Chapter A-2

Solid waste management in a slum area of Mumbai

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A-2.1 INTRODUCTION

Slums provide the housing and living environment for a large part of India's urban population. Slums are unplanned and so present many problems for solid waste management. No two slums are exactly the same, so it cannot be expected that the recommendations and solutions proposed in this chapter can be applied without modification to other slum areas, but the approaches and criteria described in this chapter are very relevant to many other slum settlements. The main emphasis of this chapter is on refuse collection; related subjects like sweeping of lanes, drain cleaning and cleaning of public toilets are considered to a lesser extent.

Studies were carried out by two different teams: one was dealing with refuse collection services from a technical, operational and economic point of view, whereas the second team was concerned with social and community aspects related to refuse collection in the same area.

A slum pocket was chosen to study the present refuse collection system, to identify problems and to suggest possible improvement measures. Investigations were based on existing physical conditions including access and housing patterns without considering the possibility of relocation of buildings to realign or widen roads.

In addition, a questionnaire survey was conducted to obtain first-hand information on the residents' needs, opinions and aspirations regarding service improvements.

Information on operations was primarily based on field investigations. Additional data were provided by officers of the Conservancy Section (Ward G-North), and from personnel of the Transport Section (G-North Garage).

A-2.2 SLUM IMPROVEMENT POLICIES IN MUMBAI

Constant migration and population growth led to the development of slums in Mumbai. In 1993 more than 50 % of the city's population was living in such areas (i.e. more than 4 million people).

According to the Maharashtra Slum Areas Act (1971) an area can be declared as a slum in case of dilapidation, overcrowding, faulty design of buildings, narrowness or faulty arrangements of streets, lack of ventilation, light or sanitation facilities or any combination of these factors.

A paper on Slum Improvement Policies in Maharashtra (1992) describes the history of improvement activities as follows:

- Resettlement of slum communities to areas outside the city centre had been practised in the past. This strategy failed because the economic base of people is related to their present location and therefore most slum dwellers were reluctant to move or came back to their original place after being resettled.
- Considering this problem the Government decided to allow the slum dweller to occupy their original place as long as it is not required for urgent public purposes.
- Slum Improvement Schemes were initiated and carried out under the Bombay Housing and Development Board (BHDB) and Municipal Corporation of Greater Mumbai (MCGM). State Government grants, (Rs 250 per person in 1993), were used to improve the living conditions in slum areas by providing basic amenities such as water supply (1 tap per 150 persons), public

toilets (1 toilet per 20-50 persons), drainage, access and street lighting. Service charges were collected at the rate of Rs 18 per resident (probably per year).

- Just prior to the time of writing, a Slum Upgrading Programme was initiated under the World Bank funded Bombay Urban Development Project. This project aimed at providing tenure rights to some 60,000 slum dwellers in 137 slums and to grant home improvement loans (between Rs 5,000 and Rs 14,000) to encourage dwellers to invest in structural improvements to their homes. This programme further aimed at improving infrastructure facilities to higher standards (e.g. one WC for 4-10 households, one water tap for 10 households, provision of hard pathways and lining of drains).

Although refuse collection was not specifically mentioned under any of the programmes, the provision of adequate collection services is likely to be an important component of improving living conditions in slum areas. In the case discussed in this document, a questionnaire survey revealed that the respondents considered refuse collection to be the most neglected service in their community (as will be discussed later in section A-2.6).

A-2.3 DESCRIPTION OF THE STUDY AREA

A slum pocket in Dharavi was selected to carry out the field investigations. Located on the northern fringe of the Island City, Dharavi was originally a peripheral area, but now it forms a central part of Greater Mumbai. About 360,000 people were living in some 60 000 to 65 000 hutments, which made Dharavi the largest slum area in Mumbai.

The study area consisted of four slum communities, namely Sameshwar, Shivashankar, Jagajiban and Mukund Nagar. A location map, including main solid waste management facilities in the area, is provided in figure A-2.1.

Based on census data, the population of the study area was estimated to be about 19,000 people, and the number of hutments was thought to be around 3,800. Considering that the area is about 6.8 hectare (16.8 acres) the population density was around 2,800 persons per hectare.

The majority of buildings along main lanes and a large percentage of buildings inside the slum area had two storeys. They were built from bricks and metal sheets, which were primarily used to construct the upper floor. A wide variety of commercial activities and small scale industries were commonly located on the ground floor whereas the second floor was used for living accommodation. Buildings usually occupied less than 20 square metres.

Access conditions and layout were investigated and are presented in figure A-2.2.

It can be seen from figure A-2.3 that only a few main lanes were wide enough for vehicular traffic and that a few secondary lanes allowed small handcarts to enter the area.

Most pathways were very narrow, usually less than two metres wide, and others became almost impassable because they accommodated ladder type stairs to the first floor or large capacity drums, which were commonly kept in front of premises for water storage as shown in photograph 3.

Almost all pathways were paved with concrete. Open drains, lined with concrete, were located along one or both sides of the lanes and used to convey sullage and rainwater. Drainage was towards Jugelekar Nallah in the centre of the area and Mahim Creek north of the Bandra Sion Road. The Jugelekar Nallah was covered below the main access lane in the direction east-west.

Open spaces were scarce and so pathways were used for various activities like cleaning, washing, bathing and as a playground for children. Therefore the lanes served important functions and people felt responsible to keep them in a clean condition.

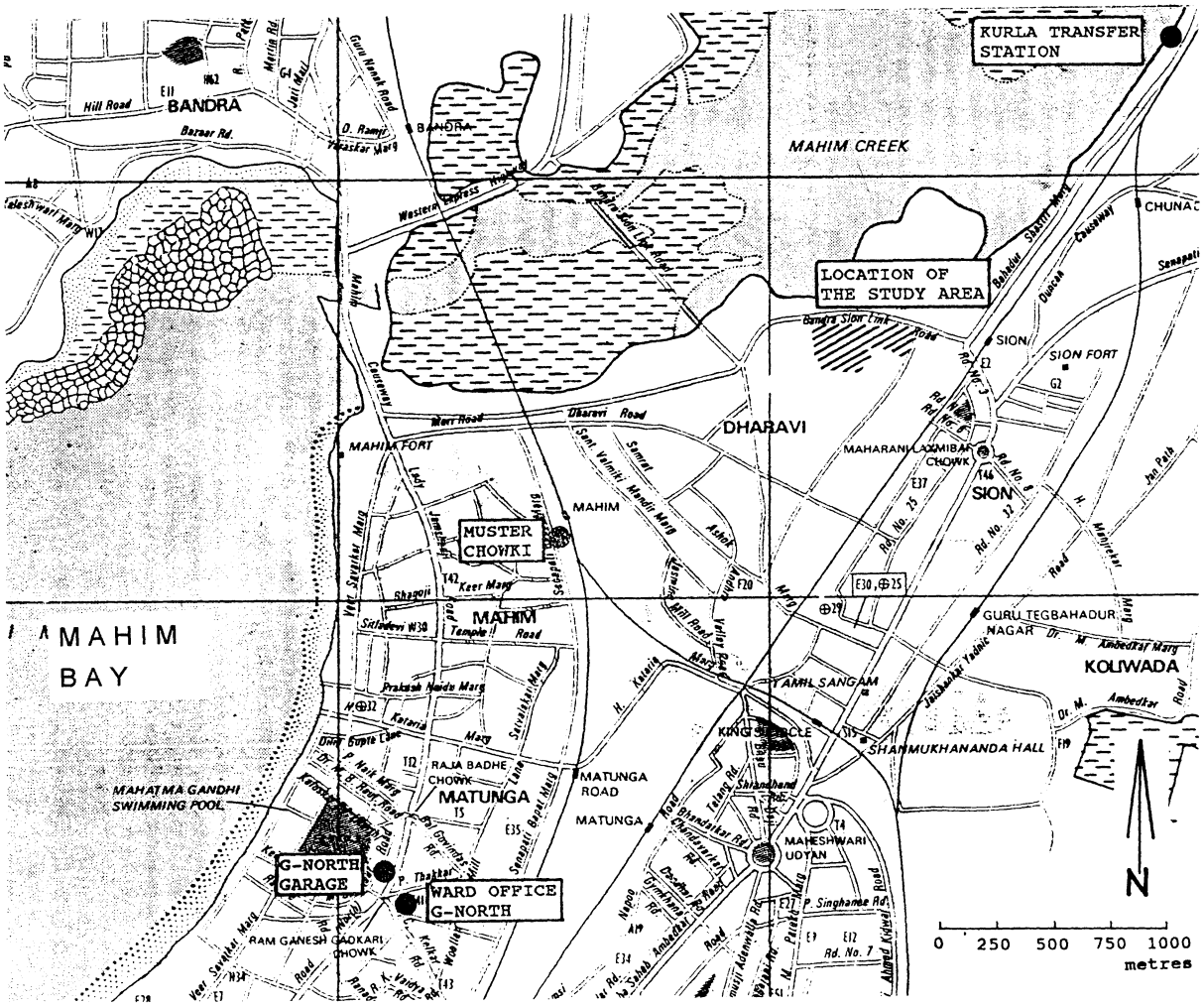

Figure A-2.1: Location of the study area

STUDY AREA: Sameshwar, Shivashankar, Jagajiban and Mukund Nagar.

MUSTER CHOWKI: Office of Junior Overseers of the Conservancy Department and place where workers and mukadams met at beginning and end of each shift.

G-NORTH WARD OFFICE: Offices of G-North Ward, including the Conservancy Section (senior SWM officers: A.H.S. and Supervisor).

G-NORTH GARAGE: Garage of the Transport Department. Maintenance and repair of MCGM vehicles. Drivers met here at the beginning and end of each shift.

KURLA TRANSFER STATION: Refuse from the study area was carried to this station. Large capacity trucks were deployed for bulky transport to Deonar dumping ground.

Houses were usually without sanitary facilities and eight public toilets had been installed in the area and were maintained by halalkhores of the MCGM.

Water supply was provided from a central network and connections to individual premises were quite common. However, supply was only for three hours in the morning, from about 6.30 to 9.30 am, and most people kept a drum for water storage in front of their houses. In addition, some handpumps

were connected to the pipe network and used to obtain water during times of low pressure in the pipe network.

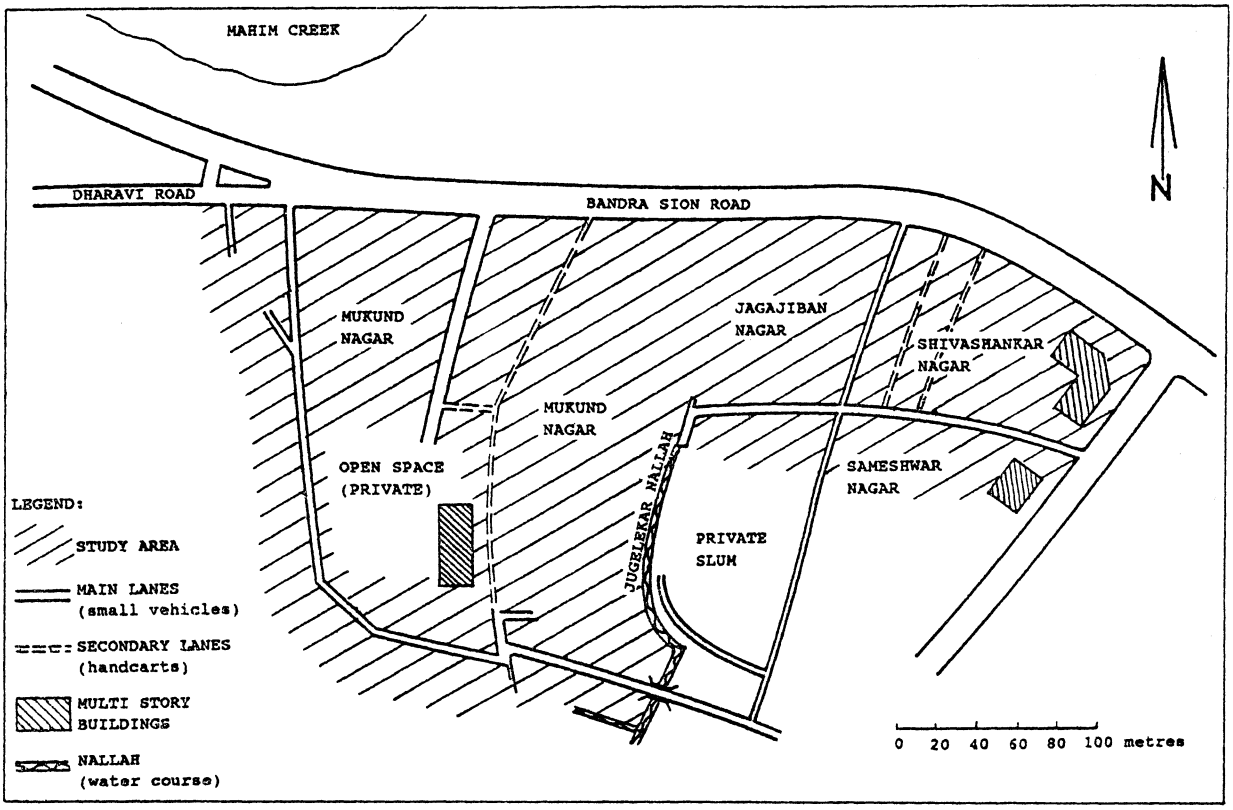

Figure A-2.2: Access and layout of study area

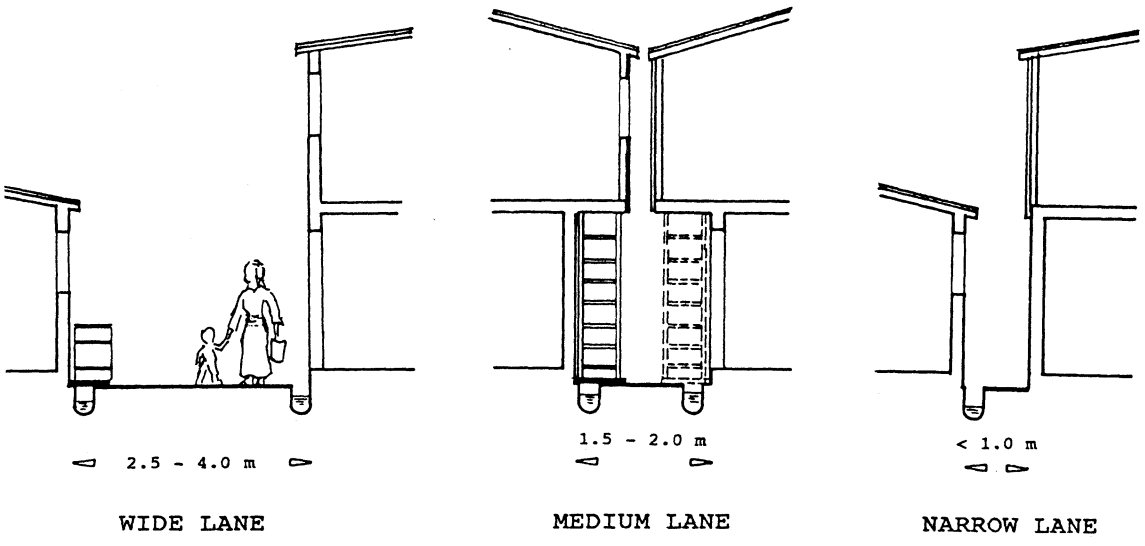

Figure A-2.3: Typical lanes in the study area

Figure A-2.2 also shows the locations of two multi-storey buildings which were provided to slum dwellers under the Prime Minister's Grant Project. Another multi-storey building adjacent to open space is shown in the south-east part of the study area. This area, including the access road, was private property.

A-2.4 SERVICES PROVIDED BY THE CONSERVANCY DEPARTMENT

The Conservancy Department provided the following services: drain cleaning, removal of refuse from community containers along the main road and from refuse collection points in the slum area, sweeping of lanes and roads as well as cleaning of public toilets.

a) Manpower and facilities of the Conservancy Department

Public toilets, community containers and refuse collection points in the study area are shown in figure A-2.4.

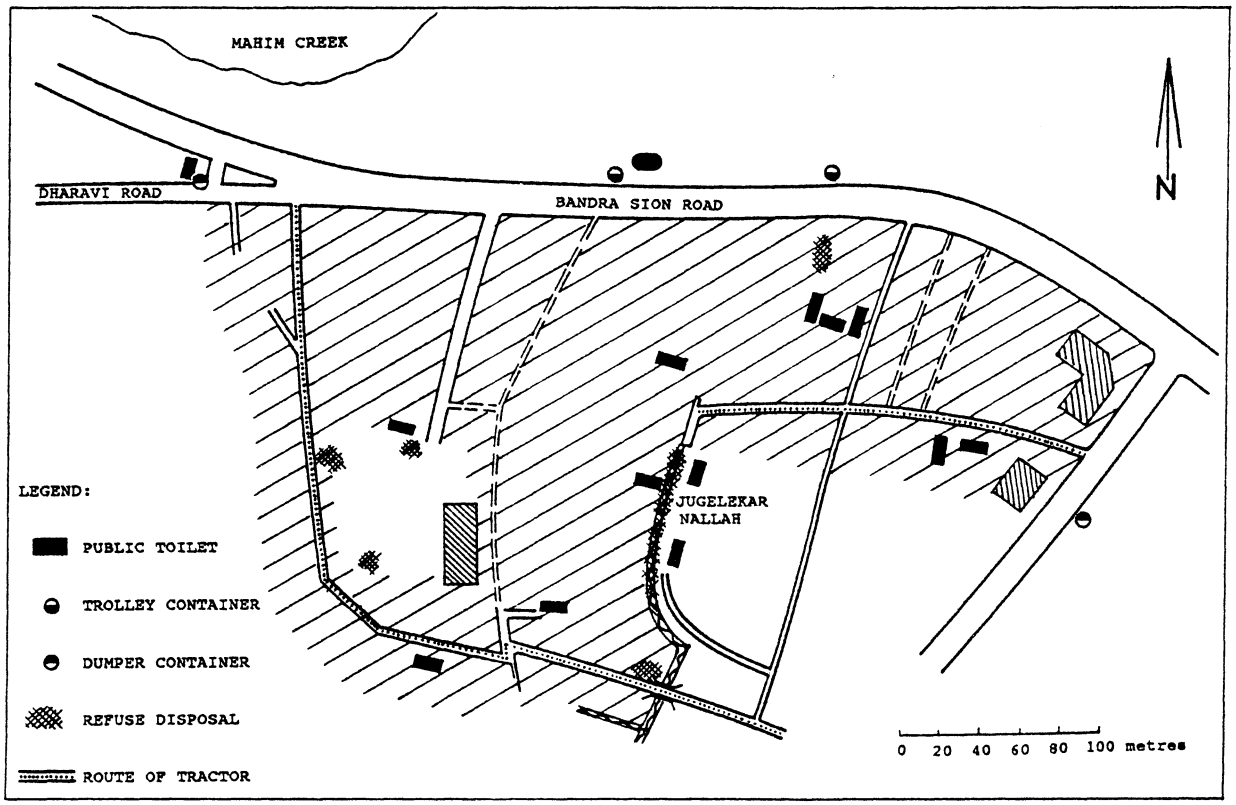

Figure A-2.4: Existing facilities of the Conservancy Department

Four community containers were provided along Bandra Sion Road; two of them were dumper placer type containers (about $4m^3$ each) and the remaining two were trolley bins ($1m^3$ each). In addition, several localities in the slum area were used for refuse disposal, including Jugelekar Nallah. A small tractor, equipped with a container at its rear, was used to transport refuse to Kurla transfer station (see figure A-2.1). The route of this vehicle is shown in figure A-2.4. This figure also shows that most public toilets were located inside the slum area. Spacing was fairly uniform and the distance

between toilets was usually about 100 metres, and up to 150 metres in three cases. Most toilets were located along the main lanes, so the walking distance for residents was generally less than 100 metres.

Table A-2.1 shows the assignment of MCGM employees in the study area.

Table A-2.1: Number and tasks of MCGM employees in the study area

3 mukadams [collection]	Supervision of drain cleaners and sweepers
32 drain cleaners	Removal of refuse from open drains and transport to containers (manual, some using handcarts).
5 street sweepers	2 for sweeping of wider lanes in the slum area, 3 for sweeping Bandra Sion Road
8 halalkhores	6 for cleaning public toilets in slum area, 2 for removal of faeces along Bandra Sion Road.
2 mukadams [transport]	One per shift, supervision of motor loaders
10 motor loaders	Five per shift, loading of refuse and drain cleanings to the tractor
2 drivers	One per shift, operation of the tractor.

Personnel for administration and supervision as well as personnel for emptying community bins along the main road are not included.

The number of MCGM employees assigned to the area was 62, which is equal to about one employee per 300 people (estimated population 19,000) or 3.3 employees per 1,000 inhabitants. This is slightly more than the overall labour ratio of the MCGM in Mumbai of about 3.0 per thousand inhabitants.

b) Refuse collection

Table A-2.2 provides an idea regarding the refuse generation in the area.

Table A-2.2: Estimated solid waste quantities in the study area

Refuse generation per capita		population	total refuse generation	
kg/p.d	litres/p.d	(estimated)	tons/day	m^3 /day
0.35 (note 1)	0.88 (note 2)	19 000	6.7	17 (note 2)

Notes (1) This value may be realistic in low income communities.
(2) Assuming that the refuse density is about 400 kg/ m^3

Only a fraction of this quantity was directly carried to existing containers along the main road. These containers provided a capacity of about 10 m^3 and were used by people from both sides of the road and commercial premises. In addition, street sweepers and drain cleaners carried waste to these containers. The facilities were emptied by dumper placer and compactor trucks of the MCGM.

Figure A-2.4 indicates several locations inside the slum area that were used as refuse dumps. Away from the main road there were no storage facilities and refuse was dumped onto the ground and into Jugelekar Nallah. These areas were cleared at very long intervals (up to one year) and posed a

threat to public health in the area. Refuse was also dumped in drains and removed by drain cleaners as described in the following section.

c) Drain cleaning

Cleaning of drains was very labour-intensive and more than 50 % of the present manpower was employed for manual removal of refuse from drains by means of tools such as those shown in figure A-2.5.

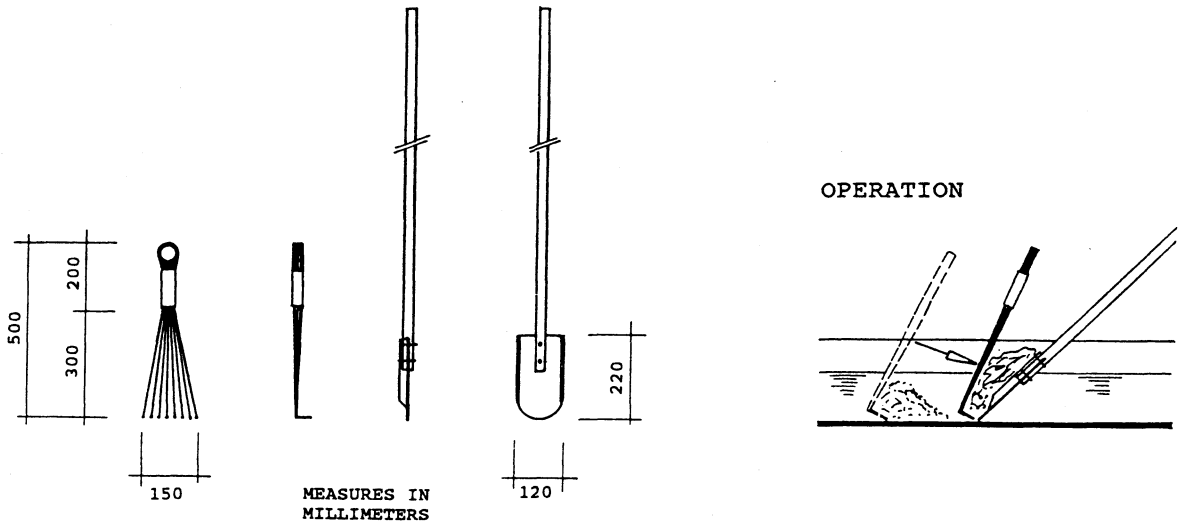

Figure A-2.5 Tools for drain cleaning

The wet material was either directly carried in small bowls to refuse containers along the main road, or loaded into handcarts for transport to the containers, or left along the main lanes for drying until removed by the small tractor.

Transport on handcarts was difficult because the material was wet and heavy. Most handcarts were equipped with two plastic bins which were designed to carry light street-sweeping wastes. When used for transporting silt from drains the bins were soon damaged and were too heavy for lifting and emptying into the containers at the main road. So the contents were usually dumped beside the containers for drying, to be loaded by the motor loaders; this practice caused long waiting periods for the trucks.

When they were dry, piles of silt along the wider lanes were loaded manually into a bin on a small tractor (International B 275) by a crew of five motor loaders. The vehicle was equipped with a container (capacity about 0.8m^3) which was fixed at its rear. Two crews were employed, one in the morning shift (6.00 am to 2.00 pm) to serve Sameshwar, Shivashankar and Jagajiban Nagar, and another in the afternoon (2.00 pm to 8.00 pm) to serve Mukund Nagar. The tractor carried the material to Kurla transfer station, some 3 kilometres north-east of Mukund Nagar along Lal Bahadur Road (see figure A-2.1). There, the container contents were unloaded manually onto the ground and transferred by a front-end loader (JCB) to large tipper trucks for transport to Deonar disposal site. Loading and transport were time-consuming and usually only two trips to Kurla Transfer Station were carried out per shift (based on records obtained from G-North Garage - 107 trips were undertaken in 48 shifts in November 1993). Hence, fourteen persons (see table A-2.1) and one tractor were employed to remove only about 3.5 m^3 of waste per day. Based on appendix AA-2.1, labour costs for this operation were about Rs 2,500 daily, which is equal to more than Rs 700 per m^3. Considering that additional costs for primary collection by drain cleaners, operation of the tractor, transfer at Kurla

station and refuse transport to Deonar on bulk carriers are also involved in the system, total costs for refuse collection are extremely high and improvement measures would be highly desirable.

In addition, a private contractor was employed about once a year to remove refuse from Jugelekar Nallah. A layer of some 0.5 metres of floating refuse, which covered the water course completely, was cleared manually. Workers, standing in the nallah without any protective clothing, used small capacity bowls to remove the material and to place it along the banks for drying. There was no access for vehicles and the material had to be picked up again and carried some 50 metres to the truck. Apart from the very high costs involved in this procedure, the working conditions are considered unacceptable.

A-2.5 IMPROVEMENT MEASURES

Inadequate refuse collection services in the slum area are considered to be the main reason for the development of crude dumping areas and for refuse disposal to open drains. This led to unhygienic conditions, blockages of drains and ineffective and costly procedures for refuse removal from the area.

Improvement measures should aim at introducing an appropriate collection system and avoiding refuse disposal to open drains. In addition to public health benefits, the labour force could be reduced and improvements might be cost-effective. Community participation is a vital aspect and will be discussed in section A-2.6.

a) Refuse collection

Refuse collection from individual households was ruled out due to difficult access conditions and high costs. As shown in figure A-2.2 only a fraction of the area is accessible for small vehicles and handcarts.

A collection system which provides a sufficient number of community containers at convenient locations inside the slum area, is considered the most promising way to improve the situation.

Table A-2.3 shows an approximate calculation of the storage requirements in the study area.

Table A-2.3: Estimated storage requirement

Refuse generation		Required capacity of community containers (m^3)		
tons/day	m^3/day	total required	existing	additional required
6.7	17	18	5	13
(note 1)	(note 1)	(note 2)	(note 3)	

Notes
(1) According to Table A-2.2 above.
(2) Assumptions: 80 % of refuse generation disposed to community bins. Provision of 33 % excess capacity. Clearance once daily.
(3) 50 % of the capacity of facilities along Bandra Sion Road considered (containers are used by people from both sides of the road).

Potential locations for community containers have been identified as shown in figure A-2.6. Ten locations for community containers are suggested in the figure; all locations are accessible for small vehicles and provide sufficient space for manoeuvring during container clearance.

Localities in front of public toilets are considered most appropriate. People are familiar with such localities and the walk to the toilet may be combined with refuse disposal. In addition, they are at

some distance from houses and therefore likely to be more acceptable to residents, who are concerned about flies and odour, (which cannot be totally avoided). A small footpath is proposed to link one of the existing dumping areas to container location 2.

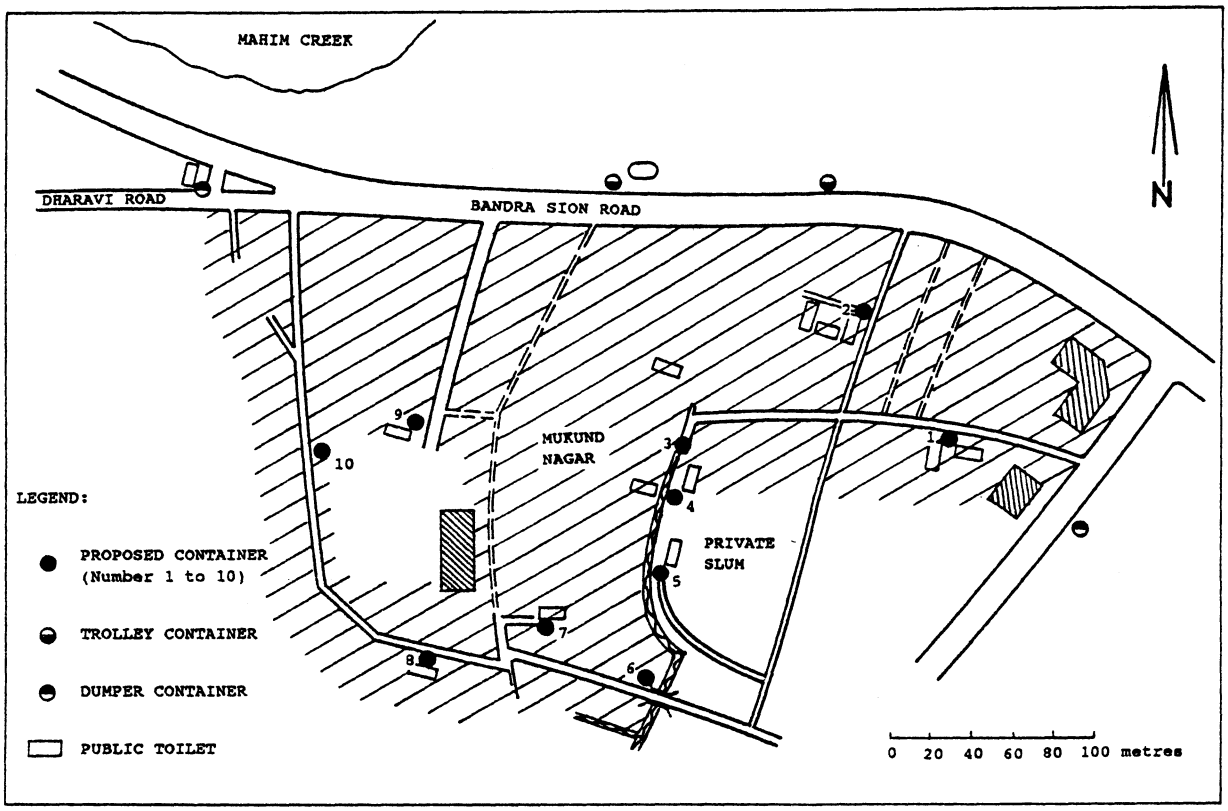

Figure A-2.6: Possible locations for community containers

Three containers (number 3, 4 and 5) are suggested along Jugelekar Nallah to provide a convenient alternative to dumping refuse into the nallah. Two of the proposed locations are east of the nallah, close to the public toilets of a private slum society. Permission of the society is required regarding access to the containers for clearance. However, the private community will benefit from the facilities and this may help to settle this issue. Two pathways crossing the nallah are suggested to provide access to the containers for people from Mukund Nagar.

In addition, a number of locations (number 6 and 10) are proposed at existing dumping areas. These locations are accepted by the people, accessible for small vehicles and provide sufficient space for small containers.

If the suggestions are followed, community containers could be provided to the residents at convenient locations. The walking distance to the facilities is generally less than 100 metres and may be acceptable for the people (see section A-2.6).

In addition, a container handling system is required for clearance and removal of refuse from the area.

b) Container handling and solid waste transport

Access restrictions to the area do not allow the use of large trucks with container emptying devices (such as dumper placers). Therefore a small, manoeuvrable vehicle is required to pick up the

containers quickly, to transport them over a short distance and to empty them directly into larger vehicles or containers for long-range transfer to the disposal site. Possible arrangements are discussed in this chapter.

Design of a detachable container The existing tractor is capable of entering the wider lanes of the study area and could be used to carry containers over short distances. However, the existing tractor is not designed for container handling and alternative arrangements are required to make the container detachable. This issue was discussed with personnel of G-North Garage, where the present container was fabricated, and was considered possible. Figure A-2.7 suggests a redesign of the container and the lifting gear of the present tractor to make it suitable for container handling.

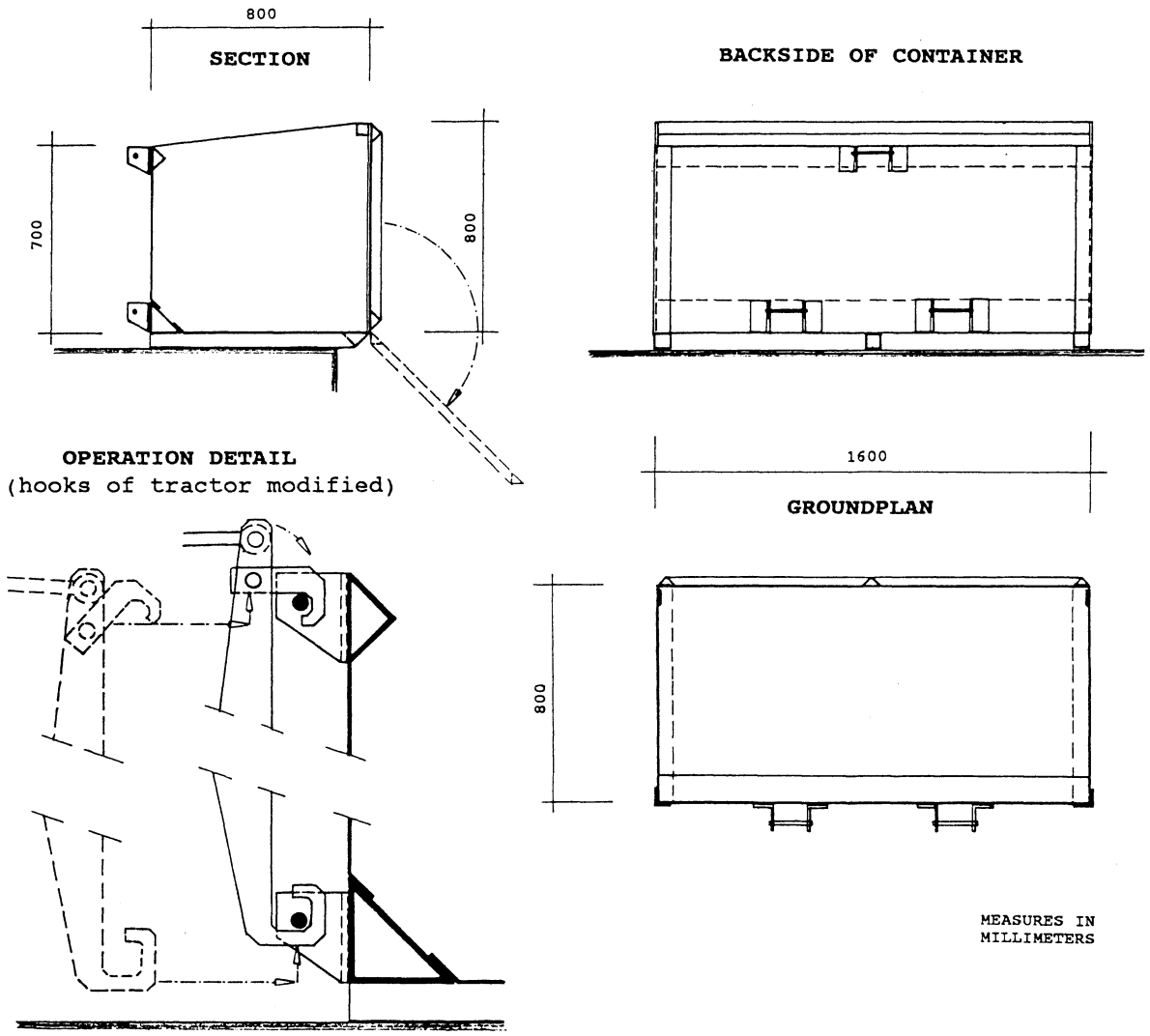

Figure A-2.7 Container design and handling system

Rigid joints (nuts and bolts) at the three supports of the container should be replaced by the proposed hook system, operated by the lifting gear of the tractor. Considering that the tractor will be used to

carry refuse rather than wet and heavy drain silt, the container capacity should be increased from the existing 0.8 m^3 to at least 1.0 m^3. It is further suggested to hinge the lid at the bottom of the container. A pilot version should be manufactured and operated for a period of time to further improve the arrangements before the system is introduced on a larger scale. If this suggestion is followed, the existing tractor could be used to handle the detachable containers. One driver and one motor loader are considered sufficient to operate the system.

The distribution of containers to ten locations would provide a storage capacity of about 10 m^3. This is less than the estimated storage requirement of 13 m^3 per day (see table A-2.3) and some containers may need to be emptied twice daily. Monitoring of the system is proposed to establish adequate clearance procedures.

Solid waste transfer Manual container emptying and double handling at Kurla transfer station are inappropriate because they involve long waiting periods for vehicles. In addition, the useful range of the tractor-container system is short and the distance to Kurla is such that using tractors would lead to poor performance and high costs. A small transfer station close to the slum area would be more appropriate. An area along Bandra Sion Road, north of Mukund Nagar, may be appropriate for this purpose and should be investigated. Some minor earth works would be sufficient to construct a split level station at this location and dumper placer containers could be used to receive waste directly from the tractor-container system. Two containers, cleared twice daily, would provide sufficient capacity for secondary storage of refuse from the tractor-container system.

Rapid pick up and unloading in combination with the short distance to the transfer station would allow a substantial increase in the tractor's performance. Time consuming and labour intensive manual unloading of refuse could be avoided and one motor loader would be sufficient to assist the driver during operations.

Performance of the container handling system Time requirements of the proposed container handling and transport system are estimated as follows:

Container pick up in the slum area	about	3 minutes,
Driving to the new transfer station	up to	10 minutes,
Unloading to larger capacity containers	about	3 minutes,
Driving to the next container location	up to	10 minutes.

Hence, less than 30 minutes should be sufficient to complete one round trip, and about 6.5 hours would be required to collect and empty 13 container loads from the study area.

Considering a net working time of 6.0 hours per shift and another hour for driving from G-North Garage to Mukund Nagar and back to the garage (shown in figure A-2.1 to be about 5 kilometres one way) at least ten round trips per shift are realistic.

Therefore the tractor's performance would increase by factor of 5 (ten instead of two trips per shift), the number of motor loaders could be reduced by factor of 5 (one instead of five), and additional localities in the vicinity of the study area could be served by the vehicle (twenty trips are possible per day, only about thirteen are required in the study area).

Daily emptying of containers is required and a rotating labour system (i.e. different labours taking a different day off) would have to be introduced.

c) Cost comparison

Costs of the present and proposed systems are estimated in appendix AA-2.2. Both estimates are concerned with primary collection and do not include costs of dumper placer vehicles and bulk transport to Deonar landfill site.

Cost calculations for the proposed system are based on the following assumptions:

- It is expected that the provision of community containers will avoid refuse disposal to drains to a large extent. Therefore ten drain cleaners might be sufficient instead of the current 32. This would also allow a reduction in the number of mukadams from the current four to one or two.
- The suggested container handling system would eliminate manual loading and unloading of containers and one motor loader would be sufficient to assist the driver (instead of the five motor loaders currently employed).
- Calculations assume that the number of sweepers remains at five.
- Costs for the tractor, drivers and motor loaders are reduced by factor 13/20 (13 trips necessary per day, 20 trips possible, remaining time spent to serve other areas in the vicinity).
- Approximate costs for the proposed transfer station at Bandra Sion Road are included.

Results of calculations in appendix AA-2.2 are summarised in table A-2.4

Table A-2.4 Costs of the primary collection system

	Present system		Proposed system	
	Rs/year	percent	Rs/year	percent
Labour costs (drain cleaning and sweeping)	22,64,000	71.8	9,04,000	66.2
Labour costs (loading and transport)	8,18,500	25.9	1,93,000	14.1
Costs of tractor and containers	72,500	2.3	1,07,000	7.8
Publicity	-		1,25,000	9.2
Transfer station and containers	-		37,000	2.7
Total costs	31,55,000	100	13,66,000	100
Costs per inhabitant (19 000 people)	Rs/month		Rs/month	
Drain cleaning/sweeping by MCGM	13.8		6.0	
Drain cleaning/sweeping by residents (note 1)			2.0	
Unit costs of the proposed tractor-container system (note 2)			**365**	Rs/tonne

Notes: (1) If people become in charge for drain cleaning and sweeping along their premises labour costs could be reduced by up to 904,000 Rs/year.
(2) Performance: 13 trips/day x (67 % x 1.0 m^3) x 0.4 tons/ m^3 x 365 d/a = 1270 tons per year. Unit costs without drain cleaners and sweepers.

The comparison shows that the reduction of the labour force would allow the introduction of the proposed system at less than 50 % of the current cost.
Publicity and awareness campaigns are suggested to encourage people to carry out drain cleaning and sweeping of lanes near their premises. Ultimately, with drain cleaning and sweeping entirely carried out by residents, only about Rs 2.0 per inhabitant monthly would be sufficient to operate the primary collection system. This would be about 15 % of the present costs and may be affordable for the majority.

d) Alternative systems

Alternatives to the tractor system may be considered once small container hoist vehicles become available in India. A recent design (by Manus Coffey) is based on a dumper truck chassis and able to carry small capacity containers under difficult road and access conditions. Although smaller than the tractor this vehicle is designed to handle and carry containers with a capacity of about 2 m^3.

Further investigations are suggested regarding solid waste transport to Deonar. Transfer operations at Kurla are very unsatisfactory and should be improved by introducing a split level station. In addition, the proposed system involves two transfer operations, one from the tractor system to dumper placer containers at the suggested Bandra Sion station and another one from dumper placers to bulk carriers at Kurla. This is quite complicated and costly and should be avoided. Larger capacity vehicles could be introduced for direct transport from the proposed transfer station to Deonar. Hook lift container systems or large capacity semi-trailers would be suitable for this purpose and market research is suggested to find out whether such systems are available in India (see also suggestions regarding bulk transfer from Mahalaxmi transfer station in Chapter B-1).

A-2.6 QUESTIONNAIRE SURVEY ON REFUSE COLLECTION

To obtain an idea about the opinions and needs of residents in the study area a questionnaire comprising thirteen questions was prepared and a survey conducted in the area.

The team had become familiar with the locality before formulation of the questionnaire. This helped to identify specific questions, which considered the existing situation, and to include realistic options regarding service improvements.

Conducting a questionnaire survey in slum areas is not an easy task because the communities consist of people from various parts of India, who represent a variety of cultural and religious groups and communicate in at least six different languages (in particular Hindi, Marathi, Kannada, Gujarati and Urdu).

Ideally, a questionnaire survey should include the following:

- Translation of questions into the different languages.
- Multilingual team of enumerators selected to conduct the survey. 50 % of the enumerators should be female to interview female residents.
- Briefing and training of enumerators (including awareness of solid waste management issues).

It was impossible to comply with all these requirements when carrying out the survey. However, although the team had to struggle with language problems it was possible to interview 34 persons from various locations in the study area.

Some of the questions and replies are reproduced below, together with comments on the responses that relate directly to the issues under consideration. The questionnaire sheet including a summary of replies is presented in appendix AA-2.3.

1. Living conditions in slum areas are far from ideal and outsiders may not be able to set the right priorities when planning infrastructure service improvements. Therefore residents were asked to indicate their own perceptions of needs and priorities:

Please rank neglected services in your locality in order of importance:	Water	Toilets	Flooding	Refuse	Roads	Sweeping	Electricity
First priority	1	12	0	18[53%]	1	1	1
Second priority	1	10	1	14 [41%]	1	7	0
Third priority	4	3	8	2	7	9[26%]	1

Replies clearly indicate that the residents consider refuse collection as the most neglected service in their community. Flooding and sweeping are commonly caused by uncollected refuse and could be combined with refuse collection. Hence, when considering combined replies, 56 % of the responses rank refuse collection improvements as most important, 65 % as second most important and 56 % as the third most important issue.
Considering that there are no individual toilets in the area and that water supply is only three hours in the morning this result is indeed surprising.

2. From a technical and economical point of view community containers are considered most suitable to improve the situation (see section A-2.5).

What do you think about the idea of sharing common bin with several families in your locality if this bin is emptied daily and kept clean?

good 32/94% fair 1 bad 1

The responses indicate that residents like the idea of sharing community bins for storage of refuse.

3. A physical survey in the locality revealed that locations close to public toilets may be most appropriate for community containers (see section A-2.5).

If a community bin would be provided at your public toilet would you be willing to bring your garbage to this place?

yes 29/85% no 2 don't know 3

Replies indicate that residents are willing to carry refuse to community bins at public toilets.

4. Prevention of refuse disposal to open drains would not only improve public health in the locality but also allows a substantial reduction in costs (see section A-2.5).

Do you feel that provision of community bins at suitable locations will prevent people from throwing refuse in drains?

yes 22/65% no 8 don't know 4

Based on the responses the majority believed that the provision of community bins would prevent refuse disposal to open drains. As shown in table A-2.4, the reduction of labour for drain cleaning allows the implementation of the proposed collection system and the reduction of costs for services provided by the MCGM. Publicity and awareness campaigns are suggested to encourage people to carry out sweeping and drain cleaning along their premises.

5. Community support is vital when introducing the proposed collection system.

Is it possible to formulate community action groups in your community to activate people in refuse collection?

yes 9 no 12 don't know 13

Replies indicate that a relatively large number of people may be willing to become actively involved in service improvements. Suitable campaigns may help to motivate additional people to participate in community activities regarding refuse collection.

6. One question has been addressed to assess the willingness of community members to pay for service improvements.

If any new system is introduced by the Corporation for improvement of the existing refuse collection system, are you willing to pay nominal charges?

yes 27/79% no 7 don't know 0

It is significant that a clear majority would be willing to pay for service improvements. Further investigations are required to evaluate affordable service charges and to establish an appropriate system to collect charges. Charges should at least allow the recovery of primary collection costs which could be reduced to a monthly charge of about Rs 2.0 per inhabitant (see table A-2.4).

7. Based on (1) above, toilets have been ranked second regarding improvement needs (35 % rank public toilets as most important, 29 % as second most important). Although not directly related to refuse collection one question was addressed as follows:

Please think about the public toilet in your locality and choose the most serious problem.

Poorly maintained	Place very dirty	Place far away	Lack of water	others
12	9	0	11	2

Lack of water was probably the main reason for poor maintenance and cleanliness of toilets. It was observed that halalkhores were obliged to use sullage from open drains to clean the facilities and that people carried water in buckets from their home for anal cleaning. Further investigations are suggested to establish suitable techniques regarding the provision of water to public toilets.
Results further show that the distance to toilets seemed to be acceptable. This may indicate that people are likely to carry refuse to these facilities, if the community containers are provided at most toilets

A-2.7 CONCLUSION

Replies in the questionnaire survey clearly indicate that residents considered refuse collection as the most neglected service in their community.
The provision of community storage facilities, mostly located at public toilets, is proposed to improve the situation. Responses of people indicate that they liked the idea of sharing community bins and that they were willing to carry refuse to these facilities. The majority of respondents further believed that the provision of community containers would prevent refuse disposal to open drains, which would allow a substantial reduction labour for drain cleaning.

Detachable containers in conjunction with the existing tractor are proposed for refuse storage and collection. In addition, a split level transfer station, located close to the slum area, is suggested. These measures would allow the performance of the tractor to be increased by factor of 5, the number of motor loaders to be reduced by a factor of 5, and the servicing of additional localities in the vicinity of the study area.
A reduction of the labour force is suggested to allow the implementation of service improvements at affordable cost. It is estimated that the proposed system would reduce the present service costs by more than 50 %. It is further suggested that intensive publicity and awareness campaigns be initiated in order to encourage people to carry out drain cleaning and sweeping of lanes adjacent to their premises. Ultimately, with drain cleaning and sweeping entirely carried out by residents, about Rs 2.0 per month and resident would be sufficient to cover the costs of primary collection. This is

only about 15 % of the costs of the present system and may be affordable for the majority. It was significant in the survey that a clear majority seemed to be willing to pay for service improvements. Further investigations are suggested to evaluate affordable service charges and to establish an appropriate system to collect charges.

Alternative collection and transport techniques should be investigated to further reduce costs. Market research is suggested regarding small container hoist vehicles which are suitable to operate under difficult road and access conditions. In addition, hook lift container systems or large capacity semi trailers should be employed to improve refuse transport operations.

APPENDIX AA-2.1 LABOUR COSTS OF MCGM EMPLOYEES

AA-2.1.1 Wage components of MCGM employees

BP: Basic Pay (monthly), increasing annually by certain amount.
Labourers: 1260 - 20 - 1400 - 25 - 1500 - 30 - 1590
Drivers: 1375 - 20 - 1450 - 30 - 1600 - 40 - 1680 - (EB) - 40 - 1880
Mukadam: 1300 - 20 - 1380 - 25 - 1480 - 30 - 1510 - (EB) - 30 - 1660
J. O.: 1590 - 50 - 1690 - 60 - 1930 - 70 - 2350 - (EB) - 70 - 2770
Supervisor: 2190 - 90 - 2550 -100 - 2950 - (EB) -110 - 3500
A.H.S.: 2600 -100 - 2900 -110 - 3450 - (EB) -110 - 3560 - 125 - 4060

E.g. labourer: Minimum Rs 1,260.-, increasing by Rs 20.- per year until BP Rs 1,400.-, increasing by Rs 25.- per year until Rs 1,500.- etc., maximum BP Rs 1,590.- (after 15 years in service).

Note: EB (Efficiency Bar): Possible additional increment to BP, based on performance of the employee, fixed by a committee.

BP in case of promotion to higher grade: One increment in same grade or next scale in higher grade.

DA: Dearness allowance (monthly, all grades), quarterly adjustment according to Mumbai Consumer Price Index, about 50 % to 80 % of BP, decreasing with increasing BP.

DP: Dearness Pay (monthly, all grades), 50% of DA at 30.06.1990, about 15 % to 25 % of basic pay

CA: Conveyance Allowance (monthly, only JO upwards), flat rate for transport during working hours, between Rs 100.- and max. 1,600.-,

WC: Washing Charges (monthly, all staff wearing uniforms, mainly labourers), flat rate of Rs 25.- for laundry services.

UWA: Unclean Works Allowance (monthly, labourers and mukadams only), flat rate of Rs 15.- (labourers) or Rs 25.- (mukadams).

MMA: Municipal Medical Allowance (monthly, all grades), flat rate Rs 70.-,

HRA: House Rent Allowance (monthly, all grades): HRA = 10 % of (BP + DP). If housing is provided by MCGM, HRA = 5 % of (BP + DP)

LTA: Leave Travel Allowance (once every second year, all grades, only provided if staff is min. 240 days per year in service). Rates depend on BP as follows:

BP up to 1,500.- :	LTA 1,250.-
BP 1,501.- to 2,000.-:	LTA 1,550.-
BP 2,001.- to 2,650.-:	LTA 2,000.-
BP 2,651.- to 3,250.-:	LTA 2,450.-
BP 3,251.- to 4,375.-:	LTA 3,250.-
BP 4,376.- to 4,900.-:	LTA 4,150.-
BP more than 4,901.- :	LTA 4,350.-

Ex Gratia: Bonus (once yearly, all grades):
(BP + DP + DA) + Rs 100.- to Rs 500.- (increasing with grade),

Scholarships (all grades): Rs 120.- per year per child, beginning with 5th standard (if marks are above 60 %). Scholarships for college students up to Rs 3,000.- per year.

RG: Retirement Gratuity (single payment, all grades):
15 days x (BP + DP + DA) per year in service
E.g. retirement of sweeper after 26 years in service
RG = 15/30 x 26 x (1,590 + 345 + 1,170) = about Rs 40,400.-.
Maximum Rs 100,000.-, payment to family in case of death of employee.

FP: Family Pension (monthly after retirement, all grades), flat rate
Rs 185.- per month (payment to family in case of death of employee).

AA-2.1.2: **Estimated labour costs**
(sweepers, motor loaders and halalkhore)

Calculation for employees who have been 5 years in service:

Basic Pay (BP):	1380
Dearness Allowance (DA):	1050
Dearness Pay (DP):	310
Unclean Works Allowance (UWA):	15
Washing Charges (WC):	20
Municipal Medical Allowance (MMA):	70
House Rent Allowance (HRA):	170 (10 % of 1380 + 310)
Leave Travel Allowance (LTA):	50 (1250 two years/24 month)
Ex Gratia:	240 (1380 + 1050 + 310 + 100) / 12
Scholarship:	100 (one child, school)
Retirement Gratuity (RG):	115 (0.5 x 5 x (1380 + 310 + 1050) / 5 x 12
Total	3,520 Rs per month

Annual working days of employees

365 days - 10 days (i.e. 20 days at half payment or 10 days full payment for medical leave) - 33 days (vacation, earned leave) - 20 days (public holidays) - 52 days (weekly day off) - 2 days (optional leave, religious holidays)
= 248 working days per year.

Considering 248 working days per year for municipal workers labour costs per shift are about:

- Workers 3,520 x 12 / 248 = Rs 170 per shift
- Mukadam (estimated) about Rs 190 per shift
- Drivers (estimated) about Rs 200 per shift

APPENDIX AA-2.2 COST ESTIMATES

AA-2.2.1 Estimated costs of the present system

				Rs/year
LABOUR: (1)	32 drain cleaners	32 x Rs 170 x 300	=	16,32,000
	5 sweepers	5 x Rs 170 x 300	=	2,55,000
	3 mukadams	3 x Rs 190 x 300	=	1,71,000
	2 drivers	2 x Rs 200 x 300	=	1,20,000
	10 loaders	10 x Rs 170 x 300	=	5,10,000
	2 mukadams	2 x Rs 190 x 300	=	1,14,000
	Management & Admin.	(10 % of labour costs)		2,80,000
TOTAL LABOUR COSTS			about	30,82,000
TRACTOR: (2)	Diesel	160 ltr/month x 6.65 Rs x 12 months		12,800
	Maintenance and repair as fuel (assumed)			12,800
	Capital	170,000, standby 1.2, interest 12 %		24,500
	Depreciation	(10 years, incl. standby)		20,400
1 CONTAINER: Capital Rs 9,000, interest 12 %				1,100
	Depreciation (5 years)			900
COSTS OF TRACTOR				72,500
TOTAL COSTS (Rs per year)			about	31,55,000

(1) Labour costs according to appendix AA-2.1, 300 working days per year.
(2) Costs are based on information obtained from G-North Garage.

AA-2.2.2 Estimated costs of the proposed system

				Rs/year
LABOUR:	10 drain cleaners	10 x Rs 170 x 300	=	5,10,000
	5 sweepers	5 x Rs 170 x 300	=	2,55,000
	1 mukadam	1 x Rs 190 x 300	=	57,000
	2 drivers	13/20 x 2 x Rs 200 x 365	=	94,900
	2 loaders	13/20 x 2 x Rs 170 x 365	=	80,700
	Management & Admin. (10 % of labour costs)			99,800
TOTAL LABOUR COSTS			about	10,97,000
PUBLICITY AND AWARENESS CAMPAIGNS (assumed)				1,25,000
TRACTOR: Capital 170,000, standby 1.2, interest 12 %		= 24,500 x 13/20		16,000
Depreciation (10 years, incl. standby x 13/20)				13,300
Diesel 250 ltr/month x 6.65 x 12 (estimated)				20,000
Maintenance and repair as fuel (assumed)				20,000
10 CONTAINERS: Capital Rs 9,000 x 10			=	90,000
Interest 12 %				10,800
Depreciation (5 years)				18,000
Maintenance (10 % of capital)				9,000
COSTS OF TRACTOR AND CONTAINERS			about	1,07,000
TRANSFER STATION: Capital approximately				1,00,000
Interest 12 %				12,000
Depreciation (10 years)				10,000
2 DUMPER PLACER CONTAINERS: Rs 17,500 x 2			=	35,000
Interest 12 %				4,200
Depreciation (5 years)				7,000
Maintenance (10 % of capital)				3,500
COSTS OF TRANSFER STATION			about	37,000
TOTAL COSTS (Rs per year)			about	13,66,000

NOTE: Assumptions are set out in section A-2.5 of the main report.

APPENDIX AA-2.3 QUESTIONNAIRE SHEET AND SUMMARY OF RESULTS

Q-1 Please rank neglected services in your locality in order of importance:

	Please rank neglected services in your locality in order of importance:						
	Water	Toilets	Flooding	Refuse	Roads	Sweeping	Electricity
First priority	1	12	0	18[53%]	1	1	1
Second priority	1	10	1	14 [41%]	1	7	0
Third priority	4	3	8	2	7	9[26%]	1

Q-2 Please think about the public toilet in your locality and choose the most serious problem.

Poorly maintained	Place very dirty	Place far away	Lack of water	others
12	9	0	11	2

Q-3 Are you satisfied with refuse collection in your locality?

yes 7 no 26 don't know 1

Q-4 What are your suggestions to improve garbage disposal in your locality?

Provision of community bins	24
Ringing bell at central location	6
Others	4

Q-5 Do you feel that provision of community bins at suitable locations will prevent people from throwing the garbage in drains?

yes 22 no 8 don't know 4

Q-6 Who is responsible for taking out refuse from your house?

Father	Mother	Children	Other family member	Private scavenger	Others
5	15	6	8	0	0

Q-7 What do you think about the existing locations where most of people in your area bring their garbage?

Garbage not removed	Clearance insufficient	Place very dirty	Location not suitable	Number of points not enough	Blank
15	11	0	0	3	5

Q-8 If a common bin would be provided at your public toilet would you be willing to bring your garbage to this place?

yes 29 no 2 don't know 3

Q-9 What do you think about the idea of sharing common bin with several families in your locality if this bin is emptied daily and kept clean?

good 32 fair 1 bad 1

Q-10 Do you think that people in your locality will bring their refuse to a community bin?

yes 29 no 3 don't know 2

Q-11 Do you feel that people will cooperate in fixing the locations?

yes 25 no 6 don't know 3

Q-12 Is it possible to formulate community action groups within community to activate people in garbage collection?

yes 9 no 12 don't know 13

Q-13 If any new system is introduced by the Corporation for improvement of the existing system, are you willing to pay nominal charges?

yes 27 no 7 don't know 0