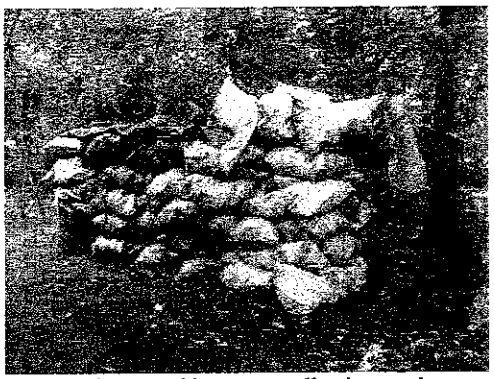
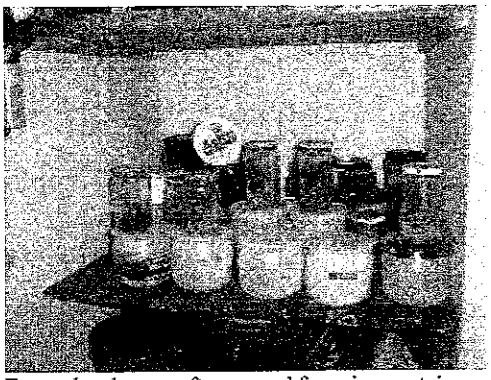
Recyclers purchase recyclables directly from households.

Used newspaper is sold at about 18 Rs per kg. It is often used for packaging and table napkins.

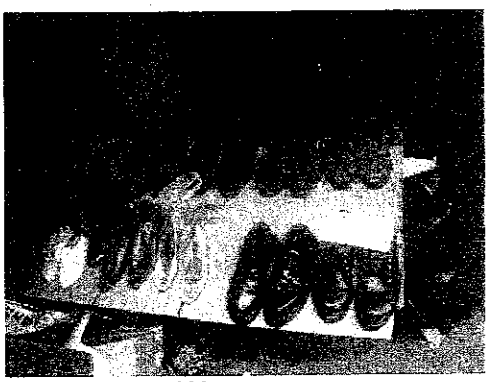


Recyclables stored by waste collection workers at Matale. This is very common practices which can be seen at most LAs.

Empty bottles are commonly reused as containers for various local products.



Empty bottles are often reused for spice containers.

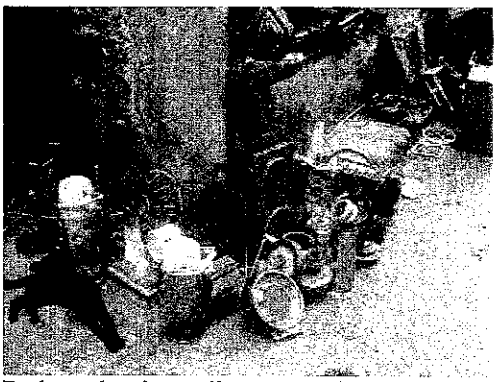


Used shoes are sold in towns.

Repairing old shoes and umbrella can be seen in any towns in Sri Lanka.

Old magazines and even Japanese magazines are sold.

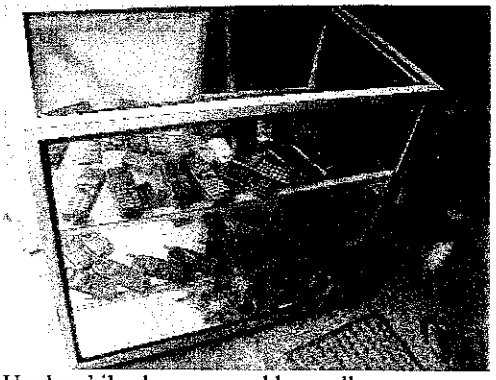
Shops selling used plastic containers and papers.



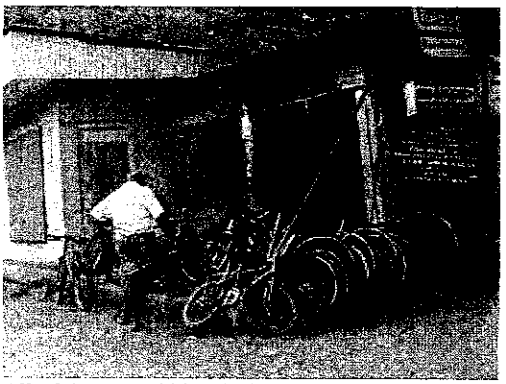
Broken electric appliances, machine parts and various items are sold.

This shop is mainly dealing with empty bottles and cans.

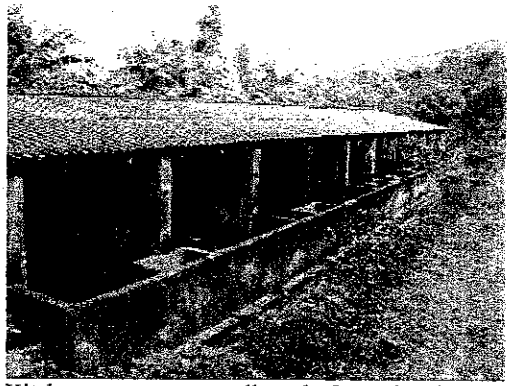
Used notebooks and documents are sold for making paper bags.



Used mobile phones are sold as well.



All of these used bicycles are brought from Japan.



Kitchen waste are collected from hotels and restaurants in Kandy for feeding to pigs.

There are quite number of reprocessing plant for plastic in the country. However, recycling used plastic is financially difficult because virgin material is often cheaper than the used plastic.

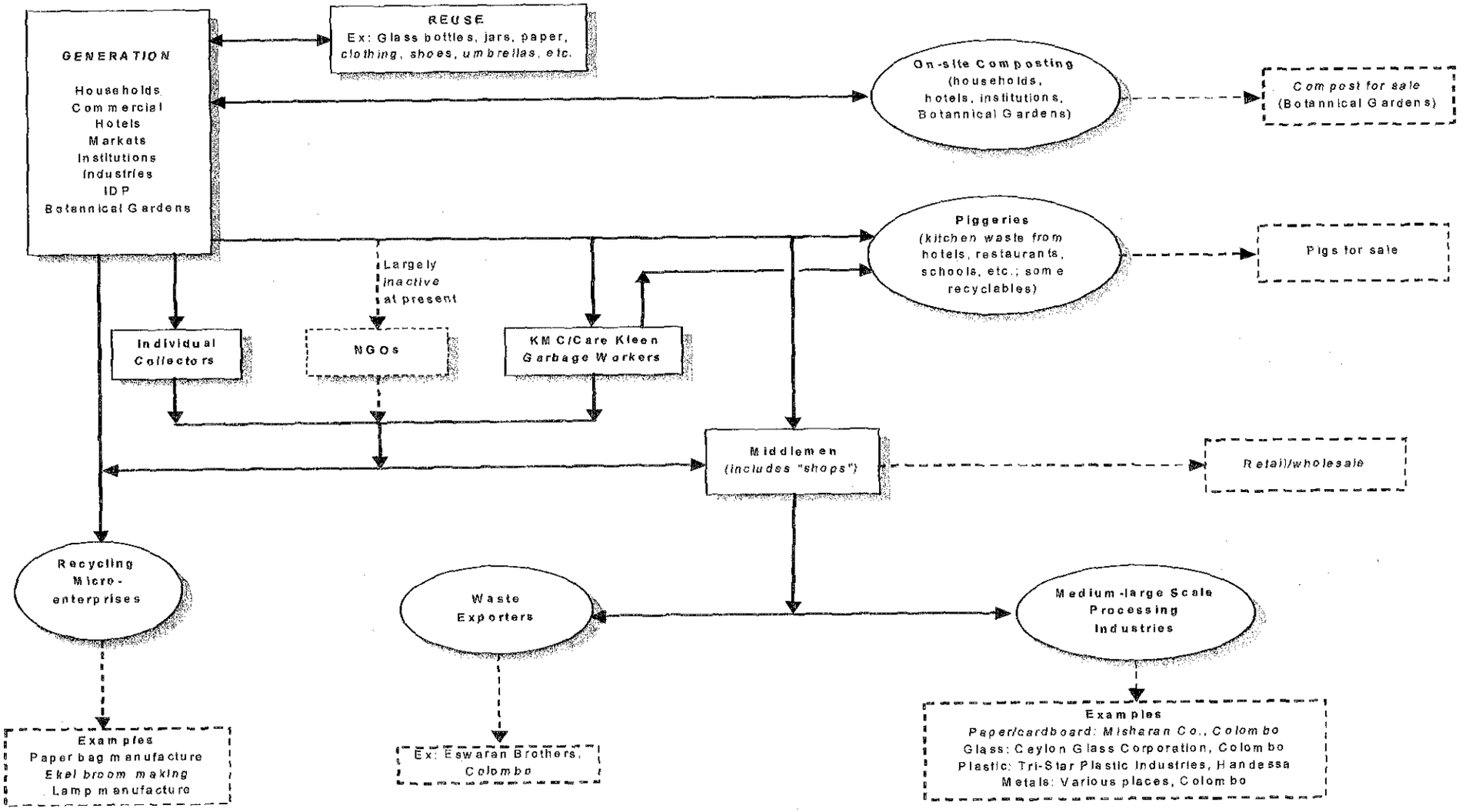


Figure 2-11: Typical 3 Rs Stream in Secondary Cities (Example at Kandy)

2.3.2.2 Newly Introduced Separate Collection System

Many projects targeting separate collection have been tried in Sri Lanka, however only a few projects are still continued. The following three projects are well known for their relatively high participation rate and stable performance. However, there is no local authority that carries out separate collection in its entire area.

a. Badwita in Dehiwala/Mt. Lavinia

In a part of Badwita, a community-based recycling program has been executed. People in 1,200 households separately discharge waste in two categories: biodegradable waste and non-biodegradable waste. White and black garbage bags are distributed by the MC to each family for that purpose. As for the biodegradable waste, the MC comes to collect it twice a week.

As for the non-biodegradable waste, two women employed by the MC collect it once or twice a week. Then, they and the manager of the newly built recycling centre sort this waste into paper, metal, and plastics (five categories: HDPE/PP/LDPE/LDPEmix/PPmix), which are sold to a private company. The method of sorting plastics was taught to them by an NGO called Seth Sevana. The profit in 2001 was about Rs.12,000.

As for paper, a volume of two to three garbage bags is collected daily. After collecting, the manager of the community recycling centre arranges it into a bale of 25 kg (equivalent to six garbage bags). This is sold to either the private company mentioned above or National Paper Cooperation.

b. Maharagama Pradeshiya Sabha

Maharagama which belongs to Western Province is very close to Colombo City. In a part of Mahalagama the separate collection of recyclable wastes started in 1998. The number of residences covered by the separate collection increased from 400 in 1998 to 3500 in 2002. Each household is given four different coloured plastic bags for plastics/polythene, paper/cardboard, metal/coconut husks and glass. The bags are provided free of charge and people have generally been very willing to cooperate with sorting their waste into different categories. The bags are collected twice every two weeks and taken to a building for further sorting. Some forms of waste can not be recycled and are taken to the dump. The remainder is sold to private organisations: paper to the National Paper Corporation, glass to the Ceylon Glass company, coconut husks to a variety of organisations while plastic/polythene waste is being stored until a suitable organisation is able to recycle it. The money made from these sales is used to fund the plastic bags.

Remaining waste is kitchen/garden waste which is suitable for composting. Some householders bury this remainder but the PS also provides composting bins at a subsidised rate of 350 Rs.

c. Arthacharya Foundation, Galle

The Arthacharya Foundation is currently working with nine low income communities or community based organisations (CBOs) in Galle on SWM recycling/home composting activities, together with a credit and savings scheme. The nine communities covers an estimated 477 households.

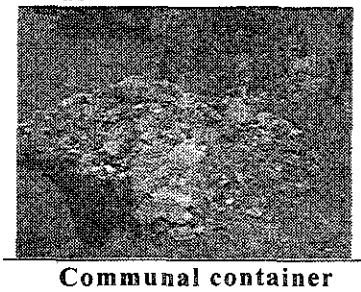
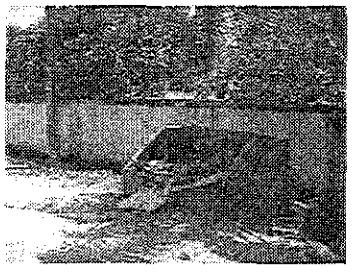
Members in each of the small groups collect, sort and store their plastic/polythene, paper/cardboard and glass, with this work typically being carried out by the women of the household. At the end of the third week of each month, the small group collects these recyclables at a group meeting, where they are weighed and subsequently transported to the city's Recycling Storage Depot for on-sale to middlemen and processing industries.

2.3.3 Discharge and Storage

2.3.3.1 Discharge and Storage System Used

a. Main system used

They are classified into the following three types.

System	Assessment
Direct discharging onto roads 	Very inappropriate. Lack of a proper storage system causes problems in regards to both sanitation and the view.
Communal container 	It is the most widely used method in local towns. However, it is unsuitable for the present social condition in Sri Lanka for the following reasons: ● It cannot prevent stray animals like dogs, goats, cows, crows, etc. from scattering waste. ● It cannot prevent waste from being scattered by wind. ● Keeping it clean is very difficult as it is communally used. ● Very difficult for loading waste onto a trailer.
Disposable bags 	It is not suitable for areas with many stray animals. It is getting very popular in Colombo, although it is still very minor in local towns. Most plastic bags currently used are made of very thin polythene which cannot prevent waste scattering by animals.

b. Improvement Measures

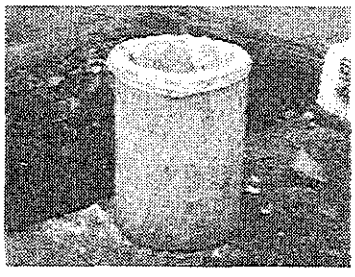
b.1 Plastic or Steel Buckets

A bucket with a lid can prevent waste scattering by stray animals. However, this does not seem suitable for the present social conditions, for low income residences in particular, due to the following reasons:

- A high possibility of stealing under the present social conditions
- Many buckets with lids as waste storage have been distributed to residences by donor agencies. However, they often use them as water containers instead of waste containers. Even though they are drilled before distribution, they are often patched and used for water.

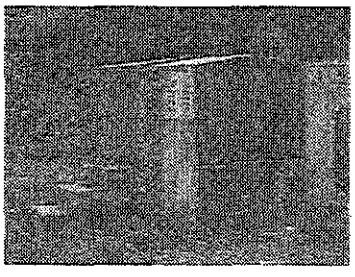
b.2 Hume Pipes

Sitavaka UC places hume pipes for waste container along roads. Because poly sacks are put in the pipes, it is easy to load waste onto a trailer. In addition, some residences separately discharge in-organic recyclables under poly sacks for recyclers. This is one of the curb-side collection methods. This is suitable for the present social condition.



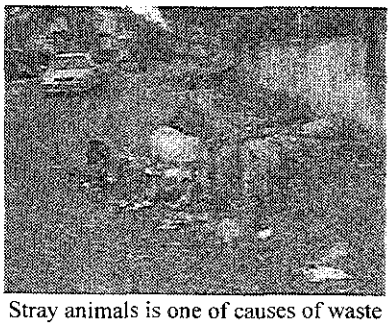
b.3 Closed waste bins

Nuwara Eliya MC widely introduced closed type waste bins in 2003. It can prevent waste scattering by all stray animals including crows. In addition, waste loading is easier by this system because the floor is elevated. This is suitable for sparsely populated areas.



2.3.3.2 Assessment of the Present System

It was found that people working in the SWM are not interested in the discharge and storage system. The appropriate discharge and storage system depends greatly on the waste composition, waste amount, town structure, waste discharge pattern, social condition, etc. However, the traditionally used waste bins which cannot prevent waste scattering by stray animals are still widely used and the usage of thin, flimsy polythene bags is increasing. Their own



Stray animals is one of causes of waste scattering

initiative toward the improvement of the discharge and storage system to fit to the current situation is scarcely seen. Therefore, most present discharge and storage systems are not suitable for the present social condition and cause the following problems:

- Deterioration of sanitary conditions and view
- An increase in street sweeping works and street sweeping workers
- An increase in waste collection works and collection workers

Consequently, the introduction of a proper discharge and storage system which fits the present social condition can greatly contribute to reducing the street sweeping cost and collection cost, and to improving the sanitary conditions and view.

2.3.4 Collection and Transportation

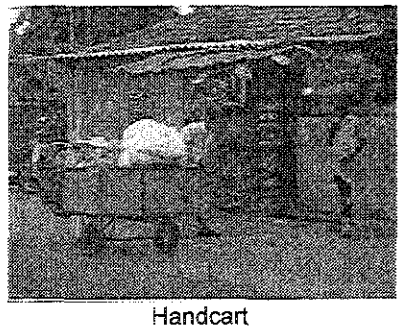
2.3.4.1 Current System

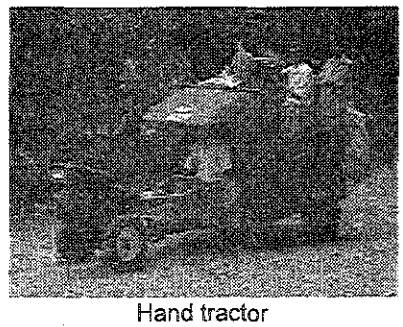
Average garbage collection service coverage is typically around 75-85%, on a population basis. The service coverage is currently much lower in Negombo (69%) and Gampaha (49%) than other towns among the seven model towns studied, due to large areas having recently being added to the municipal area in both cases.

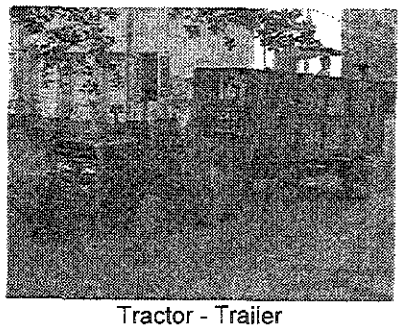
Handcarts are commonly used for primary garbage collection on a large scale in Kandy, Negombo, Matale and Nuwara Eliya and to a lesser extent in Chilaw, Gampaha and Badulla. Once full, they normally discharge their loads at formal (i.e. concrete public bins) or informal (i.e. garbage piles) collection points, or transfer them to a stationary trailer or a collection vehicle.

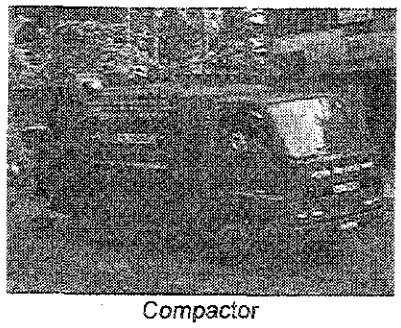
Tractors (hand tractors or tractor/trailers) are the most common vehicles used to collect garbage, although compactors are favoured in Kandy and Matale for garbage collection. In both cases, the compactors are reconditioned vehicles imported from Japan.

Garbage is commonly collected daily or every second day, with daily collection being popular for busy roads, commercial areas and high density residential areas. Some towns even operate a twice daily collection service in the city centre. Low frequency collection (once or twice per week) is


Handcart


Hand tractor


Tractor - Trailer


Compactor

typically carried out in areas with relatively few households, poor access, or which have recently been added to the municipal area.

Each city has areas where it is difficult to collect garbage. These include steep hills, housing schemes and other low income and densely populated areas due to the access roads being narrow, shops blocking the roads, etc.

In all seven towns, garbage is mainly collected from either these formal or informal collection points by collection vehicle labourers. The number of formal collection points ranges from 3 in Gampaha to 143 in Nuwara Eliya. The number of informal collection points ranges from 12 in Matale to approximately 80 in Negombo.

Secondary methods of collection include people bringing their garbage directly to the vehicle, especially in some parts of Negombo, or labourers collecting it directly from premises (e.g. local hotels, restaurants, some institutions). Some towns also use a stationary trailer collection system, generally for garbage collection from commercial areas, markets and/or hospitals.

Collection workers use a variety of tools for loading garbage into vehicles from collection points (e.g. hoe, rake, fork, spade, baskets, sack, etc.), with sacks being very popular. A sack is spread on the ground, with garbage then being placed on top of it by one labourer using a rake, fork or other tool, following which two other labourers lift the sack and throw its load into the vehicle.

Collection vehicle labourers are often provided with protective gear and equipment (e.g. aprons, gloves, boots) but many refuse to wear these, claiming that they are too uncomfortable in the hot climate or of poor quality and break easily.

Following collection, garbage is generally transported directly for processing/treatment or to final disposal, as most towns have disposal sites located relatively close to the city.

2.3.4.2 Collection Method

a. Waste Collection Days

- Most LAs have not decided on the waste collection days, or do not keep to the waste collection schedule.
- Most LAs target the daily waste collection which they understand the best.
- One of the LAs collects waste from the same road even three times a day.

b. Waste Collection Method

The following three kinds of collection systems are mainly employed and a) and b) occupy most of them.

a) Road collection: To collect waste discharged onto roads.
b) Stationary collection: To collect waste discharged in concrete waste bins.

c) Kerbside collection: To collect waste discharged in bags or containers placed in front of their premises.

2.3.4.3 Time and Motion Studies

The results of time and motion studies carried out in the seven towns covered by this Study are shown in the figure below. This shows:

- Loading takes a long time, comprising an average of 60% of the total round time (range = 47-78%)
- Round times are relatively long, the average being 3h12min (range = 2h45min to 3h43min).

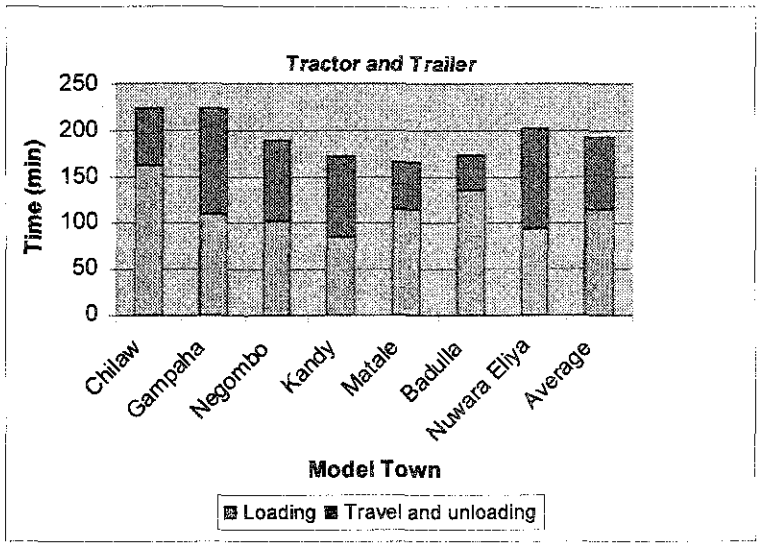


Figure 2-12: Time and Motion Study Results in Seven Model Towns

2.3.4.4 Collection Vehicle Capacities

Measured collection vehicle capacities, filling factors based on observations and the experience of the Council SWM staff were used together with appropriate density data to estimate the average tonnage per load for different vehicles, as summarised below.

Table 2-13: Typical SWM Vehicle Volume and Tonnage Data

Vehicle	Typical Volume (m^3)		Density (kg/m^3)	Fill Factor (%)	Tonnage (T)	
	Typical	Actual Range			Typical	Actual Range
Handcart	0.40	0.39-0.54	250-390	90-95	0.12	0.09-0.13
Hand Tractor	2.8-3.2	2.4-3.3	250-390	80-90	0.55-0.72	0.52-0.84
Tractor Trailer	6.0-6.5	3.4-8.9	250-390	85-105	1.3-2.5	0.99-3.5
Small Lorry	2.0-3.0		250-390	90-100	0.7-0.8	
Large Lorry	5.7–6.7		250-390	90-110	2.0-3.0	
Small compactor ($4m^3$)	3.7-3.8		608	100	2.1-2.3	
Large compactor ($8m^3$)	7.5-8.3		501	100	3.8-4.2	

Note: Density data, based on WACS survey data for collection vehicles and weighbridge data for different collection vehicles measured in Colombo in Jul-Aug 2002 (tractor: $390kg/m^3$, $4m^3$ compactor: $608kg/m^3$, $8m^3$ compactor: $501kg/m^3$).

2.3.4.5 Collection Vehicle Unit Costs

Collection vehicle unit costs were calculated for each LA using actual LA trip and cost data, supplemented by data from other sources where necessary. These costs are illustrated below.

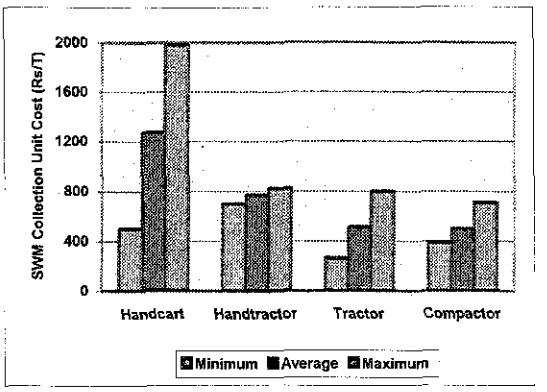


Figure 2-13: Garbage Collection Vehicles – Current Unit Costs in Seven Model Towns

This data shows:

- Handcart garbage collection is very expensive., this mainly being due to high labour costs (generally two to three workers per handcart) and the low capacity (approximately 120kg of garbage per load). However, handcart garbage collection is necessary or useful in some areas, particularly narrow roads, congested areas, markets, etc. Handcarts are also useful for collecting street sweepings and drain cleanings. Hence, it is vital to restrict handcart usage for garbage collection to essential places so as to reduce overall SWM costs.
- Hand tractor collection is moderately expensive. In addition, hand tractors are not so convenient for garbage collection – they are slow, poor at reversing and must be manually unloaded, this taking 20min or more per load. Hence, hand tractors should only be used in essential places for garbage collection (e.g. narrow roads in residential areas) or for specialized tasks (e.g. transporting meat/fish offal, hospital hazardous wastes to disposal).
- Both tractors and compactors have similar average unit costs. JICA studies have also found that both tractor/trailers and small ($4m^3$) compactors carry about the same amount of garbage to landfill (2.4T/d). These results indicate both compactors and tractors/trailers have similar collection and transportation efficiencies. This is due to the different volumes of each vehicle and the high bulk density of Sri Lankan waste (0.3-0.4kg/L), meaning that compactors can only achieve small-moderate waste compaction, compared to developed countries where the waste is much "lighter" (e.g. Japan - 0.15kg/L). Compactors have other advantages over tractors, being more manoeuvrable, easier to load, enclosed (resulting in less waste scattering than from open trailers) and faster, reducing travel times during collection and to and from the landfill. However, compactors are more difficult and expensive to maintain, require good

management to keep operation and maintenance costs down and are unsuitable for collecting mixed waste for subsequent recycling/composting.

2.3.4.6 Assessment

The present garbage collection system involves a lot of wasted effort. For example:

- Handcarts are used for primary collection and typically discharge their loads of garbage at formal or informal collection points from where they are later loaded into collection vehicles by the vehicle labourers. In some cases, handcarts and collection vehicles traverse the same routes.
- Vehicle labourers spend a lot of time loading garbage discharged on to the ground into vehicles.
- Almost all of the public garbage bins observed are very poorly designed and difficult to empty.

This system results in garbage being double handled and loading taking a long time, as described above.

Another major problem is that most LAs have an ageing vehicle collection fleet, resulting in frequent breakdowns. Many repairs take a long time, due to poor workshop capacity, involved and slow approval procedures, etc. Most LAs do not have any systematic vehicle replacement plan.

The unit costs calculated above are high in many cases, indicating there is considerable potential for reducing handcart and collection vehicle unit costs by decreasing the number of labourers and increasing the number of daily trips. Overall, both tractor/trailers and compactors are considered suitable for garbage collection in Sri Lanka, while the use of handcarts and hand tractors for garbage collection should be restricted to essential places only.

Table 2-14: LA Garbage Collection and Transportation System Details

Item	Negombo	Gampaha	Chilaw	Kandy	Matale	Nuwara Eliya	Badulla
Zones	6	7	6 + Special	6	3	6	3
Collection Vehicles:							
Handcarts	30	3	5	70 + 32	15	23	5
2WT	1	5	2	0	0	0	1
Tractors (trailers)	15 (19)	4 (4)	5 (6)	10 + 1 (13 + 6)	2 (1)	4 (6)	3 (3)
Lorry	0	0	1	0	0	1	0
Compactor	0	0	0	5 + 2	2	1	1
Average age:							
2WT	10	9.3	8	N/a	N/a	N/a	10
Tractor (trailer)	6.8 (9.0)	10.8 (Not known)	6 (5.2)	13.8 (12.2)	5.5 (Not known)	5 (5.5)	12 (13.3)
Lorry	N/a	N/a	12	N/a	N/a	Not known	N/a
Compactor (SL life)	N/a	N/a	N/a	Not known	2.5	2	4
Personnel:							
PHIs	3	2	1	2	1	3	5
Supervisors	16	5	6	20 + 5	11	9	4
Drivers	19	7	6	12 + 4	7	5	5
Labourers	180	71	69	330 + 72	121	90	84
Approximate service coverage	69%	49%	75-85%	70-80	80-90	80-90	75-85
Collection points:							
Permanent	38	3	15	160	109	143	80
Temporary (I)	65-80	26	47	21	12	52	66
Collection System:							
Main	HCs, CPs GTV, DFP	CPs GTV, DFP	CPs GTV, DFP	HCs, CPs	HCs, CPs GTV, DFP	HCs, CPs GTV, DFP	CPs GTV, DFP
Secondary	(relatively high)				(small)		
Collection Frequency	Daily → weekly	Twice daily (town) → 1-2x/wk	Daily (main roads, commercial area, some residential areas) or alternate days	Daily → 2-3 times per week	Daily → alternate days	Daily → alternate days	Daily → 1-2 times per week
Stationary trailer collection system	Yes (4) – town area, hospital	No	Yes (1) – town area	Yes (5) – markets, hospital	No	Yes (3) – town area	No

Note:

1. CP = collection point (both formal (permanent) and informal (temporary)), HC = handcart, GTV = give directly to vehicle, DFP =directly from premises.
2. Vehicle and personnel numbers are specified as A + B for Kandy, A = LA, B = private contractor (CareKleen).

2.3.5 Processing and Treatment System

This section provides an overview of waste processing and treatment activities in Sri Lanka – namely the recycling of different waste materials (plastics, paper, metals, glass), composting and energy recovery (biogas only).

2.3.5.1 Organic Waste Materials

MSW in Sri Lanka[2] comprises about 70-90% organic materials. Hence, MSW is ideal for composting and, to a lesser extent, for biogas generation, both of which are discussed in this section.

a. Composting

Home composting is being promoted by many Local Authorities, NGOs and other organisations in Sri Lanka, as a relatively simple solution to the organic waste problem. There are a range of different home composting bins available in Sri Lanka, generally about 200-300L in size, made from either metal, plastic or ferro-cement and sold for around 300-1,000 Rs ea., the lower prices applying to subsidised bins. Interview surveys of 176 households in Matale (76), Negombo (80) and Nuwara Eliya (20) to whom home compost barrels had been distributed found varying success rates, with only 5% of households still using the bins in Negombo, 40-50% in Matale and 90% in Nuwara Eliya. Key recommendations from these surveys for future home composting programmes include:

- Consider the use of a non-rusting, well designed composting system with a lid, particularly in areas along the coast and with high rainfall.
- Do not force householders into getting a compost barrel, unless they really want one.
- Provide education/training to households particularly over the first 3-6 months, with ongoing support being available to households requesting it.
- Consider providing compost barrels to households for free or at a subsidized rate – the latter option is considered more appropriate.

Jeewa Kotu, which is a Sri Lankan traditional home composting method, has been used in some local areas.

Windrow composting is the simplest, low technology approach to small-medium scale commercial composting. However, it has a mixed history in Sri Lanka with some few systems operating well (Chilaw, Madapatha, Ratnapura, Vavuniya), while some facilities have failed (e.g Nuwara Eliya, Badulla, Horana). This is mainly due to the poor management.

[2] Sri Lanka : State of the Environment 2001, published by the United Nations Environment Programme (UNEP)

An in-vessel composting[3] system, the inclined step grate digester, has been developed, patented and commercialised by Dr Ben Basnayake of Peradeniya University. Capital costs of the digester unit are higher than windrow composting systems while operational costs are lower and the system has few moving parts. It also is an enclosed system, with small quantities of leachate being generated, while aeration occurs naturally and no rotation or turning of the composting materials is required. Some commercial units have been installed, but again with mixed success.

Most composting facilities have similar problems, including:

- Necessity of an enclosed or roofed system, especially in the wet zone, in order to control rainwater entry and avoid excessive leachate generation and possible process failure.
- Difficulties in selling their compost. For example, the ORDE compost facility in Chilaw sells compost at 8Rs/kg (including 20% discount) but they are competing for customers with chemical based fertilizers (e.g. urea = 14Rs/kg (formerly 7Rs/kg until subsidy recently removed)), coir based compost (6.5Rs/kg), cow dung/straw (1.33Rs/kg) and chicken manure (1.25Rs/kg).
- Difficulties in generating enough income to cover their costs, with very few, if any facilities making a profit.
- Most composting facilities receive mixed MSW, which is of poor quality and contaminated with non-compostable materials. Pre-sorting to remove such materials is both expensive and time consuming (e.g. Chilaw: 3-4 labourers take around 3-4h to sort one tractor load of waste, costing about 350Rs/load).
- Many compost facilities do not receive any financial assistance from local or central government. Some do charge a "gate fee" for taking waste of around 150-300Rs/kg, which makes an important contribution to their financial viability.
- Difficulties in disposing of reject waste materials (about 10-30% of input waste materials).

In addition, the development of markets for compost is hampered by:

- A lack of national policies, plans and targets promoting sustainable agriculture.
- A lack of national standards for compost and approved testing facilities. Keeping testing costs to a minimum but acceptable level will be one of the key issues to resolve in developing such standards.

[3] Another type of composting system is vermi-composting (worm composting). This is practised on a relatively large scale in India but on a very small scale in Sri Lanka.

- Concerns of potential large scale customers (e.g. plantation and agricultural sectors) about the ability of compost producers to meet their large volume and quality requirements.
- High transportation costs meaning that the sales price of compost needs to increase with distance from the point of production in order to cover costs.

Increased efforts are needed to ensure the long term sustainability of small-medium scale composting facilities processing MSW. This can be achieved through central and local government assistance, particularly the payment of a "gate fee" by LAs using composting facilities. Otherwise, the industry will gain a bad reputation, hampering any chances of MSW composting being widely adopted throughout the country.

b. Biogas

The National Engineering Research and Development Centre (NERDC) is the most active organisation[4] working in the development and promotion of biogas technology in Sri Lanka. They are mainly promoting the DryBatch biogas system, which is essentially an anaerobic composting process. Basically, this involves feeding mixed garbage into a digestor without adding any water and allowing it to digest for four months. Biogas generated during this time may be used for cooking, heating or electricity generation purposes. The biogas slurry is then removed, together with undigested materials and allowed to dry for 2-3 wks in a heap on a concrete pad. Any leachate generated is collected in a tank for subsequent treatment. After this time, the material is relatively dry and suitable for sieving using a trommel screen. This separates out the biofertiliser product (sold at 15Rs/2kg) and undigested contaminants (plastics, etc.) which are incinerated.

They have constructed a number of facilities for converting MSW into biogas, including a 4 x 40T digestor system at Kirulapone which was relative unsuccessful and is no longer operating, a 2x20T digestor system in Kegalle which has been operating successfully for about 1.5years and a 16 x 50T digestor system at Mutharajawela, which began operation in August 2003. Two additional facilities (8T and 4T) should soon be constructed in Negombo at a convent and Open Prison under the Sustainable Cities Programme.

Their main problem with such projects to date has been able to get enough garbage to process, even when they do not charge a "gate fee". It seems that most LAs located near such facilities are unwilling to spend extra money transporting their wastes there, when they can currently dispose of their garbage for no, or little cost, locally.

Other major issues facing the use of biogas technology for organic MSW digestion are:

[4] The Intermediate Technology Development Group are also involved in biogas development and application.

- Quite number of technical problems unsolved, particularly in relation to removing the compost by-product once the digestion process is complete.
- The relatively high capital costs of the biogas units.
- Poor management, operational problems and a lack of technical knowledge resulting in the failure of some systems.

It is considered that this technology is still unproven. More experience needs to be gained in system design, operation and maintenance to prove its applicability to the digestion of organic MSW and assess its sustainability. Hence, it may be some time yet, before biogas technology becomes more common.

2.3.5.2 Plastics Recycling

Plastics waste currently makes up around 6-7% of MSW in Sri Lanka. This percentage is likely to increase in the future.

Trade statistics indicate Sri Lanka exported very small amount of plastic, around 63 tonnes of plastic wastes in 2001 and 63 tonnes during the first six months of 2002, the main customers being New Zealand, USA and China.

Several small to medium scale plastics recycling enterprises were visited during the course of this study (Seth Sevana, Moratuwa; Super Plastics, Yakkala; Speed Pallets, Negombo and Tri-Star Plastics, Handessa). These have been in operation for 2-18years and employ from 15 to over 37 workers. They process around 15-35T/month of waste plastics, comprising mainly low density (LDPE) and high density (HDPE) polyethylene, polypropylene (PP) and some nylon. Most of these plastics come from industry (40-75%) or commercial (20-47%). Other sources include hospitals (e.g. saline bottles) and households (2-25%).

Processing involves a variety of processes including pre-processing (washing, sorting and drying), grinding, granulating, palletising, extruding and injection moulding to produce "crush" (plastic flakes) or pellets, which are either sold to plastics manufacturing operations or processed further on-site to make a range of products (e.g. gully trap covers, nose masks, antennae parts, decorative plastics rolls). These processing steps add significant value to what were waste materials, as shown by the following prices (mid-2002):

Mixed, unwashed plastics/polythene bags:	3 – 8 Rs/kg
Sorted, cleaned, washed and dried plastics:	12 - 20 Rs/kg
Plastic crush:	35 - 40 Rs/kg
Recycled plastic pellets:	45 – 55 Rs/kg
• Total cost	95 – 123 Rs/kg
• Virgin imported plastics:	80 – 90 Rs/kg

This data clearly shows that virgin imported plastic is cheaper than recycled plastics.

Such processing can be financially viably done locally within a region, reducing subsequent handling and transportation costs to larger factories for the manufacture of new plastic products.

Common problems include cash flow/credit problems, high utility and transportation costs (especially electricity), a lack of government support for recycling and a shortage of quality recyclable materials.

The success of these operations suggests that plastics recycling is viable in Sri Lanka. However, it must be emphasised that all of these enterprises obtain 75-100% of their waste plastics as clean, sorted plastics from industrial and commercial sources. Recycling mixed, unwashed waste plastics from other sources, particularly households, is much more difficult and less economically viable for them, as such plastic wastes require expensive and time consuming washing and sorting before they can be processed further. Hence, the availability of clean, sorted plastics in relatively large quantities from single sources is crucial to the economic viability of such operations.

A survey undertaken by ITDG[5] of 19 plastic manufacturing industries, which indicated the manufacturers were willing to use locally recycled waste plastics as secondary raw materials provided the recycled plastics are of high quality and graded correctly which are always the most difficult requirements. Other concerns raised by manufacturers included:

- The ability of local suppliers to meet manufacturers' demands.
- The economic viability of small scale plastics recycling industries in Sri Lanka.
- The feasibility of recycling plastics from household waste, especially as people are not used to sorting waste.
- The lack of an export market for plastic items being a disincentive to growth of the industry and increased utilisation of recycled plastics.

Future demand for recycled plastic pellets can not be guaranteed due to a wide range of factors, including the development of biodegradable plastics, fluctuations in the virgin plastic price, the selling price of good quality plastics and the government's economic policies. For example, Seth Sevana used to make plastic chairs, mudguards and some utensils from recycled plastic pellets. However, liberalisation of the economy resulted in duties on imported plastic products falling, leading to cheaper, imported versions of these items on the market, making it uneconomic for them to continue production.

[5] Market Survey on Plastics Recycling in Sri Lanka, Ratankura R.B. (2000)

Table 2-15: Data Summary from Visits to Plastics Recycling Enterprises

Name and Location	Years of Operation and No of workers	Quantity and types of waste plastics collected	Sources		Processing	Products	Main Problems and Comments
Seth Sevana, Moratuwa	18yrs 15 workers	19-25T/mth 50-55% HDPE, 30% LDPE, 15-20% PP	75% industry 25% households	Mainly from Colombo	Sorting, washing, drying, grinding, melting, extruding, pelletising	Pellets, granules	Shortage of recyclable plastic wastes,contamination/poor quality of waste plastics obtained form households, high transportation and utility costs, difficulties in obtaining credit
Super Plastics, Yakkala (5yrs, 17 workers)	5yrs 17 workers	20T/mth LDPE, HDPE, PP, PS, some nylon (60% mixed unwashed; 40% clean)	75% industry 15% Katunayake airport 5% hospitals 5% commercial	15% Gampaha district 80% WP 5% elsewhere	Sorting, washing, granulating, pelletising, extruding and injection moulding	10-15T/mth of pellets 0.5T/mth other products: gully trap covers, broom parts, nose masks, antennae parts, etc.	Difficulties in obtaining credit, utility problems, high land/building rental costs, shortage of recyclable materials
Speed Pallets, Negombo	2yrs 19 workers	15T/mth LDPE, HDPE, PP	40% commercial 40% industry 7% households 6.5% hospitals 6.5% garages	75% NMA 25% Gampaha district	Sorting, washing, cutting, grinding, granulating, pelletising	12-15T/mth of flakes (crush), pellets	Cash flow Lack of government support for recycling
Tri-Star Plastics, Handessa	10-12yrs 37+ workers	30-35T/mth LDPE, HDPE, PP, some nylon (mainly clean and sorted)	60-70% industry 28-38% commercial 2% households	60-70% Colombo 30-40% near Kandy	Sorting, washing, palletising, manufacturing	5T/mth pellets 25T/mth rolls and other products	High electricity costs, shortage of machinery operators Lack of government support for recycling

Note: LDPE = low density polyethylene, HDPE = high density polyethylene, PP = polypropylene, PS = polystyrene

2.3.5.3 Paper Recycling

In 2001, approximately 39,000 ton of used paper is exported and 8,000 ton was domestically recycled.

According to Sri Lankan export statistics, Sri Lanka exported around 31,700 tonnes of waste paper[6] in 1999, 39,000 tonnes of waste paper in 2001 and 26,600 tonnes in the first six months of 2002, with over 99% of this waste paper going to India, other customers including Germany, United Arab Emirates, United Kingdom, Japan and Lebanon.

Waste paper makes up around 1-2% of MSW[7] in Sri Lanka, while the technology already exists in the country for the use of waste and recycled paper in paper production.

The National Paper Corporation (NPC) has been involved in paper recycling activities since 1952 when it began establishing a series of board mills with paper recycling activities around the country. As of mid-2002, about 90% of its waste paper was collected from within Colombo, with 60% coming from government related organizations (e.g. Telecom, Lake House, public banks, State Printing Corporation) and the other 40% from individuals and middlemen. NPC pays variable prices according to the waste paper quality, ranging from 1.5Rs/kg for mixed office waste up to 20Rs/kg for pure white trimmings. It's collection system comprises four collection centres, three in Colombo and one in Gampaha, and a nationwide network of about 80 agents, some of which have their own baling machines. NPC also used to operate a mobile collection service, which it is believed included a mobile baling machine, but this has now stopped.

By 1998, it collected ~2000 T/mth of waste paper, equivalent to about 17% of total paper usage in Sri Lanka. However, waste paper collection has dropped dramatically since then due to:

- High local production costs, due to failure to periodically upgrade its Board mills to keep pace with technological developments and rising environmental standards. For example, its Embilipitiya mill is 25 years old and can produce paper at 1/10 the speed of modern Chinese mills which are 30% more energy efficient, while the quality of the resulting paper can't match that of imported paper and is not suitable for use in modern printing machines. It would require an estimated 300-400M Rs to upgrade this mill alone using Indian technology.
- Reduction in the duty on imported paper from 35 to 10%, as a result of liberalizing the economy, making imported paper much cheaper, increasing competition and undermining domestic paper sales.
- High transportation costs, due to the long distance to their two mills (250-300km from Colombo).

[6] Mainly comprising old newspapers and periodicals and paper certified as having been imported.
[7] UNEP (2001), ibid

- Growing export demand for waste paper, with exporters being willing to pay about 25% higher prices than NPC for waste paper. For this reason, only about 30 of NPCs' 80 agents are currently supplying them with paper.

These factors have led to the closure of the Embilipitiya mill. NPC now only operate one mill at Valaichchenai. This has a processing capacity of about 2,000T/mth (90% waste paper, 10% pulp), and manufactures industrial grade board, for which there is a ready market. However, it is operating well below this capacity, processing about 700T/mth as of mid-2002, and now possibly much less than this.[8]

Clearly, this information shows that the waste paper export market seems to be thriving and growing, while the NPC is struggling to survive. Large amounts of money must be injected into rehabilitating NPC's two remaining board mills, if they are to become commercially viable operations. The government has stated it hopes to rehabilitate the Valaichchenai mill as part of the North-east Development agenda.

2.3.5.4 Glass Recycling

Glass makes up a relatively small proportion (<1%) of MSW in Sri Lanka.

As of mid-2002, there was only one glass producing company[9] in Sri Lanka - the Ceylon Glass Company (CGC), located in Ratmalana, Colombo. They mainly produces glass containers (bottles and jars), providing about 90 – 95% of the flint and amber glass requirements in Sri Lanka as well as exporting glass containers to Bangladesh and Mauritius. They run a bottle deposit scheme for glass bottles, which ensures bottles are reused many times before being recycled.

They also recycle used glass, collecting about 1,000 T/mth of cullet (broken glass) in 2002, compared with about 400 T/mth 4–5 years earlier. The current cullet collection rate represents about 35% of cullet in Sri Lanka (~5% of glass imports). They use from 35-45% cullet in their manufacturing processes and could increase this to 60% if the collection system could be further improved. The use of broken glass in the production process saves raw materials and energy, thus reducing costs and increases the economic lifetime of equipment.

Their collection system comprises about 100 agents covering most of the country, except for south of Matara. They pay 2.5Rs/kg and 3.5Rs/kg for amber and flint bottles delivered directly to them, while agents will pay lower prices according to their location. This system functions well in the Colombo area, where they collect about 75% of all their cullet but could be improved in rural areas. They would like to improve cullet collection, particularly of amber cullet which is in

[8] 58T/month according to Daily News article of 10 Feb 2003.
[9] One other company, Lanka Glass Manufacturers, *Baduha,* which has been closed for the last five years, was understood to be restarting operations in September 2002, manufacturing consumer glass. However, it cant use recycled glass as a raw material due to the quality of the products it will make.

short supply. For this purpose, they have recently expanded cullet collection to the Jaffna area and have produced an education/awareness leaflet about their business. They are also interested in establishing medium scale recycling centres in 2-3 places (e.g. Kurunegala and Galle), which would sort, wash and crush cullet on-site, with the crushed cullet then being transported to their factory in Ratmalana for processing.

This information shows that the status of glass cullet recycling is relatively healthy and that efforts are being made to increase cullet collection and recovery. Nevertheless, CGC can only use a maximum of around 60% of the cullet in Sri Lanka in their manufacturing processes. Hence more than 60% cullet recycling could only be achieved if CGC were to expand its production capacity, or another glass manufacturing operation that uses cullet as a raw material was to enter the market, or if cullet was to be exported.

2.3.5.5 Metals Recycling

Scrap metal (ferrous, copper, brass, aluminium) is present in relatively low quantities in MSW, as it is of high value and is quickly salvaged for recycling generally at source by individual collectors, middlemen, etc. These materials are then either sold to traders in Colombo for export or to industries for reprocessing into new items.

Trade statistics indicate Sri Lanka exported 890 tonnes of scrap copper, aluminium and tin in 2001, compared with 900 tonnes in the first six months of 2002, with 98% of this going to India. Data for ferrous scrap exports could not be obtained.

One large and one small scrap metal processing factory were surveyed in this study.

Bhuwalka Steel Industry Sri Lanka Ltd, near Madampe, is a large scrap metal factory, owned by an Indian company that started operation in 2000. It employs about 440 staff. It buys approximately 2,200T/month of steel scrap (e.g. used steel bars, windows, cars, roofing iron, etc.) from about 25 middlemen from all over Sri Lanka. About 60% of this scrap steel comes from industry, 25-30% from commercial enterprises and 10-15% from households. The factory manufactures about 2,000 T/mth of cold twisted deformed steel reinforcing rods (TOR steel) from the scrap steel, with ~6-7% of scrap being lost in the production process as slag. Their main problems are a shortage of scrap steel for processing, contamination/poor quality of the scrap steel and utilities problems (high cost, power cuts).

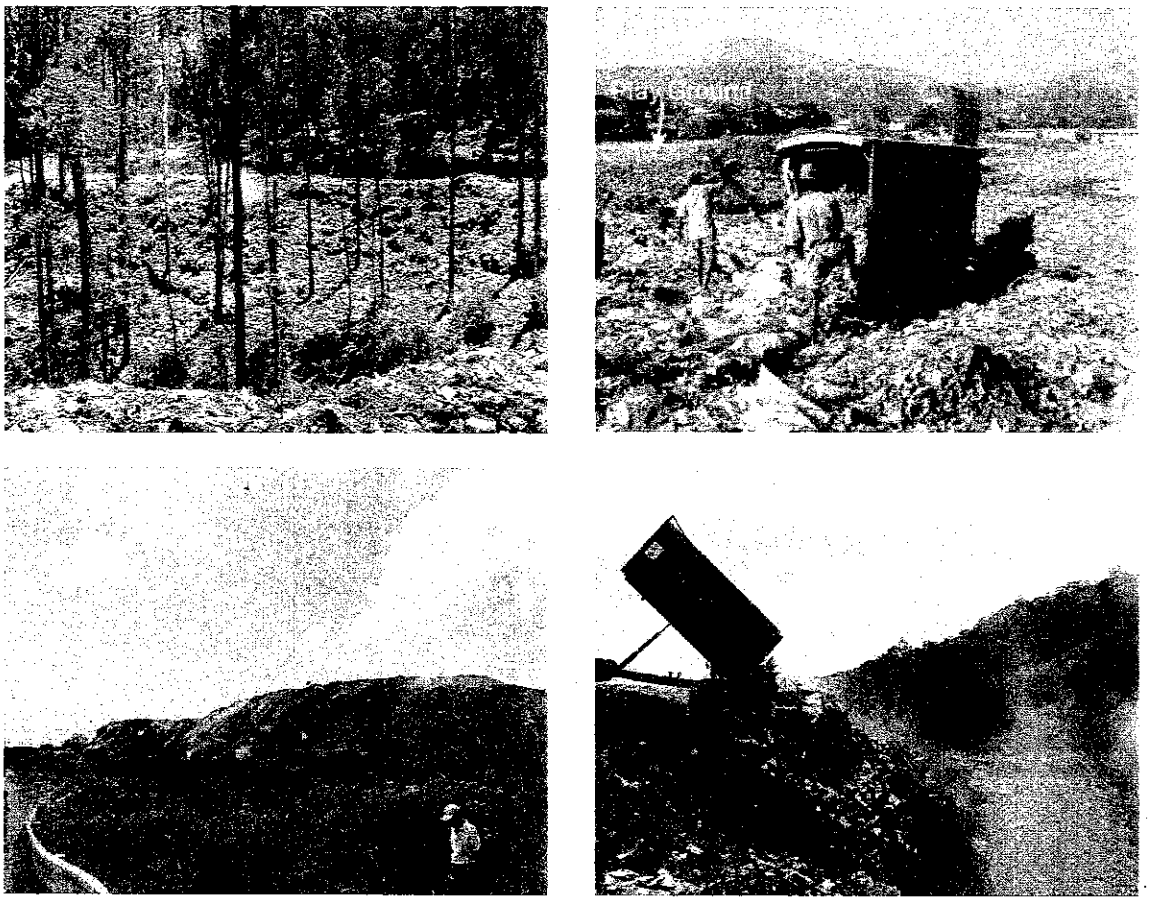
Super Steel Industries is located in Yakkala. It has been in operation for 15 years and employs 16 staff. It recycles around 12T/mth of ferrous scrap metal, mainly from commercial enterprises (95%) and households (5%) located within the Gampaha municipal area (40%), Western Province (40%) and other parts of Sri Lanka (20%). Most of the ferrous scrap is processed into various products on-site, comprising a wide range of vehicle parts (e.g. hubs, vehicle shells, battery covers, handbrakes, etc.) which are sold to commercial enterprises around Sri Lanka. Their main

problems are difficulties in obtaining credit; followed by utilities problems and excessive transportation costs. They also stated that a general problem affecting scrap metal recycling in Sri Lanka is increasing exports of copper/brass from the country, which has created a raw material shortage problem for many such small industries utilising these metals.

2.3.6 Final Disposal

2.3.6.1 Current Condition of Landfill Site

There are no measures to mitigate environmental pollution at most of the existing landfill sites in Sri Lanka. This causes serious environmental effects on the surrounding areas. The current condition of existing landfill sites in Sri Lanka are as follows:



- Upper left: Nuwara Eliya MC landfill site before improvement project,
- Upper right: Badulla MC existing landfill site,
- Lower left: Colombo MC existing landfill site,
- Lower right: Matale previous landfill site.

- The scales of existing landfill sites which cover an area of approximately 1-2 hectors are small and their remained life spans are very short.
- There is a lot of illegal dumping in forests and rivers because the local authorities can dump the waste onto natural slopes without operation of heavy equipment. Most landfill sites owned by local authorities in the town are located very close to residential areas.

- Sewage and healthcare waste are discharged without any treatment at most of the existing landfill sites.
- There is often public opposition to the existing landfill sites. The residents living near the existing landfill sites blockaded the access road at Negombo Municipal Council in 2002 and Matale Municipal Council in 2003.
- Soil covering has not been carried out regularly. Most local authorities carry out soil covering when the residents near the landfill site complain about it.
- The staffs in charge of operation of landfill sites burn the discharged waste on purpose in order to extend the life span of the landfill sites. The resulting smoke has a serious environmental impact on the residents in the surrounding area.
- Generally, while the appropriate operation of a landfill site requires approximately 200-300 RS per ton of discharged waste, most local authorities spend less than 50Rs per ton for the operation of existing landfill sites.

2.3.6.2 Management organization of the landfill site

The local authorities that operate the landfill sites are mainly responsible for managing them. Furthermore, the Central Environmental Authority or the monitoring committee consisting of Project Approving Agencies (PAA)[10] is responsible as the competent organization based on the following regulations to manage the operation of landfill sites done by local authorities.

Table 2-16: Management Organization and Method of Landfill Site

Defined regulations or landfill site	Defined Projects	Management Structure & Method
Environmental Clearance	All kinds of project consisting of facilities that have an environmental impact such as noise, air pollution, odour, and water pollution. Landfill sites are also defined.	The CEA examines whether or not the project conforms to the environmental standards based on an outline of the facility plan and a site survey. During operation of the project, the CEA monitors the operation of it periodically.
IEE or IEA	New landfill site projects defined under "The National Environmental ACT published in the Gazettes (Extra-Ordinary) No. 772/22 of 24 June 1993 and No. 859/14 of 23 February 1995" (See reference "13 Environmental Law")	Project Approving Agencies and the CEA examine the project in accordance with IEE or EIA procedures. During operation of the project, a monitoring committee consisting of PPA conducts monitoring periodically.
Environmental Protection Licenses (EPL)	All kinds of facilities that discharge 3.0 m^3 of effluent per day	After the project is approved by the CEA in accordance with Environmental Clearance or IEE or EIA procedures, an EPL is issued.

[10] Project Approving Agencies: The Gazette extra-ordinary No. 859/14 of 23 February 1995 (See reference "13 Environmental Law")

2.3.6.3 Permission for landfill site operation

In order to operate a landfill site, the project is required to obtain Environmental Clearance or Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) approval. Furthermore, if more than 3.0 m^3 of effluent per day is discharged at the landfill site, an Environmental Protection License is also required.

a. Environmental Clearance

Environmental Clearance is required for all projects which may have an environmental impact on the surrounding area including the landfill site. However, if the project is to be subjected to an IEE or EIA, Environmental Clearance is not required.

The CEA examines whether or not the noise, air pollution, odour and effluent generated by project facilities conform to general environmental standards based on an outline of the facility plan submitted by the project proponent and a site survey. Particular criteria for Environmental Clearance are not regulated; therefore, the CEA evaluates the project with the facility plan and site survey. The outline of the facility plan consists of 2-3 pages describing the layout and capacity of the facilities. However, it is not sufficient to evaluate the projects.

So far, Environmental Clearance for a landfill site project has never been conducted. All existing landfill sites in Sri Lanka are operated without Environmental Clearance; therefore, all of them are illegal dumping.

- Defined projects: All kinds of project consisting of facilities that have an environmental impact such as noise, air pollution, odour and water pollution. Landfill sites are also defined.
- Address for application: Central Environmental Authority (CEA)
- Period for application: More than two months before construction
- Fee of application: Free of charge
- Required document: Outline of facility plan
- Monitoring: Four times a year without notice. The CEA monitors the operation of a project in accordance with the project plan submitted by the project proponent.

b. IEEs and EIAs

b.1 Landfill Site Project Plans requiring an IEE or EIA

Landfill site projects defined under "The National Environmental ACT published in the Gazettes (Extra-Ordinary) No. 772/22 of 24 June 1993 and No. 859/14 of 23 February 1995, Schedule Part I-III" (See reference "13 Environmental Law") are required to conduct an IEE or EIA. The regulation defines landfill site projects under "Schedule Part I" as follows:

Article 18 Disposal Waste

- Construction of any solid waste disposal facility having a capacity exceeding 100 tons per day.
- Construction of waste treatment plants treating toxic or hazardous waste.

There is no local authority which collects more than 100 tons of waste per day in Sri Lanka except for the Colombo Municipal Council and Dehiwala/Mt. Lavina MC. Therefore, most local authorities are not required to conduct an IEE or EIA in accordance with the regulation of "(18) Disposal Waste".

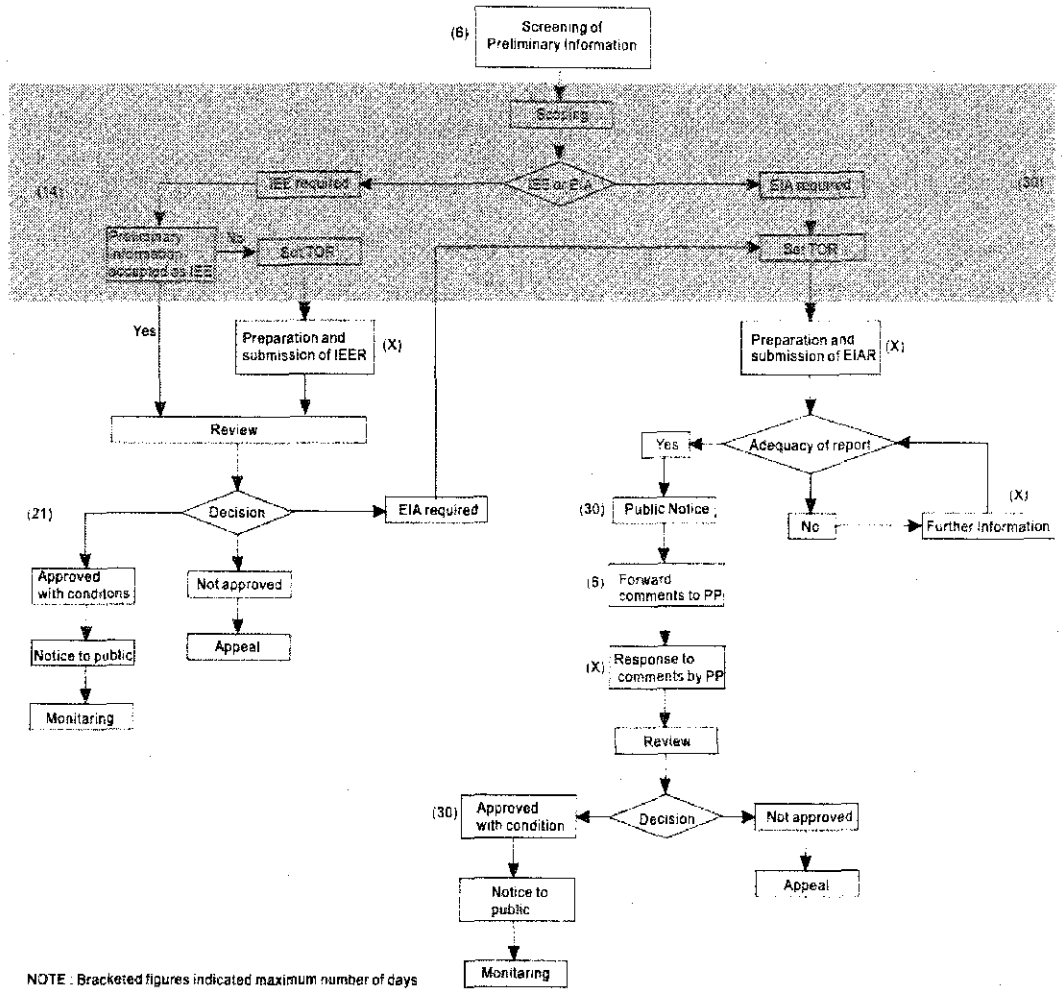
However, if a landfill site project has a capacity of less than 100 tons per day and is defined under another regulation in Part I-III, e.g. conversion of forests covering an area exceeding 1 hectare for use as a *landfill site*", the project is required to conduct an IEE or EIA

b.2 Application Procedure for IEEs or EIAs

- Defined Projects: New landfill site projects defined under "The National Environmental ACT published in the Gazettes (Extra-Ordinary) No. 772/22 of 24 June 1993 and No. 859/14 of 23 February 1995, Schedule Part I-III" (See reference "13 Environmental Law")
- Address for application: Central Environmental Authority
- Required document: Preliminary information
- Period for application: For IEEs, more than 41 days plus a minimum of three months before construction; for EIAs, more than 112 days plus a minimum of three months before construction.
- Fee of application : 50,000Rs

b.3 Procedure for IEEs and EIAs

A simple chart of the procedure for IEEs and EIAs is shown in the following figure.



Source: National Environmental Act, No.47 of 1980

Figure 2-14: Environmental Impact Assessment Procedure

Preliminary Information submitted by the project proponent is examined by a Scoping Committee which consists of the CEA and Project Approving Agencies. The role of the Scoping Committee is to judge whether the proposed project should be subjected to an IEE or EIA. Particular criteria for making such a determination are not regulated; therefore, the Scoping Committee decides whether to conduct an IEE or EIA based on the preliminary information and site survey.

For the detailed procedure for IEEs or EIAs, refer to the National Environmental (Procedure for approval of project) Regulations No. 1 of 1993 as contained in the Gazette (Extra-Ordinary) No. 772/22 of 24 June 1993 (Reference "13 Environmental Law").

According to IEE and EIA procedures, it takes 41 days for the approval of an IEE and 112 days for the approval of an EIA after the project proponent submits the preliminary information to the CEA. This period does not include the preparation of an IEE report or EIA report after the Project

Approval Agency issues the TOR. Therefore, an extra three months is needed for preparation of the report.

Except for the improvement of Nuwara Eliya Moon Plain landfill site carried in the JICA study, the only EIA conducted for a landfill site project so far was for the Hanwela landfill site project. However, the project was suspended and the construction has not implemented.

c. Environmental Protection License

Projects defined under the National Environmental (Protection and Quality) Regulation (See reference "13 Environmental Law") that have been granted Environmental Clearance or IEE or EIA approval by the CEA, are required to obtain an Environmental Protection License. The National Environmental (Protection and Quality) Regulation does not mention particular criteria regarding landfill site facilities. However, all kinds of facilities that discharge 3.0m^3 of effluent per day are subject to this regulation. As of October 2003, no local authority has obtained an Environmental Protection License regarding the operation of its landfill site except for the improvement of Nuwara Eliya Moon Plain landfill site carried out in the JICA study.

All local authorities, except for Nuwara Eliya Municipal Council, operate landfill sites which discharge leachate into public waters without an Environmental Protection License as well as without Environmental Clearance or IEE or EIA approval.

The detailed procedure for obtaining an Environmental Protection License is as follows:

- Defined Projects: All facilities defined under the National Environmental (Protection and Quality) Regulation No.1 of 1990 and 1159/22 of 22 November 2000, published in the Gazette Extra Ordinary No. 595/16 of 2 February 1990 (See reference "13 Environmental Law")
- Address for application: Central Environmental Authority
- Period for application: More than one month before operation
- Fee of application: 15,000Rs
- Required information: Outline of the facility, treatment method of waste water, quantity, quality and so on.

d. Approval of existing landfill site operation

Some local authorities have been dumping waste at existing landfill sites for more than 30 years before the mandate of Environmental Clearance and IEE or EIA. Most of the landfill sites have been generating leachate, which penetrates directly into the ground. If such an existing landfill site is to be improved, facilities on the surface of the landfill site, such as gas ventilation, fencing, covering soil and so on, can be installed easily. However, the installation of a new leachate

collection facility below the existing discharged waste is always very difficult and is not practical because the installation costs are very high. Therefore, most of the improvement of existing landfill sites cannot conform to environmental standards and this is one of the reasons why improvement of existing landfill sites has not been implemented so far.

In order to resolve these problems and promote the improvement of existing landfill sites, the CEA is planning to relax some environmental standards and establish guidelines for landfill site projects. The CEA would also give permission for the operation of existing landfill sites in accordance with the guidelines.

2.3.6.4 Guidelines for landfill sites

The CEA has been preparing for the establishment of guidelines for landfill sites; however, as of October in 2003, they have not yet been mandated.

2.3.6.5 Knowledge and training concerning sanitary landfill site operation

a. Staffs of local authorities

PHIs are mainly in charge of landfill site operation at most of the local authorities. PHIs are responsible for general public health; therefore, they do not have enough time to supervise the operation of landfill sites. Furthermore, as PHIs do not have enough knowledge regarding the operation of sanitary landfill sites, they cannot supervise the operation of them technically. PHIs take some lectures regarding general solid waste management during the one and half years at the PHI training centre. However, they do not receive any training in sanitary landfill site operation. Even after PHIs are assigned to the local authorities, they do not have any opportunity for training in sanitary landfill site operation. This is why the staffs of local authorities are not able to operate a sanitary landfill site.

b. CEA

Most of the staff members of the CEA, the competent authority of landfill site operation, have undergone some training or have visited sanitary landfill sites in foreign countries or developed countries. Therefore, they have some knowledge of sanitary landfill site operation.

The CEA is responsible for managing the existing landfill sites in accordance with general environmental standards such as water quality standards. However, the CEA has been failing to carry out its duty, though it could have. This is mainly due to the following two reasons.

b.1 Inadequate management organization of landfill site

The division of hazardous waste management in the CEA is in charge of the management of solid and liquid hazardous waste as well as the final disposal of municipal solid waste. As only five

staff members are assigned to this division, it is very difficult for them to oversee all existing landfill sites in the entire country.

b.2 Lack of information on current conditions of existing landfill sites

Information on current conditions of most of the existing landfill site is lacking. However, the CEA does have some information on existing landfill site conditions and has apparently tolerated it without remark.

c. Experts

Most of the experts of universities or research units are very keen on compost projects, recycling and technology for the collection of methane gas and so on as re-treatment systems. On the other hand, they are not so interested in sanitary landfill site operation as disposal technology.

d. Consultants

As a sanitary landfill site project has never been implemented in Sri Lanka, there are few engineers who have experience in the planning or construction of a sanitary landfill site. Therefore, there is no consultant who is capable of planning a sanitary landfill site or designing its facilities.

2.3.6.6 Ongoing or New Landfill Site Projects

As October of 2003, there are no ongoing or new projects for a new sanitary landfill site or improvement of an existing landfill site except for this JICA project.

2.3.7 Street Sweeping and Drain Cleaning

Most LAs currently undertake street cleaning using handcarts and manual labour. However, as it is common for people to discharge their garbage at the roadside, street sweepers tend to spend more of their time collecting garbage, rather than sweeping the streets. Inspection of handcart loads confirms this as they are largely full of garbage rather than typical street sweepings (litter, dust, etc.).

Similarly, drain cleaning is undertaken by most LAs using handcarts and manual labour, or tractors and manual labour (as part of Infectious Disease Prevention (IDP) works). Again, as many people, especially shop keepers, currently discharge their garbage into drains, drain cleaners spend a lot of their time removing this garbage, with the removal of litter, sand, sediment, etc. being a secondary task. Dumping garbage into drains is undesirable for other reasons, as it may cause drain blockages, resulting in nuisance or health problems, (e.g. breeding sites for mosquitoes), as well as downstream environmental problems (e.g. polluting the river, lagoon or sea into which the drains flow).

In both cases, current discharge practices mean that there is no proper distinction between garbage collection, street sweeping and drain cleaning works, particularly for handcarts, these all being lumped into a single work category by LAs. Handcart garbage collection is difficult, inefficient and expensive (refer handcart unit cost data), particularly in the case of garbage deposited into drains. As discussed, previously, handcarts should only be used for garbage collection in essential places.

Ideally, new waste discharge rules should be established, requiring people to discharge their garbage in a container according to a schedule and prohibiting the discharge of garbage at the roadside or into drains. Once the public are trained to follow this new system, this will reduce the amount of garbage deposited at the roadside or into drains. Street sweepers' work will then be much easier, as they can do the job they are intended to do - sweeping the streets, collecting litter, dust, etc. Similarly, drain cleaners will be able to focus on cleaning drains, removing the sediment, sand, litter from them.

This new system will also enable garbage collection, street sweeping and drain cleaning to be separated into different SWM work categories, with separate data recording systems and accounting codes, facilitating improved managerial and financial control of such works. It should also enable meaningful work performance targets to be set for street sweeping and drain cleaning works (e.g. India street sweeping work norms : high density area: 250-350 running metres of road length; medium density area: 400-600m running metres, low density area: 650-750 running metres).

2.3.8 Healthcare Waste (HCW) Management

This section summarises data collected from an interview survey of all (28) medical institutions with both in-patient and out-patient facilities in all seven towns. HCW is divided into three categories in accordance with Sri Lankan policy: non-risk HCW (= MSW), hazardous HCW (HHCW = clinical waste, body parts, placentas) and highly hazardous HCW (HHHCW = highly infectious wastes and sharps).

2.3.8.1 HCW Generation

HCW generation amounts are shown in the following table, together with other important survey data. Most HCW is made up of non-risk HCW, with HHCW generation being relatively small, accounting for 9.1-13.8% of total HCW generation. HCW generation rates amount to 1.19-1.87kg/bed.day for non-risk HCW, 0.131-0.137kg/bed.day for HHCW and 0.060-0.085kg/bed.day for HHHCW.

2.3.8.2 HCW Composition

HCW composition is highly organic, with food/kitchen waste being the most common waste type in surveyed medical institutions in five LAs. Paper and plastic waste are also very common. HHCW is produced by all surveyed medical institutions.

2.3.8.3 HCW Management

a. Source Segregation of HCW

None of the medical institutions surveyed are following the colour code garbage discharge system recommended by the Ministry of Health. However, most are segregating their non-risk HCW and HHCW at source and storing and disposing of them separately. For example, cardboard boxes are commonly used as sharps storage containers in most places. Only Badulla General hospital has implemented a two colour polythene bag system for the discharge and storage of HCW – black for non-risk HCW and yellow for HHCW.

b. HCW Collection and Disposal

In all seven towns, most non-risk HCW is collected by the LA or a private contractor (Kandy General hospital only) except for relatively small quantities of various materials that are recycled, as described further below. Some medical institutions dispose of some or all of their non-risk HCW on-site for a variety of reasons including no LA collection service (Dissanayake private hospital, Central dispensary (Negombo)), unreliability of the LA collection service (Gampaha Base hospital) or choice (Cooperative Hospital, Nuwara Eliya).

Inadequate collection and disposal of HHCW is a serious problem. Currently, most medical institutions dispose of such wastes by open burning and/or burial on-site, except for:

- Nuwara Eliya Base Hospital which discharges its clinical wastes for LA collection.
- Some of the smaller medical institutions producing small quantities of HHCW who tend to discharge some or all of these with their non-risk HCW for LA collection (Manthri Nursing Home and Ave Maria hospital (Negombo), Chilaw Clinic and St Mary's Nursing Home (Chilaw), Ideal Hospital (Nuwara Eliya), Central Hospital (Badulla).
- Some places (Matale Base, Gampaha Base, and Badulla General hospitals) take body parts and placentas for burial in the local cemetery.
- Arogya Hospital (Gampaha) usually transports the small quantities of HHCW to a private "local" incinerator in Kochchikade, Negombo for disposal.

Table 2-17: Medical Institution Survey Summary

	Kandy	Matale	Negombo	Chilaw	Gampaha	Nuwara Eliya	Badulla
No of places surveyed:							
Government	4	1	2	1	1	1	1
Semi-government	0	0	0	0	1	1	0
Private	4	2	3	2	1	1	2
Statistics							
No of beds	3,108	535	510	488	570	289	1,053
Bed occupancy (%)	89.5%	90.3	88.6	78.3	81.3	126.6	112.6
No of occupied beds/day	2,783	483	452	382	463	366	1,186
No of outpatients/day	2,566	706	1,093	934	1,125	498	941
No of clinical patients/day	2,516	292	457	438	419	505	792
No of staff	4,790	641	474	569	709	328	1,135
Waste Generation (survey data) (tonnes/d)	4.9	0.70	0.88	0.79	0.86	0.51	1.47
Waste Composition	F/K > Pa > Ga > HHCW	F/K > Pa > Ga > Pl > HHCW	Pa > Pl > F/K > Ga > HHCW	F/K > Pa > Pl > Ot > Ga	F/K > Pa > Pl > Ga > HHCW	F/K > Pa > HHCW > Pl	Pa > F/K > Pl > Ga/Gl
Waste Stream Breakdown:							
On-site disposal	1.9%	0.9%	19.5%	7.1%	57.2%	1.7%	1.7%
LA collection	96.3%	97.1%	76.7%	91.1%	35.7%	96.8%	95.5%
Recycling	1.4%	2.0%	3.8%	1.8%	6.0%	1.5%	0.7%
Illegal disposal	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Direct haulage	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	2.0%
HHCW Treatment:							
Incinerators (working)	2 (Yes)	0	0	1 (Yes)	0	1 (No)	1 (Yes)
Autoclaves	2	0	0	0	0	1	0
Needle burners	1	0	1	0	0	0	0
Modified waste generation data (kg/d)							
Non-risk HCW	4,734	675	758	718	819	495	1,408
HHCW	364	63	62	50	61	48	155
HHHCW	166	29	38	23	28	22	71
Total HCW	5,265	767	859	790	908	565	1,634
HHCW generation (% of total HCW)	Large (10.1%)	Small (12.0%)	Small (11.8%)	Small (9.1%)	Small (9.8%)	Small (12.4%)	Medium (13.8%)

Notes:

1. Waste Types: F/K = food/kitchen, Ga = garden, HHCW = hazardous healthcare, Ot = other, Pa = paper/cardboard, Pl = plastic.
2. Survey results for an ayurvedic university and hospital in Yakkala within the Gampaha municipal area are not included in the above table.
3. Direct haulage relates to medical institutions taking body parts and placentas to the local cemetery for burial.

Only five medical institutions surveyed have incinerators, four[11] of which are used for HHCW treatment, followed by on-site disposal of the ash residue. Of these four, one has too short a chimney (Peradeniya Dental hospital), two are relatively old (Suwasevana hospital, Kandy, Chilaw Base hospital), while the fourth is in relatively poor condition (Badulla General hospital). In addition, most of these incinerators are believed to be single chamber systems. Two hospitals in Kandy and the Nuwara Eliya Base hospital have autoclaves for the treatment of specimens and cultures prior to disposal, while some have needle burners for sterilising sharps before disposal.

c. HCW Reuse

Many medical institutions reuse waste containers. For example:

- Saline and penicillin bottles are reused, by cutting off the top and using as a container for collecting sputum, blood and urine samples.
- Cardboard boxes are used as sharps storage containers.
- Plaster of paris tins are used as carbon dioxide jars.
- Savlon bottles are collected and return to suppliers for refilling.
- In addition, Badulla general hospital uses coconut shells as fuel for its incinerator.

d. HCW Recycling

Recycling of non-risk HCW is also very common, including:

- Most used plastic, glass and metal bottles/containers/tins/cans – many places.
- Patient records and x-rays – many places (after storage for five years).
- Newspaper/cardboard - Kandy General, Gampaha and Nuwara Eliya base hospitals.
- Saline bottles - Negombo and Gampaha base and Badualla general hospitals).
- Coconut shells - Peradeniya Teaching, Negombo, Chilaw, Gampaha and Nuwara base hospitals).
- Food/kitchen waste for animal feed – Kandy General and Peradeniya Teaching hospitals.

Generally, these items (other than food/kitchen wastes) are stored and then advertised for sale by tender at intervals ranging from three months to five years. For example, Peradeniya Teaching hospital sold 67,750 containers (plastic, glass and metal containers of various sizes), 605 kg of tins and 91 kg of cardboard by tender over a seven month period in 2002. Sale prices range from 0.10-70Rs each for small tins, plastic containers and glass bottles, 0.30Rs ea. for coconut shells, 0.75Rs/kg for cardboard to 5-20Rs each for large metal tins/cans and plastic containers.

[11] Nuwara Eliya Base hospital has a relatively new incinerator but this is not used due to its inappropriate location, proximity to staff quarters and inadequate chimney height.

2.3.8.4 Attitudes towards Current and Improved HCWM

16 (57%) of medical institutions are not happy with the current HCW collection and disposal service, the main reasons being:

- Garbage collection/sweeping is not properly done: 10
- Irregular garbage collection/sweeping: 8
- Poor discharge system: 6
- Problems of handling healthcare hazardous waste: 5
- Garbage collection/sweeping frequency is too low: 5

Desired SWM improvements ranked in descending order are: WAR[12]

- Improved garbage discharge system 24.0
- Greater recycling/composting of garbage 23.0
- Improved collection and disposal of HHCW waste 21.5
- Improve collection frequency: 17.0
- Education to change peoples' bad habits 14.5
- More reliable garbage collection service 13.5

Eight medical institutions specifically requested the provision of proper incineration facilities.

Other specific proposals included:

- Financial assistance to implement the colour coded garbage discharge system recommended by the Ministry of Health (Chilaw and Gampaha base hospitals).
- Financial assistance to provide hospital labourers with appropriate garbage collection equipment (e.g. gloves) (Chilaw and Gampaha base hospitals).
- A covered trailer for the transportation of non-risk HCW transport to final disposal (Nuwara Eliya Base and Badulla General hospitals)
- A new secure, covered concrete bin for non-risk HCW (Nuwara Eliya Base hospital).
- Financial and technical assistance to start an on-site composting project (Badulla General hospital).

[12] WAR = weighted average rank