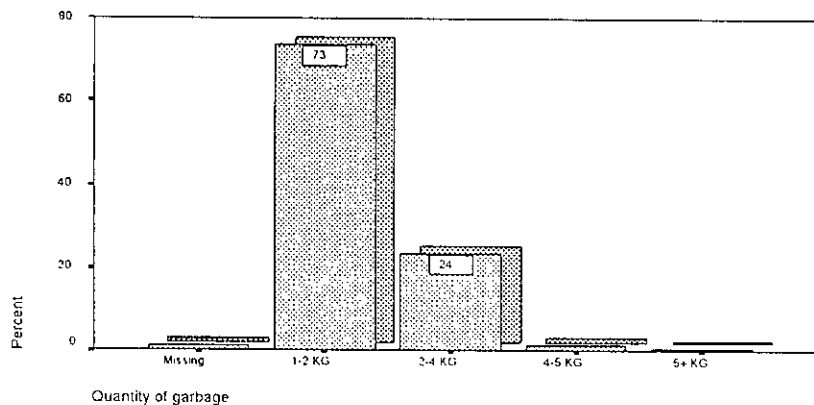
Figure 4.7: Quantity of the waste

4.3.3 Information about primary waste collection process

Waste storage process:

Solid waste management system starts at household level. So the storage of waste in a fixed place by a durable container is mandatory for Integrated Solid Waste Management System.

Fig 4.8 shows most (90%) of the people have the tendency to preserve wastes in a fixed place in their home either it is in a basket, bucket or polythene. People have a very natural tendency to keep their houses clean. If this kind of positive attitude grew among the people covering a larger area certainly we would have a clean city. But 10% of the households people put their households waste here and there. This kind of attitude is very harmful for the environment.

Waste storage process
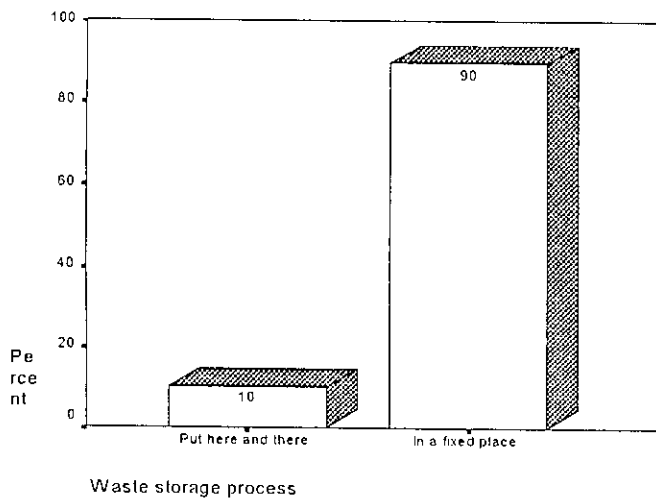
Figure 4.8:   **Waste storage process**

Persons involved in primary storage

In most of the families, family members collect wastes by themselves. Most of the time   (54%) it is done by the housemother of the house but sometimes the house-father of the house and the children are also do this. From the table 4.5 it is clear that only 28% of the total house have servants to perform this duty. Some of the household members also did it along with the servants.

Table 4.5: Primary collector of the waste in the home

Primary Collector

		Frequency	Percent
	Servant	869	28.5
	Family member	2078	68.2
	Total	2947	96.8
Missing	System	98	3.2
Total		3045	100.0

40

Types of container used in primary storage of waste.

Waste disposal /delivery in proper place depends on the types of container used in primary storage of waste. From the figure (4.7) we can see that nearly half (43%) of the total households use basket for preserving wastes. A large number of household use polythene. Some people use bucket and a few households use earthenware as waste preserver. Some of the households use more than one item to preserve wastes.

Earthenware
.8%

Bucket
18.1%

Polythene
37.8%

Basket
43.3%
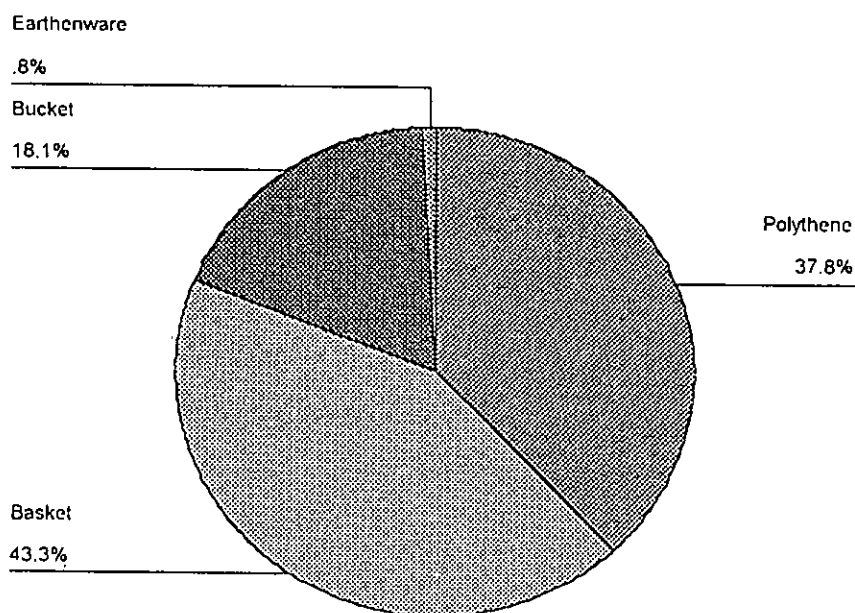
Figure 4.9: Types of waste storage

Duration of waste storage:

Duration of waste storage depends on the facility of waste disposal point or waste carrying vehicle. Table 4.6 shows 95% of household dispose their collected waste daily. But some people didn't do that. Among them some household members dispose waste after 2 days, some did it after 3 days and the rest of the household did it after more than 3 days, which is very harmful for people's health as well as for the environment.

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Table 4.6:   Duration of waste storage

Duration of waste storage

		Percent
	1 day	95.2
	2 days	1.6
	3 days	.6
	More then 3 days	.2
	Total	97.6
Missing	System	2.4
Total		100.0

Preserve for recycling

Recycling of waste is very important part in integrated solid waste management system. Intensive recycling programme can reduce the pressure on municipal conservancy services as well as protect the environment. From the figure 4.10 we can see that only a few of the total household members (11%) preserve waste for recycling.

Preserve for recycle
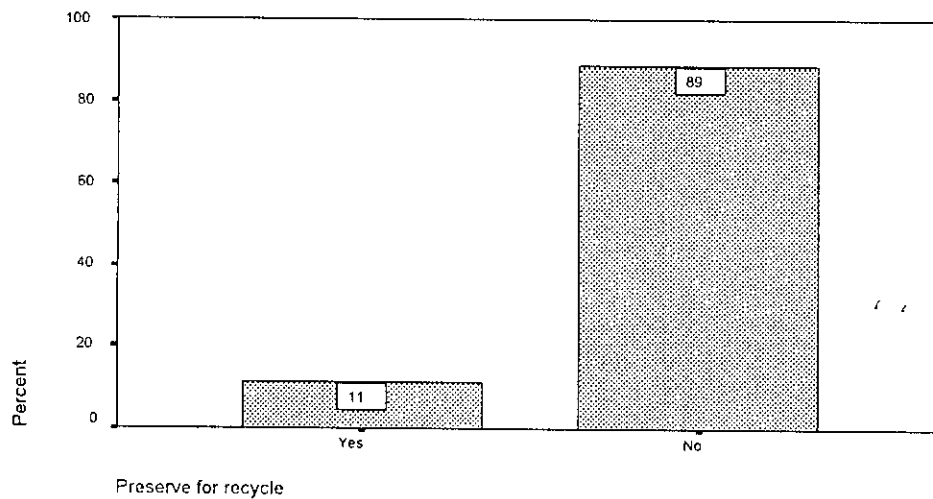
Figure 4.10:   Waste preservation for recycle

Among the households who are practicing preservation 56.9% (table 4.7) others, more than half of them never feel the importance and necessity of the preservation and recycling. 32% people have no response. A small portion of the waste is preserved directly for recycling. So a huge portion of the waste is need to bring under process by the authority.

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Table4.7: Feeling need for preservation

	Frequency	Percent
No	1728	56.9
Yes	317	10.4
Total	2045	67.4
No response	991	32.6
Total	3036	100.0

Preservation Items.

This indicates the little concept of the household on recycling programme.

Some of the specific items are preserved for recycling. These are mainly paper, plastic, can, bottle, metal and food related items. Apart from those, people also preserve wood, rubber, ash and used tea leaves. Table 4.8 indicates 16.8% household preserve food related waste, 24.6% paper waste,18.5% plastic waste.

Table4.8: Items preserved for recycling

Items

	Percent
Food related	16.8
Paper	24.6
Plastic	18.5
Can	15.6
Bottle	17.4
Metal	6.3
Chemical wastes	.1
Wood	.1
Rubber	.2
Ash	.1
Tea leaf	.2
Total	100.0

Causes for preservation of waste

Different items being preserved for different purposes. Different preserved items have different market value. Most of the people preserved it for sale. Paper, plastic, bottle, can and metal are preserved for sale. Some of the items are also preserve for re-use. Some of the waste is preserve for using as soil condition, like food related items and tea leaves. The figure 4.11 says that household in the surveyed area preserve waste as sale 79.3%   use for sale purpose 3.8% and reuse purpose is 16.9%.
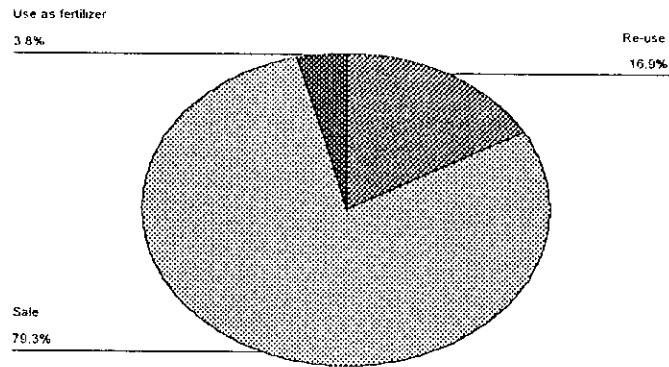
Figure 4.11: Causes for preservation of waste

Information about primary waste disposal:

4.3.4 Participation of CBOs & NGOs engaged in waste collection:

Fig 4.12 indicates (51%) of households in the surveyed area is enjoying some additional facilities from some Community Based Organizations (CBOs). There are 17 CBO's (table 4.9) are working in these area providing waste collection services from household level. 1536 households not having these type of facilities. Most of these organizations are formed by a group of young boys of the community.
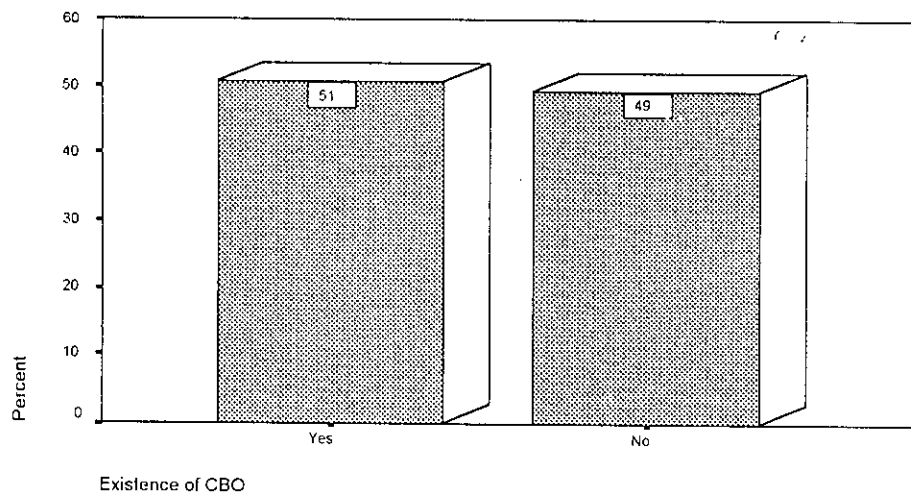
Figure 4.12 : Existence of CBO engaged in waste collection:

Table 4.9:   List of CBO's along with their covering area

Name of the organization

	Frequency	Percent
Shahialal Somaz Kollan	202	13.4
Dariapara Songstha	125	8.3
Svlhet Somaz Kollvan Songstha	183	12.1
Pavra Somaz Kollvan	295	19.5
Young Brothers Club	75	5.0
Raiargoli Somai Kollvan	23	1.5
Kewapara Somaz Kollvan	102	6.8
Waves Somaz Kollvan	15	1.0
Yeamani Porishad. Fazil Chist.	25	1.7
Machudighir Par Somai Kollvan	1	.1
Modhu Shahid Somaz Kollvan	31	2.1
Shuvechcha Somaz Kollvan	5	.3
Promukto Akota Jubo	1	.1
Purathan Medical Bovs	53	3.5
Welfare Association. Puraton Medical	54	3.6
Kazolshah Jubo	304	20.1
Somaz Kollvan Songstha	15	1.0
Tota	1509	100.0

Existence of CBOs in the locality

State of satisfaction

Regular collection of waste is very important for integrated solid waste management
Most of the organizations are able to satisfy people's demand. (figure 4.13) says that 83% of the
households those who receives organizational support are satisfied about their activities on waste
collection.
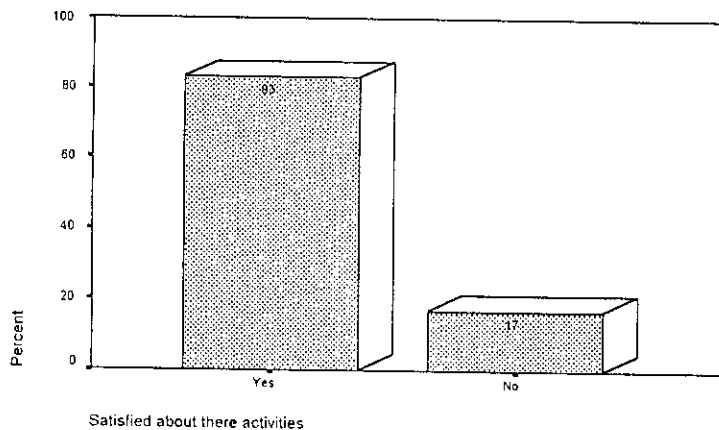
Figure 4.13:   Household Satisfaction

45

Amount wants to bear by household for CBO's

City Corporation is not responsible for primary collection of the waste. They are collecting conservancy tax for secondary collection and disposal of the waste. So the city corporation does not bear the cost incurred by CBO's Households have to pay the incurred cost.

The households have been bearing costs for the CBO who works for waste collection in their locality. This collection rate varies from organization to organization and household to household depending on their economic condition. The range of the collection rate is from Tk.10 to Tk.200. Mostly Tk.10, 15, 20 or 50 have been collected. Table 4.10 shows the cost bear by household. .Normally those who collect a large amount of money they do not limit their activities only in waste collection rather they works in the field of community development as a whole. Table 4.11 shows the list of collection rate of CBOs in the surveyed area

Table 4.10: Cost bears by household for CBO's

Amount		Frequency	Percent
	Tk.10	449	30.7
	Tk.15	229	15.7
	Tk.20	423	28.9
	Tk.25	11	.8
	Tk.30	50	3.4
	Tk.35	4	.3
	Tk.45	17	1.2
	Tk.50	269	18.4
	Tk.100	9	.6
	Tk.200	2	.1
	Total	1463	100.0

Table 4.11: List of collection rate of CBO's

Name of the organization by collection rate

	If yes, how much										Total
	Tk.10	Tk.15	Tk.20	Tk.25	Tk.30	Tk.35	Tk.45	Tk.50	Tk.100	Tk.200	
Shajalal Somaj Kollan Songstha	119	4	2					1			126
	94.4%	3.2%	1.6%					.8%			100.0%
Dariya Para Songstha	9	117	7								133
	6.8%	88.0%	5.3%								100.0%
SSKS	10	94	5	1	6		1	3			120
	8.3%	78.3%	4.2%	.8%	5.0%		8%	2.5%			100.0%
Payra Somaj Kollan Songstha	10		35	3	14			179	5	2	248
	4.0%		14%	1.2%	5.6%			72.2%	2%	.8%	100.0%
Razargolli Somaj Kollan Songstha	27	1	53		12			11	2		106
	25.5%	.9%	50%		11%			10 4%	2%		100.0%
Waves Somaj Kollan Songtha			15		1						'6
			94%		6.3%						100.0%
Yeamani Porisod Mia Fajilchist			20					2			22
			91%					9.1%			100.0%
Suvechcha Songstha Mia Fajilchist			6					1			7
			86%					14.3%			100.0%
Young Brother's Club	3		54		2		1		1		61
	4.9%		89%		3.3%		1.6%		2%		100.0%
Kewapara Somaj Kollan Sonstha	1		78		10			2			91
	1.1%		86%		11%			2.2%			100.0%
Promukto Akota Jubo Shonga	1							1			2
	50.0%							50.0%			100.0%
Masu Digirpar Songstha								1			1
								100%			100.0%
Modhushahid Somaj Kollan Songstha			29		1						30
			97%		3.3%						100.0%
Puratan Medical Boys Club	11		41	1				22			75
	14.7%		55%	1.3%				29.3%			100.0%
Puraton Medical Colony Welfare Assocation								28			28
								100%			100.0%
Somaj Kollan Songstha Sagardigir par			1	2	1	4	15	10	1		34
			2.9%	5.9%	2.9%	12%	44.1%	29.4%	3%		100.0%
Moitri Para Songstha	3										3
	100%										100.0%
Kazolshah Jubo Shango	109		13								122
	89.3%		11%								100.0%
Total	303	216	359	7	47	4	17	261	9	2	1225
	24.7%	17.6%	29%	.6%	3.8%	.3%	1.4%	21.3%	.7%	.2%	100.0%

Information where there is no CBO have been working

Distance between house and dustbin

The households where there is no CBOs working for collecting waste from houses have to put it to the dustbin by their own. According to the data a large number of people (68%) did not response about the distance between their house and dustbin. This is because probably they have no dustbin in their locality or the family member do not know the existence of the dustbin. From table (4.12) we can see that 15% of them have it which is more then 30 yards far from their house.

Table 4.12: Distance between house and dustbin

	Frequency	Percent
< 10 yards	105	3.5
10 - 20 yards	220	7.2
20 - 30 yards	200	6.6
30 > yards	443	14.6
Not known/no dustbin	2068	68.1
Total	3036	100.0

Timely waste disposal is mandatory for the success of integrated solid waste management system.. People throw their waste to the dustbin at any time at whatever distance between house and dustbin. People those who have a fixed time to waste out, they prefer to did it in the morning, a few people throw their waste to dustbin at night and some people also did it at the afternoon. (See table 4.15)

Table 4.13: Time to waste disposal in different distance

	Time to garbage out				
	Morning	Afternoon	Night	Any time	Total
< 10 yards	16.3	3.8	4.8	75.0	100.0
10 - 20 yards	19.8	1.6	7.7	70.9	100.0
20 - 30 yards	42.1	1.5	1.5	54.9	100.0
30 > yards	40.1	17.8	1.7	40.4	100.0
Total	33.6	9.3	3.3	53.8	100.0

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4.3.5 Information about dustbin

Placement and condition of dustbins

Proper placing and good condition of dustbins encourages city dwellers to dispose dispose their waste in proper place.

From the figure 4.14 we can see that nearly half (45%) of the respondents have no response about placement of dustbins. According to the active respondent's opinion, more than half of the dustbins are placed adjacent to a drain which can easily block the drainage system, if it is not maintain properly. 29.9% of the dustbin could create trouble in communications which are situated near a roadside and 19.3% of the dustbins are situated adjacent to the institutions like school, mosque, bank, clinic, office. 0.2% are near to restaurant. These improper placement is very harmful for public health.

In residential Area
.1%

Adjacent to restaura
2%

Roadside
29 9%

Adjacent to inst.
19.3%

Adjacent to drain
50 5%
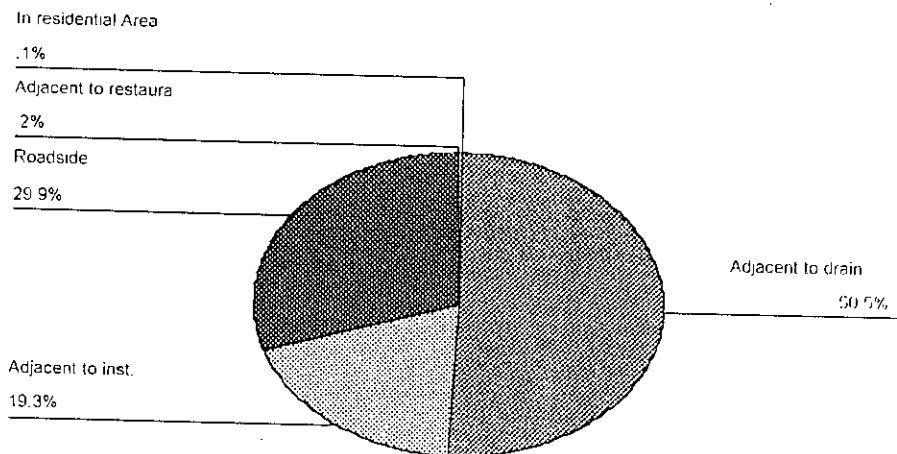
Figure 4.14: Placement of dustbins

Problem arises by overflow of the waste.

Due to limited number of dustbin, sometimes dustbin have been overflowed. When the waste overflows from the dustbin, most of the overflowed waste is lie down in the street and create troubles for people who are moving around. and also create's traffic nuisance. 62.6% household (Table 4.14) says that waste takes place on road by overflowing.

Table 4.14: The place of the overflowed waste spread out

Garbage takes place by overflowing waste	Statistics Percent
Road	62.6
Drain	31.6
Open Area	.6
Residential Area	4.9
Ponds	.3
Total	100.0

When waste is stored in the dustbin, for long days, the waste then decomposed and produces leachet and is spread out in different places and make them dirty. The liquid from the dustbin have been flows to the drain 42%. It also affects the road, water body and open places.
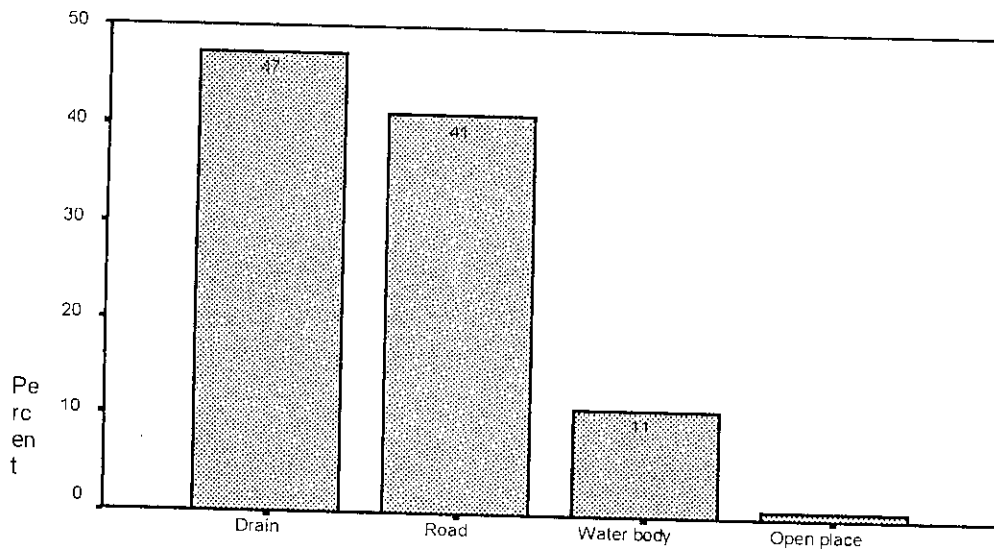
leachete from the waste in dustbin

Figure 4.15: The leachet takes place from the dustbin.

The situation becomes deteriorate in the rainy season. The table (4.15) shows that the leachete from dustbin in rainy season spreads in drain 30%

Table 4.15: The place of overflowed of waste during the rainy season

Tyiples of places	Percent
Effect drain	29.3
Lying in the street	40.0
Effect residential area	9.6
Effect water body	1.8
No response	18.9
Effect open Area	.4
Total	100.0

Types of vehicles engaged in secondary waste collection

The conservancy section of Sylhet City Corporation is responsible for collecting waste from different spot. It is very important to carry out waste from the dustbin by enclosed truck for the safety of public health. But a small portion of the waste is carried by enclosed truck and most of them are carried by open truck. Sylhet City has only 2 enclosed trucks and 8 open trucks for waste collection from the City Corporation provided dustbin to landfill.

Time to transport waste

Regularly with proper timing to transport waste is important for integrated solid waste management approach. Generally the time should be early morning or late night. The figure 4.16 show that waste is transferred by open truck in the morning.

A large number of dustbins are cleaned up at any time of the day. Most of the time waste is collected in the morning, though the morning time is one of the busy time of the day for the school going children and office bound people. The dustbins need to cleaned up in between 10 P.M. to early morning. But this facility is very limited in this area.

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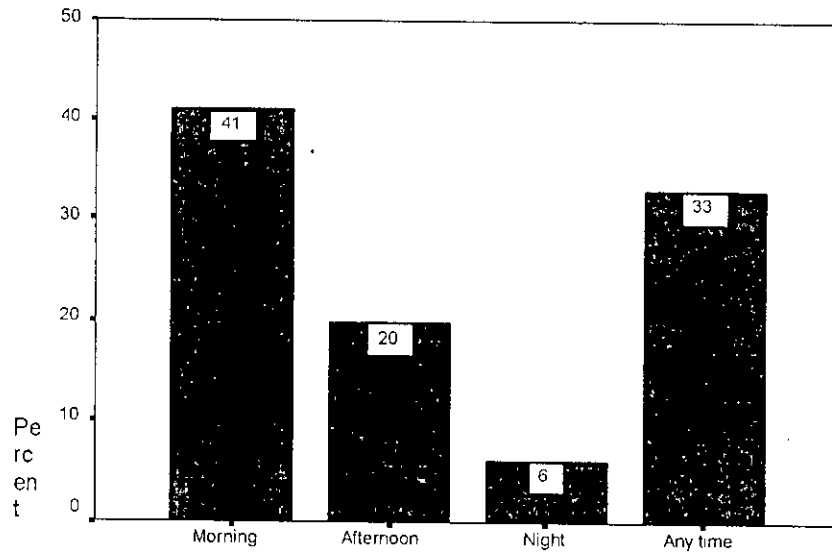
Time of garbage collection from the dustbin

Figure 4.16: Time to collect waste from the dustbin

Waste should collect regularly but from the survey, it is clear from 4.17, 36% household say that waste collection from the dustbin regularly.
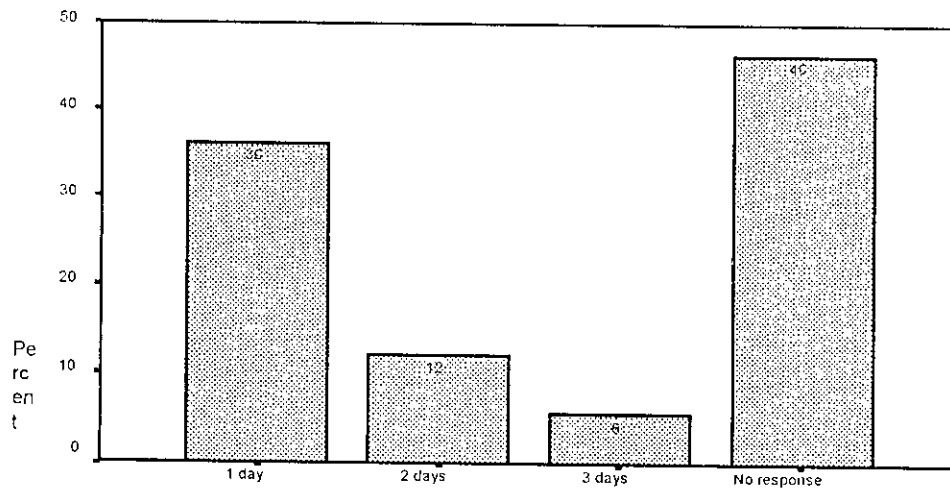
Interval of waste collection from the dustbin

Figure 4.17: Regularity of the waste collection from the dustbins

Problems arises due to improper waste collection

Different types of problem arises due to inadequate waste management system. The problem can categorized into environmentally all health and economic. Such as environmental, heath as well as economic problems. In case of health related issues, various types of diseases spread out and infect the community. These are cholera, diarrhoea, typhoid, malaria, asthma, plague etc. Environment becomes polluted due to improper waste management. Bad smell spreads out from the waste. Water body becomes polluted due to leaching of decomposed waste, resulting the death of aquatic plants and animals. The combine effects of improper waste management hampered our economy.

Improper waste management could create air pollution also. Harmful gas and smoke is being produced from decomposed waste as well as bad smell which pollute the air and make the environment unsafe for the community.

The respondendents opinion on air pollution are descried in table 4.16 water pollution in table 4.17 and soil pollution in 4.18.

Table 4.16: Types of problems arises due to air pollution

		Percent
	Create bad smell	48.3
	Produce harmful gas	39.3
	Produce smoke	10.7
	Total	98.3
Missing	System	1.7
Total		100.0

Water is affected by waste. Water loses its purity, when the waste or it's liquid mix up with it. Polluted water has bad smell and turned into different colour. An uncountable number of fish and aquatic plant has been decreasing due to water pollution.

Table 4.17:   Types of problems arises due to water pollution

		Percent
	Impurit	19.5
	Create bad	17.2
	Turned into deep	15.4
	Produce	18.0
	Epidemic of fish & water	16.0
	Impure water recess under soil	13.9
	Total	99.9
Missing	System	.1
Total		100.0

Soil, which is also polluted and lost its fertility due to various limitations in proper management of waste. 99.3% of the respondent express their concern about decreasing of soil fertility.

Table 4.18:   Types of problems arises due to soil pollution

		Percent
	Decrease fertility	99.3
	Others	.6
	Total	99.9
Missing	System	.1
Total		100.0

Community people have to face different types of health problems which related with health. Various diseases were spread out due to pollution in different sector. This pollution is the ultimate result of inadequate and improper waste management.Table 4.19 shows the name of diseases and their percent.

Table 4.19: Types of the diseases could be spread out due to health problem

		Percent
	Diarrhoea	14.4
	Dysentry	12.3
	Cholera	9.7
	Typhoid	7.0
	Plague	4.8
	Maleria	10.9
	Hepatysis	4.0
	Dyspnoea	9.7
	Dengu	10.6
	Influenza	5.4
	Skin disease	11.2
	Total	99.8
Missing	System	.2
Total		100.0

4.3.6 Level of people's knowledge about the waste management policy of Sylhet City Corporation

Peoples proper knowledge in the conservancy policy of the city corporation is fundamental to integrated solid waste management system.

Fig 4.18 indicates (93.4%) household of the surveyed area are quite ignorant about the waste management policy of Sylhet City Corporation. Even the educated, well-established citizens also sitting in the dark having no knowledge regarding the policy though they have their own houses and living in the city for more than 20 years. On the one hand the City Corporation never takes any initiative and at the same time the city citizens didn't show any kind of curiosity about the policy.
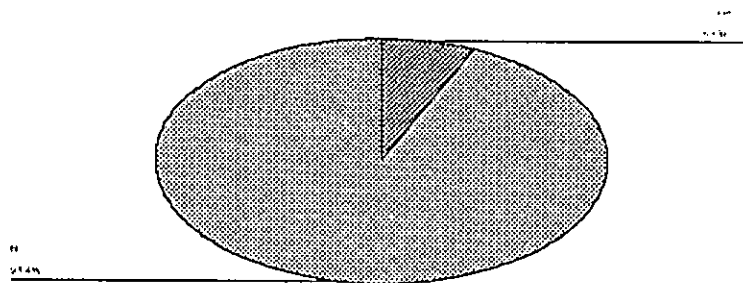
Figure 4.18 : People's knowledge on the conservancy policy of Sylhet City about waste management

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4.3.7 Peoples Recommendation for solving problem

Participatory approach is very important for success of any activities. So soliving the conservancy problem of SCC, peoples recommendation is very important.

Only 12% of the total respondents put their recommendation for solving existing problems of the Conservancy service. In their opinion the problem arises mainly for inadequate number of dustbins and not cleaning the dustbins regularly at a proper time. So out of the total respondents 60.4% gave more importance to increase the number dustbins and clean it regularly. People also recommend that number of manpower should be increase as well as awareness of the community people to support the authority to work properly. The recommendations are summarized in table 4.20

Table 4.20: **Recommendation for solving the existing problem of the City Corporation about waste management**

Recommendation

	Frequency	Percent
Dust must be clean within	9	1.7
Dust must be clean within	11	2.1
Dust must be clean after evening	14	2.7
Increase social awareness	73	13.9
Increase man power	72	13.7
Work properly	29	5.5
Increase number of dustbin	157	29.9
Dust must be clear regularly	160	30.5
Total	525	100.0

People's interest on participation

Among the respondents of the surveyed area 96% households (figure 4.19) expressed their interest to participate in awareness raising activities if any actor would take any initiative. The participation will vary from economically to counseling People are interested to work in awareness programme different ways. A significant number of people's interested area is more than one. 3.3% people have no interest to participate in any initiatives and 0.8% households have no response about it.

How

Figure 4.19: Peoples interest to participate in any initiative for awareness raising.

Chapter 5

Waste Strategy Framework

5.1   Introduction

A Waste Strategy is a policy document that sets out the overall objectives of how waste is to be managed. Projections for quantities of waste being produced, due to economic and development growth will significantly drive the nee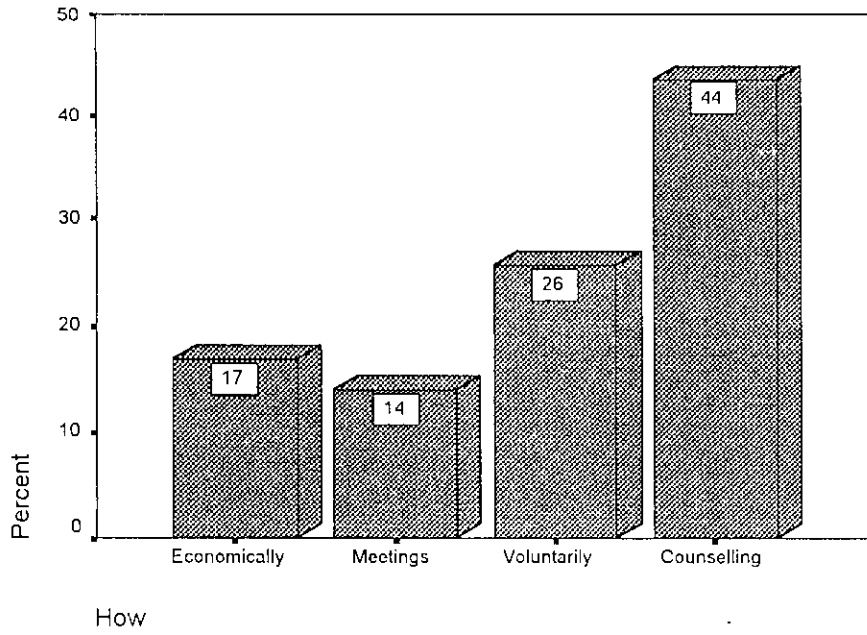ds of Waste Management in the future. The aim of this waste strategy framework is to express its commitment to improve the conservancy services. The framework will allow improvements in the way rubbish is collected from the streets of Sylhet and then disposed. The framework is built around short, medium and long-term goals.

In the short term, a Waste Strategy Steering Group have to be established and pilot schemes for the collection of rubbish from households will be established, moving on to improvements in the efficiency of city collections and ultimate City-wide expansion of the service.

Waste disposal must be properly addressed in the medium term and the long term objectives suggest the potential for waste disposal to be developed up to 10 years from the commencement.

5.2   Aims & Objectives

The aim of Sylhet City Corporation's Waste Strategy will be to improve the cleanliness of the city and reduce the effect of the city's rubbish on the environment.

This can be achieved by having short, medium and long term objectives, so that an overall improvement to waste management is achieved in a planned approach taking advantage of many small changes in the way rubbish is produced, collected and disposed.

The overall strategy will seek an integration of many organisations from the community based sector, private industry as well as the City Corporation, so that the responsibility of undertaking waste management is shared between everyone that is able to make a contribution. The City Corporation will maintain its overall responsibility, as set out in the Paurashava Ordinance, 1977, for ensuring rubbish is removed from the streets of the city and that the effects of rubbish do not compromise the health of its residents.

The gains to be achieved from implementing this framework will be visible on the street, with cleaner streets, clear drains and less flooding. Residents' health will be protected and civic awareness and pride will be enhanced.

5.3   The Short term – up to 3 years from now

The short term will include activities to be completed over two – three years.

During this period, community based organisations and the City Corporation should work together to improve the collection and removal of rubbish from homes and businesses. There are three distinct phases to achieve this:

5.3.1   Phase 1 – Pilot Schemes

Sylhet City Corporation, in conjunction with a NGO, or Community Based Organisation, will establish a trial project in one or two mohollas. The following activities will be undertaken in the first 6 – 12 months:

establish **Sylhet Waste Management Steering Group** consisting of Conservancy Section staff from the City Corporation, NGOs, and other interested bodies, chaired by the City Corporation's Chief Engineer

undertake a survey of residents in the trial areas.

raising awareness of residents so they begin to understand the importance of collecting rubbish and disposing of it in a proper way, so that pollution and flooding of drains is avoided and that the responsibility of managing rubbish is theirs as well as the city's; Civic Pride will the main objective

establish a 'Primary Collection' round that will collect separated wastes, recyclables such as paper, vegetable waste and non-recyclables. Vegetable waste will be composted, recyclables will be sold and the City will dispose non-recyclables.Rubbish collection will be undertaken using rick-shaw vans. Residents will be encouraged to pay for the collection of rubbish from their homes.

in the area that already has a scheme established, introduce community-based composting

the 'Secondary Collection' stage from corporation rubbish bins in the areas of the trial must be improved so that resident confidence in the project is maintained. Failure to maintain rubbish bins will destroy the value of raising awareness.

area around rubbish bins in the trial project area must be completely cleared of all rubbish that has overflowed into the drains over time. Rehabilitation of these areas and reconstruction of the bins, with continued maintenance of them in a clean condition will reinforce the value of the awareness raising and collection scheme

strong boots and gloves and facemasks are provided for the protection of rubbish collectors' health.

5.3.2   Phase 2 – Expansion and Improvement

This phase will focus on 2 issues in the short term up to 2-3 years;

the expansion of Primary Collection and community-based recycling and composting schemes across the whole of Sylhet City;

The outcome from the work of phase 1 will be a clear understanding of the methodology to establishing Primary Collection schemes and community-based waste recycling and composting

schemes. To assist the expansion of Primary Collection schemes across the whole city, it is proposed that a **Community Waste Toolkit** is produced. The Toolkit will set out the clear steps required to establish new schemes. The Sylhet Waste Strategy Steering Group should prepare the Toolkit and be active in promoting its use.

Expansion of Primary Collection schemes across the city will take time and it is estimated that complete coverage can be achieved in 2-3 years.
thorough improvement of the Secondary Collection undertaken by the   coupled with rehabilitation of the rubbish bins and surrounding areas where rubbish has accumulated in drains and roadsides.

Success of the awareness raising and Primary Collection scheme will depend on residents confidence in clean streets being maintained. As the Primary Collections expand across the city there will be a need for Secondary Collections to be regular and reliable. The current state of rubbish bins, with rubbish lying around and blocking the drains, will not secure this confidence. All rubbish bins must be included in a programme of rehabilitation that includes the following:
all areas around bins must be completely cleared of all accumulations of rubbish
proper hard surfacing and boundaries to bins being reconstructed to contain rubbish and prevent it falling into drains
vehicles attend rubbish bins in a sequence that is logical and efficient
vehicles attend rubbish bins at more appropriate times, such as during the night, taking advantage of less traffic and cooler temperatures
rubbish collectors are given regular health checks
investigate and, if applicable, secure more appropriate vehicles for rubbish collection and tools to load them
ensure sufficient number of vehicles are employed

It is likely that the Primary Collection schemes will create a reduction in waste for disposal per household. However, with the quantity of waste being collected increasing from 40% to near 100%, it may be the case the Corporation will not witness any reduction in the quantity being disposed in the long term.

The Corporation should consider increasing the number of rubbish bins located in streets and commence a programme of introducing litterbins along main roads. A significant problem with litter in roads is that people have no where else to place their wrapper. Litterbins when supported by awareness raising can reduce the amount of rubbish dropped in the streets by pedestrians. Litterbins could be emptied during the Secondary Collection.

The Corporation should, through development with the Sylhet Waste Strategy Steering Group, introduce new Bye-laws, Rules or Regulations, as may be suitable and in accordance with the powers of the Corporation, for the improvement of waste management on the streets and from homes and businesses. It is already feasible for waste storage containers to be stipulated as part of planning conditions for new buildings, but the Corporation may wish to insist on certain businesses, such as private clinics, containing their special wastes separately from the general waste.

5.3.3 Phase 3 – Service Development

The Waste Strategy
By the end of the Short term it will become clear how waste is being collected, both in the Primary Collection and in the Secondary Collection. The quantities of different wastes will be better known. It is at this time that the Sylhet Waste Strategy Steering Group should review this framework and commence formulating a Thorough Waste Strategy.

A Waste Strategy is a policy document that sets out the overall objectives of how waste is to be managed. Projections for quantities of waste being produced, due to economic and development growth, will significantly drive the needs of Waste Management in the future. The Strategy will identify how waste is to be disposed in the medium and long terms and estimate the capacities of any facilities that may be required. A move towards 'contracting-out' should be considered and a framework for achieving this should be included.

A Waste Strategy should also set out other significant policies that must be adopted in conjunction with Waste Management. These should include enforcement against offences relating to waste, pollution offences.

Tax Collection, Planning and public involvement

A thorough examination of the methodology the Corporation employs to collect rubbish from the designated places should have identified the need for more resources. Resources in the form of workers and vehicles require financing. It will therefore be necessary for the City Corporation, to increase the success of its tax collection.

Planning rules, if they do not already exist, should be developed to strengthen the requirement of developers and occupiers to place rubbish out for collection in designated places. Under the scheme developed in Phase 1, Primary Collection schemes will undertake collections of rubbish from homes and place it in the designated places. Developers of new properties should provide adequate capacity containers and storage space for rubbish so that Primary Collections are able to be made more efficiently and will assist in keeping streets clean in between collections.

Public involvement in all issues concerning public services is of utmost importance if responsibility, ownership and support of schemes is to be successful. In deed, it has been indicated by the World Bank and the Asian Development Bank that any applications for external funds to assist in the development of waste facilities in the medium and long term will require demonstration by the City Corporation that minimum levels of tax collection and public involvement, amongst others, have been achieved.

The City Corporation, should consider setting a tax, if one does not already exist, for the Secondary Collection and disposal of rubbish produced by shopkeepers and businesses, but most importantly, supported by an increase in the level of tax collection.

5.4 Medium Term – up to 5 years from now

The medium term covers the period 2 to 5 years from now.

Landfill

Waste disposal must be properly addressed at this time. The current practice of dumping rubbish on a field outside of the city is not Waste Disposal and will lead to increased significant pollution of water and land in the area. The area of land currently being used for this purpose should be properly engineered and remediation of the contaminated land undertaken. Any contaminated land can be used in the landfill for fill and the void it produces used as additional capacity.

The opportunity exists for the landfill site to have significant capacity for many years of disposal, but will require careful planning and implementation. Isolated capacity can be set aside for special waste such as clinical waste. Ultimately the site can be returned to pasture and potentially become a park for enjoyment of residents. This can be achieved in stages and a fully engineered site would be constructed to allow this.

Pollution from waste will be contained within the landfill site and be treated to make it safe. In the long term, electricity may be generated from the landfill site by burning the gases that are created by degrading wastes.

Financing of an engineered landfill site is likely to be achieved with the assistance of the World Bank and Asian Development Bank. However, any such applications are likely to be successful only if the City Corporation has produced a Waste Strategy and can demonstrate minimum performance levels of certain public functions, such as tax collection.

Planning for Growth

The city is developing and growing and is supporting an increasing population. Services must grow to match the demands of the population. To ignore growth will be to the detriment of the service and will undo much of the important and successful work achieved over the preceding years.

The Sylhet Waste Management Steering Group can be instrumental in maintaining quality service provision as the city grows. New Primary Collections schemes must continue to be introduced and Secondary Collections must expand to match.

Private Sector & Contract Management

The City Corporation will be very clear by this time on the levels of performance that can be achieved in the Secondary Collection. An opportunity exists for the City Corporation to enter into contracts with private sector companies to undertake Secondary Collections.

Engineered landfill must be designed and constructed in a proper way and, unless the City Corporation acquires this skill, the private sector must be used to design and construct it. It is

likely to be more efficient for the City Corporation to enter into contract with the private sector for the management of the landfill site.

Contracting-out these basic public services will leave the City Corporation with the function of Contract Managing the contractors. Therefore, contracts must be based on performance or output specifications so that the Corporation is able to monitor contractor's performance and ensure it is getting value for money.

5.5   Long Term – up to 10 years from now

The long term sets out the type of issues that must be considered and planned in the period 5 to 10 years from now so that the development of Waste Management will provide for as much as 25 years beyond that time.

This overall framework gives an indication of what the City Corporation's Waste Strategy will have to consider and include. It is nearly impossible to set out how Waste Management may develop in the next 10 years and the City Corporation must be mindful to take account of international law that may become applicable to waste management and pollution control at any time in the future.

Landfill will not continue to support a growing city and will eventually become full. The potential life of the landfill can be extended by moving to a more sustainable disposal method such as incineration with recovery of energy, generating electricity. By products from incineration such as metal recovery and recycling of bottom ash into building blocks is possible and reduces the need to dispose of incinerator ash. Some wastes will continue to be land filled.

5.6   Criteria for selecting Pilot Mohollas & NGOs

Pilot Mohollas

The Waste Strategy Steering Group should agree what the criteria for selecting the Mohollas for the pilot should be. The following provides an outline of suggested criteria.

The state of the streets in the pilot area should be as representative of the city as is possible. That is to say that it should not be the area with the least nor the most amount of rubbish on its streets If slums are concentrated in a moholla then they should be avoided for the pilot areas as these may require special attention

The concentration of housing and shops should be typical of the built-up part of the city, and should contain multi-storey buildings as well as single storey

The pilot areas must have Municipality rubbish bins located in the area

A main road should run through the pilot area containing shops and businesses

A plot of land for recycling and composting activities in the pilot areas are not necessary as it is likely that such plots will not exist in all mohollas. However, one moholla must have a plot for recycling and composting so that a comparison can be made with one that does not.

NGOs

The Waste Strategy Steering group should agree the criteria for selecting an NGO to undertake the pilot project. The following points are provided to assist the group.
It is not intended that the pilot project should develop a new methodology for creating community involvement and Primary Collections, but should attempt to replicate a successful project. Therefore, it would be useful if the NGO has experience, best practice, and a successful model, to apply to the pilot areas.

The NGO must be able to demonstrate a respectable and auditable organisational and institutional infrastructure, with a Mission Statement or similar, accounts, portfolio of activities

An NGO without experience may wish to work with another NGO that does have experience, and the Steering Group should consider this option to facilitate expedient sharing of knowledge

The NGO must have the willingness and available staff resources to dedicate to the pilot(s), and be prepared to work with other organisations for the benefit of the pilot project

Ideally, the NGO will have access to funding, or be capable of attracting funding, for the support of the pilot

5.7 . Monitoring and Evaluation

5.7.1 Introduction

Monitoring and evaluation of any work stream is an important part of project management to ensure that a project is on target to achieve its aims and objectives within the resources and timeframes set for it.

5.7.2 Standards

The framework of monitoring requires standards against which monitoring can be carried out. 'Improving the cleanliness of the city' is a subjective statement, and at any time the cleanliness may well have been improved, but the mission of the project may suggest ever improving cleanliness beyond what is economically and practically viable. Without standards, a project team in this field of work is likely to be working without a clear definition of what is expected, although job descriptions may well describe what tasks are to be carried out. Standards, allow others to be aware of what the project is trying to achieve, and sets a ceiling beyond which additional resources are likely to be wasted. The following standards are proposed:

5.7.3 Monitoring of Operations

There are two levels of monitoring that should be adopted:

- Operatives, and
- Supervision

Operatives

It is necessary in providing a reliable and quality service to be sure that the defined work is actually being carried out.

Having defined the quality of work to be undertaken and the area within work is to be carried out, it should be relatively straight forward to check that the work is being done.

Monitoring further provides the opportunity for identifying 'HOT SPOTS'. Hot spot have the result of diminishing the effectiveness of the rubbish collection scheme, possibly allowing a culture of dumping in certain areas to continue at the detriment of the whole area being cared for. Monitoring should be carried out on a daily basis, but at a time that takes account of the times of rubbish collection. The Supervisor should be in the field almost permanently while Environmental Operatives are at work. The following items are typical of those that might be recorded during a monitoring regime:

- Date, Time,
- Name of Street inspected
- Amount of rubbish evident, including litter
- Any Hot Spots, described by location and size

An example sheet is attached. It is impractical, unless absolutely necessary, to inspect every street in a day. Therefore, a regime of inspections must be developed that places the supervisor in different parts of the service area at different days and times, but so that every street is inspected over the course of a defined period, of say a week.

Supervision

Monitoring of supervision is equally important in managing the successful operation of the service and may simply take the form of reviewing the monitoring sheets on a regular basis, say once a week. The following items may be checked:

- Inspection record completed satisfactorily
- Appropriate action has been taken against any unsatisfactory performance
- All streets are being inspected.

Monitoring Record Sheet

Name of Supervisor:

Date:

Street Name	Time Inspected	Details of rubbish and litter	HOT SPOTS

Supervisor's comments:
Reasons and Action taken to correct missed or incomplete rubbish
collection:..
....
....
....

5.7.4 Performance Indicators

Performance indicators and service efficiency factors are valuable in helping assess and evaluate the service and allows the following to be carried out:

- Provide common data across a number of similar service areas and work areas
- Allow comparisons across work areas to determine best efficiency.
- identify service deficiencies for corrective action
- apply the model in other areas in a knowledgeable and informed manner

Information should be gathered based on the service area as a whole, and based on the individual work areas assigned to each of the environmental operatives. The following are examples that may be applicable, and all such information should be gathered that is considered necessary to be able to make proper decisions to improve effectiveness:

Table 5.1   Indicators of Standard (Work Area Basis)

Number	Description	Units
WA1a	Number of households served	No.
WA1b	Area served	Square metres
WA2a	Distance to nearest Municipal Rubbish Bin from centre of area	Metres
WA2b	Time to travel from centre of area to rubbish bin	Minutes
WA3	Actual time taken to complete work area	Hrs:mins
WA4	Charge collection efficiency = $\dfrac{\text{Number of households paying the charge}}{\text{Number of households served}} \times 100$	%
WA5	Other waste management options in operation	

Having attained this information, comparisons can take place and appropriate questions or reviews taken to determine and provide explanations for differences, or influence appropriate change to work areas. An important factor that may help explain differences in these indicators may be the characteristics of the area being served, and it is important to record these for applying the model to other service areas:

WAI	Number of households served	Density of households served = WA1a/WA1b	Households served per allocated man-hour	Households served per actual man-hour
Work Area 1				
Work Area 2				
Etc....				

Service Area

An overall objective of the project is that it demonstrates sustainability. It is desirable it becomes self supporting financially if it is to be replicated elsewhere, so that in the long term such schemes do not require grant aid of any sort.

The preceding indicators based on work areas will assist in reducing unnecessary costs. The following indicators should be maintained and reviewed on a regular basis:

Table 5.2:   Indicators of Standard (Service Area Basis)

Number	Description	Units
SA1a	Actual cost of residential rubbish collection per household served	Tk per household
SA1b	Charge for residential rubbish collection per household served	Tk per household (Must be greater than or equal to SA1a)
SA2	Charge Collection efficiency = total number of households paying charge / total number of households served	%
SA3a	Actual cost of VIP route rubbish collection per business served	Tk per business
SA3b	Charge for VIP route rubbish collection per business served	Tk per business (Must be greater than or equal to SA3a)
SA4	Charge Collection efficiency = total number of businesses paying charge / total number of businesses served	%

Costs should include all overheads and capital repayment and financing costs that would otherwise be payable without grant aid. All grant aid should be excluded from income costs as if it was not provided.

Service reviews

In ensuring the optimum efficiency of rubbish collections, and time allocated to the work area, the following service reviews should be borne in mind:

- The number of environmental operatives and their individual allocated times to work areas, so that appropriate time is allowed for completion of residential rubbish collection, and extended hours of rubbish collection on VIP route is allowed.

- With the introduction of recycling and composting, the amount of rubbish collected in the Primary Collection is likely to reduce. What changes to the allocated work times, number of households served etc. in the affected service areas can be introduced that will allow greater efficiency of the environmental operatives.

- What other 'added value' environmental services could be introduced in the work areas, such as clearing HOT SPOTS, if time is identified following a review.

Chapter 6

Conclusions and Recommendations

6.1 Opportunities to Improve the Solid Waste Management of Sylhet City Corporation

Options for improving the solid waste management services of Sylhet City Corporation include efforts to focus on cost effective approaches, to mobilize public support and participation, to improve policy interventions, and to close the knowledge gap. Mobilizing public support and participation for solid waste management involves raising awareness of problems and solutions and promoting participations by NGOs and by the informal sector. On the policy side efforts should focus on improving the coverage, efficiency and effectiveness of individual interventions as well as on choosing an appropriate balance of policies and instruments. This can be done efficiently by creating mutually supportive packages that emphasize strategic investments and financing.

6.2 Improving the solid waste management of Sylhet City Corporation: Key principles

Win-win environmental solutions occur when environmental and economic goals are complementary. City Corporation can develop a service department for helping and encouraging the NGOs, individuals who are interested to work on environmentally sound waste management services. City Corporation can facilitate the participants by providing land for resource recovery system without any tax.

Sylhet City Corporation

Figure 6.1: Target Area and Key Data

Table 6.1 : Household, Commercial Units, Population (Block & ward wise):

Block No	Ward No.		Number of Household	Number of Commercial Holding	Total Holding No.	Number of Population
A	1	1,2,3	4655	749	5404	29973
	2	11,12	4943	461	5404	25453
B	3	13,14	4306	4372	8678	22176
	4	15,16,17	5253	585	5838	27115
	5	18,19	9114	1988	11102	40838
C	6	8,9,10	5777	559	6336	27888
	7	6,7	6322	756	7078	31610
	8	4,5	6990	420	7320	34949
D	9	20,21	5549	300	5849	27745
	10	22	2000	88	2088	10000
	11	23,24	4074	71	4145	20370
E	12	25,26	4164	-	4164	20818
	13	27	2709	-	2709	13544
Total	13	27	65856	10349	76205	332479

Source: Sylhet City Corporation (2002)

Block A
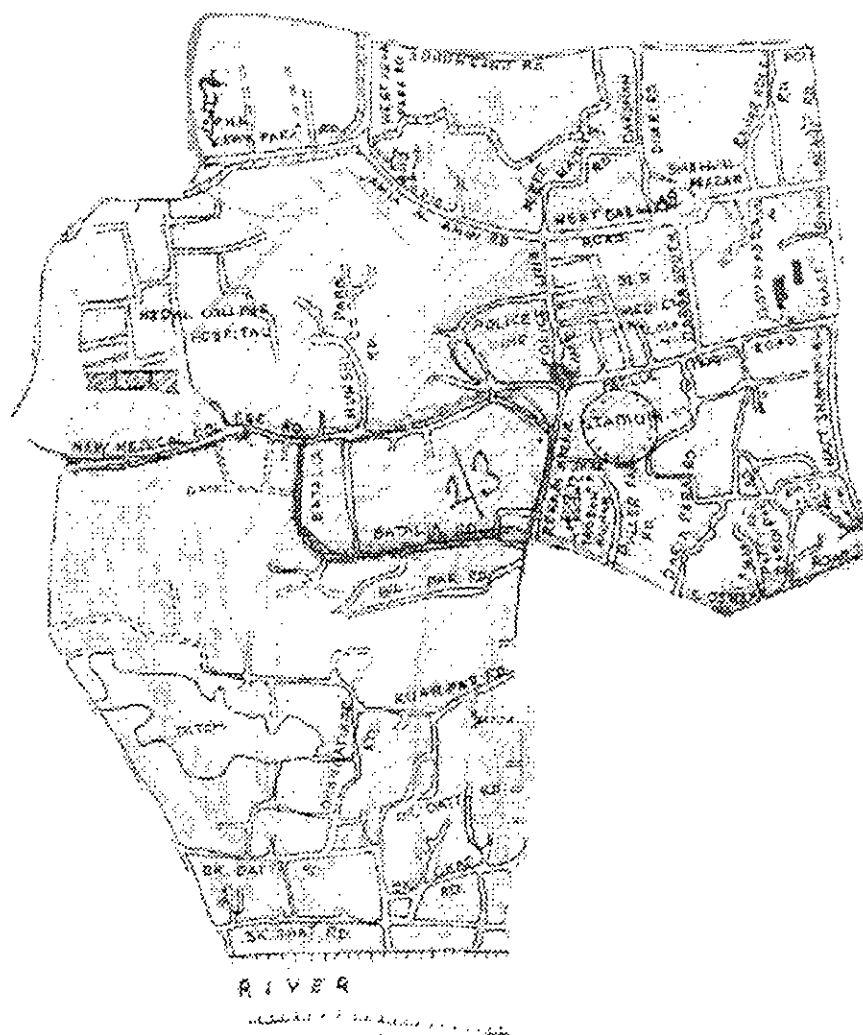
Figure 6.2: Block A

Key Data :

Items	Number
1. Electoral Wards.	1, 2
2. Number of Household	9598
3. Number of Commercial Units	1210
4. Total Holding	10808
5. Number of Population	55426

Main of Paras/ Mohollas:
Lamabazar, Shoroshpur, Kajolsha, Dorgamoholla, Kaji Ilias, Mirermoidan

Source: Sylhet City Corporation (2002)

Block B
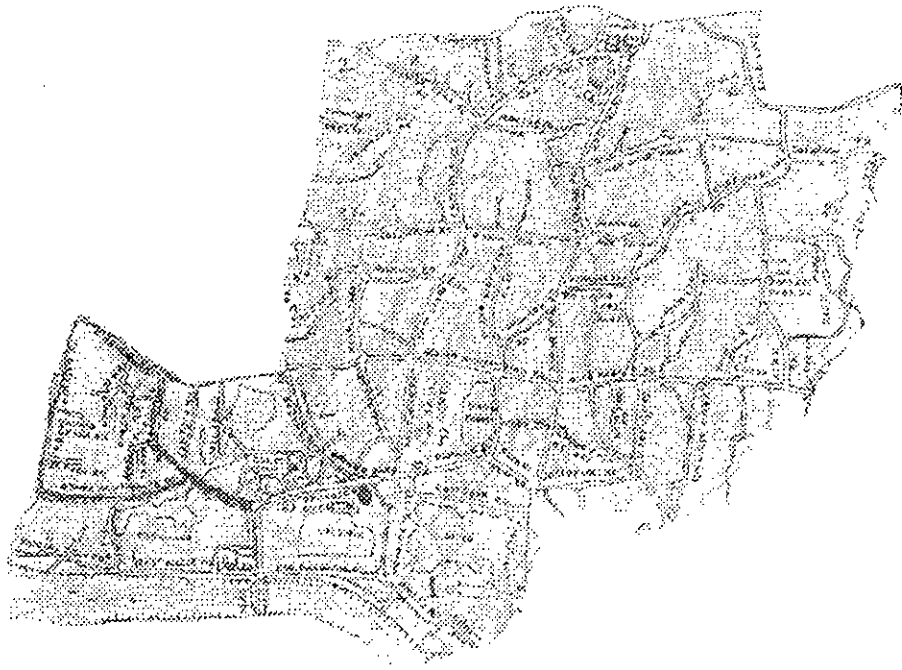
Figure 6.3: Block-B

Key Data :

Items	Number
1. Electoral Wards. (Old)	3, 4, 5
2. Electoral Wards (New)	13,14,16,17, 18,19
3. Number of Household	18673
4. Number of Commercial Units	6945
5. Total Holding	25618
6. Number of Population	90128

Main of Paras/ Mohollas:
Taltola, Topkhana, Kajitola, Howapara, Kumarpara, Mirabazar

Source: Sylhet City Corporation (2002)

Block C

Figure 6.4: Block-C

Key Data :

Items	Number
1. Electoral Wards (Old).	6, 7, 8
2. Electoral Wards (New)	4,5,6,7,8,9
3. Number of Household	19089
4. Number of Commercial Units	1735
	20824
5. Total Holding	94447
6. Number of Population	

Main of Paras/ Mohollas:
Kanishail, Bagbary, Housing Estate, Shubidbazar, Amberkhana, Mozumdary

Source: Sylhet City Corporation (2002)

Black D
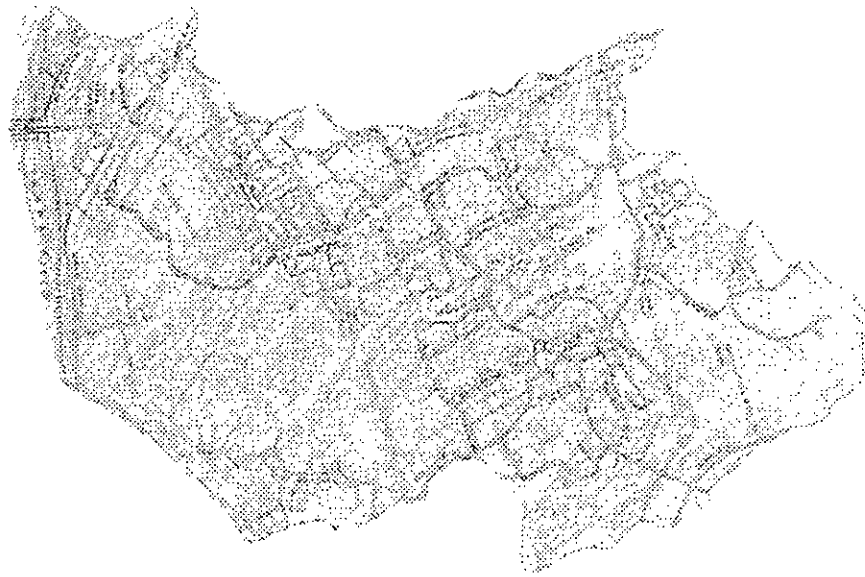
Figure 6.5: Block-D

Key Data :

Items	Number
1. Electoral Wards. (Old)	9, 10, 11
2. Electoral Wards.(New)	20,21,22,23,24
3. Number of Household	11623
4. Number of Commercial Units	459
5. Total Holding	12082
6. Number of Population	58115
Main of Paras/ Mohollas: Shibgonj, Shenpara, Tilagor, Shahajalal Uposhohor, Mirapara, Masimpur	

Source: Sylhet City Corporation (2002)

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Figure 6.6: Block-E

Key Data :

Items	Number
1. Electoral Ward (Old)	12, 13
2. Electoral Wards (New)	25,26,27
3. Number of Household	6873
4. Number of Commercial Units	- 6873
5. Total Holding	34362
6. Number of Population	

Main of Paras/ Mohollas:
Shibbari, South Surma, Kodomtoly, Vartokhola, Khozerkhola, Gotatibari

Source: Sylhet City Corporation (2002)

Table 6.2 Land Requirement for Composting Activities in Sylhet City Corporation

Zone of Sylhet City Corporation	No. of Household in 2002	No. of Households up to 2025	Quantity of Waste (ton)	Quantity of Compostable portion (ton)	Necessary Land (sft)
1	10808	310730	564	383	357339
2	25618	736518	1336	909	848097
3	20824	598690	1084	739	649487
4	12082	347358	631	430	401190
5	6873	197599	359	245	228585
Total Land Required			2484698 sft = 5734 decimal = 192 care		

Assuming Household change rate -25.2%, Waste generation rate is .33 kg /cap/ day, average household size is 5.5, compostable portion in household waste is 68.3% and 933 sft is required for 1 ton composting plant (Data Source: Baseline Study of Sylhet City Corporation (2002)

DIAGRAM 1 - EXISTING WASTE MANAGEMENT IN SYLHET

The size of the box for each element represents the size of the activity in relation to, and when, all other interdependent elements are in place and working
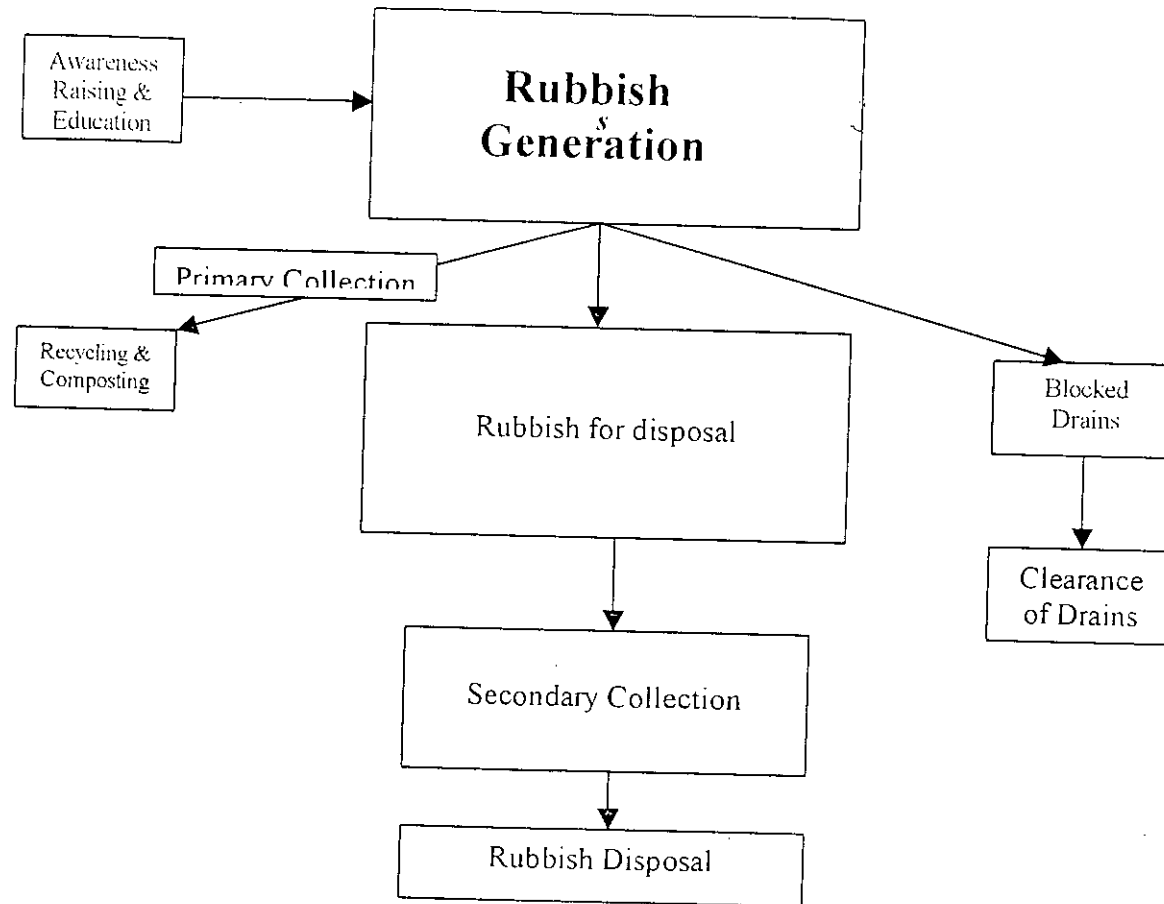
DIAGRAM 2 - IDEAL INTEGRATED APPROACH TO WASTE MANAGEMENT IN SYLHET

The size of the box for each element represents the size of the activity in relation to, and when, all other interdependent elements are in place and working.

| Awareness Raising & Education | → | **Rubbish Generation** | ← | Waste Reduction |

PRIMARY COLLECTION

| **Recycling** 11% | **Composting** 68% | Rubbish for disposal 21% |

| Rehabilitation, reconstruction and maintenance of collection points | → | Clearance & Protection of Drains | → | Secondary Collection |

Rubbish Disposal
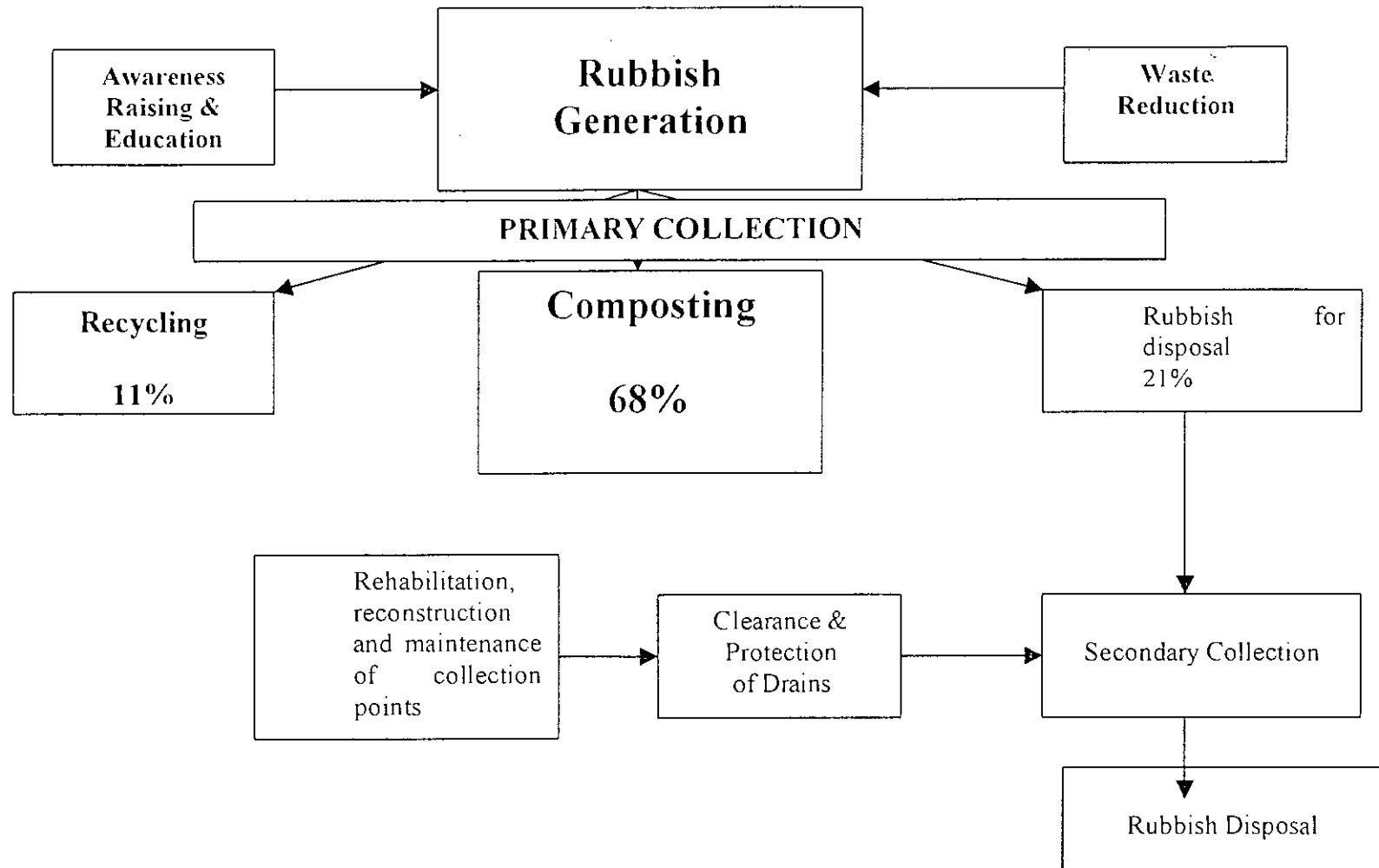
6.3 Recommendations as well as suggestions for Promoting Community based Solid Waste Management system in Sylhet City Corporation

- The policy makers of Sylhet City Corporation should consider the problems result from unhygienic solid waste management with importance and the policy of the conservancy strategy should encourage the participation of NGOs and private sector in conservancy services.

- The waste generation rate is 0.34 kg/cap/day. Most of the households (73%) produced 1-2kg daily Among the household waste, 34.7% is coming from cooking, 27% is coming from homestead activities and the rest covers cosmetics, toilet, education and cloth. Among the household waste 68.3% is compost able, 11.7% recyclable and the rest 20% is disposable.

- In developing the master plan of the City Corporation, Sylhet City Corporation should consider the necessary land (192 care) for recycling of waste for next 25 years.

- Sylhet City Corporation should consider and facilitate the private body who are interested in composting by providing land and supplying raw materials for composting.

- Sylhet City Corporation should take massive awareness programme to involve all the stakeholders such as expert, academicians, city dwellers, civic societies, city council authorities, city dwellers to aware the people in participating the model waste management programme.

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ABBREVIATIONS:

BBS	: Bangladesh Bureau of Statistics
BUET	: Bangladesh University of Engineering & Technology
CBO	: Community Based Organization
CBSWM	: Community Based Solid Waste Management
CI	: Conservancy Inspector
LGED	: Local Government & Engineering Department
NGO	: Non-Government Organization
SCC	: Sylhet City Corporation
UNDP	: United Nation Development Programme

Appendix 1

Case Study of Static Windrow Method Composting

Sylhet Partnership is a not for profit organization has been operating in Sylhet since January 2001 to bring practical innovation and sustainable solutions to tackling key urban problems in Sylhet. The key areas of intervention are community based solid waste management, better environment for education, business sector development and health and poverty. Under waste management programme Sylhet Partnership developed a framework for better conservancy services. Recently they have completed a pilot project titled "**Keep Sylhet Clean**" in 5 words of the city. Community based composting was the most important and interesting one among the project activities. They used the Static windrow method for composting.

The Pilot Project serves primary waste collection services in 2000 homes.

Number of homes	2000
Number of people	11,000
Approximate amount of rubbish collected each day	3.3 to 4.4 tonnes each day
Amount suitable for composting	2.25 to 3 tonnes each day
Land required for composting	2,100 to 4,900 square feet (53 ft by 40 ft to 82 ft by 60 ft)
Land used for composting	150 ft by 45 ft

Source: Sylhet Partnership

Methodology

Sylhet Partnership adopted following principles

* **Sorting**

An area of 40 feet by 14.5 feet is set aside at one end of the plot for the reception of rubbish from the primary collection and sorting of organic, recyclable and inorganic is taken place.

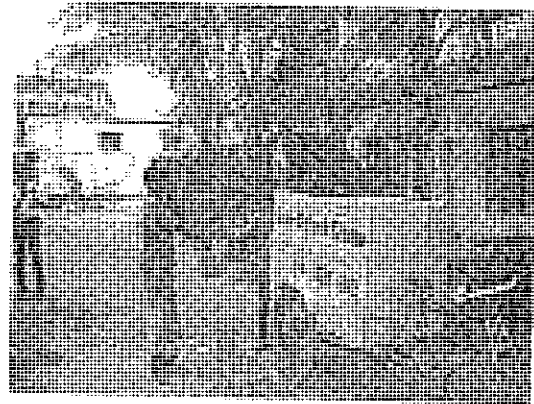Sylhet Partnership engaged 6 labours to operate the plant.

Figure 6.3: Rubbish Collection from household

- **Composting & maturing**

Eight boxes of each 160 sft size and two packaging platform of each 350 sft is constructed at the middle of the plot. Each box receives seven consecutive day's rubbish, so that all boxes can receive 8 weeks consecutive rubbish.

The boxes have internal dimensions of approximately 25' x 6.5' and 5 feet tall, giving each a capacity of 810 cubic feet.

The packaging area is two each of 25 feet by 14 feet.

Figure 6.4: Drying of Compost

Construction

Water, drainage and electricity is provided. The whole facility, including sorting, composting, maturing and packaging area is covered to protect workers from sun and rain, and to reduce unnecessary drying out of compost.

The sorting area is of concrete slab construction, with suitable drainage and soak away to allow washing down and prevent accumulation of foul water around the facility. A washing area for the operatives is provided.

The composting bays are constructed of hollow block with one-sided steel door.

All other areas between and around the composting bays are concrete, while the base of the bays is open to the earth, allowing drainage to the underlying soil and migration of worms, invertebrates and the like.

পারিবারিক জরিপ কর্মসূচী

<u>প্রশ্নমালা</u>

প্রশ্নোত্তর দানকারীর নাম

কোড নং-

ঠিকানা-

A. পারিবারিক তথ্য

১) পরিবারের সদস্য সংখ্যা কত?

জন।

২) পেশা

    ক) চাকুরী   খ) ব্যবসা   গ) অন্যান্য

৩) শিক্ষা

    ক) নিরক্ষর   খ) অক্ষরজ্ঞান সম্পন্ন   গ) শিক্ষিত

৪) মাসিক আয়

    ক) ১০০০ এর নিচে   খ) ১০০০-৫০০০   গ) ৫০০০-১০,০০০ ঘ) ১০,০০০ এর উর্ধ্বে

৫) ধর্ম

    ক) মুসলিম   খ) হিন্দু   গ) বৌদ্ধ   ঘ) খৃস্টান   ঙ) সর্বপ্রানবাদী

B. ভৌগলিক অবস্থান

১) গৃহের অবস্থান

    ক) নদী/পুকুরের পার্শ্বে   খ) খোলা মাঠে   গ) বন জঙ্গলের পাশে

    ঘ) অন্যান্য

২) কতদিন ধরে সিলেট শহরে আছেন?

৩) বাসার ধরন
    ক) নিজস্ব   খ) ভাড়া   গ) অন্যান্য
৪) বাসার হোল্ডিং নং

C. বর্জ্যের মান ও পরিমান

১) বর্জ্যের উৎস
    ক) রন্ধন কার্যে   খ) প্রসাধনি ব্যবহারে   গ) গৃহস্থালির কাজে।   ঘ) গোসলখানায়

    ঙ) শিক্ষা উপকরন   চ) পরিধেয় বস্ত্র   ছ) অন্যান্য

২) বর্জ্যের ধরন
    ক) খাদ্য সম্পর্কিত   খ) কাগজ   গ) প্লাস্টিক   ঘ) ক্যান   ঙ) বোতল   চ) ধাতব পদার্থ

    ছ) বাগানের বর্জ্য   জ) পশু পাখির বর্জ্য   ঝ) পরিবার পরিকল্পনা সম্পর্কিত

    ঞ) রাসায়নিক (প্রসাধনী) বর্জ্য   ট) চামড়া   ঠ) কাঠ   ড) রাবার   ঢ) সুতা   ণ) রং

    ত) ছাই   থ) অন্যান্য

৩) বর্জ্যের পরিমাণ
    ক) ১ - ২ কেজি   খ) ২-৪ কেজি   গ) ৪-৫ কেজি   ঘ) ৫ কেজির ঊর্ধ্ব

D. প্রাথমিক সংগ্রহ ব্যবস্থা

১) আপনার ঘরের ময়লা কিভাবে সংগ্রহ করেন?

    ক) যেখানে সেখানে ফেলে রাখেন   খ) কার্য শেষে সুনির্দিষ্ট বাক্সে রাখেন

    গ) অন্যান্য

২) বর্জ্য সংগ্রহের জন্য পাত্রের ধরন ও আকৃতি

    ক) পলিথিন   খ) ঝুড়ি   গ) বালতি   ঘ) মাটির পাত্র

    ঙ) অন্যান্য

৩) পুনঃ ব্যবস্থাপনা বা রুপান্তরের জন্য সংগ্রহ করেন কি না?
    ক) হ্যাঁ   খ) না

i) হ্যা হলে কি কি

  ক) খাদ্য সম্পর্কিত   খ) কাগজ   গ) প্লাস্টিক   ঘ) ক্যান   ঙ) বোতল   চ) ধাতব পদার্থ

  ছ) পশু পাখির বর্জ্য   জ) রাসায়নিক (প্রসাধনী) বর্জ্য   ঝ) চামড়া   ঞ) কাঠ   ট) রাবার   ঠ) ছাই

  ড) অন্যান্য

ii) কেন সংগ্রহ করেন ?

  ক) পূণঃ ব্যবহারের জন্য   খ) বিক্রির জন্য   গ) অন্যান্য

না হলে আপনি কি প্রয়োজন বলে মনে করেন ?

৪) বর্জ্যের প্রাথমিক সংগ্রহে সম্পৃক্ত ব্যক্তি

  ক) কাজের লোক   খ) বাচ্চা   গ) গৃহকর্তা   ঘ) গৃহকর্ত্রী   ঙ) অন্যান্য

৫) প্রাথমিক অবস্থায় বর্জ্য কতদিন সংগ্রহ করে রাখেন?

  ক) ১দিন   খ) ২দিন   গ) ৩দিন   ঘ) তার চেয়েও বেশি

E. আপনার বাসার আবর্জনা সাধারণতঃ কিভাবে নিষ্কাশন করেন?

১) আপনার গৃহের আর্বজনা সংগ্রহের জন্য বর্তমানে কোন সংস্থা কাজ করছে কিনা?

  ক) হাঁ   খ) না

হ্যা হলে
সংস্থাটির নাম ও ঠিকানা

না হলে

২) আপনার বাসা থেকে নিকটবর্তী ডাষ্টবিনের দূরত্ব কত?
  ক) ১০ গজের নিচে   খ) ১০ থেকে ২০ গজ   গ) ২০ থেকে ৩০ গজ   ঘ) ৩০ গজ থেকে বেশী

৩) আবর্জনা সাধারনত কোন সময়ে ডাষ্টবিনে ফেলেন?
  ক) সকালে   খ) দুপুরে   গ) রাত্রে   ঘ) যে কোন সময়ে

৪) সঠিক অবস্থানে আবর্জনা পড়ল কিনা লক্ষ্য (বর্জ্যের নিষ্কাশনে সম্পৃক্ত ব্যক্তি) রাখেন ?
  ক) হ্যা   খ) না

৫) হ্যা হলে ডাষ্টবিনের কোথায় ফেলেন?

ক) ডাষ্টবিনের মধ্যে   খ) ডাষ্টবিনের আশপাশে   গ) ডাষ্টবিন থেকে অনেক দূরে

৬) সঠিক অবস্থানে আবর্জনা পড়ল কিনা গৃহকর্তা / কর্তীরা লক্ষ্য রাখেন কিনা ?
    ক) হ্যাঁ   খ) না

F. ডাষ্টবিন সম্পর্কিত তথ্য

১) ডাষ্টবিনের অবস্থান কোথায়?
    ক) ড্রেনের নিকট   খ) প্রতিষ্ঠান/সংস্থার নিকট গ) বহুমুখী রাস্তার মোড়ে ঘ) রেষ্টুরেন্টের কাছে
    ঙ) অন্যান্য।

২) ডাষ্টবিনের অবস্থা কিরূপ?
    ক) পরিচ্ছন্ন ডাষ্টবিনের মত   খ) ভাঙ্গা চোরা   গ) অন্যান্য

৩) ডাষ্টবিনের ময়লা সাধারনত উপচে পড়ে কিনা?
    ক) হ্যাঁ   খ) না

হ্যাঁ হলে কোথায় পড়ে?

৪) ডাষ্টবিন থেকে নির্গত তরল পদার্থ কোথায় পড়ে?

    ক) ড্রেনে   খ) রাস্তায়   গ) জলাশয়ে   ঘ) অন্যান্য

৫) খুব বৃষ্টিপাতের সময় ডাষ্টবিনের ময়লার কি অবস্থা হয়?
    ক) ড্রেনে পড়ে   খ) রাস্তায় পড়ে   গ) আবাসিক এলাকায়   ঘ) জলাশয়ে

    ঙ) অন্যান্য

G. মাধ্যমিক নিষ্কাশন ব্যবস্থা

১) ডাষ্টবিনের ময়লা কোন ধরনের যানবাহনের মাধ্যমে নিষ্কাশিত হয়?
    ক) খোলা ট্রাক   খ) বদ্ধ গাড়ি   গ) ভ্যান গাড়ি   ঘ) অন্যান্য

২) ডাষ্টবিনের ময়লা কোন সময়ে পরিস্কার করা হয়?
    ক) সকালে   খ) দুপুরে   গ) রাত্রে   ঘ) যে কোন সময়ে

৩) কয়দিন ব্যবধানে ময়লা পরিস্কার করা হয়?
    ক) ১ দিন   খ) ২ দিন   গ) ৩ দিন   ঘ) অন্যান্য

H. ক্ষতিকর প্রভাব

১) আবর্জনার সঠিক ব্যবস্থাপনার অভাবে ধিক্‌ধি সমস্যা সৃষ্টি হয়?
    ক) স্বাস্থ্যগত   খ) পরিবেশগত   গ) অর্থনৈতিক

২) স্বাস্থ্যগত অসুবিধার কারণে কি কি রোগ হতে পারে?
    ক) ডায়রিয়া   খ) আমাশয় গ) কলেরা   ঘ) টাইফয়েড ঙ) প্লেগ চ) ম্যালেরিয়া ছ) হেপাটাইটিস

জ) শ্বাসকষ্ট   ঝ) ডেঙ্গু   ঞ) ইনফ্লুয়েঞ্জা   ট) চর্মরোগ   ঠ) অন্যান্য

২) পরিবেশ গত কি কি সমস্যা হতে পারে?
ক) মাটি দূষন
i) মাটির উর্বরতা নষ্ঠ করে   ii) অন্যান্য

খ) পানি দূষন
i) পানি নষ্ঠ হয়   ii) পানিতে গন্ধ হয়   iii) পানির রঙ গাঢ় হয়   iv) মশক জন্মে

v) মাছ , জলজ উদ্ভিদ মারা যায়   vi) পচাঁ পানি মাটি ভেদ করে নিচে চলে যায়

vii) অন্যান্য

গ) বায়ু দূষন
i) বিশ্রি গন্ধ বের হয়   ii) ক্ষতি কারক গ্যাস উৎপন্ন হয়   iii) ধোঁয়া হয়

vi) অন্যান্য

l. বর্তমান ব্যবস্থাপনা

১) আপনার এলাকায় আবর্জনা সংগ্রহের জন্য বর্তমানে কোন সংস্থা কাজ করছে কিনা?
ক) হ্যাঁ   খ) না

হ্যাঁ হলে সংস্থাটির নাম ও ঠিকানা

২) ব্যবস্থাপনার জন্য কোন ধরনের খরচ বহন করছেন কিনা?
ক) হ্যাঁ   খ) না

হ্যাঁ হলে কত টাকা এবং কিভাবে?

৩) সংস্থাটি যেভাবে কাজ করছে, তাদের কাজে আপনি সন্তুষ্ট কিনা?
ক) হ্যাঁ   খ) না

না হলে কেন?

J. মতামত

১) আপনি সিটি কর্পোরেশনের বর্জ্য ব্যবস্থাপনার নিয়মনীতি সম্পর্কে জানেন কিনা?
   ক) হ্যাঁ   খ) না

২) সিটি কর্পোরেশনের আবর্জনা ব্যবস্থাপনার কোন ত্রুটি থাকলে তার কারণ কি হতে পারে বলে মনে করেন?
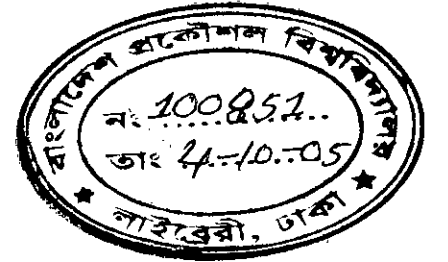
৩) সমস্যা সমাধানে আপনার উপদেশ কি?

৪) এই ব্যাপারে আমরা যদি নাগরিক সচেতনতা বৃদ্ধিতে কোন উদ্যোগ নেই তবে কি আপনি তাতে অংশ গ্রহণ ও সহযোগিতা করবেন?

   ক) হ্যাঁ   খ) না

   হ্যাঁ হলে কিভাবে?

- অর্থনৈতিক ভাবে

- সভা সমাবেশে সময় দেয়া

- স্বেচ্ছাসেবার মাধ্যমে

- পরামর্শ দিয়ে

মন্তব্যঃ

স্বাক্ষাতদানকারীর স্বাক্ষরঃ   স্বাক্ষাত গ্রহণকারীর স্বাক্ষরঃ

সঠিক তথ্য ও আন্তরিক সাক্ষাতকার প্রদানের জন্য আপনাকে অসংখ্য ধন্যবাদ।