# Chapter 9

## *Evaluation of the Master Plan*

# 9 Evaluation of the Master Plan

## 9.1 The Municipal Solid Waste Management Master Plan

### 9.1.1 Frameworks of the Master Plan

#### 9.1.1.1 Review of the Planning Frameworks

The framework of the SWM Master Plan proposed in the Interim Report was heavily relying on the participation of private sectors in refuse collection, especially in the UA's and SUPA's where the majority of residents were expected to pay RCC. However, the conclusion of the financial analysis of the Master Plan was unfeasible without the financial supports of both Areas A and B[2a], as shown in Annex 16.

DCC started the expansion of refuse collection area to 25 wards from 5 wards by increasing the number of concessionaires in August 1996; this was like a trial run of the proposal in the Master Plan. However, the increase in the waste collection amount achieved by expansion plan was found to be only 6 tonnes per day, equivalent to 0.3 % of the total waste generation and 4 % to the total refuse collection amount.

This result definitely proves that experimental expansion of the private refuse collection has failed. This was anticipated from the results of the financial study of the SWM Master Plan presented in the Interim Report. The main cause of failure was that the majority of residents refused to pay RCCs. The achieved RCC collection rate did not reach even the rate expected in the Interim Master Plan.

This forced the basic framework of the SWM Master Plan to shift from a concessionaire oriented model to a more DCC oriented one. There has been a possibility of adopting a more DCC oriented plan since July 1997 due to the rapid increase in revenue from Tax by the new DCC. Therefore, the change of the basic framework was decided jointly by the DCC and the Study Team in March 1997.

#### 9.1.1.2 Goals and Targets

a. Goals

The principal goal of the SWM Master Plan is ***to establish a proper management system for SW by the target year 2005 in Dar es Salaam City,*** this being the centre of the country's economic and industrial activities and where approximately 8% of the national population lives.

Through the establishment of a proper SWM system, ***the Plan aims at:***

- ***preservation of the environment and public health, and sustainable development of the city; and***
- ***promotion and growth of the Tanzanian economy through gaining foreign investment.***

Accordingly, the goals of the Master Plan are as follows.

1. Establishment of a self-sustainable SWM system.
2. Provision of collection services in the urban area (UA), semi-urban planned development area (SUPA) and semi-urban unplanned development area (SUUA).
3. Establishment of a reliable collection system under which regular services can be provided.
4. Construction of sanitary disposal sites which employ sufficient measures for protection of the environment and human health.
5. Development and promotion of a community based recycling system (on-site).
6. Establishment of efficient street sweeping and drain cleansing system through public co-operation.
7. Establishment of a Beneficiary-Pay-Principle (BPP) under which customers pay refuse collection charges (RCCs) and refuse tipping fees.
8. Establishment of proper legislation and regulations through modification and revision of the existing ones.
9. Establishment of a control, monitoring and auditing committee which will consist of SWM experts and will be organised by PMO.
10. Establishment of proper roles expected of organisations involved in SWM.
11. Strengthening of the management and administration system.
12. Development and promotion of public participation and education programmes.
13. Development of SWM human resources.
14. Securing funds for capital investment in equipment and facilities necessary for the realisation of the goals, especially during the time of take off.

### b. Target Year

The master plan shall cover the period between 1997 and 2006. Upon consideration of the limited resources of DCC for SWM, the goal of the master plan shall be achieved in a stepwise manner. The period of the plan is divided into the following three stages.

Table 9-1: Target Year

| Category of Plan | Target Year |
|---|---|
| Master Plan | 1997 - 2010 |
| Phase 1: Preparation for Implementing of F/S Projects | 1997 - 1999 |
| Phase 2: Implementation of F/S Projects | 2000 - 2002 |
| Phase 3: Implementation of M/P Projects | 2003 - 2005 |

### c. Targets

In order to achieve the principle goal of the master plan, the targets for the establishment of the major technical system components for each phase are proposed and tabulated in Table 9-2.

Table 9-2: Targets for Establishment of Major Technical System Components

| Phase / Components | 1996 | Phase I (1997 - 1999) | Phase II (2000 - 2002) | Phase III (2003 - 2005) |
|---|---|---|---|---|
| 1. Refuse Collection Rate | | | | |
| UA | 90 % | 100% | 100% | 100% |
| SUPA | 12 % | 30% | 50% | 70% |
| SUUA | 0 % | 4% | 30% | 50% |
| RA | 0 % | 0% | 0% | 10% |
| 2. Length Covered by Street Sweeping Service | 34 km | 50 km | 100 km | 100 km |
| 3. Intermediate Treatment and Recycling | No treatment facilities other than pilot on-site compost and an incinerator for medical waste | Promotion of organised recycling | Promotion of organised recycling | Promotion of segregation at generation for recycling |
| Rate of Recycling | | | | |
| From Generation Source | 6.5 % | 6.5 % | 8.0 % | 10.0 % |
| Total Recycling | 7.3 % | 7.3 % | 8.8 % | 10.8 % |
| 4. Final Disposal | | | | |
| Landfill Sites | Vingunguti | Vingunguti | Kunduchi | Kunduchi: Level 2 |
| Sanitary Landfill Level | Open Dumping | Level 1[1] | Level 2[2] | Ilala & Temeke: Level 3[3] |

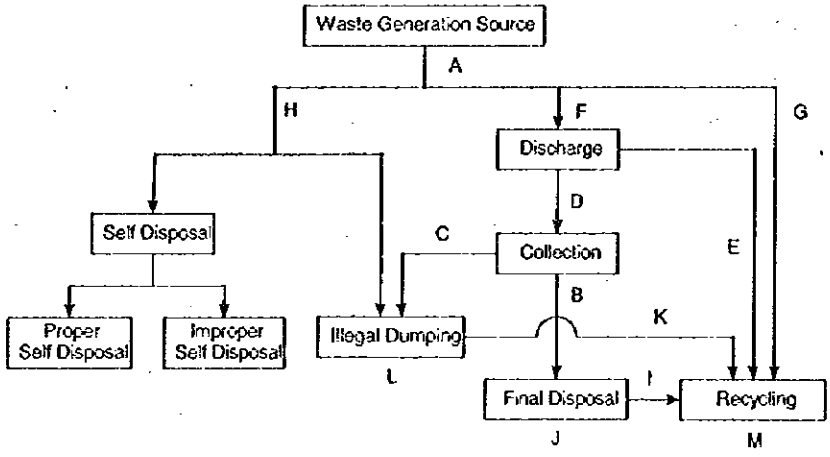
## 9.1.1.3 Future Waste Stream

The main factors that will affect the changes in the waste stream in DSM are:

- changes in waste generation amount.
- changes in waste collection system.
- changes in the recycling system.

The waste stream model below illustrates the flow of waste in DSM and shall also be used as the basis for forecasting future waste flows.

[1] Level 1: controlled tipping method.
[2] Level 2: sanitary landfill without a liner for leachate.
[3] Level 3: sanitary landfill with a liner for the prevention of leachate percolation into the ground.




### *A: Waste Generation*

The waste generation amount is as forecast in section 4.2.1.

### *B: Waste Collection for Final Disposal*

After discharge, waste may be collected by official and unofficial collectors (mainly independent handcart operators and some private illegal contractors). The former transport the collected waste to the final disposal site while the latter usually illegally dump the waste they have collected.

The planned waste collection ratio in the master plan relates to official collectors only. Hence, the waste collection for final disposal amount will increase according to the planned waste collection ratio in the master plan.

$B_n = A_n$ x expected waste collection rate

### *C: Illegal Dumping by Unauthorised Collectors*

The amount of waste illegally dumped after collection refers to the waste illegally dumped by unofficial collectors. This will decrease as the waste collection amount increases and a policy will also be implemented to eliminate this practice. This will result in the rate of illegally dumped waste after collection to the total waste generation amount decreasing from 7.3% in 1996 to 3.0% in 2002 and 0% in 2005.

$C_n = A_n$ x expected illegal dumping by unauthorised collectors

### *D: Collection*

The waste collection amount is the total amount of waste collected for final disposal including the illegally dumped waste from clandestine operators.

$D_n = B_n + C_n$

### *E: Recycling from Discharge*

The amount of waste recycled is calculated assuming that the ratio of the recycling amount to the total waste generation amount in 1996 will be maintained until 2005.

$E_n = A_n \times E_{1996} / A_{1996}$

*F: Discharge*

The waste discharge amount is the sum of the waste collected and the amount which is recycled.

$$F_n = D_n + E_n$$

*G: Recycling from Generation Sources*

The amount of waste generated that is recycled is calculated assuming that the rate of the recycling amount to the total waste generation amount will increase to 8 % in 2002 and to 10 % in 2005 with the promotion of recycling activities.

$$G_n = A_n \times \text{expected recycling rate}$$

*H: Self Disposal and Illegal Dumping from Generation Sources*

The amount of waste generated and illegally dumped or self disposed is calculated assuming that the ratio of the illegal dumping or self disposal amount to the total amount of illegally dumped and self-disposed waste in 1996 will be maintained until 2005.

$$H_n = (A_n - D_n - E_n) \times H_{1996} / (A_{1996} - D_{1996} - E_{1996})$$

*I: Recycling at Final Disposal*

The amount of waste recycled at the final disposal site is calculated assuming that the ratio of the recycling amount from final disposal to the total generation amount will be maintained until 2005.

$$I_n = A_n \times I_{1996} / A_{1996}$$

*J: Final Disposal*

The final disposal amount is the amount of waste which is finally disposed of after being transported to the final disposal sites and is equal to the difference of the waste collection for final disposal amount and the final disposal recycling amount.

$$J_n = B_n - J_n$$

*K: Recycling from Illegal Dumping*

The amount of illegally dumped waste recycled is calculated assuming that the ratio of the recycling amount from illegal dumping to the total generation amount will be maintained until 2005.

$$K_n = A_n \times K_{1996} / A_{1996}$$

*L: Final Illegal Dumping Waste Amount*

The final amount of illegally dumped waste is calculated by summing the illegally dumped waste amounts from generation and collection and then subtracting the amount of illegally dumped waste recycled.

$$L_n = (C_n + H_n) \cdot K_n$$

These formulae are used to forecast the waste stream for DSM in 2002 and 2005 as shown in the following figures.

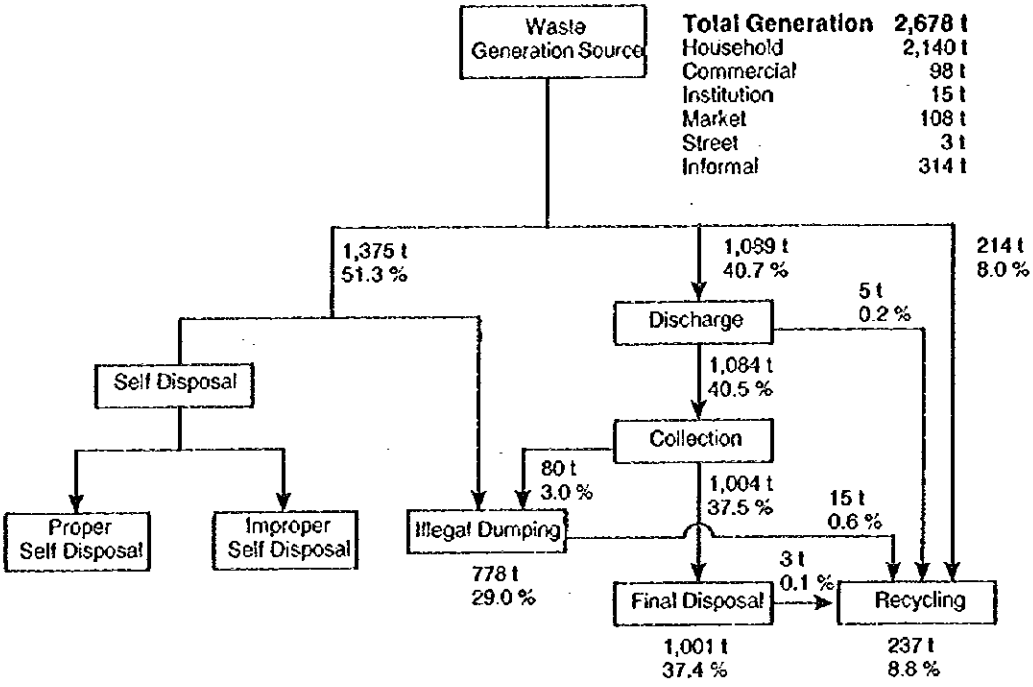



Figure 9-1: Waste Stream for DSM in 2002

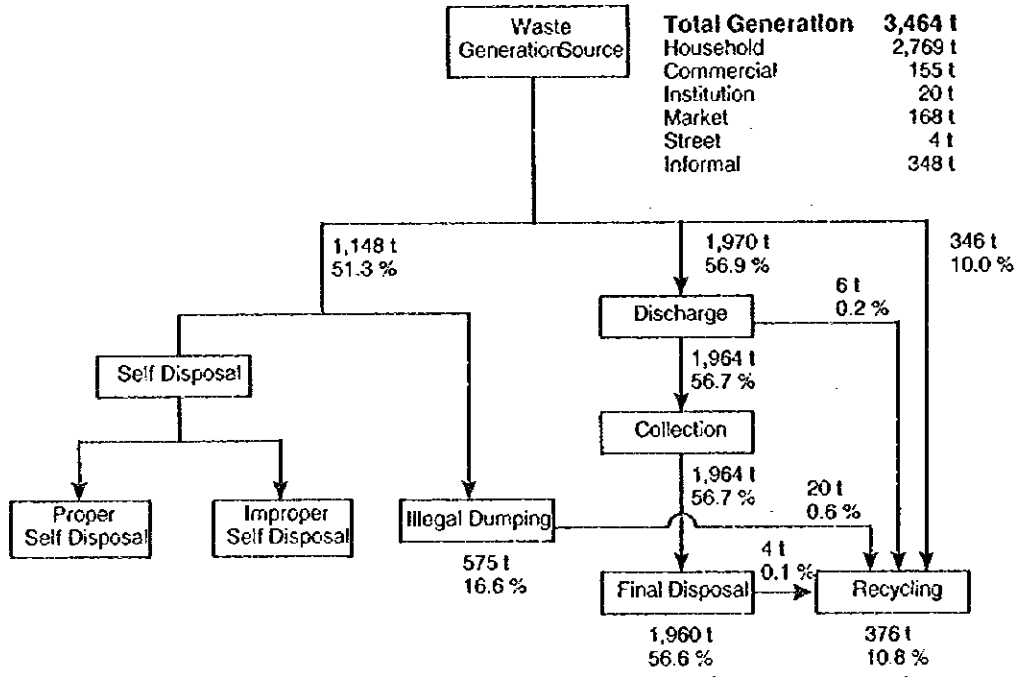



Figure 9-2: Waste Stream for DSM in 2005

### 9.1.1.4 Frameworks of the Master Plan

The Master Plan is formulated based on the following concept.

**a. Technical System**

- The proposed refuse collection system is categorised into i. Curb side collection by tipper trucks without primary collection and ii. Point collection by skip trucks without primary collection depending on accessibility of the refuse collection vehicles.
- DCC will promote recycling activities (which will not need financial aid by DCC) such as on-site composting at generation but shall not construct/operate any collective intermediate and/or recycling facilities. The construction/operation of those facilities shall be by the private sector if they are any interests.
- For street sweeping system, manual work shall be applied as much as possible.
- Wastes collected from each 3 districts shall be disposed of at its own disposal site by a sanitary landfill operation.

**b. Institutional System**

- A Waste Management Authority (WMA) shall be newly established under DCC and be responsible for the SWM in DSM city including cesspit emptying service.
- Refuse collection service shall be provided either by the contractors selected through the contract out system or by the WMA of DCC directly.
- A Supervision and Monitoring Committee shall be established in order to monitor and control the cleansing services of DCC and the private contractors.
- The main financial source for the cleansing services shall be a special fund allocated from the city taxes and the RCC (refuse collection charge). As for the RCC a joint billing system with water/sewerage of newly established DAWASA (Dar es Salaam Water and Sewerage Authority) or RCC (Refuse Collection Charge) for commercial waste collection, RCC should be collected when business licenses are applied for or renewed or for special services such as door to door collection services in the high income households shall be applied.

### 9.1.1.5 Strategy

The strategies to be adopted in the three planning stages are summarised below.

Phase 1 (1997 - 1999): Preparation for Implementing F/S Projects

*Technical Aspects*

- Upon consideration of the very limited refuse collection fleet of DCC at present, for the time being DCC shall provide and expand refuse collection services involving the private sector as much as possible. Refuse collection areas shall be divided into **Area for Private Operation:** urban area (UA), **Area for Either Private or DCC Operation** : semi-urban planned developed area (SUPA) and **Area for DCC Operation:** semi-urban unplanned developed area (SUUA) and rural area (RA). Area (A) shall be serviced by the private contractors and Area

(B) by DCC. The priority of the service expansion is the order of UA, SUPA, SUUA and RA in accordance with the degree of urbanisation.

- A reliable collection service with fixed collection frequencies and schedule shall be established.
- In order to implement the first priority projects (F/S projects), the required funds shall be secured and a detailed design of the projects shall be conducted. Then, facilities shall be constructed and vehicles and equipment procured.
- Site selection work shall be conducted to identify appropriate disposal sites for the Temeke (south) and Ilala (west) Districts.

*Institutional Aspects*

- Development of clear policies and guidelines for the provision of private refuse collection by contracting out services.
- Establishment of a more autonomous and independent solid waste management organisation (i.e., the Waste Management Authority) which will integrate functions dispersed in the three departments (Health, Works and Planning) and be fully responsible for the provision of solid waste services (including cesspit emptying services) for the city in order to enable independent competency on administration, operation and accounting.
- Allocation of a revolving fund to the Waste Management Authority, under the authority of the head of the organisation, to be used for procurement of fuel, spare parts, and all other supplies and parts which require prompt payment.
- Enhancement of the city's tax collection capability and allocation of a special fund for cleansing services (SWM) from DCC's tax revenues.
- Although the fund shall be a main financial source for cleansing services, a joint billing system for RCC with water/sewerage charges of the newly established DAWASA (Dar es Salaam Water and Sewerage Authority) shall be examined in order to establish a "Beneficiary-Pay-Principle" in the future. If the joint billing is not feasible due to certain impediments, DCC shall collect RCC (Refuse Collection Charge) for commercial waste collection when business licenses are applied for and for special services such as door to door collection services to the high income households.
- Improvement of legislation dealing with solid waste management: formulation of a Sanitary Code.
- Organisation of a human resources development project in order to train the professionals involved with solid waste management
- Establishment of an independent body (the Supervision and Monitoring Committee) to monitor and control the cleansing services of DCC and the private contractors.

### Phase 2 (2000 - 2002): Implementation of F/S Projects

*Technical Aspects*

- Operation of facilities constructed and vehicles and equipment procured in Phase 1.
- Using the newly procured skip trucks and containers, DCC shall expand its refuse collection service up to 30 % to the SUUA where the collection services coverage target is only 4 % in Phase 1.
- Conduct a feasibility study for the projects (such as construction of disposal sites for Temeke and Ilala Districts) proposed in the M/P, other than the first priority projects, and to secure funds for implementation. When the funds are secured, the detailed designs of the projects are to be carried out.

*Institutional Aspects*

- Further enhancement of the city's tax collection capability for a financially self-sustainable SWM as well as review of RCC and tipping fee of the disposal site according to the cost incurred to establish a "Beneficiary-Pay-Principle".
- Strengthening of the Supervision and Monitoring Committee for the cleansing services, with emphasis on participation of the private sector.
- Strengthening the management and administration system conceived and implemented in phase 1.

### Phase 3 (2003 - 2005): Implementation of M/P Projects

*Technical Aspects*

- The refuse collection services shall be expanded to 70 % for SUPAs and 50 % for SUUAs respectively.
- The M/P projects, such as construction of disposal sites for Temeke and Ilala Districts, shall be implemented.
- In order to pursue efficiency, the option of whether the operation of the northern Kinondoni District disposal site will be entrusted to the private sector shall be examined.

*Institutional Aspects*

- Further enhancement of the city's tax collection capability and review of RCC and tipping fees of the disposal site according to the cost incurred. With these improvements a sustainable SWM in DSM city will be established. In concrete terms, DCC will be able to construct facilities and procure equipment required for a sound SWM.
- Development of a nation-wide plan for waste minimisation and recycling.

## 9.1.2 The Municipal SWM Master Plan

### a. Outline of the SWM Master Plan

Table 9-3 shows the outline of the Master Plan.

Table 9-3: Outline of the SWM M/P

| Components \ Phase | Present (1996) | Phase I (1997 - 1999) | Phase II (2000 - 2002) | Phase III (2003 - 2005) |
|---|---|---|---|---|
| **1. Refuse Collection & Transportation** | | | | |
| Population in DSM | 2,261,000 | 2,859,000 | 3,736,000 | 5,066,000 |
| Population in the study area | 2,030,000 | 2,455,000 | 3,066,000 | 3,966,000 |
| Waste generation amount (t/d) | 1,772 | 2,144 | 2,678 | 3,464 |
| Collection rate of all waste | 8 % | 17 % | 37 % | 57 % |
| Collection rate of household waste | 5 % | 15 % | 33 % | 52 % |
| Waste collection amount (t/d) | 143 | 362 | 1,001 | 1,960 |
| Nos. of households served | 23,604 | 85,640 | 235,298 | 479,609 |
| Served population | 101,500 | 368,250 | 1,011,780 | 2,062,320 |
| Non served population | 1,928,500 | 2,086,750 | 2,054,220 | 1,903,680 |
| Collection system | Point & curb side collection | Point & curb side collection | UA: Curb side collection SUPA: Curb side collection and Point collection SUUA: Curb side collection and Point collection | UA: Curb side collection SUPA: Curb side collection and Point collection SUUA: Curb side collection and Point collection RA: Point collection |
| Major type of vehicles | Tipper Skip truck Tractor trailer | Tipper Skip truck Tractor trailer | UA: 6 ton tipper truck SUPA: 6 ton tipper truck and 8 ton skip trucks SUUA: 6 tons tipper truck and 8 tons skip trucks | UA: 4 ton compactor truck SUPA: 6 ton tipper truck and 8 ton skip trucks SUUA: 6 ton tipper truck and 8 ton skip trucks RA: 8 ton skip trucks |
| Transportation system | Direct haulage | Direct haulage | Direct haulage | Direct haulage |
| Executing organisations | | | | |
| DCC | Cleansing unit, Health dept | Cleansing unit, Health dept | WMA | WMA |
| Private contractors | 5 concessionaires | NA | NA | NA |
| Required main equipment | | | | |
| 6 ton tipper trucks | 14 | NA | 50 | 66 |
| 8 ton skip trucks | 1 | NA | 67 | 95 |
| 4 ton compactor truck | 0 | NA | 0 | 10 |
| 8 $m^3$ skip with lids | 0 | NA | 134 | 190 |
| 8 $m^3$ open skip | 8 | NA | 536 | 760 |
| No. of workers | | | 317 | 455 |
| DCC | 40 (Aug.1996) | NA | 152 | 132 |
| Contractors | 127 (Aug.1996) | NA | 165 | 323 |
| Unit cost | | | | |
| DCC (USD/ton) | 24.85 (1994) | NA | 21.44 (excluding tipping fee) | 17.33 (excluding tipping fee) |
| Private contractors (USD/ton) | 13.14 (1994) (including dumping fee) | NA | | |
| **2. Street Sweeping** | | | | |
| Method of sweeping | Manual | Manual | Manual | Manual |
| Length of sealed regional road in DSM (km) | 60.7 | 60.7 | 100 | 100 |
| Length of served road (km) | 32.8 | 50 | 100 | 100 |
| Operator | Contractors | Contractors | Contractors | Contractors |
| Nos. of workers | | | | |
| Private contractor | 72 | 110 | 220 | 220 |
| DCC | 3 | 5 | 5 | 5 |
| Contractors | 69 | 105 | 215 | 215 |
| Unit cost | | | | |
| DCC (USD/ton) | Not available | | This cost is included in the collection cost. | This cost is included in the collection cost. |
| Contractor (USD/ton) | Not available | | | |
| Main equipment | Manual | Manual | Manual work with | Manual work with |

| Components \ Phase | Present (1996) | Phase I (1997 - 1999) | Phase II (2000 - 2002) | Phase III (2003 - 2005) |
|---|---|---|---|---|
| | | | litter boxes | litter boxes |
| **3. Intermediate treatment** | •Community based pilot composting facilities<br>•Simple incinerator for infectious waste | • No requirement other than on-site & community based ones | • On-site composting | • On-site composting |
| **4. Recycling** | | | | |
| Recycling rate from generation | 6.5 % | 6.5 % | 8.0 % | 10.0 % |
| Overall recycling rate | 7.3 % | 7.3 % | 8.8 % | 10.8 % |
| Recycling system | • No organised recycling | • DCC needs to organised present recycling system | • Private sector centred system<br>• DCC encourage to organise recycling activities | • Private sector centred system<br>• DCC promotes the separate discharge of wastes for recycling |
| **5. Final Disposal** | | | | |
| Method of operation | Open dumping | Level I | Level 2 | Level 2 or 3 |
| Final disposal site | Vingunguti | Vingunguti | Kunduchi | Level 2 for Kunduchi<br>Level 3 for Ilala & Temeke |
| Transportation distance (km) | 8.7 | 8.7 | 18 | 13 (average) |
| Operation by | DCC | DCC | WMA | WMA |
| Nos. of workers | 11 | 11 | 34 | 85 |
| Tipping fee (Tsh/ton) | 800 | 800 | 3,600 | 6,100 |
| Unit cost (USD/ton) | N.A | N.A | 5.37 | 9.22 |
| Main equipment | Bulldozer 1 | Bulldozer 1 | Bulldozer: 3<br>Excavator: 1<br>Tipper truck: 3<br>Pickup: 1 | Bulldozer: 6<br>Excavator: 3<br>Tipper truck: 6<br>Pickup: 3 |
| **6. Maintenance & Repair** | | | | |
| Preventive Maintenance | Mwananyamala depot | Mwananyamala depot | Nyerere workshop | Nyerere workshop |
| Major repair | Mwananyamala depot | Mwananyamala depot | Private workshop | Private workshop |
| Operation by | E & M sec, Works Dept., DCC | E & M sec, Works Dept., DCC | WMA | WMA |
| Nos. of workers | 17 | 17 | 65 | 98 |
| **7. Public Organisations Responsible on SWM** | | | | |
| Competent authorities | Health Dept., DCC | Health Dept., DCC | WMA | WMA |
| Operation by | Cleansing Sec. | Cleansing Sec. | WMA | WMA |
| Nos. of staff | 1 | 10 | 30 | 50 |
| **8. Financial Matters** | | | | |
| Unit SWM Cost (Tsh/ton) | | | | |
| Revenue Source | • Tax<br>• RCC collected by concessionaires | • Tax<br>• RCC collected by concessionaires | • Tax<br>• RCC collected by joint billing with water or<br>• Special RCC collected by DCC | • Tax<br>• RCC collected by joint billing with water or<br>• Special RCC collected by DCC |
| Breakdown of Revenue | | | | |
| Tax (M. Tsh) | 296 | 548 | 1,165 | 1,868 |
| RCC (M. Tsh) | not available | - | 1,426 | 2,684 |
| Total Revenue (M. Tsh) | not available | - | 2,591 | 4,552 |
| Total revenue per capita (Tsh) | not available | 223 | 845 | 1,148 |
| Total revenue per beneficiary (Tsh) | not available | 1,468 | 2,561 | 2,207 |
| SWM budget per capita (Tsh) | 160 | 223 | 350 | 471 |
| DCC Budget (M. Tsh.) | 5,910 | 10,963 | 23,291 | 37,368 |
| Tax Revenue (M. Tsh) | 2,540 | 7,062 | 18,775 | 32,140 |
| Subsidy (M. Tsh) | 3,370 | 3,901 | 4,516 | 5,228 |
| Tax Forecast Scenario | not available | Moderate | Moderate | Moderate |
| Share of SWM budget | 5 % | 5 % | 5 % | 5 % |
| Collection Rate of RCC | 15 % | 15 % | 20 % | 20 % |
| Tariff Level for RCC (Tsh/month/household) | 150 or 900 | 150 or 900 | 1,250 | 1,250 |
| **9. Role of Private Org.** | | | | |
| SWM services privatised | • Parts of refuse collection<br>• Street sweeping | • Parts of refuse collection<br>• Street sweeping | • Parts of refuse collection<br>• Street sweeping | • Parts of refuse collection<br>• Street sweeping |
| Type of contract | Concession contract | Concession contract | Lump sum contract | Lump sum contract |
| **10. Legislation** | There are basic legislation but lack of enforcement | Consolidation of scattered legislation on SWM into a Sanitary Code | Enforcement of the Sanitary Code | Establishment of a law for waste minimisation and recycling |
| **11. Public Cooperation** | There are very little public education | Informing of proposed | Conduct of active public education and | Promotion of waste minimisation and |

| Components \ Phase | Present (1996) | Phase I (1997 - 1999) | Phase II (2000 - 2002) | Phase III (2003 - 2005) |
|---|---|---|---|---|
| | programmes and co-operation | institutional, administrative and legislative changes on SWM | cooperation campaigns | recycling campaigns |
| **12. Medical SWM** | • No clear classification of medical solid waste,<br>• No discharger's responsibility, Lack of laws, codes & enforcement | • Establishment of clear classification for medical SW and code of practice,<br>• Infectious wastes shall be properly treated at generation | • Enforcement of strict segregation, separate collection, transportation and disposal system for infectious waste,<br>• Examination of thermal treatment of infectious waste with hazardous industrial SW | • Establishment of thermal treatment of infectious waste with hazardous waste |
| **13. Industrial SWM** | • No clear classification of industrial solid waste<br>• No discharger's responsibility, Lack of laws, codes & enforcement | • Establishment of clear classification of industrial SW<br>• Examination of HISW generation amount and its disposal methods | • Enforcement of proper disposal of hazardous industrial SW<br>• Examination of thermal treatment of infectious waste with hazardous industrial SW | • Establishment of thermal treatment of infectious waste with hazardous waste |

### b. Location of SWM Facilities

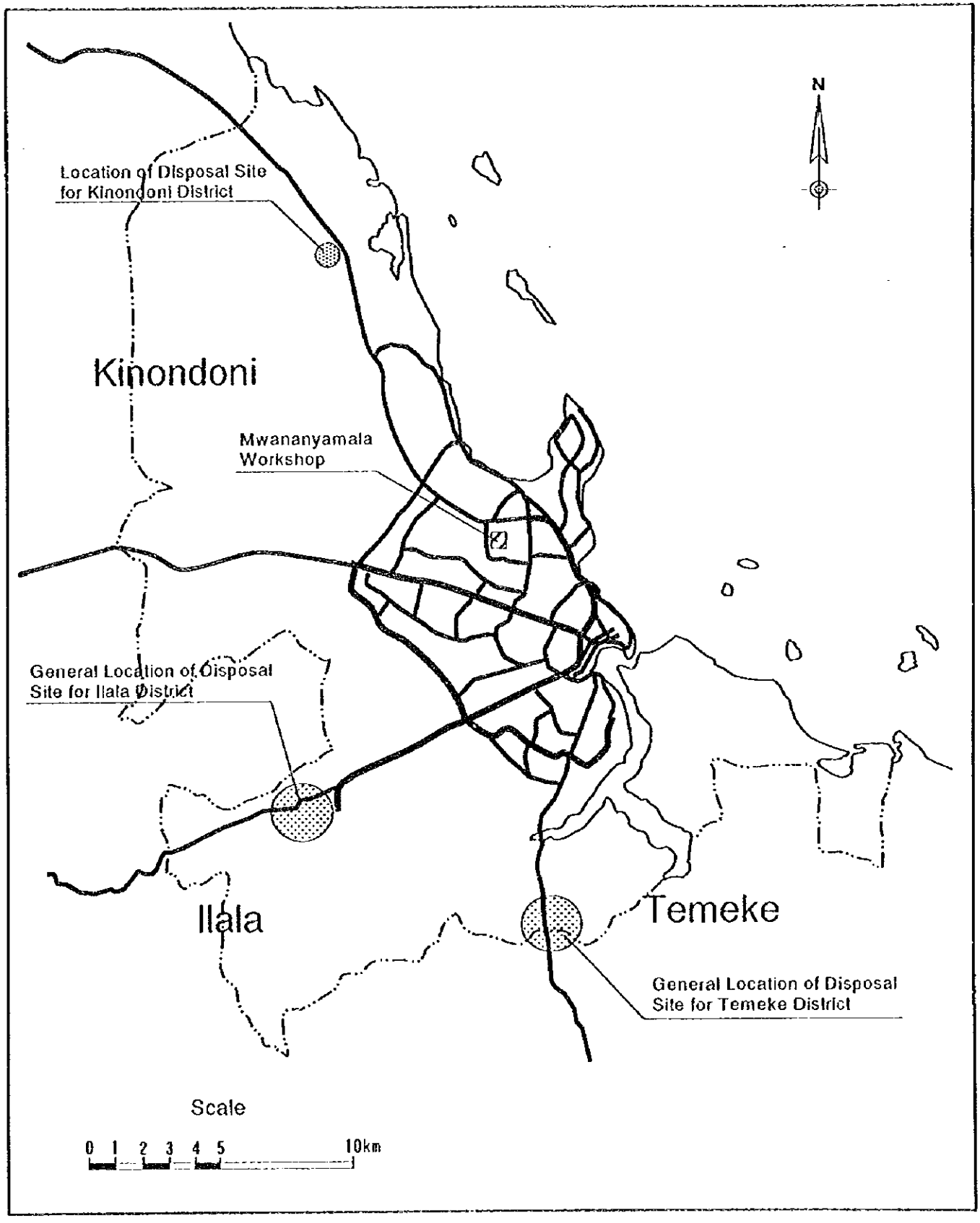



Figure 9-3: Location Map of SWM Facilities

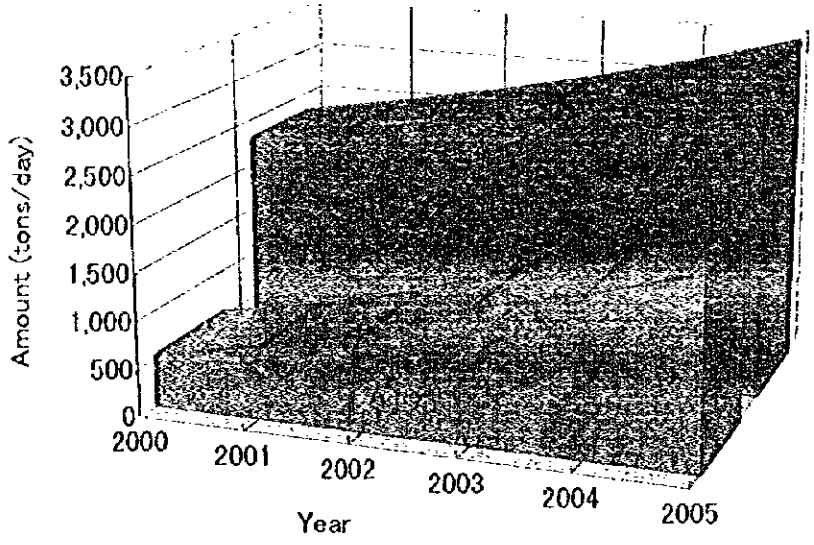
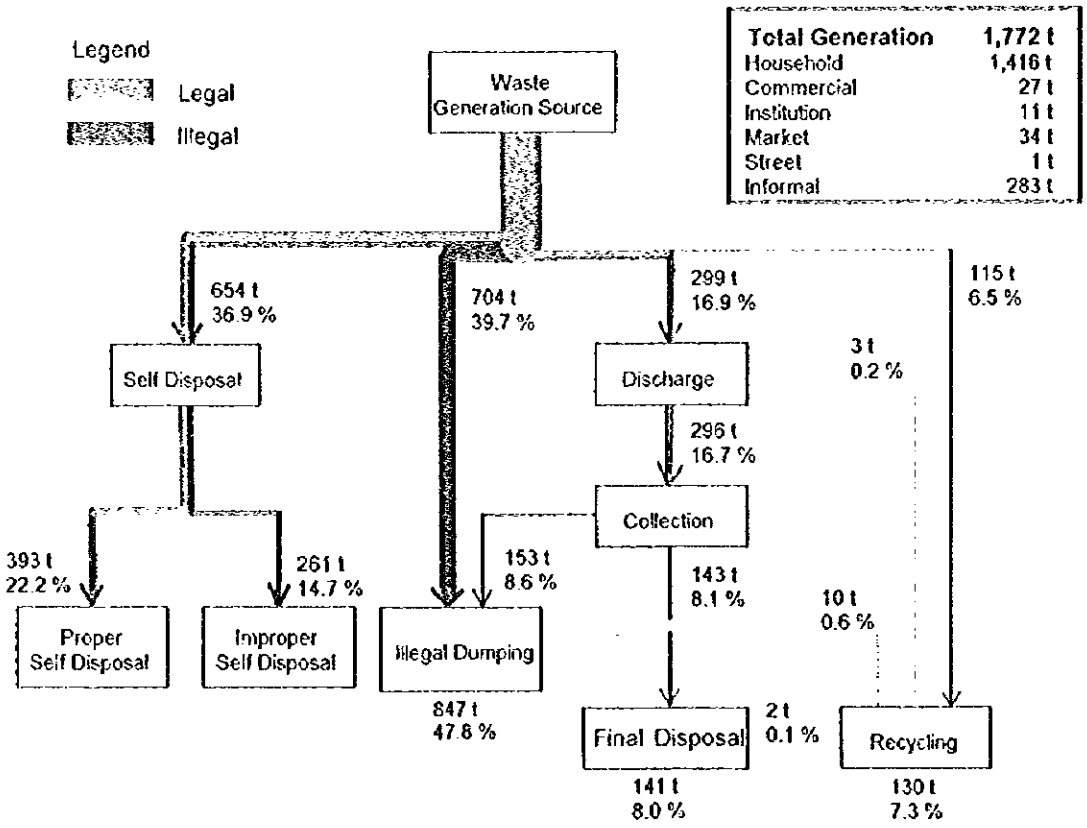



Figure 9-4: Master Plan of Waste Collection

Figure 9-5: Master Plan of The Waste Stream




**Waste Stream in DSM in 1996**

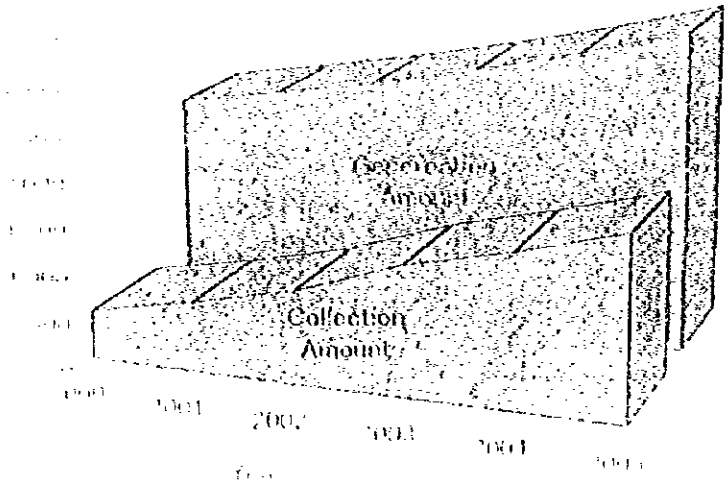
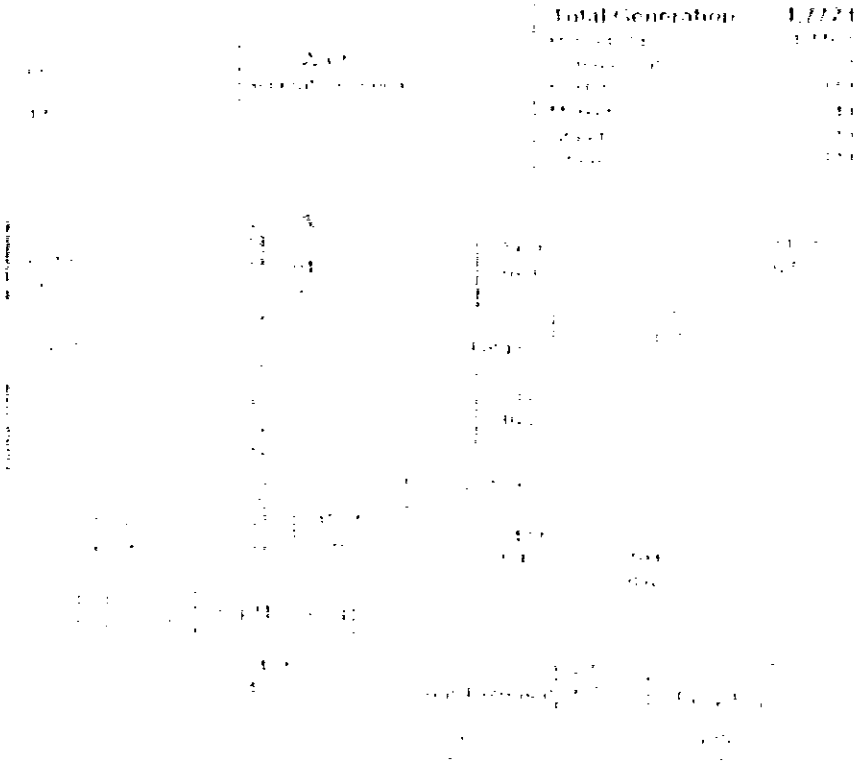
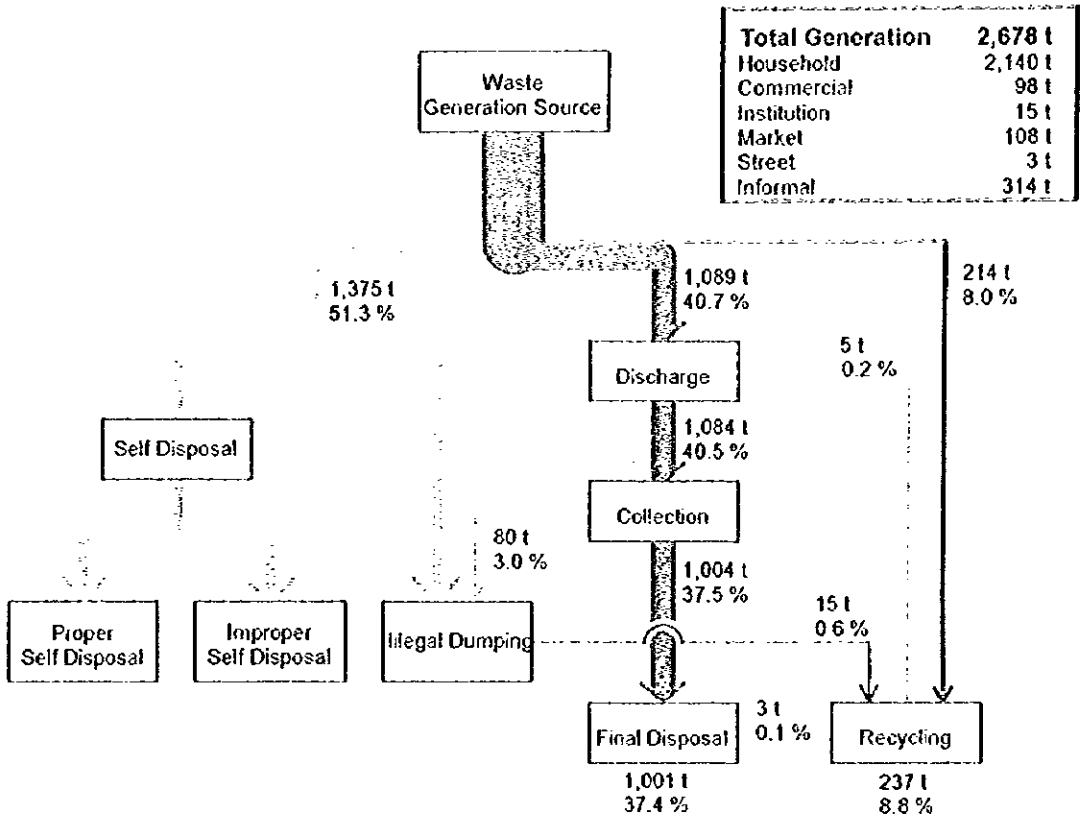



Figure 6-3 Master Plan of Waste collection

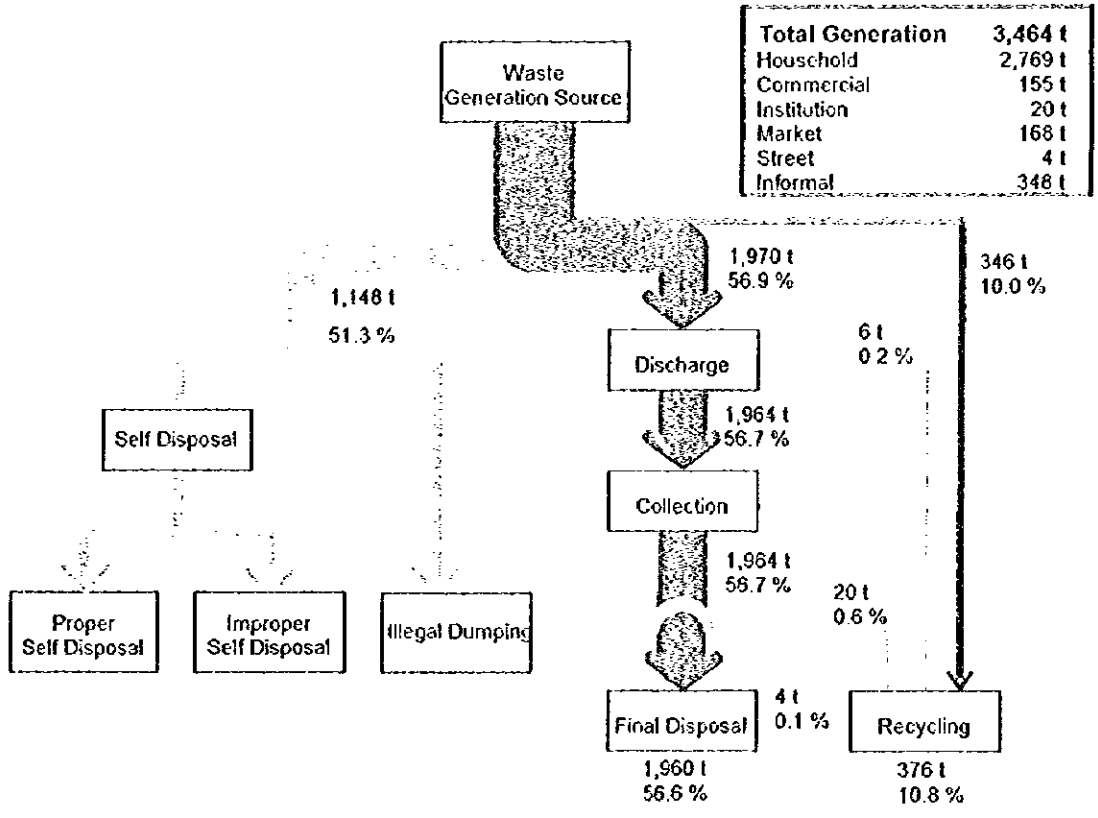
Figure 6-4 Master Plan of the Waste Stream




Waste Stream in DSM in 1996




**Waste Stream in DSM in 2002**




**Waste Stream in DSM in 2005**

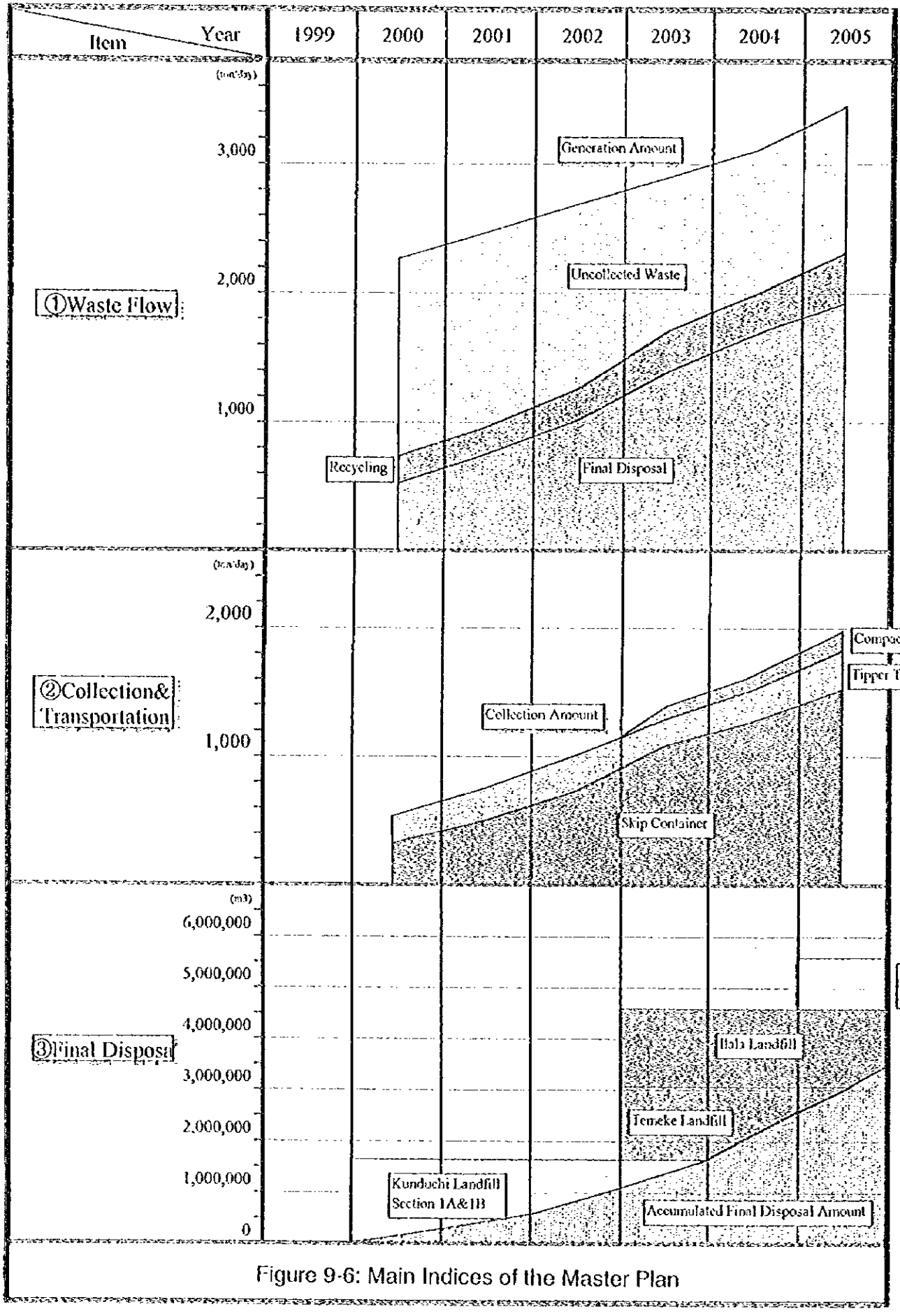



Figure 9-6: Main Indices of the Master Plan

## 9.2 Conceptual Design and Cost Estimation

This section estimates all costs required to implement the master plan. They are divided into the following items for cost estimation.

**A. Direct Cost**

1) Storage and discharge system
2) Primary collection system
3) Secondary collection and transportation system
4) Final disposal system
5) Street sweeping system

**B. Indirect Cost**

1) Maintenance shop
2) Motor pool
3) Administrative expenses of DCC

### 9.2.1 Design Conditions

**a. The Period and Projects in the SWM Master Plan to be examined**

The period and projects in the SWM Master Plan to be examined here are all projects which are planned to be implemented or operated from the year 2000 until 2005.

**b. Key Design Data**

- ASG of waste when it is transported by refuse vehicles without compaction: 390 kg/m$^3$
- ASG of waste when it is transported by refuse vehicles following compaction: 585 kg/m$^3$
- ASG of waste when it is compacted at a disposal site: 900 kg/m$^3$
- Average waste transportation distance: 18 km
- Operation efficiency of refuse vehicles: 0.8
- Operation time of waste collection time: 7.5 hours/day
  6 days/week

**c. Economic Life**

- Skips: 7 years
- Tipper trucks, skip trucks and heavy equipment: 7 years
- Machinery: 15 years
- Buildings and Civil works: 30 years

**d. Remaining Economic Life of Existing Equipment**

The economic life of most existing equipment which is being operated by DCC have expired. It is therefore assumed that the existing equipment would be operational until 2000.

### e. Waste Collection Amount

Table 9-4 shows the waste collection amount per day based on 7 day collection per week.

Table 9-4: Waste Generation and Collection Amount per Day Based on 7 Collection Days per Week

| Category of Waste | Description | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Household | Generation | t/d | 1,838 | 1,979 | 2,140 | 2,323 | 2,530 | 2,769 |
| | Collection | t/d | 380 | 535 | 705 | 1,013 | 1,211 | 1,439 |
| | Collection Rate | % | 20.7% | 27.0% | 33.0% | 43.6% | 47.9% | 52.0% |
| Commercial | Generation | t/d | 69 | 83 | 98 | 115 | 134 | 155 |
| | Collection | t/d | 49 | 66 | 88 | 115 | 134 | 155 |
| | Collection Rate | % | 70.0% | 80.0% | 90.0% | 100.0% | 100.0% | 100.0% |
| Institution | Generation | t/d | 13 | 14 | 15 | 17 | 18 | 20 |
| | Collection | t/d | 9 | 11 | 14 | 17 | 18 | 20 |
| | Collection Rate | % | 70.0% | 80.0% | 90.0% | 100.0% | 100.0% | 100.0% |
| Market | Generation | t/d | 78 | 92 | 108 | 125 | 145 | 168 |
| | Collection | t/d | 55 | 74 | 97 | 125 | 145 | 168 |
| | Collection Rate | % | 70.0% | 80.0% | 90.0% | 100.0% | 100.0% | 100.0% |
| Street Sweeping | Generation | t/d | 3 | 3 | 3 | 3 | 4 | 4 |
| | Collection | t/d | 3 | 3 | 3 | 3 | 4 | 4 |
| | Collection Rate | % | 100% | 100% | 100% | 100% | 100% | 100% |
| Informal | Generation | t/d | 299 | 305 | 314 | 324 | 335 | 348 |
| | Collection | t/d | 50 | 68 | 94 | 119 | 142 | 174 |
| | Collection Rate | % | 16.7% | 22.3% | 30.0% | 36.7% | 42.3% | 50.0% |
| Total | Generation | t/d | 2,300 | 2,476 | 2,678 | 2,906 | 3,165 | 3,464 |
| | Collection | t/d | 545 | 757 | 1,001 | 1,392 | 1,653 | 1,960 |
| | Collection Rate | % | 23.7% | 30.6% | 37.4% | 47.9% | 52.2% | 56.6% |

### f. SWM Costs Included in the Cost Estimation

All costs required to implement the SWM master plan are included in the cost estimation regardless of the type such as direct operation by DCC or contractors of DCC.

## 9.2.2 Storage and Discharge System

The SWM Master Plan proposed to use plastic sacks for tipper truck collection and skips for public use.

No cost is involved in storage and discharge of plastic sacks because plastic bags provided by shops to carry the shopping are proposed to be used .

Skips are used as communal containers. The number of containers required and the cost are estimated in section 9.2.4 (secondary collection and transportation). The required number of skip container is assumed to be 10 skip per truck.

## 9.2.3 Primary Collection System

The SWM Master Plan does not place an importance on the primary collection system because it can not be within the main stream in SWM. To improve the secondary collection and transportation system is far more important than the primary collection system in DSM where the present refuse collection rate is only 8.1 %.

To improvement of the the primary collection system is not taken into account in the SWM project costs which will be implemented by DCC. Its improvement should be conducted with financial resources from non-governmental organisations until 2005.

## 9.2.4 Secondary Collection and Transportation System

### a. Conceptual Design of Secondary Collection and Transportation System

#### a.1 Required Transportation Distance to Landfill Sites

The transportation distances for wastes to the proposed landfill sites are determined or assumed as shown in Table 9-5 based on Figure 9-3.

Table 9-5: Summary of Transportation Distance to Landfill Sites

| District | Area | 2000-2002 | | 2003-2005 | |
|---|---|---|---|---|---|
| | | Landfill Site | Distance | Landfill Site | Distance |
| Kinondoni | SUPA | Kunduchi Landfill | Average distance to Kunduchi Landfill Site is 18 km | Kunduchi Landfill | 15 km |
| | SUUA | Kunduchi Landfill | | Kunduchi Landfill | 15 km |
| | RA | Kunduchi Landfill | | Kunduchi Landfill | 10 km |
| Ilala | UA | Kunduchi Landfill | | Ilala Landfill | 13 km |
| | SUPA | Kunduchi Landfill | | Ilala Landfill | 10 km |
| | SUUA | Kunduchi Landfill | | Ilala Landfill | 10 km |
| | RA | Kunduchi Landfill | | Ilala Landfill | 10 km |
| Temeke | SUPA | Kunduchi Landfill | | Temeke Landfill | 10 km |
| | SUUA | Kunduchi Landfill | | Temeke Landfill | 10 km |
| | RA | Kunduchi Landfill | | Temeke Landfill | 10 km |

#### a.2 The Type of Refuse Collection Truck

The following three types of refuse collection trucks were determined to be appropriate for the use.

- 6 tonne tipper trucks for UA, SUPA, SUUA and RA
- 8 tonne skip container trucks for SUPA and SUUA
- 4 tonne compactor trucks for UA

Their proposed assignments are as follows.

Table 9-6: Assigment Plan of Refuse Collection Truck

| Area | 2000-2002 | | 2003- | |
|---|---|---|---|---|
| UA | 100%: | 6 ton tipper trucks | 80-100 %: | 4 ton compactor trucks |
| | | | 20-0%: | 6 ton tipper trucks |
| SUPA | 35-25%: | 6 ton tipper trucks | 25%: | 6 ton tipper trucks |
| | 65-75%: | 8 ton skip container trucks | 75%: | 8 ton skip container trucks |
| SUUA | 10%: | 6 ton tipper trucks | 10%: | 6 ton tipper trucks |
| | 90%: | 8 ton skip container trucks | 90%: | 8 ton skip container trucks |
| RA | - | | 100%: | 8 ton skip container trucks |

#### a.3 Productivity Determination of Refuse Collection Vehicles

The productivities of the collection vehicles were calculated using the following equation.

$$Tr = \frac{60 \times t1 - t2 \times E}{D \div V + t3 + t4}$$

Tr: Number of trips per day (trips)
D: Travel distance per trip (km)
V: Velocity of the vehicle (km/h)
t1: Working hours per day (hours)
t2: Time taken for daily service e.g. inspection and fuelling, etc. (min)
t3: Time taken for loading waste (min)
t4: Time taken for unloading waste (min)
E: Work efficiency

$$Qd = q \times d \times f \times Tr$$

q: Volume of a skip container or a tipping truck ($m^3$)
d: Density of waste when it is being transported (ton/$m^3$)
f: Work efficiency

Table 9-7: Productivity Determination

| Description | unit | Skip truck | | | Tipper truck | | | Compactor |
|---|---|---|---|---|---|---|---|---|
| Capacity in weight | t | 8 | 8 | 8 | 6 | 6 | 6 | 4 |
| Capacity in volume | m3 | 8 | 8 | 8 | 10 | 10 | 10 | 8 |
| Distance of one trip | km | 36 | 30 | 20 | 17 | 36 | 30 | 26 |
| Velocity of vehicle | km/h | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Density of waste when transported | t/m3 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 | 0.585 |
| t1:Working hour | h | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| t2:Daily service time | min | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| t3:Loading time per trip | min | 5 | 5 | 5 | 110 | 110 | 110 | 64 |
| t4:Unloading time | min | 5 | 5 | 5 | 10 | 10 | 10 | 10 |
| E: Working efficiency of transport | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| f: Work efficiency of transportation | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Number of trips per day | times | 5.25 | 6.11 | 8.40 | 2.30 | 1.93 | 2.04 | 2.97 |
| Waste carried per day | t/d | 13.10 | 15.25 | 20.97 | 7.18 | 6.02 | 6.35 | 11.13 |

## b. Cost Estimation

### b.1 Investment

#### b.1.1 Required Number of Equipment

Table 9-8 shows the required number of equipment which were calculated by their productivities and their distances per trip.

Table 9-8: Required Number of Equipment

| Items | Unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| 6 t tipper trucks | units | 40 | 45 | 50 | 50 | 54 | 66 |
| 8 t tipper trucks | units | 31 | 47 | 67 | 67 | 81 | 95 |
| 4 t compactor | units | 0 | 0 | 0 | 7 | 9 | 10 |
| 8 m3 container with lid | nos | 0 | 94 | 134 | 134 | 162 | 190 |
| 8 m3 container without lid | nos | 0 | 376 | 536 | 536 | 648 | 760 |

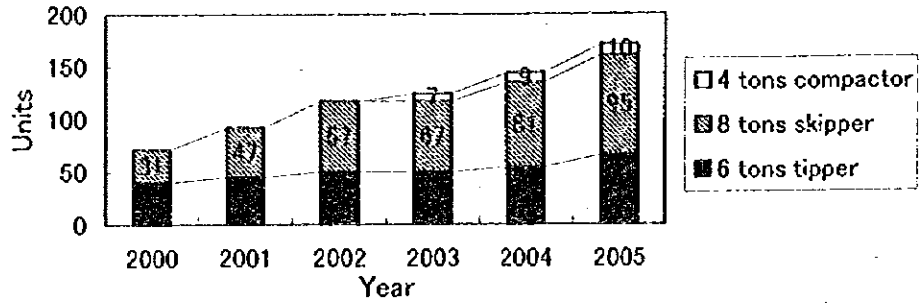



Figure 9-7: Required Number of Trucks for Refuse Collection

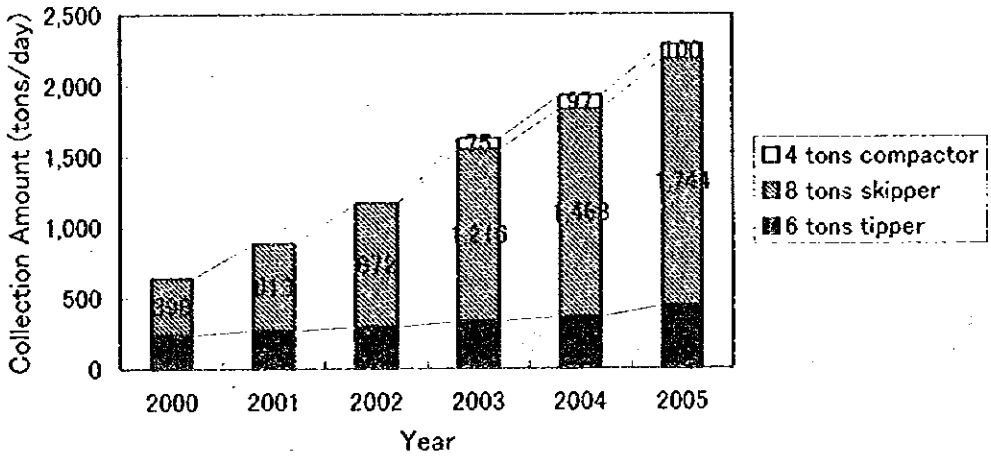



Figure 9-8: Proposed Waste Collection Amount by The Type of Vehicles

### b.1.2 Investment Schedule

Table 9-9 shows the procurement schedule which has taken their economic life into account.

Table 9-9: Procurement Schedule

| Items | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 6t tipper truck | units | 40 | 5 | 5 | 0 | 4 | 12 | 3 |
| 8t skip truck | units | 31 | 16 | 20 | 0 | 14 | 14 | 5 |
| 8 m3 container with a lid | units | 62 | 32 | 40 | 0 | 28 | 28 | 10 |
| 8 m3 container without a lid | units | 248 | 128 | 160 | 0 | 112 | 112 | 40 |
| 4 t compactor | units | 0 | 0 | 0 | 7 | 2 | 1 | 0 |

Table 9-10 shows the investment schedule to procure equipment in accordance with the schedule.

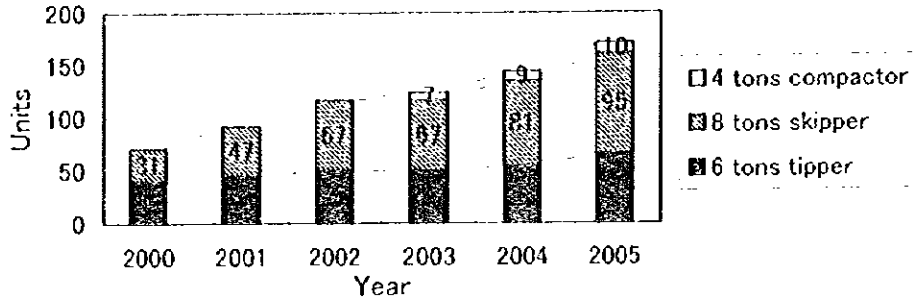



Figure 9-7: Required Number of Trucks for Refuse Collection

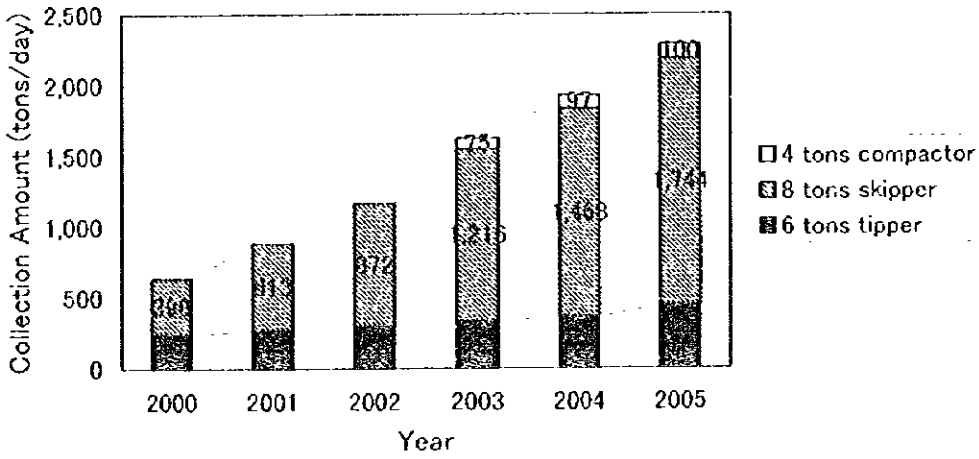



Figure 9-8: Proposed Waste Collection Amount by The Type of Vehicles

### b.1.2 Investment Schedule

Table 9-9 shows the procurement schedule which has taken their economic life into account.

Table 9-9: Procurement Schedule

| Items | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 6t tipper truck | units | 40 | 5 | 5 | 0 | 4 | 12 | 3 |
| 8t skip truck | units | 31 | 16 | 20 | 0 | 14 | 14 | 5 |
| 8 m3 container with a lid | units | 62 | 32 | 40 | 0 | 28 | 28 | 10 |
| 8 m3 container without a lid | units | 248 | 128 | 160 | 0 | 112 | 112 | 40 |
| 4 t compactor | units | 0 | 0 | 0 | 7 | 2 | 1 | 0 |

Table 9-10 shows the investment schedule to procure equipment in accordance with the schedule.

Table 9-10: Investment Schedule

| Items | unit | unit rate | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| 6t tipper truck | th. USD | 53.1 | 2,122 | 265 | 265 | 0 | 212 | 637 | 159 |
| 8t skip truck | th. USD | 74.7 | 2,314 | 1,194 | 1,493 | 0 | 1,045 | 1,045 | 373 |
| 8 m3 container with lid | th. USD | 6.0 | 369 | 190 | 238 | 0 | 167 | 167 | 60 |
| 8 m3 container without lid | th. USD | 5.2 | 1,290 | 666 | 832 | 0 | 582 | 582 | 208 |
| 4 t compactor | th. USD | 71.2 | 0 | 0 | 0 | 498 | 142 | 71 | 0 |
| total in USD | th. USD | | 6,095 | 2,316 | 2,828 | 498 | 2,149 | 2,502 | 800 |
| total in Tsh | M.Tsh | 597.8 | 3,644 | 1,384 | 1,691 | 298 | 1,284 | 1,496 | 478 |

## b.2 Operation Costs

The required manpower and materials for collection and transportation are shown in Table 9-11 and the required costs are summarised in Table 9-12.

Table 9-11: Required Quantities for Operation

| Category | Description | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Labour | 8t skip | persons | 31 | 47 | 67 | 67 | 81 | 95 |
| Driver | 6t tipper | persons | 40 | 45 | 50 | 50 | 54 | 66 |
| | 4t compactor | persons | 0 | 0 | 0 | 7 | 9 | 10 |
| | **total** | **persons** | **71** | **92** | **117** | **124** | **144** | **171** |
| Labour | 8t skip | persons | 0 | 0 | 0 | 0 | 0 | 0 |
| Collection worker | 6t tipper | persons | 200 | 225 | 250 | 250 | 270 | 330 |
| | 4t compactor | persons | 0 | 0 | 0 | 21 | 27 | 30 |
| | **total** | **persons** | **200** | **225** | **250** | **271** | **297** | **360** |
| Required Diesel | 6t tipper | l/d | 960 | 1,080 | 1,200 | 1,200 | 1,296 | 1,584 |
| | 8t skip | l/d | 1,519 | 2,303 | 3,283 | 3,283 | 3,969 | 4,655 |
| | 4 t compactor | l/d | 0 | 0 | 0 | 210 | 270 | 300 |
| | **total** | | **2,479** | **3,383** | **4,483** | **4,693** | **5,535** | **6,539** |

Table 9-12: Required Operation Cost Schedule

| Item | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Labour, driver | M.Tsh/y | 51 | 66 | 84 | 89 | 104 | 123 |
| Labour, collection worker | M.Tsh/y | 96 | 108 | 120 | 130 | 143 | 173 |
| Diesel | M.Tsh/y | 213 | 291 | 386 | 404 | 476 | 563 |
| Lubricant | M.Tsh/y | 21 | 29 | 39 | 40 | 48 | 56 |
| **Total** | **M.Tsh/y** | **382** | **494** | **629** | **664** | **770** | **915** |

## b.3 Maintenance Costs

The maintenance cost includes prices of spare parts and costs incurred when repair works are commissioned to outside garages. The costs of preventive maintenance which will be provided by the central workshop are included as indirect expenses of the maintenance shop.

The maintenance costs for vehicles is estimated as 10 % of basic prices and for skip containers it is regarded as 3 % of basic prices. The estimated maintenance costs are summarised in Table 9-13.

Table 9-13: Required Maintenance Costs Schedule

| Item 1 | Item 2 | Item 3 | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| Vehicles | Basic Price | 6t tipper | th. USD | 2,432 | 2,736 | 3,040 | 3,040 | 3,283 | 4,013 |
| | | 8t skip | th. USD | 2,651 | 4,019 | 5,729 | 5,729 | 6,926 | 8,123 |
| | | 4 t compactor | th. USD | 0 | 0 | 0 | 566 | 728 | 809 |
| | | Total | th. USD | 5,083 | 6,755 | 8,769 | 9,335 | 10,937 | 12,944 |
| | Repair Cost | 10 % of Basic Price | th. USD | 508 | 675 | 877 | 933 | 1,094 | 1,294 |
| Skip Container | Basic Price | 8 m3 with lid | th. USD | 391 | 592 | 844 | 844 | 1,021 | 1,197 |
| | | 8 m3 without lid | th. USD | 1,438 | 2,181 | 3,109 | 3,109 | 3,758 | 4,408 |
| | | Total | th. USD | 1,829 | 2,773 | 3,953 | 3,953 | 4,779 | 5,605 |
| | Repair Cost | 3 % of Basic Price | th. USD | 55 | 83 | 119 | 119 | 143 | 168 |
| Total Repair Cost in USD | | | th. USD | 563 | 759 | 995 | 1,052 | 1,237 | 1,463 |
| Total Repair Cost in Tsh | | | M.Tshy | 337 | 454 | 595 | 629 | 740 | 874 |

### b.4 Summary of Cost Estimation

Table 9-14 shows the summary of required costs for secondary collection and transportation.

Table 9-14: Estimated Costs of Secondary Collection and Transportation

| Description | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 1. Investment | | | | | | | | |
| Equipment | M.Tsh | 3,644 | 1,384 | 1,691 | 298 | 1,284 | 1,496 | 478 |
| 2. Operation | | | | | | | | |
| Labour Cost | M.Tsh | 0 | 147 | 174 | 204 | 219 | 246 | 296 |
| Material and Fuel, etc. | M.Tsh | 0 | 235 | 320 | 424 | 444 | 524 | 619 |
| 3. Maintenance | M.Tsh | 0 | 337 | 454 | 595 | 629 | 740 | 874 |
| Total | M.Tsh | 3,644 | 2,103 | 2,639 | 1,521 | 2,577 | 3,005 | 2,267 |

## 9.2.5 Final Disposal System

### a. Conceptual Design of Final Disposal System in the Master Plan

### a.1 Final Disposal Programme

The remaining capacity of the existing Vingunguti disposal site is only for another 1 to 2 years as of July 1996 and it is causing serious environmental problems in its environs. Proper sanitary landfills are therefore, urgently required.

The final disposal system proposed in the Master Plan is summarised as follows.

| Sites | Description | Before 2000 | 2000-2002 | 2003-2005 |
|---|---|---|---|---|
| Vingunguti | Level: 1 | • Operation<br>• Receive all waste collected | • Closed | • Closed |
| Kunduchi | Level: 2<br>Capacity:<br>3.5 million $m^3$<br>Life year: 2000-2010 | • Construction | • Operation<br>• Receive all wastes collected | • Operation<br>• Receive waste collected in Kinondoni |
| Ilala | Level: 3<br>Capacity:<br>1.5 million $m^3$<br>Life year: 2003-2009 | • Site selection | • Construction | • Operation<br>• Receive waste collected in Ilala |
| Temeke | Level: 4<br>Capacity:<br>1.5 million $m^3$<br>Life year: 2003-2010 | • Site selection | • Construction | • Operation<br>• Receive waste collected in Temeke |

- Until the end of 1999, the existing Vingunguti disposal site will be in use.
- At the beginning of the year 2000, the new disposal site to be constructed in Kunduchi New MECCO quarry will commence its operation. It will receive all wastes collected from DSM from 2000 until 2002.
- At the beginning of 2003, two disposal sites for Ilala and Temeke districts will commence its operation and each site of the three will receive all wastes collected from its district.
- The proposed sanitary level of disposal sites are Level 2 for the Kunduchi landfill and Level 3 for the landfills to be constructed in Ilala and Temeke.
- The ratio of coverage soil volume to the waste volume will be 18 %.

### a.2 Required Capacity of Disposal Sites

Based on the forecast for waste disposal amount , the volume of waste to be dumped at each disposal site was estimated as follows.

Table 9-15: Annual Estimate of Waste Amount at Disposal Sites (1)

| | Collection Amount | | | | Waste Disposal Amount | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Kunduchi | Ilala | Temeke | Total | Vingunguti | Kunduchi | Ilala | Temeke | Total |
| unit | t/y | t/y | t/y | t/y | t/y | t/y | t/y | t/y | t/y |
| 1996 | 24,042 | 12,784 | 14,640 | 51,465 | 51,465 | 0 | 0 | 0 | 51,465 |
| 1997 | 34,900 | 19,101 | 21,189 | 75,190 | 75,190 | 0 | 0 | 0 | 75,190 |
| 1998 | 46,682 | 26,555 | 28,599 | 101,835 | 101,835 | 0 | 0 | 0 | 101,835 |
| 1999 | 59,629 | 35,495 | 37,006 | 132,130 | 132,130 | 0 | 0 | 0 | 132,130 |
| 2000 | 88,121 | 55,233 | 55,571 | 198,925 | 0 | 198,925 | 0 | 0 | 198,925 |
| 2001 | 119,756 | 79,559 | 76,990 | 276,305 | 0 | 276,305 | 0 | 0 | 276,305 |
| 2002 | 154,401 | 109,459 | 101,531 | 365,390 | 0 | 365,390 | 0 | 0 | 365,390 |
| 2003 | 208,244 | 158,983 | 140,854 | 508,080 | 0 | 208,244 | 158,983 | 140,854 | 508,080 |
| 2004 | 238,329 | 198,025 | 166,992 | 603,345 | 0 | 238,329 | 198,025 | 166,992 | 603,345 |
| 2005 | 271,321 | 246,627 | 197,573 | 715,520 | 0 | 271,321 | 246,627 | 197,573 | 715,520 |
| 2006 | 285,330 | 252,201 | 216,628 | 754,158 | 0 | 285,330 | 252,201 | 216,628 | 754,158 |

Table 9-16: Annual Estimate of Waste Volume at Disposal Sites (2)

| | Collection Amount | | | | Waste Disposal Amount | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Kunduchi | Ilala | Temeke | Total | Vingunguti | Kunduchi | Ilala | Temeke | Total |
| unit | m3/y | m3/y | m3/y | m3/y | m3/y | m3/y | m3/y | m3/y | m3/y |
| 1996 | 26,713 | 14,204 | 16,266 | 57,183 | 57,183 | 0 | 0 | 0 | 57,183 |
| 1997 | 38,778 | 21,223 | 23,543 | 83,544 | 83,544 | 0 | 0 | 0 | 83,544 |
| 1998 | 51,868 | 29,505 | 31,776 | 113,150 | 113,150 | 0 | 0 | 0 | 113,150 |
| 1999 | 66,255 | 39,438 | 41,118 | 146,811 | 146,811 | 0 | 0 | 0 | 146,811 |
| 2000 | 97,912 | 61,370 | 61,746 | 221,028 | 0 | 221,028 | 0 | 0 | 221,028 |
| 2001 | 133,063 | 88,399 | 85,544 | 307,006 | 0 | 307,006 | 0 | 0 | 307,006 |
| 2002 | 171,556 | 121,621 | 112,812 | 405,989 | 0 | 405,989 | 0 | 0 | 405,989 |
| 2003 | 231,382 | 176,647 | 156,504 | 564,533 | 0 | 231,382 | 176,647 | 156,504 | 564,533 |
| 2004 | 264,810 | 220,027 | 185,546 | 670,383 | 0 | 264,810 | 220,027 | 185,546 | 670,383 |
| 2005 | 301,467 | 274,029 | 219,525 | 795,022 | 0 | 301,467 | 274,029 | 219,525 | 795,022 |
| 2006 | 317,033 | 280,223 | 240,698 | 837,954 | 0 | 317,033 | 280,223 | 240,698 | 837,954 |

Table 9-17: Estimate of Waste Accumulated at Disposal Sites

| Site | Vingunguti | Kunduchi | Ilala | Temeke |
|---|---|---|---|---|
| unit | m3/y | m3/y | m3/y | m3/y |
| 1996 | 57,183 | 0 | 0 | 0 |
| 1997 | 140,728 | 0 | 0 | 0 |
| 1998 | 253,878 | 0 | 0 | 0 |
| 1999 | 400,689 | 0 | 0 | 0 |
| 2000 | 400,689 | 221,028 | 0 | 0 |
| 2001 | 400,689 | 528,033 | 0 | 0 |
| 2002 | 400,689 | 934,022 | 0 | 0 |
| 2003 | 400,689 | 1,165,404 | 176,647 | 156,504 |
| 2004 | 400,689 | 1,430,214 | 396,675 | 342,051 |
| 2005 | 400,689 | 1,731,681 | 670,704 | 561,576 |
| 2006 | 400,689 | 2,048,714 | 950,927 | 802,273 |

Table 9-18: Required Landfill Volume including Soil for Coverage

| Site | Vingunguti | Kunduchi | Ilala | Temeke |
|---|---|---|---|---|
| unit | m3/y | m3/y | m3/y | m3/y |
| 1996 | 67,476 | 0 | 0 | 0 |
| 1997 | 166,059 | 0 | 0 | 0 |
| 1998 | 299,576 | 0 | 0 | 0 |
| 1999 | 472,813 | 0 | 0 | 0 |
| 2000 | 472,813 | 260,813 | 0 | 0 |
| 2001 | 472,813 | 623,079 | 0 | 0 |
| 2002 | 472,813 | 1,102,146 | 0 | 0 |
| 2003 | 472,813 | 1,375,177 | 208,444 | 184,675 |
| 2004 | 472,813 | 1,687,652 | 468,076 | 403,620 |
| 2005 | 472,813 | 2,043,384 | 791,431 | 662,659 |
| 2006 | 472,813 | 2,417,483 | 1,122,094 | 946,683 |

The appropriate capacities of proposed disposal sites were therefore set up as shown in Table 9-19.

Table 9-19: Proposed Capacities of Disposal Sites

| Site | Capacity (million $m^3$) | Reserve for Waste (million $m^3$) | Volume for Coverage Soil (million $m^3$) | Life years (years) | Operation Period |
|---|---|---|---|---|---|
| Kunduchi | 3.5 | 2.87 | 0.63 | 11 | 2000 - 2010 |
| Ilala | 1.5 | 1.23 | 0.27 | 7 | 2003 - 2009 |
| Temeke | 1.5 | 1.23 | 0.27 | 8 | 2003 - 2010 |

## c. Investment

### c.1 Landfill

The cost for operating the Kunduchi landfill adopted here is based on the cost estimated in the Main Report for the Feasibility Study.

The cost for the Ilala and Temeke landfill sites adopted here are based on the costs estimated as presented in Annex 16. The unit construction cost of the landfill site is 1,170 Tsh per cubic metre of landfill.

Table 9-20: Summary of Investment O & M Costs

unit: M.Tsh

| Site | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Kunduchi Landfill | 831 | 0 | 0 | 430 | 0 | 580 | 0 |
| Ilala | 0 | 0 | 0 | 1,755 | 0 | 0 | 0 |
| Temeke | 0 | 0 | 0 | 1,755 | 0 | 0 | 0 |

### c.2 Equipment

#### c.2.1 Determination of Productivity

The operating capacity of a bulldozer and tipper truck are calculated below.

*Bulldozer, 210 Hp class*

Bulldozers are used for pushing, spreading, levelling and compacting wastes at disposal sites. Its productivity is estimated below.

Probable cycle time (Cm)

| | |
|---|---|
| Pushing: 15 m @ 60 m/min | = 0.250 min |
| Returning: 15 m @ 80 m/min | = 0.188 min |
| Fixed time, loading and shifting gears | = 0.320 min |
| Total cycle time | = 0.785 min |

Output

$$Qh = \frac{60 \times q \times f \times E}{Cm}$$

| | |
|---|---|
| Qh: Output per hour | ($m^3$/h) |
| q: Output per push | ($m^3$/h) |
| f: Conversion factor of waste | 1.0 |
| E: Operation efficiency | 0.5 |

Hence, Qh is 133.6 $m^3$/h.

Qd = 133.6 $m^3$/h x 7 h/d = 935 $m^3$/d

= 935 $m^3$/d x 0.39 t/$m^3$ = 365 t/d

*Tipper truck, 8 tons*

The main task of tipper trucks at disposal sites is to carry soil from outside to cover the waste. Its productivity is estimated below.

Probable cycle time (Cmt)

| | |
|---|---|
| Carrying: 1 km @ 15 km/60 min | = 4.0 min |
| Return trip: 1 km @ 20 km/60 min | = 3.0 min |
| Loading: | = 5.0 min |
| Dumping: | = 1.0 min |
| Total | = 13.0 min |

Output

$$Qh = \frac{60 \times C \times f \times Et}{Cmt}$$

| | |
|---|---|
| Qh: Output per hour | ($m^3$/h) |
| C: Output per trip | ($m^3$/h) |
| f: Conversion factor of waste | 1.0 |
| E: Operation efficiency | 0.5 |

Hence, Qh is 40 tons per hour.

Qd = 40 t/h x 7 h/d = 280 t/d

### c.2.2 Required Number of Equipment

Based on the estimated productivity of the equipment, their required number were estimated as shown in Table 9-21.

Table 9-21: Required Number of Landfill Equipment

| Disposal Site | Equipment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Vingunguti | Bulldozer | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kinondoni | Bulldozer | 0 | 2 | 2 | 3 | 2 | 2 | 2 |
| | Tipper truck | 0 | 3 | 3 | 3 | 2 | 2 | 2 |
| | Excavator | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Pckup | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ilala | Bulldozer | 0 | 0 | 0 | 0 | 1 | 2 | 2 |
| | Tipper truck | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| | Excavator | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | Pckup | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Temeke | Bulldozer | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| | Tipper truck | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| | Excavator | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | Pckup | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Total | Bulldozer | 2 | 2 | 2 | 3 | 4 | 5 | 6 |
| | Tipper truck | 0 | 3 | 3 | 3 | 6 | 6 | 6 |
| | Excavator | 0 | 1 | 1 | 1 | 3 | 3 | 3 |
| | Pckup | 0 | 1 | 1 | 1 | 3 | 3 | 3 |

### c.2.3 Investment Schedule of Equipment

Table 9-22 shows the procurement schedule which has taken their economic life into account.

Table 9-22: Procurement Schedule of Landfill Equipment

| Equipment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Bulldozer | 2 | 0 | 1 | 1 | 1 | 1 | 0 |
| Tipper truck | 3 | 0 | 0 | 3 | 0 | 0 | 0 |
| Excavator | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| Pckup | 1 | 0 | 0 | 2 | 0 | 0 | 0 |

Table 9-23 shows the investment schedule to procure equipment based on the above.

Table 9-23: Investment Schedule for Landfill Equipment

| Site | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Kunduchi | 600 | 0 | 150 | 0 | 0 | 0 | 0 |
| Ilala | 0 | 0 | 0 | 196 | 150 | 0 | 0 |
| Temeke | 0 | 0 | 0 | 398 | 0 | 150 | 0 |

### c.2.4 Iterim Investment

Sanitary landfill operation requires some construction works intermittently, for example extension of gas removal, leachate collection, provision of impermeable clay layer for slopes, etc. These costs are regarded as a part of operation costs since its characteristics are similar.

### d. Operation and Maintenance Cost

The maintenance cost include spare parts prices and cost incurred from commissioning repairs to outside garages. The costs of preventive maintenance which will be provided by the central workshop are included as indirect costs of the maintenance shop.

The maintenance costs for vehicles are estimated as 10 % of basic prices.

Table 9-24 summarises the costs required related to the final disposal plan.

Table 9-24: O & M Schedule for Final Disposal

unit: M.Tsh

| Site | Items | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Kunduchi | Labour cost | 20 | 20 | 21 | 19 | 19 | 19 |
| | Material and fuel | 64 | 70 | 92 | 62 | 64 | 67 |
| | Spare parts & repair | 60 | 60 | 75 | 54 | 54 | 54 |
| Ilala | Labour cost | 0 | 0 | 0 | 16 | 17 | 17 |
| | Material and fuel | 0 | 0 | 0 | 44 | 61 | 65 |
| | Spare parts & repair | 0 | 0 | 0 | 40 | 54 | 54 |
| Temeke | Labour cost | 0 | 0 | 0 | 16 | 16 | 17 |
| | Material and fuel | 0 | 0 | 0 | 42 | 45 | 61 |
| | Spare parts & repair | 0 | 0 | 0 | 40 | 40 | 54 |

### e. Summary of Cost Estimation

Table 9-25 shows the summary of the costs required for final disposal.

Table 9-25: Estimated Cost Schedule of Final Disposal

| Site | Items | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Kunduchi | Investment for facilities | 831 | | | 430 | | 580 | |
| | Investment for equipment | 600 | 0 | 150 | 0 | 0 | 0 | 0 |
| | Operation for labours | 0 | 20 | 20 | 21 | 19 | 19 | 19 |
| | Operation for material and fuel | 0 | 64 | 70 | 92 | 62 | 64 | 67 |
| | Spare parts and repares | 0 | 60 | 60 | 75 | 54 | 54 | 54 |
| Ilala | Investment for facilities | | | | 1,755 | | | |
| | Investment for equipment | | | | 196 | 150 | 0 | 0 |
| | Operation for labours | | | | 0 | 16 | 17 | 17 |
| | Operation for material and fuel | | | | 0 | 44 | 61 | 65 |
| | Spare parts and repares | | | | 0 | 40 | 54 | 54 |
| Temeke | Investment for facilities | | | | 1,755 | 0 | 0 | 0 |
| | Investment for equipment | | | | 398 | 0 | 150 | 0 |
| | Operation for labours | | | | | 16 | 16 | 17 |
| | Operation for material and fuel | | | | | 42 | 45 | 61 |
| | Spare parts and repares | | | | | 40 | 40 | 54 |
| Total | | 1,431 | 144 | 300 | 4,722 | 484 | 1,102 | 411 |

## 9.2.6 Street Sweeping System

### a. Description of Street Sweeping Plan

- The SWM Master Plan concerns only collecting litter from streets, excluding sand and grass cuttings which are currently being conducted by the Works Department in DCC and the Ministry of Works.
- Only asphalt paved streets are planned to be swept.
- The planned length to be swept is as follows:

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Length to be swept | 67 km | 83 km | 100 km | 100 km | 100 km | 100 km |

- The frequency of street sweeping are set up below.

The method of street sweeping is manual sweeping. The required resources are:

| | |
|---|---|
| Machinery | trucks |
| Labour | drivers |
| | road sweepers |
| Material | broom |
| | handcart |
| | waste basket |
| | traffic safety devices |
| Fuel | petrol or diesel |

### b. Investment

Table 9-26 shows the required equipment and manpower for future street sweeping work.

Table 9-26: Required Equipment and Manpower

| Items | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| 4t truck | units | 3 | 4 | 5 | 6 | 6 | 6 | 6 |
| Driver | persons | 3 | 4 | 5 | 6 | 6 | 6 | 6 |
| No. of worker | persons | 110 | 147 | 183 | 220 | 220 | 220 | 220 |

Table 9-27 shows the schedule of Procurement and Investment.

Table 9-27: Procurement and Investment Schedule

| Item | | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Procured | 4t truck | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Investment | M. Tsh | 23 | 23 | 23 | 0 | 0 | 0 | 0 |

### c. Operation Cost

Table 9-28 shows the operation cost schedule until 2005.

Table 9-28: Operation Cost Schedule

| Category | Description | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Labour | Driver | M.Tsh | 3 | 4 | 4 | 4 | 4 | 4 |
| | Worker | M.Tsh | 71 | 88 | 106 | 106 | 106 | 106 |
| Fuel | Diesel, Petrol, Lubricant | M.Tsh | 5 | 6 | 8 | 8 | 8 | 8 |
| Material | Broom, handcart, safety devices etc. | M.Tsh | 20 | 25 | 30 | 30 | 30 | 30 |
| Total | | M.Tsh | 99 | 123 | 148 | 148 | 148 | 148 |

### d. Maintenance Cost

Maintenance costs include spare parts prices and cost incurred from commissioning repair works to outside garages. The costs of preventive maintenance which will be provided by the central workshop are included as indirect costs of the maintenance shop.

The maintenance costs for vehicles are estimated as 10 % of basic prices. The estimated maintenance costs are summarised in Table 9-29.

Table 9-29: Maintenance Cost Schedule

| Item | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Repair | M.Tsh | - | 9 | 12 | 14 | 14 | 14 | 14 |

## 9.2.7 Maintenance Shop

The Nyerere depot which is presently closed is planned to be used as a central workshop for SWM equipment. This workshop is planned provide preventive measures. Major repair works are planned to be done at private garages.

### a. Investment

All improvement works of the Nyerere Workshop in the Master Plan are to be implemented in 1999.

### a.1 Facilities

Total investment for facilities is 42 million Tsh as shown below.

| | |
|---|---|
| Water Tank | 5 M.Ths |
| Pavement | 15 M.Ths |
| Drainage | 10 M.Ths |
| Car cleaning pit | 5 M.Ths |
| Sub-station | 5 M.Ths |
| Furniture | 3 M.Ths |
| Total | 42 M.Ths |

### a.2 Machinery

Total investment for machnery is 297 million Tsh as shown below.

| Description | Amount (USD) | Amount (M. Tsh) |
|---|---|---|
| Battery Shop | 4,279 | 3 |
| Inspection Pit | 22,646 | 14 |
| Welding Equipent | 6,665 | 4 |
| General Maintenance & Repair | 78,850 | 47 |
| Tire Shop | 15,982 | 10 |
| Other Equipment | 287,189 | 172 |
| Training Material | 80,880 | 48 |
| Total | 496,490 | 297 |

### b. Operation and Maintenance Costs

Table 9-30 shows the required manpower for operating the Nyerere Workshop.

Table 9-30: Manpower Schedule

Unit: persons

| Description | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Manager | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mechanical Engineer | | 3 | 3 | 4 | 5 | 6 | 7 |
| Mechanic | | 8 | 10 | 13 | 15 | 17 | 20 |
| Assistant Mechanic | | 27 | 34 | 43 | 49 | 57 | 66 |
| Security Guard | | 4 | 4 | 4 | 4 | 4 | 4 |
| Total | 1 | 43 | 52 | 65 | 74 | 85 | 98 |

Table 9-31 shows the operation and maintenance costs from 1999 to 2005.

Table 9-31: O & M Cost Schedule

| Category | Description | unit | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| Labour | Manager | M.Tsh | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | Mechanical Engineer | M.Tsh | 0 | 4 | 4 | 5 | 6 | 7 | 8 |
| | Mecanic | M.Tsh | 0 | 6 | 7 | 9 | 11 | 12 | 14 |
| | Assistant Mecanic | M.Tsh | 0 | 13 | 16 | 21 | 24 | 27 | 32 |
| | Security Guard | M.Tsh | 0 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Total | M.Tsh | 4 | 28 | 33 | 40 | 46 | 52 | 60 |
| Material | Power supply | M.Tsh | | 3 | 4 | 5 | 6 | 7 | 8 |
| | Water supply | M.Tsh | | 3 | 4 | 5 | 6 | 7 | 8 |
| | Others | M.Tsh | | 4 | 5 | 7 | 7 | 9 | 10 |
| | Total | M.Tsh | 0 | 11 | 14 | 17 | 19 | 22 | 25 |
| Maintenance | | M.Tsh | 0 | 15 | 18 | 22 | 26 | 29 | 34 |
| Total | | M.Tsh | 342 | 54 | 64 | 80 | 91 | 104 | 119 |

### 9.2.8 Motor Pool

The Master Plan proposes for each district to have a motor pool for refuse collection vehicles so that the travel time can be shortened. The proposed locations of motor pools are as follows.

- Kinondoni District: Mwananyamala depot
- Ilala District: DRIMP depot
- Temeke District: Temeke district office

The every site already has a fence and security guards. The present conditions of these facilities are satisfactory for the use as a motor pool, and therefore further investment is unnecessary. Only operation costs are therefore included.

Table 9-32: Operation Cost Schedule

unit: M.Tsh

| District | Site | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Kinondoni | Mwananyamala | 2 security guards | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Miscellaneous | 1 | 1 | 1 | 1 | 1 | 1 |
| | | sub-total | 2 | 2 | 2 | 2 | 2 | 2 |
| Ilala | DRIMP | 2 security guards | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Miscellaneous | 1 | 1 | 1 | 1 | 1 | 1 |
| | | sub-total | 2 | 2 | 2 | 2 | 2 | 2 |
| Temeke | Temeke District Office | 2 security guards | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Miscellaneous | 1 | 1 | 1 | 1 | 1 | 1 |
| | | sub-total | 2 | 2 | 2 | 2 | 2 | 2 |
| Total | Labour | | 3 | 3 | 3 | 3 | 3 | 3 |
| | Miscellaneous | | 4 | 4 | 4 | 4 | 4 | 4 |
| G-Total | | | 7 | 7 | 7 | 7 | 7 | 7 |

### 9.2.9 Administrative Expenses

Table 9-33 shows the administrative costs.

Table 9-33: Administrative Costs

| Items | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Inv. for facilities | 29 | 0 | 0 | 0 | 0 | 0 | 0 |
| Inv. for equipment | 123 | 21 | 21 | 31 | 21 | 21 | 21 |
| O&M for labor | 38 | 48 | 58 | 67 | 77 | 86 | 96 |
| O&M for material & fuel | 0 | 8 | 10 | 11 | 13 | 15 | 16 |
| Spare parts & repair | 4 | 4 | 5 | 6 | 7 | 8 | 9 |
| **sub-total** | **194** | **81** | **93** | **115** | **117** | **130** | **142** |
| **Total** | **536** | **142** | **165** | **202** | **215** | **241** | **268** |

### 9.2.10 Project Cost Summary

#### a. Project Cost Schedule

Table 9-34 summarises the project cost schedule from 1999 to 2005 for implementing all the master plan projects.

Table 9-34: Project Costs Summary

unit: M.Tsh

| Category | Category | | Description | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Direct Cost | Collection & Transport | | Inv. for equipment | 3,644 | 1,384 | 1,691 | 298 | 1,284 | 1,496 | 478 |
| | | | O&M cost for labor | 0 | 147 | 174 | 204 | 219 | 246 | 296 |
| | | | O&M for material & fuel | 0 | 235 | 320 | 424 | 444 | 524 | 619 |
| | | | Spare parts & repair | 0 | 337 | 454 | 595 | 629 | 740 | 874 |
| | | | sub-total | 3,644 | 2,103 | 2,639 | 1,521 | 2,577 | 3,005 | 2,267 |
| | Final Disposal | Kunduchi | Inv. for facilities | 831 | 0 | 0 | 430 | 0 | 580 | 0 |
| | | | Inv. for equipment | 600 | 0 | 150 | 0 | 0 | 0 | 0 |
| | | | O&M cost for labor | 0 | 20 | 20 | 21 | 19 | 19 | 19 |
| | | | O&M for material & fuel | 0 | 64 | 70 | 92 | 62 | 64 | 67 |
| | | | Spare parts & repair | 0 | 60 | 60 | 75 | 54 | 54 | 54 |
| | | Ilala | Inv. for facilities | 0 | 0 | 0 | 1,755 | 0 | 0 | 0 |
| | | | Inv. for equipment | 0 | 0 | 0 | 196 | 150 | 0 | 0 |
| | | | O&M cost for labor | 0 | 0 | 0 | 0 | 16 | 17 | 17 |
| | | | O&M for material & fuel | 0 | 0 | 0 | 0 | 44 | 61 | 65 |
| | | | Spare parts & repair | 0 | 0 | 0 | 0 | 40 | 54 | 54 |
| | | Temeke | Inv. for facilities | 0 | 0 | 0 | 1,755 | 0 | 0 | 0 |
| | | | Inv. for equipment | 0 | 0 | 0 | 398 | 0 | 150 | 0 |
| | | | O&M cost for labor | 0 | 0 | 0 | 0 | 16 | 16 | 17 |
| | | | O&M for material & fuel | 0 | 0 | 0 | 0 | 42 | 45 | 61 |
| | | | Spare parts & repair | 0 | 0 | 0 | 0 | 40 | 40 | 54 |
| | | sub-total | | 1,431 | 144 | 300 | 4,722 | 484 | 1,102 | 411 |
| | Street Sweeping | | Inv. for facilities | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | Inv. for equipment | 23 | 23 | 23 | 0 | 0 | 0 | 0 |
| | | | O&M cost for labor | 0 | 73 | 91 | 110 | 110 | 110 | 110 |
| | | | O&M for material & fuel | 0 | 25 | 31 | 38 | 38 | 38 | 38 |
| | | | Spare parts & repair | 0 | 9 | 12 | 14 | 14 | 14 | 14 |
| | | | sub-total | 23 | 132 | 158 | 162 | 162 | 162 | 162 |
| | Total | | | 5,098 | 2,378 | 3,097 | 6,405 | 3,223 | 4,269 | 2,840 |
| Indirect Cost | Maintenance Workshop | | Inv. for facilities | 42 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | Inv. for equipment | 297 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | O&M cost for labor | 4 | 28 | 33 | 40 | 46 | 52 | 60 |
| | | | O&M for material & fuel | 0 | 11 | 14 | 17 | 19 | 22 | 25 |
| | | | Spare parts & repair | 0 | 15 | 18 | 22 | 26 | 29 | 34 |
| | | | sub-total | 342 | 54 | 64 | 80 | 91 | 104 | 119 |
| | Motor pool | | O&M cost for labor | 0 | 3 | 3 | 3 | 3 | 3 | 3 |
| | | | O & M for others | 0 | 4 | 4 | 4 | 4 | 4 | 4 |
| | | | Sub-total | 0 | 7 | 7 | 7 | 7 | 7 | 7 |
| | Administration | | Inv. for facilities | 29 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | Inv. for equipment | 123 | 21 | 21 | 31 | 21 | 21 | 21 |
| | | | O&M cost for labor | 38 | 48 | 58 | 67 | 77 | 86 | 96 |
| | | | O&M for material & fuel | 0 | 8 | 10 | 11 | 13 | 15 | 16 |
| | | | Spare parts & repair | 4 | 4 | 5 | 6 | 7 | 8 | 9 |
| | | | sub-total | 194 | 81 | 93 | 115 | 117 | 130 | 142 |
| | Total | | | 536 | 142 | 165 | 202 | 215 | 241 | 268 |
| Grand Total | | | | 5,634 | 2,520 | 3,262 | 6,607 | 3,438 | 4,510 | 3,108 |

## b. Unit SWM Cost

Table 9-35 shows the unit SWM costs when all projects proposed in the Master Plan are implemented.

Table 9-35: Unit Solid Waste Management Cost

| Type of Works | Unit SWM Cost | | | |
|---|---|---|---|---|
| | Present Value | | Including Interest of 11.6 % | |
| | Tsh/ton | USD/ton | Tsh/ton | USD/ton |
| Collection and Transportation plus Street Sweeping | 5,209 | 8.71 | 10,596 | 17.33 |
| Final Disposal | 3,049 | 5.10 | 5,510 | 9.22 |
| Total | 8,258 | 13.81 | 16,106 | 26.94 |

The indirect costs composed of maintenance workshop, motor pools and administration expenses were distributed to the transportation plus street sweeping cost and the final disposal cost in accordance with their percentages of the total direct cost.

## 9.3 Financial Plan

### 9.3.1 Alternative Options for the Financial Source

#### a. Basic Concept for the Financial Plan

From the financial and economic evaluation of the Master Plan, it has been evident that the privatisation scheme under the concessionaire system proved to be a failure during the course of the study, concluding that the required financial sources should be partly generated from the municipal tax revenue and partly covered by the refuse collection charges through joint billing with DAWASA to all waste generators or direct special RCC to commercial, institutional and market waste generators. Based on this, the alternative options for the financial scheme for the Master Plan shall be discussed in the following manner so as to make the Master Plan financially feasible.

#### b. Alternative Options for the Financial Source

Previously in Progress Report 3, a number of alternative options for the financial scheme for the Master Plan were assessed. In the preliminary assessment, the following 8 options were discussed.

Table 9-36 Options for the Financial Scheme for the Master Plan

| Option | Financial Source |
|---|---|
| Option a | Continuation of direct billing for all waste generators |
| Option b | Joint billing with TANESCO for all waste generators |
| Option c | Joint billing with DAWASA for all waste generators |
| Option d | Direct Billing of RCC for household wastes in relatively rich areas and a special fund based on the municipal tax for relatively poor areas |
| Option e | Direct Billing of RCC for only commercial, institutional and market wastes, and a special fund based on the municipal tax |
| Option f | Special fund based on the municipal tax |
| Option g | Special fund based on the municipal tax and joint billing with TANESCO for all waste generators |
| Option h | Special fund based on the municipal tax and joint billing with DAWASA for all waste generators |

Case e and Case h were recommended by the Study Team and finally selected by DCC as final alternative scenarios of revenue sources for the Master Plan.

#### c. Parameters for Financial Evaluation

The following parameters for the financial evaluation of the Master Plan shall be employed as major variables of the financial plan.

#### c.1 Prices and Exchange Rate

All prices relevant to the financial evaluation will be converted to Tsh., and the rate will be set at 597.8 Tsh. to 1 USD, which is the mean rate among commercial banks as of the end of February 1997. The cost estimate for the Master Plan shall be also based on the price level as of the end of February 1997.

### c.2 Project Life

The Master Plan will start in 1999 upon delivery of the first consignment of vehicles procured and will end in 2005 when their economic life expires. Accordingly, the project life of the Master Plan to be used for the financial evaluation shall be 7 years (1999 to 2005).

### c.3 Scrap Value

The vehicles procured after 1999 will have some residual value at the end of the project in the year 2005. The scrap value of these vehicles will be accordingly included as revenue in 2006.

### c.4 Cut-off Rate

A cut-off rate, also known as an opportunity cost of capital, is fixed at 11.6 % per annum, which is equivalent to the real interest rate in the capital market of Tanzania.

## 9.3.2 Revenue Forecast

### 9.3.2.1 Tax Revenue Forecast

Apart from setting up a few parameters for the financial evaluation of the Master Plan, since all the alternative cases for the financial scheme require DCC's tax revenue sources on which the Master Plan is based, the revenue forecast of major municipal tax sources will be absolutely necessary.

The tax revenue for the Master Plan was forecasted through the following 3 steps: the first step was to accurately forecast DCC's potential tax revenue, the second was to fix the budget allocation of DCC's tax revenue for solid waste management, and the last step is to apply this fixed budget allocation for the overall SWM expenditure.

#### a. Methodology of Tax Revenue Forecast

The majority of DCC's tax sources include levies and taxes for development, property, petrol, services, hotels, businesses and markets etc. Revenue from these major tax sources shall be forecasted based on the following 3 factors.

- growth rate of the potential revenue
- maximum collection rate of the actual revenue to the potential revenue
- growth rate of the actual revenue

#### b. Growth Rate of the Potential Revenue

Since the production level affects the amount of taxable resources, it could be safely argued that a growth rate of the potential revenue is roughly in proportion to the growth rate of the national Gross Domestic Product (GDP) of the country, unless the tax level remains unchanged. Accordingly, the growth rates of the potential revenue of all taxes and levies are fixed at 5.0% per annum, which is the target real growth rate of GDP of Tanzania.

### c. Maximum Collection Rate of the Actual Revenue to the Potential Revenue

Although the potential revenue from each source will grow at any rate, the maximum collection rate will never be 100 %. This is due to the fact that the tax administration cannot economically accumulate all the potential revenue. However, the petrol levy is collected by Tanzania Revenue Authority and a fixed proportion of it, decided politically, is allocated to DCC. Considering these factors, the maximum collection rate of potential revenue are set as follows.

Table 9-37 Maximum Collection Rate of Potential Revenue

| Group | Tax | Maximum Collection Rate of the Revenue Potential |
|---|---|---|
| Maximum collection rate decided economically | Development Levy, Property Tax, Service Levy, Hotel Levy, Business Licenses, Market Dues, Other Taxes | 80 % |
| Maximum collection rate decided politically | Petrol Levy | 100% |

### d. Growth Potential of Actual Revenue

#### d.1 Development Levy

The Local Government Finance Management Act states that any person over the age of 18 years is required to pay the development levy. According to the estimate by DCC in 1996, while the potential revenue of the development levy stood at 2.88 billion Tsh., the real tax revenue was 55.6 million Tsh., which is only 19.3% of the potential value, indicating that there is a relatively higher potential for the further growth of the actual revenue of the development levy.

Therefore, the development levy is categorised as a relatively higher revenue potential, where the growth rate of the revenue from the development levy is estimated at 160 % in an optimistic scenario, 140 % in a moderate scenario, and 120 % in a pessimistic scenario. Table A - 1 and Figure A - 1 illustrate the estimated growth rate of the development levy from 1995 to 2006.

#### d.2 Property Tax

The owner of a property is charged based on the value of the real estate. According to the estimate by DCC in 1996, while the potential revenue of the property tax stood at 2.4 billion Tsh., the real tax revenue was 560.0 million Tsh., only 23.3% of the potential revenue, indicating that there is a relatively higher potential for further revenue increase as valuation of fixed assets is still going on.

Therefore, the property tax is categorised as a relatively high revenue potential, where the growth rate of the revenue from the property tax is estimated at 160 % (optimistic), 140 % (moderate), and 120 % (pessimistic). Table A - 2 and Figure A - 2 illustrate the estimated growth rate of the property tax from 1995 to 2006.

#### d.3 Petrol Levy

The petrol levy is collected by the Tanzania Revenue Authority (TRA) under the Ministry of Finance at a rate of 60 Tsh. per litre of petroleum products, and, out of this the DCC is supposed to receive a share of 5 Tsh. According to the estimate by the DCC in 1996, while the potential income from the petrol levy stood at 1.697 billion Tsh., for

the five years up to 1995, the central government only received 100.0 million Tsh., which is only 5.9% of the potential revenue, indicating that there is a higher potential for a further growth of the actual revenue of the petrol levy, if the central government commits itself to proper allocation of the petrol levy to DCC.

Therefore, the petrol levy can be considered as a potentially large revenue source, where the growth rate of the revenue from the petrol levy is estimated at 170 % (optimistic), 150 % (moderate), and 130 % (pessimistic). Table A - 3 and Figure A - 3 illustrate the estimated growth rate of the petrol levy from 1995 to 2006.

### d.4 Service Levy

The service levy was a newly introduced levy which was formerly known as the "industrial cess". The levy is imposed on major transactions of goods and services at the rate of 0.75% of the turnover of these transactions. According to the estimate by DCC, while the revenue potential of the service levy in 1996 was 3,417million Tsh., the actual revenue of the levy was only 353.1 million Tsh, indicating that there is potential for further increase in actual revenue.

Therefore, the service levy has a high revenue potential, where the growth rate is estimated at 170 % (optimistic), 150 % (moderate), and 130 % (pessimistic). Table A - 4 and Figure A - 4 illustrate the estimated growth rate of the service levy from 1995 to 2006.

### d.5 Hotel Levy

The hotel levy is imposed on owners of hotels and guest houses based on the number of rooms. It is estimated that the number of hotels and guest houses in DSM is approximately 3,000, and the current tariff for the hotel levy is 10% of the room charge. According to the estimate by DCC, while the revenue potential of the hotel levy in 1996 was 767 million Tsh., but the actual revenue of the levy was only 114 million Tsh., which is 14.8% of the potential, indicating it is highly probable that the revenue can be increased.

Therefore, there is a scope of improving revenue from the hotel levy, where the potential income is estimated at 160 % (optimistic), 140 % (moderate), and 120 % (pessimistic). Table A - 5 and Figure A - 5 illustrate the estimated growth rate of the hotel levy from 1995 to 2006.

### d.6 Business Licenses and Market Dues

DCC estimates that the actual revenues from business licenses and market dues are 33.3 % and 60.2 % of the potential values, respectively, implying that there is less potential in raising funds from business licenses and market dues.

Therefore, business licenses and market dues are considered to have a lower revenue potential, where the growth rate of the revenue from business licenses and market dues is estimated at 130 % (optimistic), 120 % (moderate), and 110 % (pessimistic). Table A - 6 and Figure A - 6 illustrate the estimate of the growth rate of business licenses from 1995 to 2006, and Table A - 7 and Figure A - 7 illustrate the estimated growth rate of market dues from 1995 to 2006.

### d.7 Others

Although other taxes and levies include a wide range of revenue sources, there is a relatively lower probability for the further growth.

Therefore as with the business levies, these taxes and levies have a low potential for further development: the growth rates are estimated at 130 %(optimistic), 120 % (moderate), and 110 % (pessimistic). Table A - 8 and Figure A - 8 illustrate the estimated growth rate of other taxes and levies from 1995 to 2006.

### d.8 Overall Forecast of DCC's Tax Revenue

Summing up DCC's rax revenue forecast, the following 3 scenarios of the total tax revenue are set up.

Table 9-38 Scenarios of DCC's Total Tax Revenue

unit : million Tsh.

| Revenue | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Optimistic | 6,779 | 9,103 | 11,771 | 14,639 | 16,279 | 17,250 | 18,112 |
| Moderate | 4,807 | 5,782 | 6,981 | 8,462 | 10,281 | 12,538 | 15,062 |
| Pessimistic | 3,441 | 3,730 | 4,045 | 4,388 | 4,763 | 5,172 | 5,618 |

The achievement rates by revenue source in the 3 revenue scenarios are tabulated in Table A - 9, Table A - 10 and Table A - 11, the growth rates by revenue source are tabulated in Table A - 12, Table A - 13 and Table A - 14. The achievement rate of the total tax revenue in the 3 revenue scenarios are illustrated in Figure A - 9 and the growth potential of the total tax revenue in the 3 revenue scenarios are illustrated in Figure A - 10.

As a result, Table A - 15, Table A - 16 and Table A - 17 indicate the overall estimate of DCC's tax revenue as well as the subsidy from the central government for the 3 scenarios; Figure A - 11 to Figure A - 16 illustrate the overall estimate of DCC's tax revenue and the supposed share of each revenue source.

### e. Budget Allocation of DCC's Tax Revenue to the Solid Waste Management

Considering the recent trend in budget allocation of DCC's tax revenue to the solid waste management sector, the following 3 cases are set up; Tables 9-57, 9-58 and 9-59 give detailed accounts of the budget allocation forecast of DCC's Tax Revenue from 1997 to 2005. Also, the tables show the actual budget allocation for 1996, which is given as a fixed index.

Table 9-39 Estimated Budget Allocation of DCC's Tax Revenue to SWM

unit : %

| Revenue | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Optimistic | 5.0 | 5.2 | 5.4 | 5.6 | 5.8 | 6.0 | 6.2 | 6.4 | 6.6 | 6.8 |
| Moderate | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Pessimistic | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 |

### c. Forecast of Budget Allocation Amount for SWM

On applying the budget allocation share to the forecasted tax revenue, the following 9 scenarios of budget allocation amount for SWM in the Master Plan were estimated, details of which are shown in Table A - 21.

Table 9-40 Scenarios of Budget Allocation Amount for SWM

unit : million Tsh.

| Tax Revenue | Budget Allocation Rate to SWM | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Optimistic | Optimistic | 804 | 1160 | 1481 | 1729 | 1990 | 2287 | 2627 |
| | Moderate | 717 | 1000 | 1235 | 1394 | 1555 | 1732 | 1932 |
| | Pessimistic | 631 | 840 | 988 | 1060 | 1119 | 1178 | 1236 |
| Moderate | Optimistic | 614 | 804 | 1072 | 1444 | 1872 | 2198 | 2541 |
| | Moderate | 548 | 693 | 893 | 1165 | 1493 | 1665 | 1868 |
| | Pessimistic | 482 | 582 | 714 | 885 | 1053 | 1132 | 1196 |
| Pessimistic | Optimistic | 470 | 549 | 645 | 762 | 904 | 1081 | 1299 |
| | Moderate | 420 | 473 | 537 | 614 | 707 | 819 | 955 |
| | Pessimistic | 369 | 398 | 430 | 467 | 509 | 557 | 611 |

## 9.3.2.2 Forecast of Revenue from RCC

### a. RCC collected through Joint Billing with Water Charge

The amount of RCC to be collected was forecast as follows.

#### a.1 Household waste

| | |
|---|---|
| Target people | All households that receive refuse collection services |
| Amount of RCC | Tsh. 1,250 per household per month (according to the interview on willingness to pay) |
| Billing rate | 30 %: (present provision rate of water supply (40%) x present billing rate of water supply charge (80%) |
| Collection cost rate of RCC | 30%: 30% of RCC is paid to DAWASA for the collection cost |

#### a.2 Wastes other than household waste

| | |
|---|---|
| Target people | All dischargers of official, commercial and market waste that receive the service |
| Amount of RCC | Tsh. 20,000 per ton (approximately 1.33 times of Willingness to Pay of household waste) |
| Billing rate | 70%: present provision rate of water supply of 80% x present billing rate of water supply charge of 90% |
| Collection cost rate of RCC | 30%: 30% of RCC is paid to DAWASA for the collection cost. |

#### a.3 Forecast of RCC collected through Joint Billing with Water Charge

unit: million Tsh

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| RCC from Households | 377 | 531 | 701 | 1,006 | 1,203 | 1,430 |
| RCC from Others | 410 | 552 | 725 | 937 | 1,085 | 1,254 |
| Total | 787 | 1,083 | 1,426 | 1,943 | 2,288 | 2,684 |

### b. Special RCC collected by DCC

The amount of Special RCC to be collected was forecast as follows.

#### b.1 Business Waste (Commercial, Market and Institutional Wastes)

| | |
|---|---|
| Target people | All dischargers of official, commercial and market waste that receive the service |
| Amount collected | Tsh. 20,000 per one ton (approximately 1.33 times of Willingness to Pay of household waste) |
| Billing rate | 80% |

#### b.2 Household Waste

Concerning household waste, the special RCC is to be set up for the special refuse collection services, such as door to door collection, bulky waste collection, garden waste collection, etc., where collections costs are generally more expensive than for normal household waste.

#### b.3 Forecast of Special RCC ollected by DCC

unit: million Tsh

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| RCC from Households | 656 | 883 | 1,161 | 1,499 | 1,736 | 2,007 |

## 9.3.3 Case Studies for the Financial Plan

For the financial analysis several cases are set up regarding the following 3 aspects:

- Financial sources: Financial sources for the investment of the project cost
- Revenue source 1: RCC system
- Revenue source 2: Special Fund to be allocated from revenue from the city's tax revenue

### a. Financial Sources for the investment of the project cost

The following 3 cases were presented as financial sources.

| Case | Description |
|---|---|
| A | All of the project costs are covered by a loan. |
| B | The investment in 1999 for the construction of the final disposal site and landfill equipment is granted by foreign aid. |
| C | All investment in 1999 for the construction of the final disposal site, landfill equipment, refuse collection vehicles, machinery for the maintenance workshop, etc. are granted by foreign aid. |

### b. Refuse Collection Charge System

Following two cases were assumed for the refuse collection charge system.

| | |
|---|---|
| Case 1 | Joint billing with water supply and sewerage fee by DAWASA |
| Case 2 | Special RCC collected by DCC |

### c. Special Fund to be allocated from the City's Tax Revenues

Following three cases were assumed for the total amount of special fund allocated from the city's tax revenues.

| | |
|---|---|
| Case a | Most optimistic scenario of increase in city tax revenue and allocation ratio for solid waste management |
| Case b | Most likely scenario of increase in city tax revenue and allocation ratio for solid waste management |
| Case c | Most pessimistic scenario of increase in city tax revenue and allocation ratio for solid waste management |

### e. Revenue

The following three (3) cases out of the nine (9) SWM budget allocation scenarios are set up as further options in terms of the revenue forecast of the municipal tax for the Master Plan.

Table 9-41 Alternative Scenarios in terms of Revenue Forecast

unit : million Tsh.

| Case | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| a = Most Optimistic | 804 | 1,160 | 1,481 | 1,729 | 1,990 | 2,287 | 2,627 |
| b = Most Likely | 548 | 693 | 893 | 1,165 | 1,493 | 1,665 | 1,868 |
| c = Most Pessimistic | 369 | 398 | 430 | 467 | 509 | 557 | 611 |

As a result, financial plans were formulated for a total of 18 cases (3 x 2 x 3) i.e. cost conditions (3 cases), billing system (2 cases), and revenue forecast (3 cases). Table A - 22 to Table A - 39 illustrate the method of financial planning for these 18 cases.

## 9.4 Examination on the Master Plan by Pilot Projects

a. Objectives of the Pilot Projects

Judging from previous experiences, numerous problems are bound to surface with the implementation of the projects proposed in the M/P. Pilot projects were carried out in the study to identify these problems and ways to be overcome these difficulties. The objectives of the pilot projects are summarised below.

- Examination of the applicability of technologies proposed in the master plan.
- Acquisition of basic data for the preliminary design of the feasibility study.
- Enhancement of public awareness and increase public participation in SWM.
- Demonstration of some improvement measures to authorities concerned and the public.

### b. Implementation of Pilot Projects

The following four pilot projects were implemented.

Code:

A. Enhancing of Public Awareness on SWM.

B. Environmental Improvement of the Vinguguti Disposal Site.

C. Improvement of the Refuse Collection System in Kariakoo.

D. Improvement of the Refuse Collection System in Buguruni.

Pilot projects were planned in order to examine the applicability of the technologies and plans proposed in the Master Plan as countermeasures to problems identified in the first phase of the study.

Table 9-42: Contents of Pilot Projects

| Current Problems | Proposals in the M/P | Contents of Pilot Projects | Code No. |
|---|---|---|---|
| **Inappropriate technical system and lack of resources** | Improvement of refuse collection system | • To examine the expedience of skip collection system in Kariakoo and Buguruni. | C, D |
| | Sanitary Landfill | • Improvement of the environmental sanitary condition of the landfill site and its environs.<br>• Demonstration of environmental protection technologies such as gas removal, soil cover, etc.<br>• Demonstration and technical transfer of waste amount control system by using the computerised weighbridge system installed by JICA. | B |
| | Improvement of street cleaning system | • Installation of 100 litter bins in Kariakoo ward and garbage collection from them. | C |
| **Lack of knowledge of dangers by refuse** | Education on refuse | • Production of 20,000 refuse education textbooks.<br>• Trial lessons on refuse to primary school pupils.<br>• Seminar on refuse education to primary school teachers.<br>• Poster competition by primary school pupils.<br>• Educational cultural show on refuse.<br>• Educational film show on refuse. | A |
| **Lack of moral concern about refuse** | To raise public awareness of refuse problems and to promote public cooperation | • "Beautify Your City" campaign was conducted. In order improve public spirit in DSM and make people feel responsible for maintaining the city clean, the catch phrase "Beautify Your City" for public the campaign was adopted.<br>• Most activities in the pilot projects were concentrated in February with February named as *"Beautify Dar es Salaam Month"*. The contents of the pilot projects were publicised timely.<br>• Banners, posters, stickers, TV, newspaper, T shirts, etc. were used in order to advertise "Beautify Your City" and promote public cooperation.<br>• An open 10 km Taka Race from the City Hall to the National Stadium took place on 2nd March as the closing event of *"Beautify Dar es Salaam Month"* in order to raise public awareness on refuse. Every participant ran with stickers showing "Beautify Your City" on the front of his/her shirt. | A |

### c. Findings from Pilot Projects

Through the implementation of the pilot projects the Team found out the following important issues for the modification of the M/P and the execution of the F/S for the first priority projects.

i. It is difficult to gain public co-operation for the prevention of littering if a sufficient refuse collection service is not provided. For example, the litter bins

installed in Kariakoo ward were used not only for litter but also for the discharge of residential and commercial wastes. Most of them became refuse collection points as a result. This shows that litter bins (which requires public co-operation for the prevention of littering) can not function according to their purpose without the provision of a sufficient refuse collection system. This also indicates that the skip collection system can work in Kariakoo ward, i.e. in the SUPA.

ii. Public co-operation for primary refuse collection to a skip can be obtained if refuse collection services are sufficiently provided. For example in Buguruni ward, although skip containers were placed just beside the Uhuru road which is some distance from residential areas, it was observed that considerable amounts of household wastes were discharged into them. This proved that a considerable number of people would bring and discharge their wastes into skips to be installed along a trunk road even without primary collection services in the SUUA.

iii. A major problem with any future campaign is the perception many residents have of the DCC. In the words of one participant: "DCC says a lot but does little". This is the main reason why many residents thought it was unfair to ask citizens to change their attitudes without a corresponding improvement in DCC's SWM performance. It is vital that the general public's perception of DCC is improved and this will primarily be achieved through improved SWM performance, not by education and awareness raising campaigns.

iv. Programmes for public education require sufficient "attraction power" for the public so that the majority of public are willing to participate in them by their own will. Educational cinema shows and culture shows conducted as pilot projects gathered large audiences every time and it was shown that the cinema show in particular is a very cost effective measure for public education.

## 9.5 Evaluation of the Master Plan

### 9.5.1 Technical Evaluation

The technical system proposed in the Master plan is very simple as it will mainly constitute basic elements of collection, transportation, and final disposal. It will not include a major intermediate treatment system. This technical system would be suitable for DSM because it is consistent with the institutional requirements for the area, that are identified in Chapter 5, and also with the SWM objective for DSM, i.e. improvement of sanitary conditions.

Skip trucks were proposed as the main collection and transportation equipment. DSM has been using skip trucks (3) since 1988 until recently when they broke down. The tipper trucks which were also obtained in the same period are still in operation. The breakdown of the skip trucks is attributed to excessive use: the number of trips made by the skip trucks was 3 - 5 times more than the tipper trucks. DCC is adequately equipped with the technical skills required for the maintenance of skip trucks and the necessary spare parts are available in DSM. These trucks cost very little to operate and are quite convenient, and they are, therefore, most appropriate for DSM.

Tipper trucks were proposed for curb collection in some parts of Area A. The use of these trucks was decided because they are not technologically too advanced and will not require any sophisticated form of maintenance.

The Master Plan proposed the use of compactor trucks for collection in the city centre. The reasons why the use of compactor trucks in DSM between, 1991-1992, was terminated were unsuitability of the screw type compactor for the collection of waste with high density, and lack of technical assistance. However, the use of compaction trucks in the city centre would be very advantageous, particularly in consideration of the traffic conditions and the lighter density of wastes in this area, because they not only carry a lot of waste but also have a small body.

Leachate control is also considered essential in DSM, but because it usually requires expensive investment and O & M cost, a disposal system equipped only with primary leachate treatment system was proposed. This system will be investigated in detail to determine whether costs can be minimised with the use of simple technology.

No intermediate technology was proposed, except for on-site composting which does not require complicated techniques.

Since the proposed technical system is very simple, problems are not envisaged. However, there is a need to improve the capability of the maintenance workshop proposed in the Master Plan in anticipation of maintenance problems that would result from the rapid increase in the number of refuse collection vehicles.

### 9.5.2 Social Evaluation

Prior to the financial and economic evaluation, the master plan was evaluated in terms of the intangible social impacts it will incur, i.e., improvements in sanitary and public health conditions, prevention of flood, promotion of foreign investment and tourism, and increase in land value.

### a. Improvements in Public Health and Sanitary Conditions

Poor collection or disposal practices encourage the breeding of insects, rodents, and pathogens that can cause and transmit diseases, particularly several of the diseases in the tropical cluster: schistosomiasis, trypanosomiasis, and Bancroftian filariasis. Since the master plan intends to mitigate the effect of such diseases by the elimination of waste heaps and the introduction of sanitary landfills with proper facilities, considerable improvements in public health conditions as well as conditions in nearby illegal dumping sites and in disposal sites can be anticipated.

The study by the World Bank suggests that 25 percent of soil transmitted diseases will be averted through feasible interventions such as covering of waste with soil at the dumpsite, fifteen to thirty centimetres deep, at the end of each day. Meanwhile, the Ministry of Health reported that 12.0 percent of the mortality rate in DSM is caused by some kind of soil transmitted diseases. The male mortality rate in DSM ranges from 19 per 1000 persons between the ages of 10-14 to 535 per 1000 persons between the ages of 75-79, and that the female mortality rate in DSM ranges from 16 per 1000 persons between the ages of 10-14 to 455 per 1000 persons between the ages of 75-79. Therefore, the calculated impact on the mortality rate ranges from 0.57 per 1000 persons between 10-14 to 16.17 per 1000 persons between 75-79.

### b. Prevention of Flood

Inadequate collection and transport of wastes may also clog open drains, creating breeding grounds for malaria and dengue-transmitting mosquitoes, or causing floods in rainy seasons, which may increase human contact with pathogen-infected faeces contained in the waste. The master plan will significantly mitigate the dangers these situations may bring about through the regular road sweeping services it promotes.

### c. Promotion of Investment and Tourism

In addition to the above-mentioned health effects, the proper collection, transport and disposal of wastes shall provide DSM with the favourable environment for the promotion of foreign investment and tourism. Since DSM, as the central gateway, is connected by major railroads and trunk roads to neighbouring countries, the improvement of its environment will enhance its image, and eventually contribute to attracting more investors and tourists to the area.

### d. Increase in Land Value

Well-managed waste disposal services also improve the living environment which result in increased land values. A study on the correlation between the living environment and land value suggests that, with other factors held constant, housing values further from a landfill rise at an average rate of 6.2 % a mile within a two-mile radius of the landfill, presumably because the environmental and aesthetic problems associated with living near a landfill diminish as distance from it increases[4]. Thus, the master plan with proper sanitary landfilling measures should increases the land value around the present illegal dumping sites and the disposal site.

[4] Beede, D.N. and Bloom, D.E. 1995, The Ecoonics of Municipal Solid Waste, The World Bank

### 9.5.3 Environmental Evaluation

Table 9-43 summarises the impacts which are predicted to occur with the implementation of the SWM Master plan.

Table 9-43: Summary of Environmental Evaluation of the SWM Master Plan

| Project | Components | Positive Impacts | Negative Impacts |
|---|---|---|---|
| Increase in Waste Collection Rate | | • Improvement in air quality<br>• Improvement in water quality<br>• Removal of offensive odour<br>• Improvement in aesthetic conditions<br>• Reduction of public nuisance | • Air pollution<br>• Noise pollution |
| Construction of new disposal sites in the outskirts of DSM | Closure of the Vinganguti dumping site | • Improvement in air quality<br>• Improvement in water quality<br>• Removal of offensive odour<br>• Improvement in aesthetic conditions<br>• Reduction of public nuisance<br>• Reduction of traffic in access road | |
| | Operation of new disposal site | | • Deterioration of sanitary conditions<br>⇒ Increase in morbidity & mortality<br>• Worsening view<br>• Air pollution<br>• Water pollution<br>• Noise pollution<br>• Offensive odour |
| | Increase in Transport Distance | | • Air pollution<br>• Noise pollution<br>• Contribute to global warming |

#### a. Impacts of Increase in Waste Collection Rate

The positive impacts are predicted to result from increase in waste collection rate, while the negative impacts are predicted to result from increase in refuse collection trucks. These are further discussed below.

#### a.1 Positive Impacts

**Improvement in air quality**

Methane ($CH_4$) and carbon dioxide ($CO_2$) are mainly emitted through the decomposition of organic solid wastes. This impact may not be recognised seriously because only a little gas is dispersed in a wide area. However, wherever it is emitted at generation sources or the landfill, the total pollutant load of emission gas will be the same. They would affect air quality anyway.

**Improvement of water quality**

Where waste collection services are absent, they are often disposed of at small open spaces or at rivers and drainage near generation points. Wastes disposed of at small open spaces will produce leachate consequently polluting surface and ground water. Wastes disposed of in rivers will pollute river water as well.

**Removal of offensive odour**

Removing wastes from the catchment area will remove the causes of offensive odour.

**Improvement in aesthetic conditions**

The removal of scattered wastes from the catchment area will improve aesthetic conditions, i.e., view, landscape.

**a.2 Negative Impacts**

Air pollution, noise pollution and traffic accidents would increase with the increased presence of refuse collection vehicles.

**b. Construction of new disposal sites in the outskirts of DSM**

This project consists of three diverse components, and because they will have different impacts, they are described separately as follows.

**b.1 Closure of the Vingunguti Disposal Site**

The improper landfill operation conducted at the Vingunguti disposal site has resulted in various negative environmental impacts. Therefore, its closure would be a positive environmental preservation measure as it would bring about: improvements in sanitary conditions, cleanliness, improvements in air quality, elimination of offensive odour and public nuisance.

**b.2. Operation of New Disposal Site in the Outskirts of DSM**

Basically, the same negative environmental impacts caused by the operation of the Vingunguti landfill site are also predicted to occur in the new disposal sites, but on a lesser scale because of the following reasons.

- The sanitary landfill level and operation of the new disposal sites will be much better than the existing disposal site.
- The new disposal sites will be located in areas suited to their functions.

**b.3. Increase in Waste Transportation Distance**

Increase in waste transportation distance and waste collection rate will increase the overall travel distance of refuse collection vehicles and consequently generate the following negative impacts:

**Air pollution**

Air quality would be affected by emissions, such as carbon dioxide, carbon monoxide (CO), oxides of nitrogen (NOx) and total suspended particulate (TSP) from vehicles.

**Global warming**

Carbon dioxide emitted by vehicles would contribute to global warming.

**Traffic accidents**

Operation of vehicles would cause traffic accidents, which would then generate casualties, traffic congestion, etc., as secondary impacts.

**Consumption of fossil fuel**

The vehicles will consume fuel which is a non-renewable resource.

**c. Conclusion**

The implementation of these projects will generate various significant positive impacts on the waste catchment area. These impacts will outnumber the negative impacts that will result from the increase in the use of refuse vehicles.

Conclusively, the three new disposal sites will generate less negative impacts than the existing Vingunguti disposal site due to the adoption of the following environmental preservation measures.

- Use of environmentally sound landfill structures and landfill operation system;
- The new disposal sites will be located in less populated areas.

### 9.5.4 Financial Evaluation

**a. FIRRs**

FIRR was calculated regarding the following the combined eighteen cases (3x2x3) of the three cases of project cost (A: all loan, B: grant provided only for disposal site, C: grant provided for disposal site, collection vehicles, workshops), two cases of billing (RCC) system (1: joint billing, 2. RCC only for special collection service), and the three scenarios of forecast regarding the special fund allocated from the city's tax revenue. The results of the calculations are tabulated below. Table A - 40 to Table A - 57 present the calculations for the relevant FIRRs, and Table A - 58 together with Figure A - 17 summarise the results of the FIRRs.

Table 9-44: FIRRs of Each Financial Case Study

| Financial Plan for Investment | Financial Source | Revenue Forecast | Case | FIRRs (%) |
|---|---|---|---|---|
| All loan | Tax and RCC collected by joint billing with water supply charge | Optimistic | A-1-a | 1.52% |
| | | Most Probable | A-1-b | -5.38% |
| | | Pessimistic | A-1-c | -13.90% |
| | Tax and Special RCC collected by DCC | Optimistic | A-2-a | -2.83% |
| | | MostProbable | A-2-b | -8.91% |
| | | Pessimistic | A-2-c | -17.79% |
| Grant provided only for the investment in 1999 for construction of the disposal site and landfill equipment | Tax and RCC collected in joint billing with water supply charge | Optimistic | B-1-a | 4.88% |
| | | MostProbable | B-1-b | -3.14% |
| | | Pessimistic | B-1-c | -12.56% |
| | Tax and Special RCC collected by DCC | Optimistic | B-2-a | 0.10% |
| | | Most Probable | B-2-b | -7.66% |
| | | Pessimistic | B-2-c | -16.74% |
| Grant provided for all investment in 1999 | Tax and RCC collected in joint billing with water supply charge | Optimistic | C-1-a | 31.92% |
| | | MostProbable | C-1-b | 8.34% |
| | | Pessimistic | C-1-c | -7.05% |
| | Tax and Special RCC collected by DCC | Optimistic | C-2-a | 17.01% |
| | | Most Probable | C-2-b | 0.57% |
| | | Pessimistic | C-2-c | -12.76% |

Following conclusion was drawn from the above FIRRs.

- In the case where there is a total loan scheme (Case A-1-a, A-1-b, A-1-c, A-2-a, A-2-b and A-2-c), FIRRs of all the financial cases was much lower than the opportunity cost of capital (cut-off rate) of Tanzania. Therefore, it is not financially feasible. It implies that supply of higher external financial sources such as foreign grant assistance for investment is essential.
- In the case where grant assistance covers investment cost for 1999 to construct the final disposal site and acquire landfill equipment (Case B-1-a, B-1-b, B-1-c, B-2-a, B-2-b and B-2-c), it is judged that all financial cases will be financially unrealistic because the FIRRs in all cases are under the cut-off rate. It implies that more financial resources, not only for the final disposal site but also for other investment costs, with a higher foreign grant equivalent is indispensable.
- In the case where all required investment for 1999 is granted (Case C-1-a, C-1-b, C-1-c, C-2-a, C-2-b and C-2-c), RCC is collected by DAWASA with water charge and tax forecast is most probable (Case C-1-b), the FIRR is 8.34 %. Although this value is slightly lower than the cut off rate of 11.6 %, the project implementation can be made financially feasible by DCC making additional efforts such as collect more taxes, increase RCC collection rate, etc.
- In the case where all required investment for 1999 is granted, special RCC is collected by DCC and tax forecast is most probable (Case C-2-b), the FIRR is 0.57 %. Although this value is lower than the cut off rate of 11.6 %, the required operation and maintenance cost can be at least covered by the revenue. In addition, further investment can be made by making additional efforts such as collect more taxes, increase RCC collection rate, etc.

### 9.5.5 Economic Evaluation

The economic evaluation has been carried out to determine economic impacts of the Master Plan on the national economy of Tanzania. Since the various factors distort the price level of the costs and benefits, financial costs and benefits will be converted as economic costs and benefits using relevant conversion factors. The locally-traded goods and services and unskilled labour force are over valued in the financial cost, thus, various taxes and subsidies, which are mere transfers of income, are excluded from the financial cost.

Table A - 59 presents the calculations of the conversion factors for investment, operation and maintenance, and indirect costs. The financial planning table, using these conversion factors, is shown in Table A - 60 together with the result of the economic internal rate of return (EIRR) shown in Table A - 61. The calculation indicates that the EIRR of the Master Plan is almost at the same level as the cut-off rate of 9.25%, suggesting that the Master Plan will contribute to the improvement of the economic development of Tanzania.

### 9.5.6 Overall Evaluation

The projects proposed in the Master Plan were evaluated in terms of their technical, social, environmental, financial and economic impacts.

The technical evaluation concluded that the simplicity of the proposed technical system is very appropriate for the present level in DSM. Although problems in vehicle and equipment maintenance are foreseen, they can be overcome by improvements in the proposed maintenance workshop.

The social evaluation concluded that the implementation of the proposed projects would generate various positive significantly intangible impacts such as improvements in public health and sanitary conditions, prevention of floods, promotion of foreign investment and tourism, increase in land value, etc.

The environmental evaluation concluded that the positive effects from the projects shall outnumber the negative impacts.

In the financial evaluation, FIRR (financial internal rate of return) for the 18 cases were calculated. As a result, if:

- All investment cost for 1999 is granted.
- The most probable scenario of increase of tax revenue is taken.
- RCC is collected by either DAWASA included in the water charges or the DCC directly.

1) In the case where RCC is collected by DAWASA with water charges , FIRR is 8.34 %. Although this value is slightly lower than the cut off rate of 11.6 %, the project implementation can be made financially feasible by DCC making additional efforts such as collect more taxes, increase RCC collection rate, etc.

2) In the case where special RCC is collected by DCC, FIRR is 0.57 %. Although this value is lower than the cut off rate of 11.6 %, the required operation and maintenance cost can be at least covered by the revenue. In addition, further investment can be made by making additional efforts such as collect more taxes, increase RCC collection rate, etc.

The economic evaluation is done based on the EIRR (economic internal rate of return) which is calculated from total economic cost (which is calculated by economic price obtained from the modification of the deviation in domestic market price) and total economic benefits. Therefore the evaluation takes into account that:

- All project costs are covered by a loan without any grant component.
- RCC is collected by joint billing with DAWASA.
- There is a special fund to be allocated from city taxes revenue.

As a result, the EIRR is calculated at 9.25 %, which is almost equal to the cut-off rate of 11.6 %. Therefore, the implementation of the master plan will contribute to the national economy.

The overall evaluation concluded that the execution of the Master Plan would be essential to maintain the basic level of urban environment sanitation and public health and to enable sustainable urban development for DSM, at the same time it would be feasible technically, socially, environmentally, financially and economically.

## 9.6 Initial Environmental Examination

During the second period of work in Tanzania (March-August 1996 inclusive) the selection of appropriate disposal sites for DSM city was made using five criteria based on the existing proposal for future disposal site allocation within DSM city and social, environmental, technical and financial aspects. Only one site, Kunduchi New MECCO quarry, was assessed as being appropriate and it was examined for use as the new disposal site in the feasibility study to be conducted in the third phase of this Study.

This section deals with the IEE (Initial Environmental Examination) of the proposed disposal site. At present there are no formal environmental assessment guidelines in Tanzania. Instead, for major projects, it is required that an Environmental Impact statement be submitted to NEMC but no definition of "major" nor any criteria concerning the contents of this statement are given. Hence, JICA's Environmental Guidelines[5] have been followed for the IEE and will be used in the EIA (Environmental Impact Assessment). Definitions of the terms used are given in the Guidelines and Fig 9-9 from the Guidelines is reproduced here to illustrate the procedure for environmental consideration.

The JICA Guidelines list 23 environmental items for evaluation under the headings: 'social environment', 'natural environment' and 'pollution'. In this case, a 24th item ('litter') was added under the 'pollution' heading. The guidelines state that "the scope should cover not only the project site for final disposal but also the entire area where it would create an impact directly or indirectly, including the routes of waste collection vehicles and where the effluent is discharged". In this case, the scope/IEE covered the proposed disposal site and the main access road (Bagamoyo Road) to the intersection with Sam Nujoma Road at Mwenge. Only this section of road was included as it will experience the most significant increase in traffic volume due to the passage of refuse vehicles.

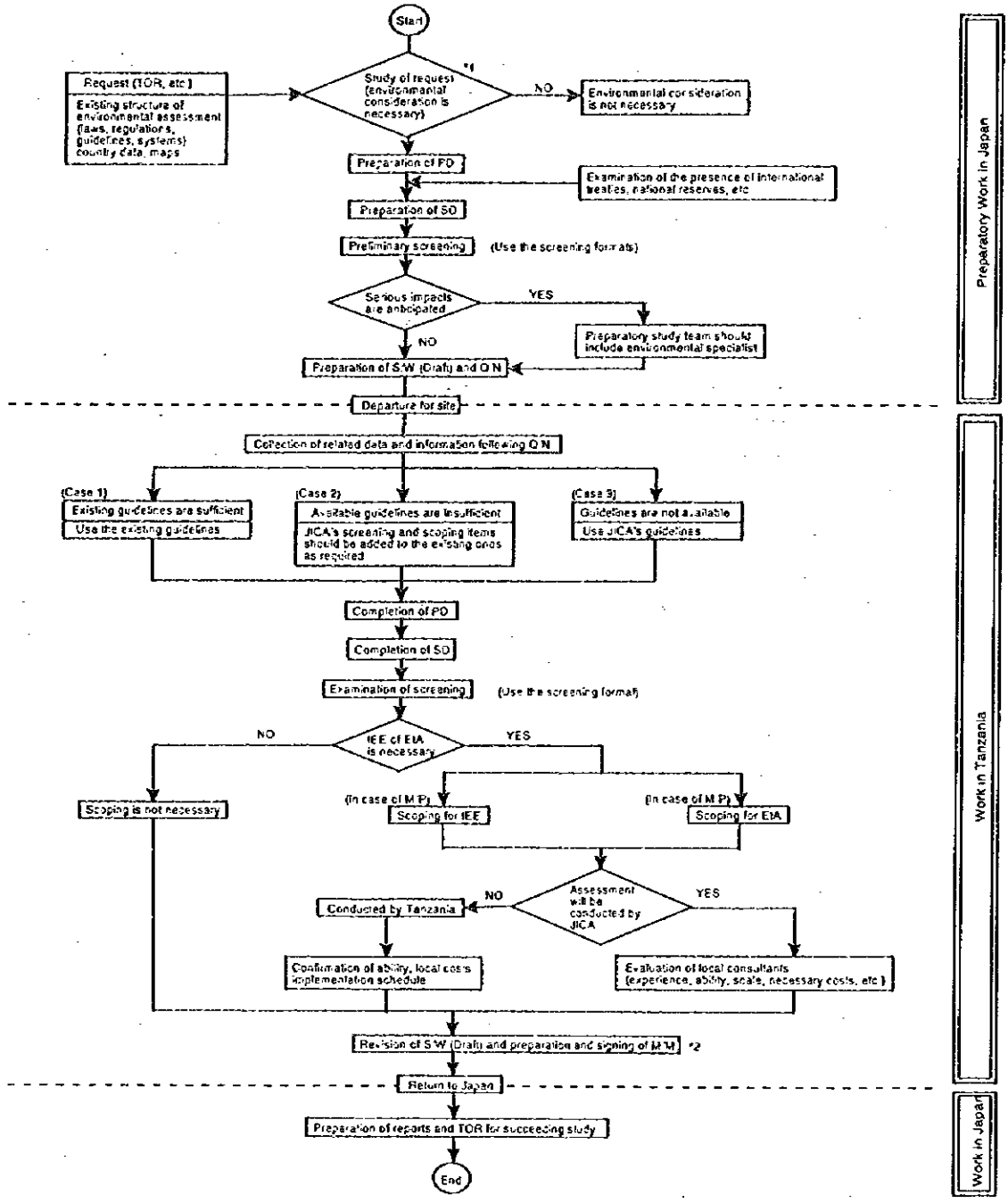
The IEE consisted of the following steps:

1. The general screening and scoping assessments made by the Preparatory Study team were reviewed and scoping was then carried out for the Kunduchi New Mecco quarry site in order to identify the items requiring an Environmental Impact Assessment (EIA). The results of this assessment are shown in Table 9-45.

2. The contents of the EIA (i.e. required work) and possible environmental conservation/mitigation measures were then defined for each environmental item, using available data and in consultation with Tanzanian counterparts. The results of this examination are shown in Table 9-62.

These results show that serious environmental impact is expected for water pollution while some impact is expected for public health, hazards/risks, landscape/aesthetics, air pollution, soil contamination, noise and vibration, offensive odor and litter. The extent of the impact for economic activities, traffic and public facilities, waste, topography and geology, groundwater, hydrological situation and flora and fauna is unknown at this stage but should be clarified through the EIA which will be conducted during the third phase of this Study.

[5] Environmental Guidelines for Infrastructure Projects No.VI Solid Waste Management, JICA, Sept 1992




Note : *1. The environmental consideration is not necessary when infrastructure projects are not anticipated to have serious impacts, such as preparation of topographic maps and telecommunication projects, etc.
*2 When the environmental factors that may have serious impact are not identified, it is necessary to mention in the M/M that such items would be clarified in the full-scale study.

PD : Project Description
SD : Site Description

Figure 9-9: Procedure of Environmental Consideration of JICA

### 9.6.1 Scoping of Environmental Impacts

Table 9-45: Scoping of Environmental Impacts for Proposed Disposal Site at New MECCO Quarry

| No. | Environmental Item | Description | Evaluation | Reason |
|---|---|---|---|---|
| | | **Social Environment** | | |
| 1 | Resettlement | Resettlement due to land acquirement for project(s) (transfer of rights of land ownership/residence). | D | No houses/residents in area for proposed site. |
| 2 | Economic Activities | Loss of bases for economic activities (e.g. land) and effects on these activities. | C | Ministry of Works crushing plant operations and some individuals performing manual excavation works and associated activities in or near quarry will be affected; effect on recycling/scavenging activities unknown although scavengers at Vingunguti will be displaced. |
| 3 | Traffic and Public Facilities | Impacts on schools, hospitals, etc. and traffic conditions (e.g. increased traffic congestion/accidents). | C | Schools, hospitals and other public facilities in area may be affected; increased traffic congestion/accidents, especially on Bagamoyo Rd, near Mwenge, may occur. |
| 4 | Division of Community | Division of Community geographically due to project location, interruption of area traffic, etc. | D | No community in proposed area. |
| 5 | Cultural Property | Damage to or loss of value of churches, temples, archaeological remains or other cultural assets. | D | No cultural property in area around landfill site. |
| 6 | Water Rights/ Access Rights | Obstruction of fishing rights, water rights and rights of common access. | D | None; land is under control of Ministry of Energy and Minerals; no water/fishing rights affected. |
| 7 | Public Health | Deterioration of public health and sanitary conditions due to refuse generation and increase in pathogens/vermin. | B | Impact will be most significant near landfill site due to refuse disposal; deterioration in air and water quality will also affect public health. |
| 8 | Waste | Generation of construction wastes/debris. | C | Impact of construction wastes/debris should be considered although it is likely to be small. |
| 9 | Hazards/Risks | Increase in natural disasters (e.g. landslides) and man-made hazards (e.g. landfill gas explosions, refuse fires). | B | Possibility of natural disasters is unlikely to increase; impact of man-made hazards should be small if good landfill management practices followed. |
| | | **Natural Environment** | | |
| 10 | Topography and Geology | Changes of valuable topography and geology due to excavation, construction and/or filling works. | C | Natural environment has already been seriously damaged by quarry operation - scale of construction excavation works should be small but further impact on natural environment should be assessed; some soil may be taken from other areas for impermeable liner and/or covering material for landfill - impact on these other areas should be considered although impact is likely to be small. |
| 11 | Soil Erosion | Topsoil erosion by rainfall after earthfilling and deforestation. | D | Topsoil has already been removed by quarry operation. |
| 12 | Groundwater | Changes in groundwater level due to infiltration of leachate and run-off from disposal site. | C | Impact on groundwater level is likely to be small but should be considered. |
| 13 | Hydrological Situation | Changes in river discharge and riverbed condition due to inflow of run-off and landfill. | C | Impact on surface water sources in vicinity of landfill is likely to be small but should be considered. |
| 14 | Coastal Zone | Coastal erosion and changes in vegetation due to coastal reclamation and coastal changes. | D | Project will not impact on coastal zone. |
| 15 | Fauna and Flora | Obstruction of breeding and extinction of species due to changes in habitat conditions. | C | Flora has already been damaged by quarry operation; increase in vermin numbers may threaten flora and fauna. |
| 16 | Meteorology | Changes in temperature, rainfall, wind, etc. due to large scale land changes and building construction. | D | None; scale of landfill is too small to produce such changes. |
| 17 | Landscape/ Aesthetics | Changes in topography and vegetation due to earthworks; deterioration in environmental aesthetics. | B | Topography and vegetation has already been seriously damaged by quarry operation; further changes will occur in immediate vicinity of landfill site but impact is likely to be small. |
| | | **Pollution** | | |
| 18 | Air | Pollution caused by exhaust/toxic | B | Landfill gases (e.g. methane) will be generated; |

| No. | Environmental Item | Description | Evaluation | Reason |
|---|---|---|---|---|
| | Pollution | gases, dust, smoke, fumes, etc. from refuse collection vehicles and the landfill site. | | smoke/dust may be problematic especially during dry season; impact of fumes/exhaust gases from refuse collection and landfill vehicles should be small. |
| 19 | Water Pollution | Pollution caused by inflow of sand, silt, leachate and run-off from disposal site into rivers, groundwater and sea near river discharges. | A | Due primarily to leachate. |
| 20 | Soil Contamination | Contamination of soil by leakage and diffusion of ash, leachate, etc. | B | Due primarily to leachate and hazardous/toxic substances in refuse. |
| 21 | Noise and Vibration | Noise and vibration generated by refuse collection vehicles and landfill site equipment. | B | Due to refuse collection vehicles and heavy landfill site equipment (e.g. bulldozers). |
| 22 | Land Subsidence | Deformation of land and land subsidence due to lowering of groundwater table. | D | Pumping of groundwater will be negligible; effect on land subsidence due to groundwater level changes caused by infiltration of leachate/run-off will be insignificant. |
| 23 | Offensive Odor | Generation of offensive odors from landfill site, associated treatment facilities and during waste transportation. | B | Odors due to landfill gases, refuse smell and leachate will be generated at landfill site. |
| 24 | Litter | Scattering of litter from landfill site and refuse collection vehicles. | B | Impact will be small, especially if appropriate counter-measures taken. |

Note: Evaluation categories: A - serious impact expected; B - some impact expected; C - extent of impact unknown (examination needed; impacts may become clear as Study progresses); D - no impact expected; EIA not necessary

## 9.6.2 Summary of Relevant Factors for each EIA Item

Table 9-46: Explanation of Item 2

| Item | 2. Economic Activities |
|---|---|
| Description | Loss of bases for economic activities (e.g. land) and effects on these activities |
| **Causes of Impacts**<br>1. Acquisition of land for new disposal site.<br>2. Shifting of disposal site from Vingunguti to New MECCO Quarry in 2000. | |
| **Possible Environmental Impacts**<br>1. Displacement of Ministry of Works Crusher Operation from quarry.<br>2. Loss of work for individuals who perform manual excavation works and associated activities (e.g. canteen for quarry workers) in or near quarry.<br>3. Shifting of disposal site will force changes in the present scavenging/recycling system conducted at Vingunguti disposal site.<br>4. Loss of work for individuals involved in scavenging/recycling activities (scavengers and middlemen) presently conducted at Vingunguti disposal site.<br>5. Social upheaval for individuals who choose to move to the new disposal site in order to begin or continue their scavenging/recycling activities. | |
| **Useful Factors for Evaluation**<br>1. Status of Ministry of Works Crusher Operations.<br>2. Number of individuals involved in manual excavation works and associated activities and their income generating activities.<br>3. Number of permanent scavengers and middlemen at Vingunguti disposal site and details of their income generating activities.<br>4. Response of individuals involved in scavenging/recycling at Vingunguti to shifting of disposal site. | |
| **Possible Counter-Measures**<br>1. Good communication and consultation with affected individuals/communities/Ministry of Works.<br>2. Possible compensation for those losing employment (monetary payment, alternative employment, etc.).<br>3. Assist adaptation of recycling system to changed circumstances. | |
| **Related Subjects for Study**<br>1. Effect on scavenging/recycling system when the disposal site was shifted from Tabata to Vingunguti.<br>2. Future recycling plans.<br>3. Organisation of Scavengers in DSM. | |

## Table 9-47: Explanation of Item 3

| Item | 3. Traffic and Public Facilities |
|---|---|
| Description | Impact on schools, hospitals, etc. and traffic conditions (e.g. increased traffic congestion/ accidents) |
| **Causes of Impacts**<br>1. Construction traffic in and around disposal site.<br>2. Passage of refuse collection vehicles to and from disposal site. | |
| **Possible Environmental Impacts**<br>1. Greater traffic congestion and risk of accidents due to increased traffic volume on access roads and around disposal site.<br>2. Disturbance to public facilities along access roads due to increased traffic volume (noise, fumes, etc.). | |
| **Useful Factors for Evaluation**<br>1. Road and traffic conditions near the disposal site and on main access road near Mwenge including assessment of accident danger spots.<br>2. Location of public facilities (e.g. schools, hospitals, army barracks) along main access roads and near disposal site.<br>3. Frequency distribution of refuse collection vehicles (weekly basis).<br>4. Collection routes of refuse collection vehicles. | |
| **Possible Counter-Measures**<br>1. Improvement of roads around the disposal site including possible modifications of the traffic system.<br>2. Proper scheduling of refuse collection vehicles and routes to avoid peak hour traffic.<br>3. Fix hours of operation of landfill site to consider traffic conditions.<br>4. Site entrance to landfill site to avoid queuing on main road.<br>5. Installation of traffic safety features, especially in accident danger spots.<br>6. Reduction in disturbance to public facilities by landscaping, screening, etc. | |
| **Related Subjects for Study**<br>1. Present land use and traffic conditions.<br>2. Future land use and transportation plans including development of public facilities. | |

## Table 9-48: Explanation of Item 7

| Item | 7. Public Health |
|---|---|
| Description | Deterioration of public health and sanitary conditions due to refuse generation and increase in pathogens |
| **Causes of Impacts**<br>1. Increase in pathogens (microorganisms, insects, rodents, etc.) around disposal site.<br>2. Emission of gases, smoke, fumes, dust from the disposal site and refuse collection vehicles.<br>3. Contamination of groundwater and surface water sources around disposal site.<br>4. Presence of health hazards (e.g. syringes, broken glass, contaminated food) in refuse at disposal site. | |
| **Possible Environmental Impacts**<br>1. Animals, birds and insects at final disposal site could become vectors of disease, affecting public health.<br>2. Increased incidence of respiratory diseases from gases, smoke, dust, fumes from the disposal site and refuse collection vehicles.<br>3. Increased incidence of water-related diseases due to groundwater/surface water contamination.<br>4. Health hazards to workers and scavengers if collection and disposal works are not conducted properly. | |
| **Useful Factors for Evaluation**<br>1. Recent history of incidence of disease, especially epidemics, in vicinity of final disposal site.<br>2. Water quality (groundwater, surface water sources) in immediate vicinity of disposal site.<br>3. Air quality in immediate vicinity of disposal site.<br>4. Amount and nature of hazards in refuse disposed at final disposal site. | |
| **Possible Counter-Measures**<br>1. Conduction of appropriate surveys at regular intervals, to obtain base line and subsequent data for comparison (water and air quality, public health, vermin, etc.) for area around disposal site.<br>2. Installation of monitoring, collection and treatment facilities/venting for leachate/landfill gases.<br>3. Prevention of pathogens by proper disposal site management including possible use of pesticides (for vermin) and control of stagnant waters to minimise breeding of vectors of disease (e.g. mosquitoes).<br>4. Exclusion of hazardous/toxic waste from landfill.<br>5. Public education on sanitation for local residents, refuse workers and scavengers to avoid infection. | |
| **Related Subjects for Study**<br>1. Occurrence and frequency of vectors of disease in DSM, especially near landfill sites.<br>2. Habitation and propagation of small mammals (e.g. rats) and insects (e.g. flies, mosquitoes).<br>3. Occurrence and frequency of refuse-related, air-related and water-related diseases in DSM.<br>4. Meteorological data (e.g. precipitation, humidity, etc.)<br>5. Topographical and Geological Survey.<br>6. Examination of corresponding data (water quality, public health, etc.) for Vingunguti and Tabata disposal sites. | |

## Table 9-49: Explanation of Item 8

| Item | 8. Waste |
|---|---|
| Description | Generation of construction wastes/debris |
| **Causes of Impacts**<br>1. Generation of debris and construction waste due to construction of final disposal site. | |
| **Possible Environmental Impacts**<br>1. Environmental degradation due to disposal of construction wastes/debris in inappropriate manner. | |
| **Useful Factors for Evaluation**<br>1. Estimation of amount of construction wastes/debris according to scale of excavation/construction works.<br>2. Alternative uses for construction wastes/debris. | |
| **Possible Counter-Measures**<br>1. Careful construction planning and management, including specification of standards/procedures for disposal of construction wastes/debris in project documents.<br>2. Temporary storage of construction wastes/debris during construction with subsequent transfer to new landfill.<br>3. Reuse of construction wastes/debris (e.g. earthfilling in low lying areas, erosion control). | |
| **Related Subjects for Study** | |

## Table 9-50: Explanation of Item 9

| Item | 9. Hazards/Risks |
|---|---|
| Description | Increase in natural disasters (e.g. landslides) and man-made hazards (e.g. landfill gas explosions, refuse fires) |
| **Causes of Impacts**<br>1. Changes in natural environment (topography, ground stability, etc.) due to construction, operation and after-care of disposal site.<br>2. Introduction of man-made hazards due to construction, operation and after-care of disposal site. | |
| **Possible Environmental Impacts**<br>1. Increased occurrence of natural disasters in area around landfill.<br>2. Increased occurrence of man-made disasters (e.g. landfill gas explosions, refuse fires) | |
| **Useful Factors for Evaluation**<br>1. Types and quantities of toxic/hazardous wastes in refuse normally disposed at Vingunguti disposal site.<br>2. Incidence of natural disasters in area around disposal site.<br>3. Prediction of amounts of landfill gas produced throughout lifetime (operation and after-care) of landfill site.<br>4. Incidence of fires at Vingunguti disposal site (annual basis) to identify high risk times of the year. | |
| **Possible Counter-Measures**<br>1. Risk analysis of landfill site.<br>2. Containment, collection and venting of landfill gases.<br>3. Provision of fire safety measures, fire fighting equipment and appropriate training of refuse workers.<br>4. Preparation of safety procedures for landfill site.<br>5. Exclusion of toxic/hazardous waste from landfill.<br>6. Use of run-off for sprinkling. | |
| **Related Subjects for Study**<br>1. Topographical and Geological Survey.<br>2. Meteorological data (e.g. precipitation, wind direction and speed, etc.).<br>3. Risks/hazards associated with sanitary landfill operation in tropical climates. | |

## Table 9-51: Explanation of Item 10

| Item | 10. Topography and Geology |
|---|---|
| Description | Changes of valuable topography and geology due to excavation, construction and/or filling works |

**Causes of Impacts**
1. Excavation of soil during construction works at landfill site.
2. Excavation of suitable soils for impermeable liner and/or covering material of landfill from other areas.
Note: Natural environment of landfill site has already been seriously damaged by quarry operation. Additional excavation and construction work should not significantly impact further on topography/ geology.

**Possible Environmental Impacts**
1. Damage to valuable topography and geology due to excavation works during construction and/or obtaining lining and/or covering material from other areas.

**Useful Factors for Evaluation**
1. Quantifying of construction excavation works to be conducted.
2. Location and availability of soils suitable for use as impermeable liner and/or covering material for landfill.

**Possible Counter-Measures**
1. Careful construction planning and management with specification of standards/procedures to be followed for all excavation works in project documents.
2. Good excavation practice (e.g. minimising exposure of bare soils; timing of soil movements to suit season; careful storage of topsoils, etc.).
3. Placement, restoration and after-care programmes to appropriate standards.

**Related Subjects for Study**
1. Topographical and Geological Survey of landfill site and other areas.
2. Permeability of soils around disposal site.

## Table 9-52: Explanation of Item 12

| Item | 12. Groundwater |
|---|---|
| Description | Changes in groundwater level due to infiltration of leachate and run-off from disposal site |

**Causes of Impacts**
1. Infiltration of leachate and run-off from disposal site into groundwater.

**Possible Environmental Impacts**
1. Changes in groundwater level due to changed infiltration flows.
2. Depression of groundwater level and land subsidence due to the extraction of groundwater in excavations below the water table.

**Useful Factors for Evaluation**
1. Effects of an impermeable liner in landfill on infiltration flows.
2. Permeability of soil around area of disposal site.
3. Groundwater conditions around and downstream of the site.
4. Water use around and downstream of the site, particularly in consideration of women.

**Possible Counter-Measures**
1. Collection and treatment of all leachate with control and monitoring of discharge.
2. Segregation and treatment of run-off from waste areas, with control and monitoring of discharge.
3. Possible use of impermeable liner for landfill.
4. Exclusion of hazardous/toxic waste from landfill.
5. Monitoring of groundwater around and downstream of the disposal site (including base line data).

**Related Subjects for Study**
1. Topographical and Geological Survey.
2. Precipitation and Hydrological Survey.
3. Examine relevant surveys concerning quarry's impact on groundwater.

## Table 9-53: Explanation of Item 13

| Item | 13. Hydrological Situation |
|---|---|
| Description | Change of river discharge and riverbed condition due to inflow of run-off and landfill |

**Causes of Impacts**
1. Inflow of drainage into rivers and lakes from disposal site.
2. Deposition of landfill into rivers and lakes from disposal site.

**Possible Environmental Impacts**
1. Change in regime of rivers and lakes by alteration of water bodies may damage ecosystems (plants, fish, animals, etc.).
2. Reduction in income to fishermen.

**Useful Factors for Evaluation**
1. Distribution of surface water bodies in area around landfill site.
2. Variation in surface water flows throughout the year.

**Possible Counter-Measures**
1. Segregation and treatment of run-off from waste areas, with control and monitoring of discharge.
2. Collection and treatment of all leachate with control and monitoring of discharge.
3. Monitoring of surface water bodies around and downstream of the disposal site.
4. Careful management of construction and landfill operations to prevent landfill entering surface water bodies.

**Related Subjects for Study**
1. Topographical and Geological Survey.
2. Precipitation and Hydrological Survey.
3. Water use from rivers and lakes around landfill site.
4. Aquatic life in rivers and lakes around landfill site.

## Table 9-54: Explanation of Item 15

| Item | 15. Flora and Fauna |
|---|---|
| Description | Obstruction of breeding and extinction of species due to changes in habitat conditions |

**Causes of Impacts**
1. Removal of vegetation and disturbance of animal and bird habitats for the construction/operation of landfill site.
2. Increase in pathogenic insects, animals and birds at disposal site.
3. Smoke, fumes and gases from landfill site and refuse collection vehicles.
4. Water pollution by leachate and run-off from disposal site.
5. Noise and vibration caused by the operation of construction equipment and refuse collection vehicles.
Note: Flora and fauna has already been extensively damaged by quarry operation.

**Possible Environmental Impacts**
1. Reduction in population of valuable and precious species which may affect biodiversity (extinction possible).
2. Increased numbers of flies, birds and rats which may obstruct the breeding of other species.
3. Advese effects on flora and fauna around and downwind/downstream of site due to air/water pollution.

**Useful Factors for Evaluation**
1. Survey of flora and fauna in area around landfill site; in particular, assessing if there are species unique to the locality and/or endangered/rare species in the area.
2. Existence of national, bilateral and/or multilateral conventions on flora and fauna.

**Possible Counter-Measures**
1. Schedule construction work to avoid breeding and nesting season.
2. Good landfill practice and pollution control.
3. Conservation of major and/or sensitive flora and fauna features.
4. Briefing of site workers.
5. Control of seagulls and rats.

**Related Subjects for Study**
1. Ecosystem and food chain in area around landfill site.

## Table 9-55: Explanation of Item 17

| Item | 17. Landscape/Aesthetics |
|---|---|
| Description | Changes in topography and vegetation due to earthworks; deterioration in environmental aesthetics |
| **Causes of Impacts**<br>1. Change of topography and vegetation for the construction of final disposal site.<br>2. Change in topography during landfill operation and after-care.<br>3. Visual appearance of landfill site and facilities.<br>Note: Topography and vegetation has already been seriously damaged by quarry operation. | |
| **Possible Environmental Impacts**<br>1. Deterioration in environmental aesthetics due to adverse visual impact of landfill site and facilities.<br>2. Adverse effect on tourism in the area.<br>3. Residents feelings may be aggravated if the landscape is related to their religious/cultural beliefs. | |
| **Useful Factors for Evaluation**<br>1. Consideration of the role of the landscape in religion, culture, tourism, etc. in the area.<br>2. Opinions of residents concerning the visual impact of the landfill site and facilities.<br>3. Evaluation of the host country should be taken into consideration.<br>4. Frequency of tourists using main access road (Bagamoyo Road). | |
| **Possible Counter-Measures**<br>1. Careful design of disposal site and facilities including fencing, gates, siting of flares, plant and offices.<br>2. Good communication and consultation with residents.<br>3. Limiting the maximum height of landfill.<br>4. Good landfill practice (e.g. contouring and matching existing landscape, screening with bunds or vegetation)<br>5. Restoration/rehabilitation plan for landfill. | |
| **Related Subjects for Study**<br>1. Distribution of tourist spots and historial sites.<br>2. Local history and folklore.<br>3. Tourism development plan. | |

## Table 9-56: Explanation of Item 18

| Item | 18. Air Pollution |
|---|---|
| Description | Pollution caused by exhaust/toxic gases, dust, smoke, fumes, etc. from refuse collection vehicles and the landfill site. |
| **Causes of Impacts**<br>1. Generation of dust and landfill gases at disposal site.<br>2. Emission of smoke from occasional refuse fires at disposal site.<br>3. Generation of dust, exhaust gases and fumes from construction vehicles, refuse collection vehicles and landfill site equipment (e.g. bulldozers). | |
| **Possible Environmental Impacts**<br>1. Increase in respiratory diseases due to dust, gases, smoke and fumes from the disposal site and refuse collection vehicles and associated equipment.<br>2. Retarding growth of plants due to toxic gases and dust falling on their leaves.<br>3. Adverse effects on nests of birds due to gases, dust, etc. | |
| **Useful Factors for Evaluation**<br>1. Meteorological data (e.g. wind direction and speed, air temperature distribution).<br>2. Residential population density in surrounding area, especially downwind of the dominant winds.<br>3. Proximity of public facilities (e.g. hospitals) requiring clean air.<br>4. Condition of roads and traffic density (residents will be affected by dust and exhaust gases when landfill site access roads are unpaved or have heavy traffic).<br>5. Land use in area around landfill. | |
| **Possible Counter-Measures**<br>1. Preparation of air pollution monitoring programme.<br>2. Good landfill practice (e.g. compaction, rapid cover, aprinking to prevent fires and dust).<br>3. Containment, collection and venting of landfill gases.<br>4. Preparation of fire prevention and fire fighting procedures.<br>5. Monitor/maintain refuse collection vehicles on a regular basis.<br>6. Covering of vehicles, wheel wash and dust control. | |
| **Related Subjects for Study**<br>1. Tanzania Air Quality Standards and/or Regulations.<br>2. Topographical Survey.<br>3. Previous studies on air quality in DSM.<br>4. Incidence of respiratory related diseases in DSM and their causes. | |

## Table 9-57: Explanation of Item 19

| Item | 19. Water Pollution |
|---|---|
| Description | Pollution caused by inflow of sand, silt, leachate and run-off from disposal site into rivers and groundwater |

**Causes of Impacts**
1. Inflow of sand and silt from construction of final disposal site.
2. Inflow of leachate and run-off into rivers and groundwater.
3. Leakage of hazardous substances during rainfall into rivers and groundwater.

**Possible Environmental Impacts**
1. Pollution of groundwater and rivers.
2. Obstruction to growth of aquatic life due to deterioration in water quality.
3. Occurrence of health problems due to using contaminated water.

**Useful Factors for Evaluation**
1. Permeability of soil around disposal site.
2. Groundwater and surface water conditions within the catchment area and downstream of the site.
3. Water use around and downstream of the site, particularly in consideration of women.

**Possible Counter-Measures**
1. Preparation of water pollution monitoring programme.
2. Timing of major earthworks to avoid wet season.
3.Collection and treatment of leachate with control and monitoring of discharge.
4. Segregation and treatment of run-off from waste areas with control and monitoring of discharge.
5. Possible use of impermeable liner for landfill.
6. Monitoring of groundwater and surface water quality around and downstream of the disposal site (including base line data).
7. Exclusion of toxic/hazardous waste from landfill.
8. Provision of another water supply for residents in immediate vicinity of site.

**Related Subjects for Study**
1. Topographical and Geological Survey.
2. Precipitation and Hydrological Survey.

## Table 9-58: Explanation of Item 20

| Item | 20. Soil Contamination |
|---|---|
| Description | Contamination of soil by leakage and diffusion of ash, leachate, etc. |

**Causes of Impacts**
1. Infiltration of leachate and run-off.
2. Leakage of hazardous substances during rainfall into soil.
3. Application of refuse-derived compost, contaminated by heavy metals to farmlands.

**Possible Environmental Impacts**
1. Contamination of soil under and around disposal site.
2. Subsequent contamination of groundwater and downstream water sources.
3. Adverse effects on human health due to absorption by crops of contaminants in compost.

**Useful Factors for Evaluation**
1. Design policy for leachate collection, treatment and disposal.
2. Amount and nature of hazardous/toxic waste to be disposed at final disposal site to assess magnitude of soil contamination risk.
3. Investigation is needed if some refuse is to be composted and possible uses of compost.
4. Water and land use around the disposal site.

**Possible Counter-Measures**
1. Preparation of soil pollution monitoring plan.
2. Exclusion of toxic/hazardous waste from landfill.
3. Use of impermeable liner for landfill.
4. Collection and treatment of leachate.
5. careful sorting of any refuse to be used for compost production.

**Related Subjects for Study**
1. Topographical and Geological Survey.

## Table 9-59: Explanation of Item 21

| Item | 21. Noise and Vibration |
|---|---|
| Description | Noise and vibration generated by refuse collection vehicles and landfill site equipment |
| **Causes of Impacts**<br>1. Use of construction equipment and vehicles for construction (e.g. bulldozers, dump trucks, etc.).<br>2. Use of equipment at disposal site (e.g. bulldozer) and refuse collection vehicles around disposal site and along the main access road. | |
| **Possible Environmental Impacts**<br>1. Residents, hospitals, schools and other public facilities along the access road would be affected by noise.<br>2. Cracks in buildings on soft ground caused by vibrations.<br>3. Disturbance to farm animals and wildlife along the access road and around the disposal site. | |
| **Useful Factors for Evaluation**<br>1. Noise and vibration levels around disposal site and along access road.<br>2. Distribution of residents and living conditions (especially housing).<br>3. Distribution of public facilities such as schools, hospitals along access road.<br>4. Ground conditions near landfill site and along access road.<br>5. Distribution of livestock farming and wildlife habitats near landfill site and along access road. | |
| **Possible Counter-Measures**<br>1. Installation of buffer zone (e.g. planted area, trees) or other noise reduction methods (e.g. enclosures, screens, bunding) at disposal site and near sensitive locations.<br>2. Correct use and maintenance of disposal site facilities, equipment and refuse collection vehicles.<br>3. Careful consideration of construction and operation hours for landfill site.<br>4. Careful consideration of operation hours and routes for refuse collection vehicles.<br>5. Use of low noise and vibration construction equipment. | |
| **Related Subjects for Study**<br>1. Topographical and Geological Survey.<br>2. Land use around the disposal site and along the access road. | |

## Table 9-60: Explanation of Item 23

| Item | 23. Offensive Odour |
|---|---|
| Description | Generation of offensive odours from landfill site, associated treatment facilities and during transportation of refuse |
| **Causes of Impacts**<br>1. Putrid smell from refuse in disposal site in the case of open dumping without soil cover.<br>2. Leachate and run-off from disposal sites, wash water from washing of refuse collection vehicles.<br>3. Emission of landfill gases.<br>4. Refuse smells and fumes from refuse collection vehicles. | |
| **Possible Environmental Impacts**<br>1. Landfill gases could generate offensive odours, which depending upon wind direction and speed may affect inhabitants.<br>2. Complaints about odour from residents and users of public facilities such as schools and hospitals around the final disposal site and access roads.<br>3. Decrease in property values in the vicinity of the disposal site and along access roads. | |
| **Useful Factors for Evaluation**<br>1. Meteorological data (e.g. wind direction and speed, air temperature distribution, precipitation).<br>2. Distribution of residents, schools, hospitals and other public facilities around disposal site and along access road.<br>3. Land use around disposal site and along access road.<br>4. Careful consideration of frequency of refuse collection to take into account waste composition, residents' living conditions and climatic conditions.<br>5. Location and nature of washing facilities for refuse collection vehicles. | |
| **Possible Counter-Measures**<br>1. Frequent soil cover of refuse.<br>2. Containment, collection and venting of landfill gases.<br>3. Collection and treatment of leachate.<br>4. Careful consideration of location of leachate treatment plant. | |
| **Related Subjects for Study**<br>1. Topographical Survey.<br>2. Past complaints regarding offensive odours at Vingunguti and Tabata disposal sites. | |

Table 9-61: Explanation of Item 24

| Item | 24. Litter |
|---|---|
| Description | Scattering of litter from landfill site and refuse collection vehicles |
| **Causes of Impacts**<br>1. Poor design and operation of landfill site.<br>2. Inadequate covering of refuse during transportation. | |
| **Possible Environmental Impacts**<br>1. Pollution of the environment and deterioration in aesthetics due to scattering of litter from refuse trucks along access road and around disposal site. | |
| **Useful Factors for Evaluation**<br>1. Willingness of refuse workers to use anti-litter devices.<br>2. Composition of refuse from different sources. | |
| **Possible Counter-Measures**<br>1. Covering of refuse collection vehicles during final transportation to disposal site.<br>2. Rapid cover of refuse at disposal site and use of portable fence to catch scattered litter.<br>3. Briefing of refuse workers. | |
| **Related Subjects for Study**<br>1. Meteorological data (e.g. wind direction and speed, precipitation). | |

## 9.6.3 Works Required for EIA

Table 9-62: Work Required for EIA and Environmental Conservation/Mitigation Measures

| Environmental Item | Evaluation | Description of Work Required for EIA | Possible Environmental Conservation/Mitigation Measures |
|---|---|---|---|
| 2. conomic Activities | C | - Assessment of status of Ministry of Works operations at site.<br>- Economic Survey of workers doing excavation works and associated activities at or near quarry.<br>- Economic Survey of permanent scavengers and middlemen at Vinguguti disposal site and other places (completed).<br>- Assessment of impact on recycling system of shifting the disposal site[6]. | - good communication and consultation with affected individuals/communities/Ministry of Works.<br>- possible compensation for those losing employment.<br>- assist adaptation of recycling system to changed circumstances. |
| 3. Traffic and Public Facilities | C | - Traffic Survey near disposal site and on access road near Mwenge.<br>- Description and location of public facilities in area (part of Land Use Survey).<br>- Obtaining Land Use (for public facilities) and Road Development plans for area near site and along access road. | - improvement of roads around disposal site including possible modifications of traffic system.<br>- proper scheduling of refuse collection vehicles and routes to avoid peak hour traffic.<br>- site entrance to landfill to avoid queuing on main road.<br>- installation of traffic safety features, especially in accident danger spots.<br>- reduction in disturbance to public facilities by landscaping, screening, etc. |
| 7. Public Health | B | - Baseline Public Health Survey in area around disposal site.<br>- Baseline Water Quality (groundwater, surface water sources) Survey in area around and downstream of disposal site.<br>- Baseline Air Quality Survey in area around disposal site. | - taking measures to eradicate pathogens including use of pesticides (for vermin) and control of stagnant water (to minimise breeding of vectors).<br>- installation of monitoring, collection and treatment facilities/venting for leachate/landfill gases.<br>- exclusion of toxic/hazardous waste from landfill.<br>- public education on sanitation for local residents, refuse workers and scavengers to avoid infection. |
| 8. Waste | C | - Estimation of amount of construction wastes/debris according to scale of excavation/construction works.<br>- Investigation of alternative uses for construction wastes/debris. | - careful construction planning and management, including specification of standards/procedures for disposal of construction wastes/debris in contract documents.<br>- temporary storage of construction wastes/debris during construction with subsequent transfer to new landfill.<br>- reuse of construction wastes/debris. |
| 9. Hazards/ Risks | B | - Risk Assessment of landfill site. | - exclusion of toxic/hazardous waste from landfill.<br>- containment, collection and venting of landfill gases. |

[6] Decision on scavenger policy for new landfill required

| Environmental Item | Evaluation | Description of Work Required for EIA | Possible Environmental Conservation/Mitigation Measures |
|---|---|---|---|
| | | | - provision of fire safety measures, fire fighting equipment and appropriate training of refuse workers.<br>- preparation of safety procedures for landfill site.<br>- use of run-off for sprinkling. |
| 10. Topography and Geology | C | - Topographical and Geological Survey[7].<br>- Quantifying of construction excavation works to be conducted at landfill site.<br>- Location and availability of soils suitable for use as impermeable liner and/or covering material for landfill. | - careful construction planning and management with specification of standards/procedures to be followed for all excavation works in contract documents. |
| 12. Groundwater | C | - Topographical, Hydrological and Geological Survey.<br>- Meteorological data (precipitation, evaporation).<br>- Present groundwater use around and downstream of the site.<br>- Land Use Development plan to assess future groundwater use. | - collection and treatment of all leachate with control and monitoring of discharge.<br>- segregation and treatment of run-off from waste areas, with control and monitoring of discharge.<br>- possible use of impermeable liner for landfill.<br>- exclusion of toxic/hazardous waste from landfill.<br>- monitoring of groundwater around and downstream of the disposal site. |
| 13. Hydrological Situation | C | - Topographical, Geological and Hydrological Survey.<br>- Meteorological data (precipitation, evaporation).<br>- Water use from rivers downstream of landfill site.<br>- Land Use Development plan to assess future surface water use. | - segregation and treatment of run-off from waste areas, with control and monitoring of discharge.<br>- collection and treatment of all leachate with control and monitoring of discharge.<br>- monitoring of surface water bodies around and downstream of the disposal site.<br>- careful management of construction and landfill operations to prevent landfill entering surface water. |
| 15. Flora and Fauna | C | - Survey of Flora and Fauna in area around landfill site; including assessing if there are species unique to the locality and/or endangered/rare species in the area.<br>- Obtaining any existing national, bilateral and/or multilateral conventions on flora and fauna. | - schedule construction work to avoid breeding and nesting season.<br>- good landfill practice and pollution control.<br>- conservation of major and/or sensitive flora and fauna features.<br>- briefing of site workers.<br>- control of seagulls and rats. |
| 17. Landscape/ Aesthetics | B | - Topographical Survey.<br>- Assessment of the role of the landscape in religion, culture, tourism, etc. in the area.<br>- Preparation of pictorial model showing visual impact of the landfill site and facilities.<br>- Description and location of tourist facilities in area (part of Land Use survey).<br>- Obtaining tourism development plan for area (part of Land Use Development plan). | - careful design of disposal facilities including fencing, gates, siting of flares, plant and offices.<br>- good communication and consultation with residents.<br>- limit maximum height of the landfill.<br>- good landfill practice (e g. contouring and matching existing landscape, screening with bunds or vegetation).<br>- restoration/rehabilitation plan for landfill. |
| 18. Air Pollution | B | - Baseline Air Quality Survey and air pollution forecast.<br>- Meteorological data (wind direction and speed, air temperature distribution).<br>- Land Use Survey (distribution of agriculture, housing, public facilities (especially those requiring clean air), tourist facilities, etc.), including estimation of population density distribution in area near disposal site.<br>- Land Use Development plan. | - preparation of air pollution monitoring programme.<br>- good landfill practice (e.g. compaction, rapid cover, sprinkling to prevent fires and dust).<br>- containment, collection and venting of landfill gases.<br>- preparation of fire prevention and fire fighting procedures.<br>- maintenance of refuse collection vehicles on a regular basis.<br>- refuse vehicle wheel wash and dust control. |
| 19. Water Pollution | A | - Baseline Water Quality Survey and water pollution forecast.<br>- Topographical, Geological and Hydrological Survey.<br>- Meteorological data (precipitation, evaporation).<br>- Water use in area (groundwater and rivers).<br>- Land Use Development plan to assess future water use. | - preparation of water pollution monitoring programme.<br>- timing of major earthworks to avoid wet season.<br>- collection and treatment of leachate with control and monitoring of discharge.<br>- segregation and treatment of run-off from waste areas with control and monitoring of discharge.<br>- possible use of impermeable liner for landfill.<br>- monitoring of ground/surface water quality around and downstream of the disposal site.<br>- exclusion of toxic/hazardous waste from landfill.<br>- provision of another water supply for residents in |

[7] Necessity for impermeable liner will be established on analysis of topographical and geological survey results.

| Environmental Item | Evaluation | Description of Work Required for EIA | Possible Environmental Conservation/Mitigation Measures |
|---|---|---|---|
| | | | immediate vicinity of site. |
| 20. Soil Contamination | B | - Soil pollution forecast.<br>- Topographical and Geological survey.<br>- Water and land use in area. | - preparation of soil pollution monitoring plan.<br>- exclusion of toxic/hazardous waste from landfill.<br>- possible use of impermeable liner for landfill.<br>- collection and treatment of leachate.<br>- careful sorting of any refuse to be used for compost production. |
| 21. Noise and Vibration | B | - Noise and Vibration Survey near disposal site and along access road.<br>- Land Use Survey (distribution of agriculture, housing, public facilities, tourist facilities, etc.) in area around disposal site and along access road. | - installation of buffer zone (e.g. planted area, trees) or other noise reduction methods (e.g. enclosures, screens, bunding) at disposal site and near sensitive locations.<br>- correct use and maintenance of disposal site facilities, equipment and refuse collection vehicles.<br>- careful consideration of construction and operational hours for landfill and operational hours and routes for refuse vehicles |
| 23. Offensive Odor | B | - Meteorological data (wind direction and speed, air temperature distribution, precipitation, evaporation).<br>- Land Use Survey (distribution of housing, public facilities, tourist facilities, etc.) in area around disposal site and along access road. | - frequent soil cover of refuse.<br>- containment, collection and venting of landfill gases.<br>- collection and treatment of leachate.<br>- careful consideration of location of leachate treatment plant. |
| 24. Litter | B | - Consideration of appropriate anti-litter devices for refuse collection vehicles and disposal site. | - covering of refuse collection vehicles during final transportation to disposal site.<br>- rapid cover of refuse at disposal site and use of portable fences to catch litter.<br>- briefing of refuse workers. |

Note: Evaluation categories: A - serious impact expected; B - some impact expected; C - extent of impact unknown (examination needed; impacts may become clear as Study progresses); D - no impact expected; EIA not necessary.

## Table 9-63: List of Works required for EIA

| No. | Description of Work | Environmental Item No. Reference |
|---|---|---|
| 1 | Topographical Survey | 10, 12, 13, 17, 19, 20 |
| 2 | Geological Survey | 10, 12, 13, 19, 20 |
| 3 | Hydrological Survey | 12, 13, 19 |
| 4 | Traffic Survey | 3 |
| 5 | Noise and Vibration Survey | 21 |
| 6 | Economic Survey (at disposal site) | 2 |
| 7 | Economic Survey (at Vingunguti) | 2 (completed) |
| 8 | Baseline Public Health Survey | 7 |
| 9 | Baseline Water Quality Survey and Water Pollution Forecast | 7, 19 |
| 10 | Baseline Air Quality Survey and Air Pollution Forecast | 7, 18 |
| 11 | Baseline Soil Pollution Survey and Soil Pollution Forecast | 20 |
| 12 | Flora and Fauna Survey | 15 |
| 13 | Land Use Survey (distribution of agriculture, housing, public facilities, tourist facilities, etc.) for area near disposal site and along access road including estimation of population density | 3, 17, 18, 20, 21, 23 |
| 14 | Risk Assessment of Landfill Site | 9 |
| 15 | Meteorological data collection (precipitation, wind direction and speed, air temperature distribution, evaporation) | 12, 13, 18, 19, 23 |
| 16 | Obtaining Development plans for land use (agriculture, housing, public facilities, tourist facilities, etc.) and roads | 3, 12, 13, 17, 18, 19 |
| 17 | Water Use in area (groundwater and surface water) | 12, 13, 19, 20 |
| 18 | Estimation of amounts of construction wastes/debris that will be produced and investigation of alternative uses for construction waste | 8 |
| 19 | Research on location and availability of soils suitable for use as impermeable landfill liner. | 10 |
| 20 | Assessment of impact on recycling system of shifting disposal site | 2 |
| 21 | Assessment of status of Ministry of Works operations at site | 2 |
| 22 | Obtaining any existing national, bilateral and/or multilateral conventions on flora and fauna | 15 |
| 23 | Assessment of the role of the landscape in religion, culture, tourism, etc. in the area | 17 |
| 24 | Preparation of a pictorial model showing visual impact of the landfill site and facilities | 17 |
| 25 | Consideration of appropriate anti-litter devices for refuse collection vehicles and disposal site | 24 |

## 9.7 Implementation Plan

The proposed implementation programme of the Master Plan is shown in Figure 9-10.

Figure 9-10: Implementation Programme of the Master Plan