PREPARATORY SURVEY
FOR
INTEGRATED SOLID WASTE MANAGEMENT
IN NAIROBI CITY
IN
THE REPUBLIC OF KENYA

FINAL REPORT

VOLUME 3

SUPPORTING REPORT

SECTION D

3R AND INTERMEDIATE TREATMENT

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SECTION D

3R AND INTERMEDIATE TREATMENT

1. INTRODUCTION

1.1 General Concept of Formulation of 3R and Intermediate Treatment Plan

This Section D deals with the planning of the 3R concept of waste reduction, recovery, and recycling and intermediate treatment. Although basic solid waste management services can be performed in waste collection, transportation and final disposal, 3R and intermediate treatment are required for the purpose of establishing an integrated solid waste management system for local government units. With the introduction of 3R and intermediate treatment facilities encompassing waste amount reduction and diversion, the solid waste management system will be effective and efficient as a whole, especially, towards an environmentally sound system that could mitigate the impacts of climate change.

The reduction of solid waste amount, recovery of recyclable materials and reuse at generation sources can reduce waste amounts for collection, transportation and final disposal, and would lighten the cost burden of CCN on solid waste management services. Moreover, they will be a useful measure for saving finite resources. As for the benefit of intermediate treatment, the reduction of waste volume and early stabilisation are expected of the residual wastes for disposal and waste diversion as a whole.

The 3R and Intermediate treatment plans are formulated basically by updating the SWM Master Plan prepared and submitted by JICA in 1998 (hereinafter called JICA SWM MP-98) through reviewing the change of planning conditions in the last 12 years. The 3R and intermediate treatment plans will incorporate the necessary actions, programmes and projects for the improvement of solid waste management services of Nairobi for the period from 2011 to 2030. Development of the 3R plan and the intermediate treatment plan as described in this section were carried out based on the planning objectives, policies and strategies described in the following subsections and in **Chapter 3 of Volume 2, Main Report**, as the basic rule for integration and consistency with the other plans and programmes to establish a comprehensive solid waste management system for Nairobi. To formulate the 3R and intermediate treatment plans, therefore, the minimum system that would bring the maximum level of output to improve the solid waster management system as proposed in the following subsections was considered including the current financial situation of CCN.

1.2 Approach to Update 3R and Intermediate Treatment Plan

In order to update the JICA SWM MP-98, the procedure to formulate the 3R and intermediate plans was discussed in a meeting among the Technical Working Group, the JICA Survey Team, the counterpart staff of CCN, and the representatives of the Kenyan government agencies concerned, the procedure shown in **Figure D.1.1** was decided.

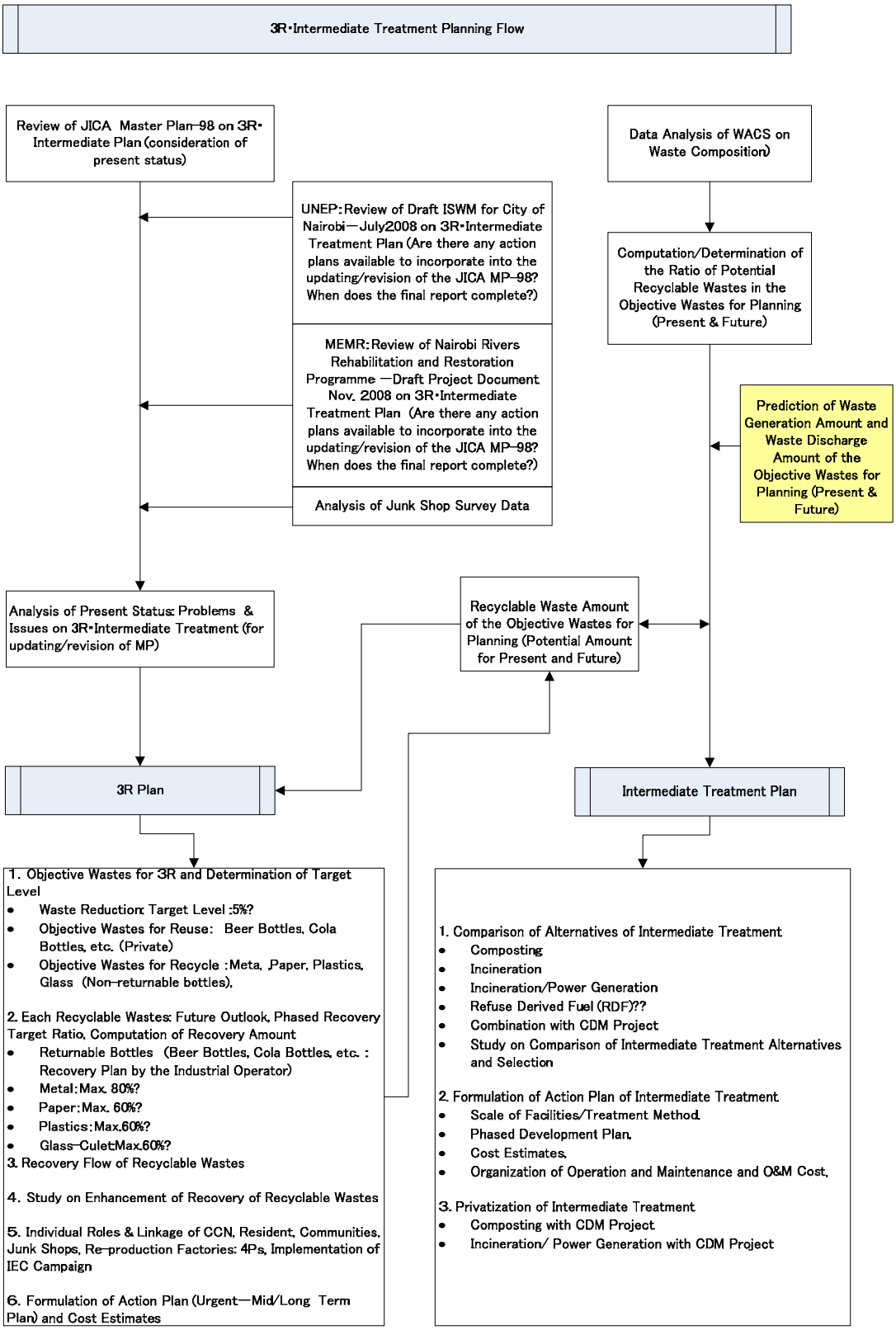


Figure D.1.1 Procedure for Updating the 3R and Intermediate Plan in the JICA SWM MP-98

2. COLLECTION OF DATA/INFORMATION AND ANALYSIS

2.1 Recovery Flow of Recyclable Materials

Recyclable materials in municipal waste are recovered basically in accordance with the flow chart shown in **Figure D.2.1**. There were three major recovery flows identified in the course of the survey. Firstly, the recyclable wastes stored by the waste generators are recovered by the waste pickers going around the town. Secondly, recyclable materials are recovered by the waste collection workers in the course of waste collection work. Thirdly, the waste pickers at the Dandora Dumpsite pick up the recyclable materials. In addition to the aforementioned recovery processes, some of the large waste generators of establishments sell wastepaper or plastics through auctions or contracts, but the recovered amount of recyclable materials through auctions or contracts could not be verified. Recovery amounts are as described in the following subsections.

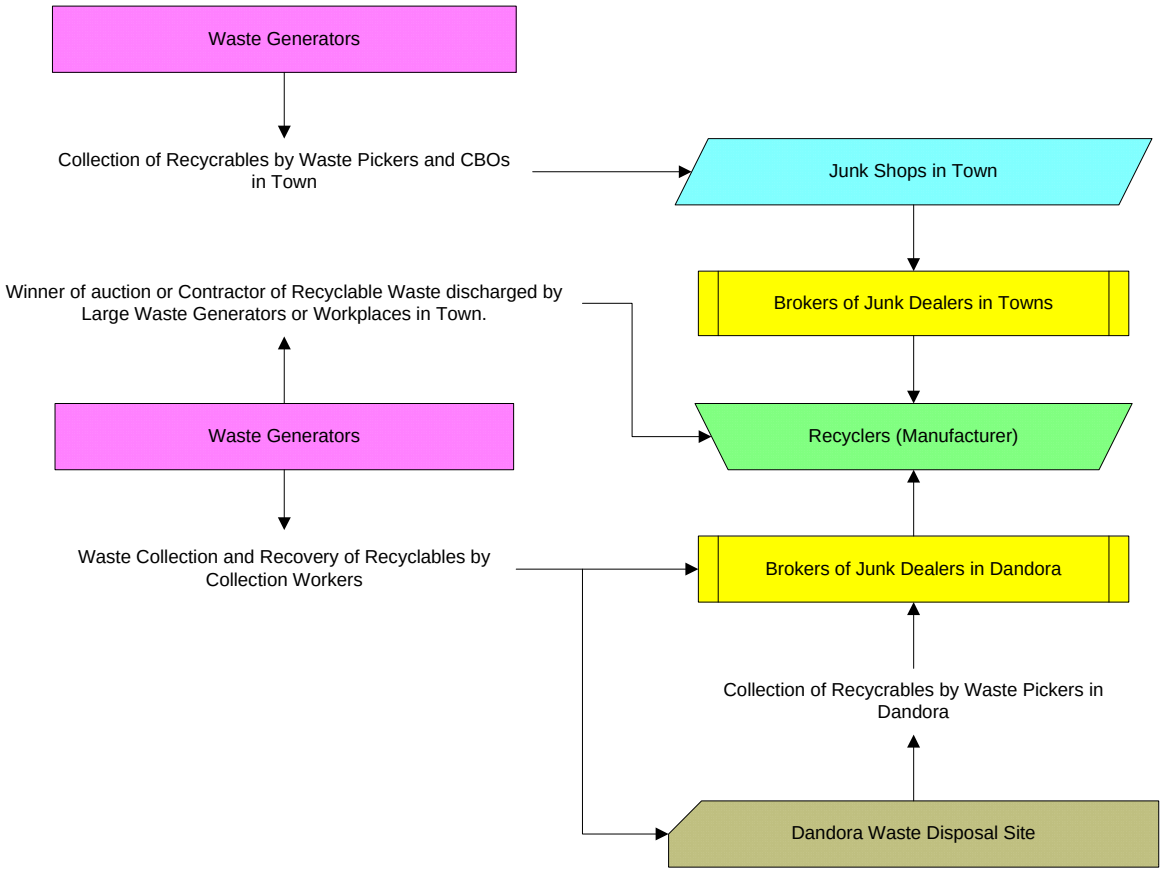


Figure D.2.1 Recovery Flow of Recyclable Materials at Present

2.2 Estimated Recovery Amount of Recyclable Materials

2.2.1 Amount of Recyclable Materials Recovered by Junkshops

The Junkshop survey was conducted by the JICA Survey Team in January 2010, utilising the services of a local consultant. As shown in **Table D.2.1**, the total recovery amount of recyclable materials by the ten (10) junkshops reached 41.1 tons per month or 1.37 tons per day in 2009. The major recyclable materials handled were scrap iron by 9 junkshops and plastics by 7 junkshops. Scrap iron recovered

were 103 kg, followed by plastics at 37 kg per day per junkshop. Aluminum is handled by 3 junkshops and 2 tons are recovered per month or 23 kg per day per junkshop. The total recovery amount increased from 19.2 tons per month in 2007 to 37.7 tons per month in 2009, excluding the amount for car batteries which are not recovered through the waste collection services. One of the major recyclable materials, wastepaper, is not handled by the ten (10) junkshops surveyed. There are many junkshops in Nairobi and it is very difficult to grasp their recovery activities at present because they operate without being registered or licensed by the authority concerned. Most of the junkshops do not have a channel that would sell the recovered recyclable materials directly to the recyclers/factories so that the materials are sold through dealers or middlemen. Accordingly, the amount of recyclable materials recovered by the junkshops was obtained from the survey on dealers/middlemen.

Table D.2.1 Recyclable Materials Recovered by Junkshops (January 2010)

Recyclables in 2009	**No. of Junkshop Handling Recyclables**	**Recovered Amount per Month (kg)**	**Recovered Amount per Day (kg)**	**Recovered Amount per Month Per Junkshop (kg/month)**	**Recovered Amount per Day Per Junkshop (kg/day)**
Aluminum	3	2,030	68	677	23
Brass & Bronze	2	210	7	105	4
Car battery	3	3,400	113	1,133	38
Plastics	7	7,700	257	1,100	37
Scrap Iron, Tin & Cans	9	27,770	926	3,086	103
Total		41,110	1,370		
Total excl. Car Battery		37,710	1,257		
Recyclables in 2008	**No. of Junkshop Handling Recyclables**	**Recovered Amount per Month (kg)**	**Recovered Amount per Day (kg)**	**Recovered Amount per Month Per Junkshop (kg/month)**	**Recovered Amount per Day Per Junkshop (kg/day)**
Aluminum	3	1,830	61	610	20
Brass & Bronze	2	210	7	105	4
Car battery	3	3,400	113	1,133	38
Plastics	6	6,200	207	1,033	34
Scrap Iron, Tin & Cans	8	25,170	839	3,146	105
Total		36,810	1,227		
Total excl. Car Battery		33,410	1,114		
Recyclables in 2007	**No. of Junkshop Handling Recyclables**	**Recovered Amount per Month (kg)**	**Recovered Amount per Day (kg)**	**Recovered Amount per Month Per Junkshop (kg/month)**	**Recovered Amount per Day Per Junkshop (kg/day)**
Aluminum	1	1,330	44	1,330	44
Brass & Bronze	1	10	0	10	0
Car battery	2	2,600	87	1,300	43
Plastics	4	3,700	123	925	31
Scrap Iron, Tin & Cans	6	14,170	472	2,362	79
Total		21,810	727		
Total excl. Car Battery		19,210	640		

Source: Result of 10 Junkshop Survey Conducted by JICA Survey Team, January 2010

2.2.2 Amount of Recyclable Materials Recovered by Dealers

The survey was carried out in April-May 2010 for the brokers of junk dealers in the town area and the brokers handling the recyclable materials recovered at the Dandora Dumpsite. The survey was made in collaboration with the solid waste supervisors/inspectors for each Division in the first survey and the manager and staff of the Dandora Dumpsite in the second survey. **Table D.2.2** shows the result of the surveys on brokers. The survey had not covered all dealers in Nairobi but covered the large dealers and covered most of the recyclable materials handled in Nairobi. The dealers in town recovered about

13 tons per day of recyclable materials while the dealers at the Dandora Dumpsite recovered 7 tons per day from the waste collection workers and the waste pickers in the Dandora Dumpsite. The survey shows that the total amount of recyclable materials handled by the 43 brokers is approximately 20 tons per day and the actual amount of recyclable material recovery is a little over the said amount.

Table D.2.2 Recyclable Materials Recovered by Junk Dealers

Recyclable Materials	24 Brokers Operating in Town (ton/day)	19 Brokers Handling Recyclables from Dandora (ton/day)
Plastics	3.57	2.5
Paper	2.09	2.9
Glass	2.07	0.2
Scrap Metals	5.35	1.1
Others	0.11	0.3
Total	13.19	7.0

2.2.3 Amount of Recyclable Materials Used by Recyclers/Factories

According to the data obtained from the Compliance & Enforcement Office in NEMA, there were 17 companies with license for recyclers as of December 2009. Fourteen (14) out of 17 recyclers are operating in Nairobi. One company, a glass factory, is not registered but uses recovered glass for its production processes. As indicated in **Table D.2.3**, the total amount of recyclable materials reaches 148 tons per day. This amount of recyclable materials is collected from Nairobi and the neighbouring provinces. Among the recyclable materials, scrap metals rank the first with 67 tons per day for recycling followed by glass with 50 tons per day. **Tables D.2.4 and D.2.5** show the details pertaining to the licensed recyclers and the result of the survey on major recyclers in Nairobi.

Table D.2.3 Amount of Recyclable Materials used by the Recyclers/Factories

Recyclable Materials	No. of Recyclers/ Factories in Nairobi with License from NEMA as of December 2009 *1	No. of Recyclers/ Factories Collected Data *2	Amount of Recyclable Materials used by the 9 Recyclers Surveyed (ton/day) *2
Plastics	6	4	23
Paper	4	3	8
Glass	0	1	50
Scrap Metals	3	2	67
Others (oil/sludge)	1	0	-
Total	14	10	148

Source: *1 Table D.2.4
*2 Table D.2.5

Table D.2.4 Waste Recyclers Licensed under the Waste Management Regulations of 2006

No	Name of Recyclers	District	Type of Waste	Telephone No.	Address
1	Steel Plus Ltd.	Nairobi	Scrap metals	-	13428-00800
2	Polypipes Ltd.	Kikuyu District	Plastics	0735 33025	3-Kikuyu
3	G.N & Company Polythene	Nairobi District	Plastic waste	-	78122-00507
4	Kenafric Industries	Nairobi District	Plastics	-	39257-00623
5	A-one Plastics	Nairobi District	Plastic waste		23750-00100
6	Devki Steel Mills Ltd.	Machakos District	Scrap Metals	045-22816/7/8/9	33319-00600
7	Ace enterprises Ltd.	Nairobi East District	PVC waste	-	915-00600
8	Kamongo waste papers	Nairobi East District	Waste Paper	020-555240	67313-00100
9	Madhupaper Kenya Ltd.	Nairobi East District	Waste Paper	020-552557/555110	78065
10	Platium Scraps Associates	Nairobi East District	Scrap Metals	0725-733862	4076-00506
11	Greenloop/Greenplasts International Ltd.	Nairobi East District	Plastics	020-630409	39058-00623
12	Friendly Polimars	Nairobi East District	Plastics	020-559278	66594-00800
13	Morris and Company(2004) Ltd.	Nairobi East District	oil/Sludge	020-533628	59307-200
14	Accurate Steel Mills	Nairobi East District	Scrap Metals	020 554170	74332-00100
15	Chandaria Industries	Nairobi North District	Waste Paper	020 8563252	30621-00100
16	Premier Industries Ltd.	Nairobi North District	Waste Paper	020 8562260	22460-00400
17	Agriplast Kenya Ltd.	Thika District	Plastics	020-55424	39183-00623

Source: Compliance & Enforcement Office, NEMA, December 2009

Table D.2.5 Results of Survey on Major Waste Recyclers

No	Name of Recycler Factory	Location and Address	Contact Number	Amount of Recovered Materials	Goods Produced	Type of Material	Remarks
1.	G.N Polythene	Embakasi Road	Mr. Gatonye (MD) 823475	35 ton/m	Polyethylene bags	Polythene and Plastics	
2.	Premier Industry	Baba Dogo 8562269	Sundia N. Shah (Director) 8562260	400 ton/m	Plastics	Plastics	
3.	Chandaria Industries	Baba Dogo 8563252	Mr Achakya (Prod) 254-20-8563 252	Carton: 5 ton/m, Paper: 93 ton/m, Cotton: 250 ton/m	Cotton wool, Tissue paper	Carton, Papers, Cotton fabric	
4.	Friendly Polymers Ltd.	Lunga Lunga rd	Mr. Nitin (Director)	90-105 ton/m	Polythene bags	Polythene and Plastics	
5.	Morris and Co.	59307-00200 Mogadishu rd	Peter Omeno (PM) 533628/29	Steel 15 to 17 t/d, Alum. 20 to 25 kg/d	Reinforce-ment bars	Scrap Metal and Aluminum	
6.	Ken Afric Industries	Baba Dogo 8645000	020-8645000	5 ton/d	Chairs, Shoes, Canvass	Polythene, Shoe soles, Various Plastics	
7.	Kamongo Waste Papers	Baba Dogo 555240	020-555240	5 ton/d	Straw boards	Paper, Carton	Recycle waste paper, also sell recycle paper to other Recyclers

No	Name of Recycler Factory	Location and Address	Contact Number	Amount of Recovered Materials	Goods Produced	Type of Material	Remarks
8.	Accurate Steel Millers	Enterprise Road	733610313	50 ton/d	Reinforcement Bars	Scrap metal	Production at half capacity due to lack of raw materials
9.	Central Glass Industries	Off Thika Road	Mutagi Manager 0208643000	50 ton/d	Container Glass	Broken Glass	Production Capacity 130 ton/day
	Total-Plastics (t/d)	4		23			
	Total-Paper (t/d)	2		8			
	Total-Glass (t/d)	1		50			
	Total-Metal (t/d)	2		67			
	Grand Total (t/d)			148			

Source: JICA Survey Team, April 2010

2.3 Analysis of Waste Picker Survey Data

The survey was conducted on 10 waste pickers in January 2010. The findings of the waste picker survey are as summarised below. Refer to **Section D of Volume 4, Data Book** for details.

- Respondents of the survey are 6 male and 4 female waste pickers;
- Age of waste pickers ranges from 18 to 60 years old with the average being 34 years old;
- Monthly earnings of waste pickers ranges from KSh 5,000 to 9,000 per month with the average being KSh 6,600 per month;
- Seven (7) waste pickers work daily, one (1) waste picker work twice a month and two (2) waste pickers work once a month; and
- All waste pickers sell the recovered materials to brokers; no waste picker sells directly to the recyclers/factories.

2.4 Activities of CBOs on Recycling and Composting

The data of DoE as of December 2009 indicate that there are 140 registered CBOs representing the groups related to solid waste management. According to the list, most of the CBOs work in the field of waste collection, one CBO work in the field of plastics and another one in paper. (Refer to **Section G of Volume 3, Supporting Report.**)

The Compliance and Enforcement Office in NEMA has a list of licensed waste handlers under the Waste Management Regulations of 2006. As of April 2010, 26 companies were licensed, as shown in **Table D.2.6**. Among them only two companies are registered in Nairobi and the rest are registered in the provincial areas. It may be necessary to promote the registration and licensing of more companies and/or groups in Nairobi.

Table D.2.6 Licensed Waste Handlers (Composters) under the Waste Management Regulations of 2006

No.	Name of proponent	Contacts	District	Waste type	License
1	Maji Mazuri Flowers	P.O Box 7640 Eldored Tel: 020 2047800	Uasin Gishu	Organic	
2	Wildfire Ltd	Private Bag Mumias	Nakuru District	Biodegradable	
3	Equator Flowers (k) Ltd	Tel; 053-2063138	Usin Gishu District	Organic	
4	Mumias Sugar co.	Private Bag Mumias	Mumias/Butere District	Liquid/Solid	
5	Taiho Properties LTD	P.O Box 17545 Tel: 020 557009	Narok District	Domestic	
6	Kapchorua Tea Co.	P.O Box 12 Ka[chorua	Nandi South District	Biodegradable	
7	Penta Tancon T/A Penta Flowers	P.O Box 40452-00100 Nairobi Tel: 067 24011	Thika District	Organic waste	yes
8	Penta Tancon T/A Penta Flowers-Ndarugu	P.O Box 40452-00100 Nairobi Tel: 067 24012	Thika District	Industrial/Plant	yes
9	Penta Tancon T/A Penta Flowers	P.O Box 40452-00100 Nairobi Tel: 067 24013	Thika District	Industrial/Plant	
10	Winchester Farm Ltd	P.O Box 15139 - 00509 Nairobi	Nairobi west	Organic/inorganic	Yes
11	Penta Tancon T/A Penta Flowers	P. O Box 40452 - 00100 Nairobi	Thika District	Industrial waste	Yes
12	Maji Mazuri Flowers	P.O Box 15139 - 00509 Nairobi	Uasin Gishu	Organic waste	Yes
13	Elbur Flora Ltd	P.O Box 54 - 20102 Elburgon	Nakuru District	Organic waste	Yes
14	Red Lands Roses	P.O Box 10 - 00232 Ruiru	Nairobi East	Organic waste	Yes
15	Zena Roses Ltd	P.O Box 2759 - 00100 Thika	Thika District	Organic waste	Yes
16	Colour Group Ltd	P.O Box 14870 Nakuru	Nakuru District	Organic waste	Yes
17	Karen Roses Ltd	P. O Box 202 - 20103 Eldama Ravine	Koibatek	Organic waste	Yes
18	Wildfire Ltd	P.O Box 379 Naivasha	Nakuru District	Organic/inorganic	Yes
19	Penta Tancon T/A Penta Flowers	P.O Box 40452 - 00100 Nairobi	Thika District	Oraganic waste	Yes
20	Penta Tancon T/A Penta Flowers	P.O Box 40452 - 00100 Nairobi	Thika District	Organic waste	Yes
21	Wildfire ltd	379 Naivasha	Nakuru District	Organic waste	Yes
22	Colour Groups Limited	14870 Nakuru	Nakuru District	compost	Yes
23	Winchester Farm Ltd	15139-00509 Nairobi	Uasin Gishu	compost	Yes
24	Elbur Flora ltd	54-20102 Elburgon	Nakuru District	compost	Yes
25	Maji Mazuri Flowers	15139-00509 Nairobi	Uasin Gishu	compost	Yes
26	Zena Roses Ltd	2759-00100 Thika	Thika District	compost/organic manure	Yes

Source: Compliance & Enforcement Office, NEMA, April 2010

2.5 Estimated Recovery Amount of Biodegradable Waste

Around 30 to 50 groups including CBOs, companies and community groups engage in the composting of biodegradable wastes from market waste and domestic waste. **Table D.2.7** shows the compost production amounts ranging from 1.1 to 1.5 tons per day by 15 groups. Generally, the weight of input raw material become about 30% to 35% for final compost product through reduction of water content and rejects of unsuitable material. Accordingly, input raw materials converted into compost by the 15 groups is estimated at 3.4 to 4.4 tons per day or 0.23 to 0.29 ton per group per day. Assuming that the number of composting groups is 40, the total raw material input is about 9 to 12 tons per day at present.

Table D.2.7 Estimated Production Amount of Compost and Raw Material Input

No.	Group	Source of waste for compost production	Estimated production of compost (kg/month)	Estimated production (kg/day: minimum)	Estimated production (kg/day: maximum)
1.	Afya Bora Group[*1]	Kawangware Market	600	20	20
2.	City Park Environmental Group*1	City Park Hawkers' Market	2,500	83	83
3.	Mathare Mbolea[*1]	Households	1,000	33	33
4.	Huruma Cisa[*1]	Households	,000	33	33
5.	Lunga Lunga[*1]	Households	500	17	17
6.	Kayaba-Mwanganza[*1]	Households	600	20	20
7.	Kibera Siranga[*1]	Households	300	10	10
8.	Ushirika Womens' Group[*1]	Households	200	7	7
9.	Kuku Womens' Group[*1]	Households	1,000	33	33
10.	Nyayo Market Mbolea Group[*1]	Nyayo Market	600	20	20
11.	Eco Holdings Ltd.[*2]	Market & domestic	10-15t/m	333	500
12.	Kenya Institute of Organic Farming[*2]	Farm waste & domestic	60-120t/y	164	329
13.	Kayole Environmental Management Association[*2]	Market & domestic	84t/y	230	230
14.	PENTA Flowers Ltd.[*2]	Flower waste & coffee husks	24t/y	66	66
15.	Kibera Public Space Project: New Nairobi Dam Community Group[*2]	Market & domestic	20-24 t/y	55	66
Estimated total amount of compost produced		kg/day		1,125	1,467
Conversion to Raw Material (Biodegradable Waste)		kg/day		3,375	4,401
Raw material used per composting group per day		kg/day/group		225	293
Estimated no. of composting group in Nairobi		group/company		40	40
Estimated amount of raw material used for composting in Nairobi		ton/day in Nairobi		9	12

Source: [*1] JICA, CTI Engineering Co., Ltd. and Environmental Technology Consultants Co., Ltd., "The Study on Solid Waste Management in Nairobi City in the Republic of Kenya, Final Report, Volume 4, Supporting Report," August 1998, Section G p.G-50

[*2] Inventory and Analysis of Users, Producer and Markets for Compost, Biogas and Livestock Feeds, pp. 94-97

2.6 Potential Amount of Recyclable Materials and Biodegradable Waste

Table D.2.8 shows the result of weighted average of domestic waste composition survey conducted through the local consultant engaged by the JICA Survey Team. Domestic waste in Nairobi consists of 91.2% organic waste, 8.4% of inorganic waste and 0.4% domestic hazardous waste and unclassified waste.

Table D.2.8 Result of Waste Composition Survey
(Weighted Average of Domestic Waste)

Waste Composition			Weighted Average (%)
1.	Food Waste		62.37
2.	Paper	Recyclable Paper	4.15
3.		Recyclable Cardboard	0.31
4.		Mixed Paper	1.89
5.		Diapers	7.61
		Subtotal-Paper	13.96
6.	Plastics	Plastic Sheet	7.13
7.		Recyclable Plastics	3.14
8.		PET Bottles	0.46
9.		Other Plastics	0.21
		Subtotal-Plastics	10.93
10.	Rubber and Leather		0.81
11.	Textiles		1.58
12.	Yard Waste		0.35
13.	Lumber and Logs		0.73
14.	Other Organic Waste		0.43
	Total-Organic Waste		**91.16**
15.	Glass	Returnable Bottles	0.31
16.		Other Live Bottles	0.97
17.		Glass bins	0.00
18.		Broken Glass	0.22
		Subtotal-Glass	1.50
19.	Metals	Scrap Iron, Tins & Cans	0.10
20.		Aluminum cans	0.04
21.		Copper	0.00
22.		Other Metals	0.60
		Subtotal-Metal	0.74
23.	Dirt, Ash, Stone, Sand		6.15
	Total-Inorganic Waste		**8.39**
24.	Unclassified Residual Waste		0.29
	Domestic Hazardous Waste		0.00
25.	Batteries - Dry Cells		**0.04**
26.	Other Domestic Hazardous Waste		0.13
	Grand Total		**100.00**

With regard to the recovery of recyclables in waste, the list of major types of recyclable materials is given in **Table D.2.9,** together with the data from the JICA SWM Master Plan of 1998. The commingled ratios of the major recyclable materials are almost the same as the results in 1998 except for glass and metals, which are currently recovered more actively. These comingled ratios were considered as the potentially available target ratio of resource recovery from the municipal waste in Nairobi.

Table D.2.9 Comparison of Percentages of Potential Recyclable Materials in Domestic Waste

(Unit: %)

Waste Type	JICA SWM Master Plan 2010*	JICA SWM Master Plan 1998
Paper	14.0	10.5 – 19.1
Plastics	10.9	4.1 – 16.1
Glass	1.5	1.5 – 3.8
Metals	0.7	1.3 – 4.2
Food Waste	62.4	48.6 – 67.0

Note: *Percentage showing in this row is indicated as weighted average.

2.7 Issues and Expected Solutions for Updating 3R and Intermediate Treatment Plan

This section presents the probable issues on planning and implementation of 3R and the intermediate treatment plan. The issues are taken into consideration in the formulation of the plans and programmes of the action plans for improvement of the solid waste management in Nairobi City.

2.7.1 Issues on Involvement of Stakeholders including Residents, Communities, CBOs, and NGOs in 3R and Intermediate Treatment

The issues under this item concern the ability of CCN to organise or take initiative in obtaining the cooperation of agencies especially in waste segregation activities at sources for development of appropriate intermediate facilities/system, home-composting, community composting, etc. The relevant issues are summarised as follows:

- Current inactive status of source segregation by the waste generators including residents, commercial shops, institutional buildings, etc.; and
- No separate collection of segregated recyclable waste by CCN, subcontractors and the private collection service providers.

2.7.2 Issues on Enhancement of 3R Activities

The issues under this item are related to the institutional setup of the primary agency, CCN, and raising the awareness or cooperativeness of the waste generators towards enhancement of the 3R activities.

(1) Policy of CCN and the Government on 3R

(2) Concepts/Purposes, policies, strategies of 3R

(3) Outlook on the future potential/activities of recycling

(4) Determination of the target resources and target level of recovery for reuse

- Glass: Returnable bottles (beer bottles, coca-cola bottles, etc.) by private industries
- Other reusable resources (clothes, antiques, old books, chinaware, glass ware, etc.) through garage sale organised by CCN, CBOs, church groups, NYS (National Youth Service), etc.

(5) Determination of target resources and target level of recycling/production

- Glass: Live bottles, culets
- Plastics: PET Bottles, HDPE, other reproducible plastics
- Paper: Carton, White Paper-Clean Paper
- Metals: Ferrous Iron, Copper, Aluminum

(6) Involvement of waste generators/junkshops in recovering more recyclable materials

- Definition of functions and roles of waste generators/junkshops in the recovery of recyclables.
- How can CCN make use of the functions/roles of the waste generators/junkshops to the maximum extent?
- How can CCN make a good linkage with the waste generators/junkshops?
- What kinds of incentive can CCN provide to the waste generators/junkshops?
- Promotion/incentives for recovery of more recyclable waste at the generation sources

(7) How the waste generators can reduce waste generation amount from the tendency of upgrading daily life?

- Implementation of IEC campaign programmes by CCN through media, CBO/NGO/NYS (National Youth Service), etc., to be targeted to residents, commercial establishments, industries and institutional buildings
- Involvement of shops, enterprises and industries to reduce the weight of products, over-packaging, use of returnable bottles, use of eco-bags, etc.
- Can CCN procure budget for the IEC campaign programme?

2.7.3 Recovery and Treatment of Biodegradable Waste (Food Waste and Garden Waste)

In view of the high commingled ratio of biodegradable waste in Nairobi, recovery and treatment of biodegradable waste will be a key for the improvement of waste management services. Implementing the matters concerned implicate with the following issues:

(1) Recovery and treatment of waste not collected by the junkshops

- Cooperation of waste generators in segregation of food waste and garden waste
- Separate collection of segregated biodegradable wastes by CCN, collection service subcontractors, and private collection service providers

(2) Composting of bio-degradable waste

- Lack of sufficient information on home composting, community level composting, central composting activities by residents, communities, NGO/CBO/NPO, etc.
- How can CCN promote home composting, community level composting and central composting?
- Can it be possible to start central composting with the biodegradable waste of city markets?
- Can the tenants of the markets cooperate in the segregation of biodegradable wastes?
- Can CCN provide storage containers for recovery of biodegradable wastes from the city markets?
- Can it be possible to enlarge the scale of composting from the market waste scale to the full-scale using the biodegradable wastes from the entire city?

(3) Compost Demand and Supply

- Data of cultivation area by type of crops, cropping patterns, vegetable farms, orchards, coffee farms, tea farms, pastures, horticulture farms, city parks, reserved forests, national parks in Nairobi and the neighbouring area

- Estimation of demand/consumption/supply of organic fertiliser, compost, chemical fertiliser in Nairobi and the neighbouring area
- Is the cost of compost worthy for the saving of cost for organic fertiliser and/or chemical fertiliser?

2.7.4 Issues on the Setup of Waste Bank/MRF/Buy-Back Centre, etc., for Waste Recovery

The current situation of recovery of recyclable materials by waste generators is not always active due to lack of recovery system to attract or give benefits to the people. The waste bank system which is considered as one of the solutions to activate the waste recovery, implicates the following issues to initiate the programme:

(1) Can CCN or NGO/CBO/NPO or other organisations or groups open and operate the waste bank or buy-back centre or a similar system where junkshop activities are relatively low?

(2) Can it be possible to stabilise the buying/selling price of each recyclable among the groups including waste pickers, households, commercial shops, junkshops, middlemen, and factories?

2.7.5 Issues on Development of Intermediate Facilities

Development of intermediate facilities will improve the stability of disposed waste and reduce health risks and/or environmental deterioration caused by solid waste. However, the financial burden will become the bottleneck for construction, operation and management. The issues on establishing sustainable development and management of the intermediate facilities implicate the following issues to be tackled by the implementing agency(s):

(1) Determination of appropriate capacity of intermediate treatment facilities and selection of the appropriate method

- Incineration?
- Incineration with Power Generation (Waste to Energy)?
- Methanisation with Power Generation?
- Composting?

(2) Who will be the implementing agency for construction, operation, maintenance and management of the selected intermediate treatment facilities

- Does CCN have the technical capability to implement the project for development of intermediate facilities?
- Are there possibilities for implementing the project through 3P (public-private partnership)?
- Are there private companies or other by-players and/or major players such as NGOs and CBOs interested in the development project of intermediate treatment?

(3) Financing for the development of intermediate treatment facilities

- Does CCN have the financial capability to implement the development project?
- Are there any financing organisations offering loan for the development project?
- Does CCN desire to make a loan for operation and maintenance from those financing organisations?

- Which of the financing agencies show interest in offering a loan for implementing the development project?

(4) Possibility to apply for the CDM Project

- Can it be possible to implement the development project of intermediate treatment through the CDM project?
- Has any company, organisation or group ever offered the CDM project to CCN for development of intermediate treatment project?
- Will it be possible to implement the central composting or incineration or incineration with power generation through the CDM project?
- Are there private enterprises or NGOs or other organisations interested in the CDM project for development of intermediate treatment facilities?

3. REVIEW OF RELEVANT REPORT

3.1 Review of JICA SWM Master Plan 1998

The JICA SWM Master Plan (JICA SWM MP-98) was prepared and submitted to Nairobi City in 1998 as a comprehensive solid waste master plan composed of the plans for waste collection and transportation, waste reduction, recycling and intermediate treatment, waste disposal and institutional setup supported by the financial plan, including social and environmental considerations.

Under the JICA SWM MP-98, the waste reduction, recycling and intermediate treatment plan was formulated with the key themes, issues and recommendations of the following items:

(1) Case Study on Community-Based SWM Projects

(2) Solid Waste Amount and Composition

(3) Resource Recovery by Dandora Waste Pickers and Community-Based Groups

(4) Role of CCN in Waste Reduction and Recycling

(5) Waste Reduction and Recycling Plan

(6) Intermediate Plan

(7) Establishment of the Special Task Force

(8) Proposed Target Levels and Prospects

(9) Recommendations of Waste Reduction, Recycling and Intermediate Treatment

The following sections describe briefly the key points of waste reduction, recycling and intermediate plan of the JICA SWM MP-98 and the reviews in consideration of the current conditions.

3.1.1 Case Study on Community-Based SWM Projects

(1) General

Fifteen (15) groups implementing community activities on solid waste management especially on composting biodegradable waste were identified in Nairobi. These 15 groups produced 8.3 tons of final products of compost. Given that it takes 30% to 50% in weight of final products is produced from raw biodegradable wastes (fruit and vegetable peelings, etc), roughly 15 to 25 tons per month of raw biodegradable wastes were converted to compost. As a result, the effect on the SWM of Nairobi was almost negligible. However, in the local context, on sites where composting does take place successfully, the localised effects have included better public health and cleanliness of the area, and in some cases a supplement to the income.

(2) Activities of Selected Four CB SWM Groups

Among the 15 groups, the activities of four representative groups, Kagawangware Afya Bora, City Park Hawkers Market, Kitui Pumwani Integrated Project, and Karen and Langata District Association are as follows.

Kawangware Afya Bora

- Successful project in a slum area
- Small-scale donor support
- Solved problem of market waste dumpsite - at least 50% of wastes from the market are handled by the composting group

City Park Hawkers Market

- Successful project in high income residential area
- Reliance on major donor support - excellent infrastructure for the project
- Helped lower problem of waste scavenging in the market
- Has reduced problem of market dump site - CCN need to collect much less frequently

Kitui Pumwani Integrated Project

- Composting project failed due to "land-grabbing"
- Have experimental projects on candles, soap, and waste paper briquettes
- Sensitised community: source separation is carried out by 100% of all households

Karen and Langata District Association

- A pioneering resident's association lobbying for services and accountability by CCN and the Central Government.
- Some successful court cases have resulted in similar groups being formed throughout the city, mainly in high income areas.

(3) Problems and Constraints of CB SWM Groups

The problems and constraints encountered by some of the groups, in general, in starting up and implementing the community-based SWM projects are summarised as follows:

Location and Site

- Lack of transportation means for garbage collection and transport of ready compost to potential markets
- Sites frequently inaccessible due to poor access roads
- Sites in areas which deter potential buyers who would not be willing to come for fear of security/walking/driving in the slum
- Lack of space for a site to start activities, or lack of permanent site
- Political issues: threat of "land-grabbing"
- Lack of a central collection point easily accessible by road
- Insecurity: storage of tools, vandalism

Incentives

- Labour intensive nature of the work has deterred some members
- Lack of strong and dynamic leadership in the group
- Low motivation by members not seeing any immediate financial gain

Community Attitudes

- Community interference: children play at the site; goats, sheep, and chicken may roam at the sites and eat some of the wastes
- Changing the public attitude, e.g., community to stop using the land as wasteland, dumping site or public toilet facility
- Residents of the area in one of the projects started to ask for money for the wastes
- Vandalism

Markets

- Supply cannot meet demand in the rainy season; supply may be greater than demand in the dry season; and the groups have no place to store the compost
- Lack of vigorous marketing strategies
- Lack of ready market for some of the more inaccessible sites
- Chemical fertilisers are widely available in the shops, whereas awareness about compost is low

Others

- Green wastes essential for composting are sold to cattle farmers, especially in the dry season

3.1.2 Solid Waste Amount and Composition

The JICA SWM MP-98 estimated the waste composition of 2008 based on the waste composition survey conducted in 1997 assuming that organic waste decrease from 92.4% to 85% while inorganic waste increase from 7.6% to 15% in consideration of waste composition trends in developed countries. The estimated waste composition in 2008 is as shown in **Table D.3.1**. The result shows that the major recyclable wastes, i.e., paper, plastics, glass, and metals are potentially commingled in municipal waste at 13.3%, 4.3%, 3% and 3.4% respectively, while the major biodegradable wastes, i.e., food waste and garden wastes (grass/wood) account for 47.4% and 6.2% respectively.

Table D.3.1 Estimated Municipal Solid Waste Amount and Composition

Composition		1997		2008	
		Amount (t/d)	Ratio (%)	Amount (t/d)	Ratio (%)
Food Waste		734	51.5	1,293	47.4
Paper	Recyclable	206	14.5	363	13.3
	Other Paper	41	2.8	71	2.6
Textile		38	2.7	67	2.5
Plastic	Container	67	4.7	118	4.3
	Other Plastics	102	7.1	179	6.6
Grass/Wood		96	6.7	168	6.2
Leather		13	0.9	23	0.8
Rubber		21	1.5	37	1.3
Organic Waste Sub-Total		1,317	92.4	2,321	85.0
Glass	Container	21	1.5	81	3.0
	Others	11	0.8	43	1.6
Metal	Container	25	1.7	93	3.4
	Others	13	0.9	49	1.8
Others		38	2.7	143	5.2
Inorganic Waste Sub-Total		109	7.6	410	15.0
Total		1,426	100.0	2,730	100.0

Source: JICA SWM MP-98

Waste composition surveys were conducted in December 2009 and January 2010 for domestic waste. Preliminary analysis was made and indicated under **Section 2.2** of this report. Further analysis shall be carried out together with the waste composition of other types of wastes, including commercial wastes, institutional wastes, etc.

3.1.3 Resource Recovery by Dandora Waste Pickers and Community-Based Groups

Figure D.3.1 shows the result of questionnaire survey on 513 waste pickers at the Dandora Dumpsite. There was duplication of data in recovery amount because of existence of middle men among the waste pickers. However, the materials recovered by the waste pickers reached more than 30 types and the major materials recovered were ferrous metal (tin & cans), plastics, bottles, bones, paper, textile,

non-ferrous metal (aluminum & copper), etc. In average, each waste picker recovered 46-65kg per day and the total recovery amount reached 22-31 tons per day at the Dandora Dumpsite in 1997.

The self-help Mukuru Group Project A recovered 1,018 tons of recyclable materials per year or 2.8 tons per day by 60 group members in 1996. In addition, the group also produced 5,500kg of compost derived from the neighbouring households and markets in July and November 1997.

Result of Questionnaires Survey to Waste Pickers (Summary of Recovery Material)

Basic Data Table

Recovered Materialas	Aluminium	Copper	Metal	Tins	Plastics	Paper	Bone	Bottle	Cotton	Net	Fire Wood	Spoon	Others	Total
Count (material)	38	12	44	170	121	71	73	83	54	11	6	14	47	744

Type of Recovery Material Collected by the Waste Pickers

Ferrous Metal	Plastics	Bottle	Bone	Paper	Textile	Non-ferrous Metal	Spoon	Net	Fire Wood	Others	Total
214	121	83	73	71	54	50	14	11	6	47	744
28.8%	16.3%	11.2%	9.8%	9.5%	7.3%	6.7%	1.9%	1.5%	0.8%	6.3%	100.0%

Breakdown of Other Recovery Material

Bags	3	
Bottle tops	3	Metal
Bulbs	1	
Carton Box	12	Paper
Fat	3	
Food	4	
Gloves	1	
Ken chic	1	
Na s.w	1	
Onion	2	
Paint	1	
Sacks	4	
Scraps	6	
Shining	1	
Shoes	1	
Skins	1	
Soles	1	
Sponge	1	
Tyres	1	
Waste Mat	5	
No Answwer	8	
Etc.	1	
Total	62	

Collected Amount and Income per Day per Person and Total of 513 Waste Pickers

Item	Average	Total
Daily Min. Weight (kg)	46	21,866
Daily Max. Weight (kg)	65	30,957
Daily Min. Income (KSh)	105	52,832
Daily Max. Income (KSh)	141	70,684

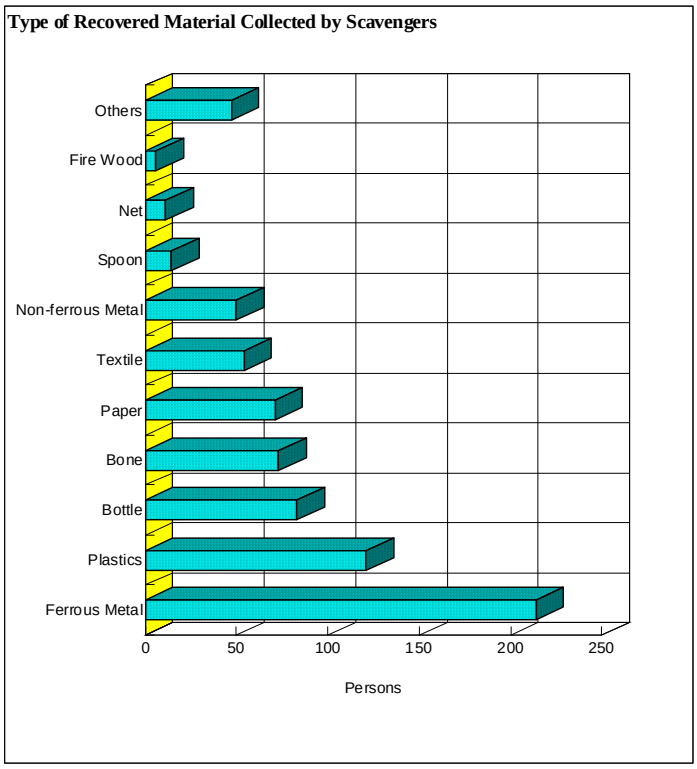


Figure D.3.1 Type of Recyclable Materials Recovered by Waste Pickers
Source: JICA SWM MP-98

3.1.4 Role of CCN in Waste Reduction and Recycling

JICA SWM MP-98 states that the role and responsibility of the central government, local governments, enterprises and residents shall be clarified by legislative measures to establish effective solid waste management for the municipalities. In addition, it states that CCN shall have responsibility for public campaign and education, encouragement, assistance, and coordination to form a link between the community groups and recycling companies. CCN shall also collect and publicise the database on the community groups, list of recycling companies, trading sites of the recovered materials (buy-back centres), etc., and control/coordinate the standard price for maintaining a stable market for the recycled materials. With regard to the waste pickers, the JICA SWM MP-98 describes that banning of material recovery by the waste pickers is not a wise method since CCN has been receiving a large benefit in

volume reduction of solid waste at the disposal site by their activities without paying any cost, although CCN's control and/or systemisation is essential to give a position to waste pickers in forming a better recycling system for CCN.

3.1.5 Waste Reduction and Recycling Plan

The waste reduction and recycling plan proposed under the JICA SWM MP-98 for the challenging programmes of waste generation source management, waste discharge control and recovery/recycling of recyclable materials is as shown in **Figure D.3.2**. A stage-wise action plan was proposed for each task in the flow chart for implementation by the CCN, residents, private sector and the central government organisation. Tasks in the flow chart shall be modified or added in the course of updating the SWM Master Plan of Nairobi City.

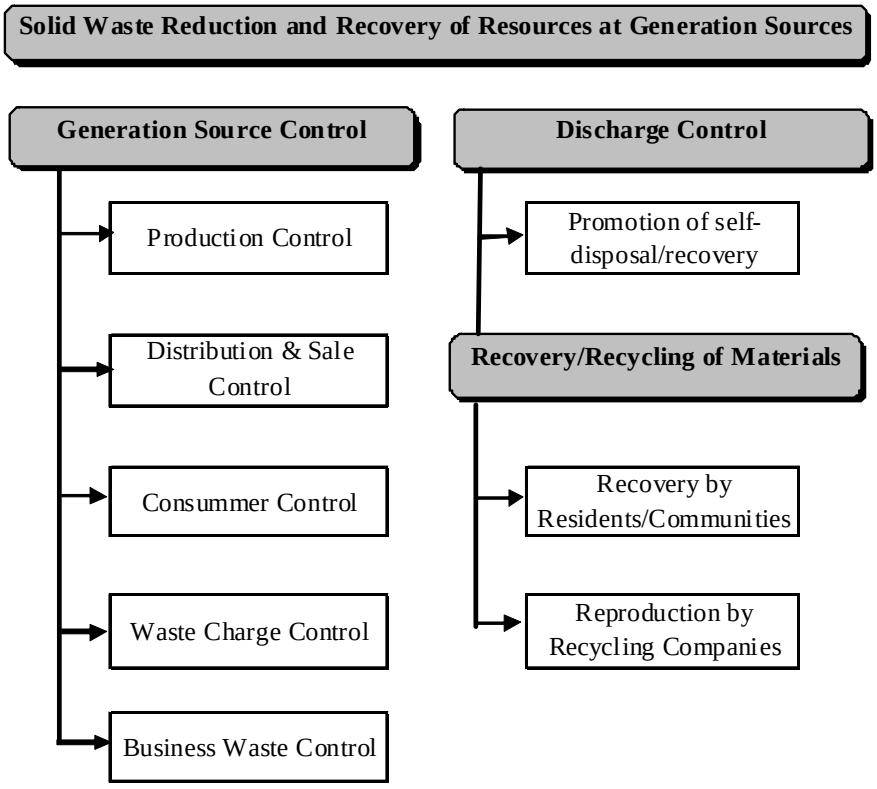


Figure D.3.2 Conceptual Flow of Waste Reduction and Recovery of Resources

3.1.6 Intermediate Treatment Plan

(1) Timing for Implementation of Intermediate Treatment Plan

The JICA SWM MP-98 suggests that the implementation of intermediate treatment facilities should be made after improvement of the financial condition of CCN to avoid financial burden in addition to the priority projects for improvement of waste collection and transportation and waste disposal. However, it also says that the intermediate treatment facility is indispensable for establishment of the integrated solid waste management system for Nairobi in the near future.

(2) Consideration of Intermediate Treatment Process

Due to the low calorific value of municipal waste of Nairobi obtained from the waste composition survey conducted in 1997, the types of intermediate facilities for “waste to energy” projects became

the minor alternatives under the JICA SWM MP-98. However, incineration treatment remained as the alternative in future again after increase of calorific value of waste accumulated from sufficient data. Instead, composting was proposed for the main alternative to initiate intermediate treatment for implementation of the integrated SWM of CCN.

(3) Potential Demand of Compost

Compost demand was estimated at 1 million tons per day based on the horticultural production area in the vicinity of Nairobi. There are many other farmlands that need compost or soil conditioner to improve the physical condition of soil and to keep healthy conditions for growing plants, and there is a great demand of compost. With regard to marketing, the JICA SWM MP-98 proposed to use a function of the Kenya Farmers Association (KFA) and the Horticultural Crops Development Authority (HCDA).

(4) Implementation of Composting

The community level composting and the centralised composting were proposed in the JICA SWM MP-98. The community level composting was suggested to be implemented through encouraging and assisting the community-based groups such as the 13 self-help groups organising the Nairobi Composting Committee Self-Help Group (NCCSG). For the purpose of expanding their activities, the JICA SWM MP-98 suggests solving the problems on land issues, marketing of compost, operation of composting work, working capital, etc., through external assistance and support from the public bodies such as CCN, district office and/or the other government agencies. The centralised compost facility was proposed to initiate with 50-ton per day pilot compost plant to collect raw materials from organic wastes and food waste from hawkers markets, restaurants, hotels, etc., since solid waste from these sources contain more biodegradable waste and commingle almost no hazardous waste.

3.1.7 Establishment of the Special Task Force

JICA SWM MP-98 proposed establishment of a Special Task Force under the proposed Community Development Unit in DoE for implementation of waste reduction and resource recovery programmes. The team shall be comprised of 18 staff members headed by a manager and two assistant managers for the services in the central office and two special task officers each for six collection districts. In addition, one engineer and two assistant engineers are to be appointed for the promotion of community-based composting activities and study for implementation of intermediate treatment in the future, and carry out the services in coordination with the staff of waste reduction and recycling operation.

3.1.8 Proposed Target Levels and Prospects

(1) Waste Reduction

The target level of waste reduction is proposed to realise the rate at 5% by 2008 and 10% within 10 to 15 years by the waste amount at the generation sources.

(2) Estimated Amount of Waste Reduction and Resource Recovery

The recycling and intermediate treatment plan was proposed to be implemented initially with the public campaigns by CCN/MoLG to develop social movement for waste reduction and recovery of recyclable materials through participation of the residents, community-based organisations, offices, factories and other business establishments. The four programmes under the waste reduction, recycling and intermediate treatment were expected to bring about the following results:

- Waste reduction of 137 tons per day at waste generation sources by realising the target ratio of 5% in 2008;

- Recovery of recyclable waste at waste generation sources at 125 tons per day by the target ratio of 5% in the year 2008;
- Composting of green waste by the pilot compost plant of 50 tons per day in addition to the composting by 15 community groups of 1ton per day by the efforts of the groups through encouragement and support by NCC;
- Recovery of recyclables by waste pickers at disposal site at 120 to 240 tons per day under the control of NCC so that the scavenging will not obstruct the daily landfill operation.

The flow chart in **Figure D.3.3** shows the overall waste flow stream of waste reduction, recycling and intermediate treatment formulated under the JICA SWM MP-98. The waste stream and the programmes shall be reviewed based on the current waste composition and the social movement on waste management in the course of updating the SWM master plan.

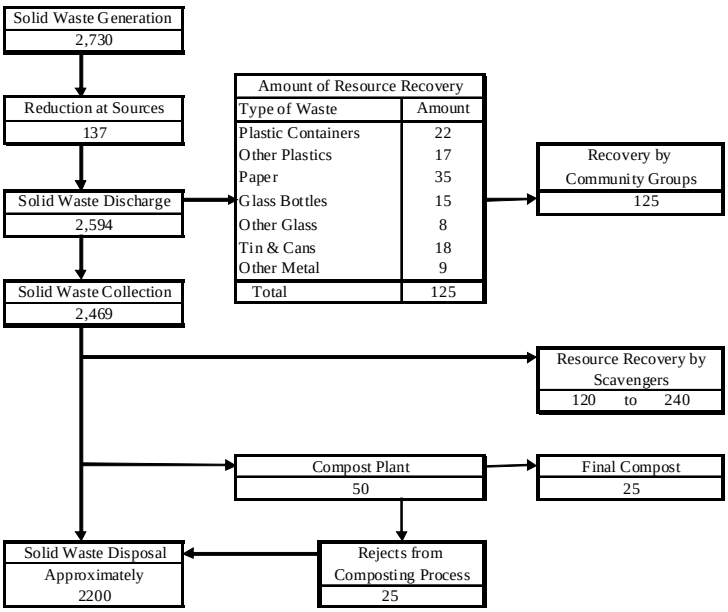


Figure D.3.3 Waste Reduction, Recycling and Intermediate Flow and Amount in 2008

3.1.9 Recommendations of Waste Reduction, Recycling and Intermediate Treatment

The following section summarises the recommendations of JICA SWM MP-98 for waste reduction, recycling and intermediate treatment. These plans and programmes shall be modified or adjusted in the course of updating the SWM Master Plan to meet the current conditions together with the future aspects.

(1) Waste Reduction

(a) Target

The reduction of solid waste generation rate shall be targeted at 5% and 10% by the year 2008 and within 10 to 15 years, respectively.

(b) Action Programmes in the First Implementation Stage

- Establishment of a Special Task Force under the proposed Community Development Unit in DoE composed of 18 staff for waste reduction, resource recovery and intermediate treatment services.

- Waste reduction plan to be carried out by "Generation Source Control" and "Discharge Control" at the waste generation sources.
- The waste generation control shall be started with "Distribution & Sale Control", "Consumer Control", and "Waste Charge Control".
- Waste amount reduction shall be realised as a result of materials recovery by the community-based groups and the recycling industries, and self-disposal at home.
- CCN shall execute public campaign and education to promote participation of the public.

(c) Action Programmes in the Second Implementation Stage

- "Business Waste Control" shall be started for reducing the waste generation amount from shops, markets, offices, institutional buildings, etc.
- Public campaign shall be made continuously addressed to the residents and business establishments.

(d) Action Programmes in the Third Implementation Stage

- "Production Control" shall be started to encourage factories to participate in the waste reduction movement.
- Public campaign shall be made for the factories to play a role in the waste reduction and continue the campaign to the residents and business establishments.

(2) Recycling and Resource Recovery

(a) Target

Recycling and resource recovery shall be set at 5% by 2008 and 10% within 10 to 15 years, respectively.

(b) Action Programmes in the First Implementation Stage

- The Special Task Force shall be dispatched to each collection district office to implement the waste reduction and recycling activities.
- Waste recycling shall be started with "Recovery by Residents/Communities" to separate and recover recyclable materials.
- DoE shall initiate the programmes for waste separation, collection, transportation, sale and routes through the campaign to ask participation of the public.
- The women's groups will be the best to facilitate/initiate separation and recovery of recyclable materials.
- Materials recovery shall be carried out for plastics, paper, glass and metals through the activities of the community-based groups.
- Waste picking at the landfill site may be permitted as long as the activities of the waste pickers are well under the control of DoE.
- CCN shall set up the buy-back centres where any individual can bring recyclable materials in exchange of money.

(c) Action Programmes in the Second Implementation Stage

- "Reproduction by Recycling Companies" shall be started to encourage the recycling industries.
- CCN/MoLG shall take an action to encourage and assist the recycling industries to play an important role for waste recycling activities.

- Public campaign and guidance shall be made addressing especially the recycling industries.

(d) Action Programmes in the Third Implementation Stage

- The public campaign, guidance and assistance shall be made continuously to develop the recycling activities.
- The system and the activities shall be reviewed to increase efficiency and effectiveness for further development of the activities.

(3) Intermediate Treatment

(a) Target

DoE shall accumulate database, e.g., waste treatment technologies, compost demand and market, needs of the society and study.

(b) Action Programmes in the First and Second Implementation Stages

- The Special Task Force shall start service for linking with the community-based compost groups to encourage and assist their activities and the compost market.
- Raising awareness of the public on the benefits of compost for farming and gardening.

(c) Action Programmes in the Third Implementation Stage

- Accumulation of database and analysis by reviewing the past activities for studying the need of the intermediate treatment facilities.
- CCN/MoLG shall start promotion of the pilot compost plant with the capacity of 50 tons per day to start operation in the possible earliest time.
- The engineering design shall be started, if required, based on the study to prepare for tender, construction and operation of the intermediate treatment facilities.

Table D.3.2 Comparison between Old Master Plan and New Master Plan

Action Plans in Old Master Plan 1998	Actual Performance of Action Plans in Old Master Plan 1998		Proposed Action Plans in New Master Plan 2010	New Concepts to Remove Constraints in Old Master Plan 1998
	Results (Done: ●, Not done yet: × Partially done: ▲)	Cause or Constraints of "Not done yet" or "Partially done"		
Programme 2: 3R and Intermediate Treatment Plan				
Short-Term Plan (Old Master Plan: 1998 - 2003, New Master Plan: 2011 - 2015)				
Establishment of Special Task Force	×	- Lack of staff in DoE and budgetary constraints to recruit members for the Special Task Force - Counterpart from the Social Services and Housing Department, CCN retirees	- Establishment of Task Force by the staff of DoE	- Capacity development of the staff through the request and implementation of technical assistance programme
Implementation of waste reduction plan through "Distribution & Sale Control", "Consumer Control", "Waste Charge Control" and "Discharge Control"	×	- Special Task Team was not established and the implementation plan was not prepared	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign and education in collaboration with the Public Participation Promotion Plan	- Implementation of the action plans and programmes in collaboration with the Public Participation Promotion Plan
Implementation of public campaign and education to promote participation	▲	- Special Task Team was not established and the implementation plan was not prepared - Implementation of public sanitation campaign and education	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign and education in collaboration with the Public Participation Promotion Plan	- Implementation of the action plans and programmes in collaboration with the Public Participation Promotion Plan
Segregation and recovery of recyclables at waste generation sources	▲	- Special Task Team was not established - Resource recovery and selling to the junkshops by individual waste generator	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign and education in collaboration with the Public Participation Promotion Plan	- Implementation of the action plans and programmes in collaboration with the Public Participation Promotion Plan
Set-up Buy-back centre by CCN	×	- Special Task Team was not established and the plan was not prepared - Budgetary constraints	- Optional plan to construct and operate the MRF or Buy-back Centre or Waste Bank at Dandora Dumpsite for supporting the waste pickers after closure of Dandora Dumpsite	- Implementation of the action plans and programmes in collaboration with the Public Participation Promotion Plan
CCN make a link with composting CBOs to encourage and assist their activities	▲	- Special Task Team was not established and the activities were not promoted - Linkage through seminars and workshops by CCN and other agencies	- Preparation of implementation plan of composting projects - Implementation of two pilot community composting plants	- Implementation of pilot community composting in collaboration with the Public Participation Promoting Plan - Operation and management by the CBOs supported by CCN through the request of technical assistance project
Raising awareness of the public for the		- Special Task Team was not established and the	- Preparation and implementation of	- Operation of demonstration

Action Plans in Old Master Plan 1998	Actual Performance of Action Plans in Old Master Plan 1998		Proposed Action Plans in New Master Plan 2010	New Concepts to Remove Constraints in Old Master Plan 1998
	Results (Done: ●, Not done yet: × Partially done: ▲)	Cause or Constraints of "Not done yet" or "Partially done"		
benefits of compost for farming and gardening		plan was not promoted	public campaign and education in collaboration with the Public Participation Promotion Plan,	farm in the proposed pilot community compost plant for searching the effectiveness of compost, -Implementation of public campaign in collaboration with the Public Participation Promotion Plan
Mid-Term Plan: (Old Master Plan: 2004 - 2007, New Master Plan: 2016 - 2020)				
Start "Business Waste Control" and continue the programmes started in the Short-Term period.	×	- Special Task Team was not established and the implementation plan was not prepared	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign & education in collaboration with the Public Participation Promotion Plan	- Implementation in collaboration with the Public Participation Promotion Plan,
Continuation of public campaign & education for participation to the programme	▲	- Special Task Team was not established and the implementation plan was not prepared - Implementation of public sanitation campaign and education	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign & education in collaboration with the Public Participation Promotion Plan	- Implementation in collaboration with the Public Participation Promotion Plan,
CCN/MOLG shall take action to encourage and assist the recycling industries	▲	- Special Task Team was not established and the implementation plan was not prepared - Ministry of Industrialisation is preparing the Policy on Waste Utilisation in Industry.	- CCN/MOLG and Ministry of Industry finalise the policies and start implementation for more utilisation of recyclable materials in Industry.	- Involvement of Ministry of Industrialisation for promotion of waste utilisation in industry
CCN shall continue to make a link with composting CBOs to encourage and assist their activities	▲	- Special Task Team was not established and the activities were not promoted - Linkage through seminars and workshops by CCN and other agencies	- Preparation of implementation plan of composting projects - Implementation of pilot community composting projects	- Implementation of pilot community composting in collaboration with the Public Participation Promotion Plan - Operation and management by the CBOs supported by CCN through the request of technical assistance project
Continue the programme to raise awareness of the public on the benefits of compost for farming and gardening	×	- Special Task Team was not established and the implementation plan was not prepared	- Preparation and implementation of public campaign and education in collaboration with the Public Participation Promotion Plan,	- Operation of demonstration farm in the compound of pilot community compost plant for searching the effectiveness of compost, -Implementation of public campaign in collaboration with the Public Participation Promotion Plan
Long-Term Plan (Old Master Plan: 2008, New Master Plan: 2021 - 2030)				
Start "Production Control" and continue	×	- Special Task Team was not established and the	- Preparation of implementation plan of	- Implementation through collaboration with the Public

Action Plans in Old Master Plan 1998	Actual Performance of Action Plans in Old Master Plan 1998		Proposed Action Plans in New Master Plan 2010	New Concepts to Remove Constraints in Old Master Plan 1998
	Results (Done: ●, Not done yet: × Partially done: ▲)	Cause or Constraints of "Not done yet" or "Partially done"		
the programmes started in the Short-Term period and in the Middle-Term period.		implementation plan was not prepared	3R by the Special Task Force and start of campaign & education in collaboration with the Public Participation Promotion Plan	Participation Promotion Plan
Continuation of public campaign & education for participation in the programme and expand the campaign and education to the factories & business establishments.	▲	- Special Task Team was not established and the implementation plan was not prepared - Implementation of public sanitation campaign and education	- Preparation of implementation plan of 3R by the Special Task Force and start of campaign & education in collaboration with the Public Participation Promotion Plan	- Implementation through collaboration with the Public Participation Promotion Plan
Review the overall 3R systems and activities to increase efficiency and effectiveness for further development of the activities	×	- Special Task Team was not established and the plan was not implemented	- The Special Task Force shall monitor and evaluate the activities and prepare the annual report	
Accumulation of database and analysis for studying the need of the intermediate facilities.	×	- Special Task Team was not established and no CCN Section accumulated the data	- The Special Task Force shall monitor and evaluate the activities and prepare the annual report	
CCN/MOLG shall promote to implement the 50 ton per day pilot compost plant	×	- Budgetary constraints -No linkage between CCN/MOLG for promoting construction of the plant	- Operation & maintenance of 10 ton per day pilot central compost plant at four (4) sites constructed in the Short-Term and Mid-Term periods	- Construction and operation of 10 ton per day pilot central compost plant at four(4) sites
Start engineering design, tender, construction and operation of the 50 tons per day pilot compost plant	×	- Budgetary constraints	- Operation & maintenance of 10 tons per day pilot central compost plant at four (4) sites constructed in the Short-Term and Mid-Term periods	- Smaller scale of 10 tons per day pilot central compost plant at four (4) sites to lighten financial burden of CCN

3.2 Review of UNEP Integrated Solid Waste Management Plan

The report on the Integrated Solid Waste Management Plan to be developed by CCN is under preparation in collaboration with the United Nations Environment Programme (UNEP), persons from the academe and other relevant stakeholders. The latest progress of the report can be taken from the report prepared in February 2010, which gives a proposal on the Mission, Goals, Targets, Guiding Principles, Core Values for the framework to formulate the integrated solid waste management plan. In addition, the report includes the situation analysis for waste composition, waste quantity and trends, success factor analysis, gap analysis, themes for action, specific actions for implementation, etc.

Some of the conceptual statements of the report regarding the 3R and the intermediate plan are summarised as follows:

(1) As a part of the Mission, it is stated that "…to maximise resource recovery through a participatory approach;"

(2) The statement "To build (awareness and capacity for) source separation as an essential component of suitable waste management" is shown under the Goals;

(3) Under the Targets, the draft final report has statements such as "School curriculum to include 4R…. by the year 2013," "Awareness among the general public about the 4R at 75% by the year 2015", etc.;

(4) Under Section 8, Specific Actions for Implementation, the enforcement of by-law and media campaign activities are stipulated for source separation of recyclable waste and organic waste to be implemented in 2011-2013;

(5) The actions for development of material recovery and transfer facilities are stipulated also under Section 8 to secure land and conceptual design for implementation as a build-and-operate scheme in the period 2013-2015;

(6) Several alternatives for derivation of value from the organic waste fractions including bio-digestion, composting and waste treatment through the activities of DBOs and large waste generators; and

(7) Strengthening of specific recycling strategies for development of policies and strategies for currently non-targeted recoverable wastes such as paper through encouragement and provision of seed funding for private enterprises in paper and other recyclable materials.

However, the report neither presents any concrete planning framework nor the action plans at this stage, and it is required to watch about the configuration of 4R and the intermediate plan to be formulated by the ISWMP report even hereafter for the possible coordination to update the Nairobi SWM Master Plan.

3.3 Review of Nairobi Rivers Rehabilitation and Restoration Programme

3.3.1 General

The Draft Project Document of the Nairobi Rivers Rehabilitation and Restoration Programme prepared in November 2008 consists of the following chapters:

Chapter 1: The Context and Rationale for the Programme

Chapter 2: Situation Analysis

Chapter 3: Project Description

Chapter 4: Implementation Strategy

Chapter 5: Resource Mobilisation

The following paragraphs summarise the matters related to SWM under the Nairobi Rivers Rehabilitation and Restoration Programme reviewed based on the Draft Project Document of November 2008.

Solid waste composition is presented under 2.2.3, Solid Waste, Chapter 2. The waste composition shows that about 54% of the waste is biodegradable waste, 14% is recyclable paper, while recyclable plastics is 10%. It is apparent that 54% is organic, amenable to composting and first degradation followed by paper and plastics. Plastics are especially of major concern.

3.3.2 Key Activities of Integrated Solid Waste Management Plan

Under Subsection 3.1.4.3, Integrated Solid Waste Management (ISWM), the Project Document states the following key activities to be included in the ISWM:

- Improvement of waste collection and transportation by developing a comprehensive waste removal plan focusing initially on riparian zone;
- Identification and procurement of land and establishment of collection centres, transfer stations and material recovery facilities for solid waste management in Nairobi;
- Involvement of National Youth Service in removal, transportation, and safe disposal of solid waste during the initial massive cleanup;
- Promotion of the 4R concept, that is, reduce, reuse, recycle and recover to minimise waste dumping;
- Involvement of youths and CBOs in waste related enterprises as a job creation venture;
- Design and construction of energy recovery facilities (waste digester, gas fire and incinerators) using clean development mechanisms;
- Decommissioning of Dandora dumpsite and turning it into a recreational site;
- Design, development and management of the sanitary landfill site at Ruai;
- Development of an integrated solid waste management system for the City of Nairobi; and
- Development of a strategy for making Nairobi City into a carbon market and a Clean Development Mechanism (CDM) Project.

3.3.3 Strategies for Controlling Solid Waste Discharge

The strategies for controlling solid waste discharge are stated under Subsection 4.4.3, Stopping Illegal Discharge. The following items are quoted from the Project Document regarding SWM related activities for implementation of the Project in collaboration with the Nairobi Rivers Rehabilitation and Restoration Programme:

- Conduct baseline inspection survey to identify illegal discharge points and solid waste dumping sites;
- Conduct quarterly waste sampling and quarterly analysis to determine and monitor the effects of the intervention activities;
- Ensure relevant lead agencies undertake corrective measures to stop illegal discharges, restore and rehabilitate infrastructure and environmental conditions;
- Maintain regular inspections and monitoring along the rivers to ensure compliance with environmental regulations; and
- Strengthen inspection unit of NEMA for sustainable compliance and enforcement activities throughout the programme and beyond.

3.3.4 Development and Implementation of an Integrated Solid Waste Management System

The methodologies for developing and implementing the ISWM System are stated under Subsection 4.4.6 of the Project Document of November 2008. The Project Document proposes to conduct a one-time cleanup of the City to be undertaken initially after which the daily production of over 2,400 tons will be managed under the integrated system development within the Ministry of Industrialisation to be developed. It also states the necessity of creation of a department within the Ministry of Industrialisation to promote the "reduce, reuse, recycle and recover (4R)" solid waste concept. In addition, the Project Document envisages the following activities to be undertaken for

developing and implementing the ISWM and estimated the cost of intervention at Eight Billion, Eight Hundred and Fifty Million (KSh 8.85 billion) with GoK contributing One Billion Shillings.

- Develop a comprehensive waste removal plan focusing initially on the riparian zone;
- Identify and procure land and establish four transfer stations for solid waste in Nairobi in addition to the Kariobangi Transfer Station;
- Involve NYS in removal, transportation and safe disposal of solid waste;
- Promote use of reduce, reuse, recycle and recover (4R) to minimise waste dumping;
- Involve youths and CBOs in waste-related enterprises across the city;
- Decommission Dandora Dumpsite and rehabilitate it to a recreation site;
- Develop a sanitary waste disposal site at Ruai;
- Develop an integrated solid waste management system for the City of Nairobi; and
- Develop a strategy for making Nairobi City into a carbon market and a Development Project Mechanism Project.

As a whole, the Project Document of the Nairobi Rivers of Rehabilitation and Restoration Programme prepared in November 2008 states the concepts to be included under the formulation and implementation of the integrated solid waste management project. These concepts shall be taken into consideration for updating the SWM master plan for Nairobi.

3.4 Review of Draft National Municipal Solid Waste Management Strategy

The following paragraphs summarise the Draft National Municipal Solid Waste Management Strategies quoted from the presentation paper of the Workshop held on 25 November 2009 as a part of the activities of the present preparatory survey work of the JICA Survey Team for updating the SWM master plan of Nairobi City.

The Draft National Municipal Solid Waste Management Strategies have been prepared by the Office of the Deputy Prime Minister and the Ministry of Local Government aiming at providing a framework for the transformation of waste management from waste disposal oriented to waste recovery oriented. In order to comply with the Waste Management Act of 2006, these strategies will guide all the local authorities to prepare the specific action plans for the period between 2008 and 2030.

Under the Draft National Municipal Solid Waste Management Strategies, the local authorities must meet statutory 30% recovery of the waste by 2018 for the short-term and med-term targets and progressively increase the recovery ratio to over 50% by 2030 for the long-term target.

For compliance with these targets, each local authority will be required to submit action plans every two years. To perform the plan, the embedded mechanisms are the programmes to involve all the stakeholders through capacity building, public education and raising awareness, collaboration with the manufacturing industry and agricultural sector to boost markets, and funding for the development of SWM specific SWM programmes.

Reviewing the recovery ratio of recyclable waste set at 30% by 2018 and more than 50% by 2030, it is considered that the target levels are considerably challenging to attain the targets. The recyclable waste ratio accounted for in the commingled municipal waste is more or less 20-25% and all the recyclable waste will not be practically recovered. The key to attain the target level will be the means of handling organic waste or biodegradable waste which accounts for more or less 60% of municipal waste. Accordingly, the concepts of waste to energy and/or composting of organic waste will become the important alternatives for updating the SWM master plan of Nairobi.

3.5 Review of Good Practices of 3R and Intermediate Treatment in Developing Countries

As reported earlier in the Inception Report of this survey work, the possible application of good practices of 3R activities and intermediate treatment was presented for one of the basic policies to update the SWM master plan for Nairobi. The following items reiterate the examples of good practices of 3R activities and intermediate treatment in the developing countries.

3.5.1 Waste Bank System and Material Recovery Facility (MRF)

(1) Waste Bank System in Thailand

In Thailand, the bank for recyclable waste or the waste bank was established for the segregated recyclable wastes such as paper, glass, plastics and metal recovered directly from the waste generation sources by the residents and/or from the community activities. The recovered recyclables are sold at the bank and the junkshops or the recyclers purchase the recovered waste from the bank. At present, the system is being practiced mainly in schools and communities in the local municipalities in Thailand.

The profits from selling the valuable wastes from the houses are returned to the people who bring the valuable waste, and the community-based organisations for their operating funds. For example, the profits are used for the procurement of stationery and text materials in the schools and the costs for improvement of the environment in the communities. In addition, some parties use the profits to hire waste pickers and deploy them to operate and maintain the recyclable waste storage facilities after training on segregation methods.

According to the report "Waste Minimisation in Thailand: Experience and Trend" by Mr. Rangsan Pinthong, Pollution Control Department, MONRE, Thailand, nowadays, more than 500 waste recyclable bank systems have been established in 30 provinces. The report introduces several good practice community activities. In the Suksan-26 community, they started their own solid waste management programmes for segregation of waste at waste generation sources and composting programmes. The results of this programme brought about reduction of waste disposal amount and income generation through marketing the recovered recyclable wastes and compost products. In Lumphun Municipality, residents discharge organic waste at the storage provided by the local authority for composting and reduced 50% of waste for final disposal. In Phitsanulok Municipality, many communities have conducted composting programmes and provided the composting techniques to other communities. In Rayong Municipality, they are trading recyclable waste with eggs as substitute for cash payment.

(2) Material Recovery Facility in the Philippines

The establishment of a materials recovery facility (MRF) is mandated to the local barangays (villages) under the Ecological Solid Waste Management Act of 2000 as the centre for recovery of recyclable waste. Accordingly, the MRF shall have the role as a core facility of 3R activities operated by the barangays (villages) with the participation of community residents. However, in most cases, the MRF facilities in the Philippines are operated mainly for the community level composting of organic wastes since the recovery of valuable wastes by private junkshops is very active and the valuable wastes brought to the MRFs are very few.

Considering the examples in the Philippines and Thailand as well as the situation in Nairobi, the application of good practices of 4R activities shall be studied/modified and formulated in the course of updating the SWM master plan of Nairobi City.

3.5.2 Introduction of Composting of Organic Wastes

(1) Home Method Composting in Indonesia

In Surabaya, Indonesia, the breathing or ventilation type container such as the plastic basket lined with geo-textile is used for the Home Method Composting to put in raw wastes discharged from kitchens, etc., together with seeding material for composting. One of the seeding materials called "composting kit" made from Lacto-base bacteria solution composed of fermented soy beans, yoghurt, yeast, etc., which are effective for fermentation, decompose organic wastes into compost without rotting and reduce offensive odour generated in the anaerobic composting processes. After a couple of months, the input waste could be discharged from the container and buried into the ground or piled up for final maturation. The matured organic waste, compost, could be used by residents for their gardens or parks in the region.

In Surabaya, the NGO, PUSDAKOTA, established by the Surabaya University is planning to collect home-made compost in return for money. The NGO also plans to guide the people, depending on the compost quality, on how to input organic waste, maintain the compost container, etc., for the purpose of improving the compost quality. The price of compost brought by the residents depends on the compost quality and this pricing system gives incentive to the people for producing a better quality of compost at home. This method shall be studied to search for the possibility of its introduction in the area especially in the high income group houses with gardens wide enough for home composting.

(2) Susun Method for Community Level Composting in Indonesia

PUSDAKOTA as a counterpart of Kitakyushu International Techno-Cooperative Association in Japan (KITA) has been implementing the community level composting since 2006 in conjunction with the activities of the waste bank system mentioned above. The Susun Method also uses the breathing type or basket plastic containers. Raw organic waste together with native microorganisms is put into the plastic basket lined with geo-textile and then the plastic baskets are piled up to appropriate heights and widths to easily handle the containers manually. Pre-fermented compost taken out from the plastic basket is shredded and piled up to 1-1.5m compost pile for maturation. Tuning of the compost pile, measurement of temperature and adjustment of moisture is carried out in every two days depending on the conditions. Control of composting processes through the efforts of the staff of the community group results in a better quality of compost produced and the system to return the profit derived from the recyclable waste is being established. This example shall be studied to search the possibilities of introducing the system in the area of low income groups in Nairobi.

(3) Central Method in Bangladesh

Waste composition in Dhaka City Corporation (DCC), the capital of Bangladesh, is very similar to that of Nairobi where the majority contains organic waste. DCC has not taken effective measures against organic waste for many years mainly due to financial difficulties. Under the circumstances, Waste Concerns, the registered NGO, constructed a middle-scale compost plant with the capacity of 130 tons per day and started operations in the beginning of 2009 to produce compost from biodegradable wastes collected from markets upon approval of DCC. This plant was approved by the Government of Bangladesh and by the CDM Executive Board of UN for the CDM Project.

This example is a good case to develop the central compost project through linkage with the activities of the private sector regardless of the financial weakness of the local government. Composting by the central method could be started firstly with composting of organic wastes from public markets and the second step could make use of kitchen waste or food waste from the households, restaurants and hotels through establishment of waste segregation and separate collection systems. In addition, the study shall be carried out to discover the possibility of linkage

between the government and the private sectors since the cooperation of these parties will be a key to the development of a central compost plant in Nairobi.

4. FORMULATION OF 3R AND INTERMEDIATE TREATMENT PLAN

4.1 Objective, Planning Policy and Strategies

The 3R and Intermediate Treatment Plan is composed of the plans for waste reduction, recovery of resources, reuse, recycling and intermediate treatment, and the objectives are stated as follows:

4.1.1 Objective

(1) The objective of the Waste Reduction Plan is to lighten the cost burden to CCN through reduction of solid waste amount for collection and disposal.

(2) The objective of the 3R Plan is to save finite resources and minimise landfill space as a result.

(3) The objective of the Intermediate Treatment Plan is stabilisation and reduction of residuals in addition to resource recovery through waste conversion.

4.1.2 Planning Policy

(1) The Waste Reduction Plan shall be formulated under the condition to perform a role of each party, i.e., the role of the Government, local authority and the beneficiaries.

(2) Solid waste recycling shall make use of the existing functions of the residents, junkshops, community-based organisations, NGOs and the recycling industries (recyclers) to the maximum extent.

(3) The Intermediate Treatment Plan shall be formulated by means of the applicable technology in Kenya so as not to cause a financial burden on SWM.

4.1.3 Strategy

(1) Waste reduction shall be carried out to reduce discharge of domestic, commercial and other business wastes through participation of the consumers, shops, workplaces, CCN, and the government agencies concerned.

(2) CCN shall have the primary responsibility for promotion, guidance and assistance to the residents, community groups, enterprises, and all other stakeholders for establishing the recovery, reuse and recycling systems.

(3) Practical and initial solid waste recycling activities shall be carried out mainly through materials recovery by the waste generators at sources and the activities of waste pickers, waste collection workers and junkshops in town.

(4) Small-scale intermediate treatment will be promoted through home composting and community level composting for recycling biodegradable waste.

(5) Large-scale intermediate waste treatment or waste conversion shall be introduced in the future

4.1.4 Goals

(1) Short-Term Plan

- Waste reduction ratio of 5% to the potential waste discharge amount in 2015
- Total resource recovery amount of about 180 tons per day or the equivalent ratio of about 10% to the potential waste collection amount in 2015

(2) Mid-Term Plan

- Waste reduction ratio of 10% to the potential waste discharge amount in 2020
- Total resource recovery amount of about 270 tons per day or the equivalent ratio of about 12.5% to the potential waste collection amount in 2020

(3) Long-Term Plan

- Waste reduction ratio of 10% to the potential waste discharge amount in 2030
- Total resource recovery amount of about 450 tons per day or the equivalent ratio of about 16% to the potential waste collection amount in 2030

4.2 Development of 3R and Intermediate Treatment Plan

As stated in **Section 3.4**, the 3R and Intermediate Treatment Plan will be formulated with involvement of the stakeholders through utilisation of the existing functions to the maximum extent, including improvement. In addition, the intermediate treatment shall be formulated in consideration of the applicable technology in Kenya and the least cost alternatives to avoid excessive financial burden to CCN. With the aforementioned as the basic rule, the 3R plan and the intermediate treatment plan will be developed as described in the following subsections.

4.2.1 3R Plan

(1) Outline for Development of 3R Plan

The programmes under 3R plan are formulated basically with soft component programmes defining the roles, responsibilities and the activities of each party including CCN, waste generators and the central government. Implementation of the programmes shall be carried out with the primary initiatives and efforts of CCN. There are many programmes commonly practiced in the world for 3R activities which can be categorised with waste generation source control, waste discharge control, waste recovery & reuse and recycling of materials. These programmes are also applicable for 3R activities in Nairobi City. These programmes and the activities will be performed mostly with raising awareness of the waste generators and the stakeholders through public campaign, formal and school education, pilot projects and capacity development of the CCN staff concerned. In addition, the programme of hard component will be considered for activating the recovery of recyclable materials by the development of material recovery facility. Each programme under 3R plan is delineated in the following subsections.

(2) Technical Options of 3R

Basically, the 3R concept is composed of many kinds of soft component programmes for waste reduction, recovery, reuse and recycling to promote 3R activities among the parties concerned. The plan shall be implemented comprehensively with all the possibly effective programmes which are divided into the four categories summarized below. The 3R programmes in the four categories are inter-related, and shall be implemented to achieve the goals of 3R.

- Waste Generation Source Control for Waste Reduction

  The programmes under the waste generation source control target the activities to minimise the generation of waste through the production of durable goods and the avoidance of over-packaging in distribution and sale, and by motivating and changing the awareness of waste generators toward a lifestyle of resource and environmental conservation. These activities shall be implemented in five sub-programmes, namely; production control, distribution and sale control, consumer control, waste charge control, and commercial and institutional waste control.

- Waste Discharge Control for Recovery and Waste Diversion

  Waste discharge control aims at reducing the amount of waste discharged by individual waste generation sources through self-disposal at the backyard, converting organic waste into compost, repair and reuse of broken instruments and appliances, and exchange or sale of reusable goods within the community. These activities shall be carried out at the waste generation sources.

- Recovery of Recyclable Materials at Generation Sources and Reuse

  Activities under this programme intend to enhance the recovery of recyclable materials through segregation at waste generation sources, recovery of recyclable materials before the waste is discharged to the waste collection service, securing the routes for recovery and trading of recyclable materials, etc. These activities require extensive participation of the stakeholders and the communities.

- Recycling of Recyclable Materials

  Recycling industries or the recyclers shall take the primary role in the activities of this programme by performing regular and constant recovery of recyclable materials and utilising the recovered materials for the production of goods. Support of CCN and the relevant government agencies is also important for the implementation of these activities by the recycling industries or recyclers.

Figure D4.1 shows the conceptual flow of the four programmes and sub-programmes for easier understanding of the 3R activities. Reference shall be made to the required actions in **Table D.4.11 under Subsection 4.3.2(2)**.

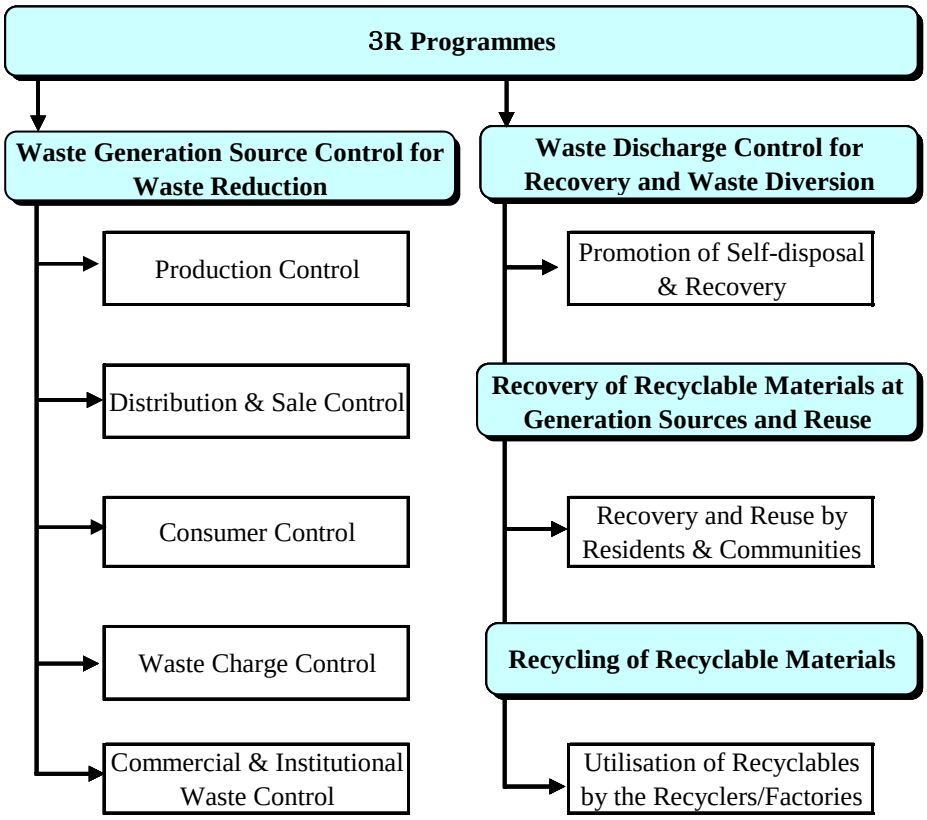


Figure D.4.1 Conceptual Flow of Implementation of 3R Programmes

There are several key elements involved in the implementation of 3R programmes. For example, the strong initiative of CCN is inevitable for promoting the 3R activities. The increase of efficiency in recovering recyclable materials and securing a storage area, a distribution centre, networking, etc., are also indispensable for the sustainability of 3R activities. The following subsections explain these key elements and the proposed target level associated with the 3R Plan for Nairobi City.

(3) Technical Options of Resource Recovery

In the process of recovery of recyclable materials from municipal waste in Nairobi, the following four technical options are considered depending on the waste segregation condition summarised in **Table D.4.1**. Those technical options are explained in the following paragraphs.

Table D.4.1 Technical Options for Recovery of Recyclable Waste

Technical Option	Segregation Condition	Function of MRF, Buy-back Centre or Waste Bank
Option 1	Segregation at Waste Generation Source	Secondary segregation of recyclable materials, storage and distribution centre
Option 2	Mixed Waste	Primary and secondary segregation of mixed waste and recovery of recyclable materials, storage and distribution centre
Option 3	Mixed Waste and Recovery by Collection Workers	Secondary segregation of recyclable materials, storage and distribution centre
Option 4	Mixed Waste and Recovery by Waste Pickers at Disposal Site	MRF may not be required

Option 1:

This option is set in the highest hierarchy in resource recovery since the most challenging segregation activities at generation sources require the involvement or active participation of the waste generators into the solid waste management system of local government units. Source separation is practiced partly in Nairobi and waste pickers working in town collect the recyclable materials directly from the waste generators. Segregation at source shall be set up for a base as the local government units implement resource recovery from waste. Option 1 stands on the fact that waste as mixed is only waste but waste as segregated become resources and is expectable for recovery of more amount of recyclable materials. With this Option 1, the MRF will function at be the centre for secondary segregation, storage and distribution, similar to the Buy-back Centre or the Waste Bank.

Option 2:

Mixed waste collection is the system practiced in Nairobi today and potentially recyclable materials get dirty due to mixing, especially with food waste. As mixed waste is discharged, recovery of recyclable materials becomes hard work for the necessity of primary and secondary segregation or sorting. In case the MRF is used for the recovery place, the recovery process is designed with manual and/or mechanical segregation systems for receiving mixed waste and need considerations to the neighbouring environment and the health risk to the workmen.

Option 3:

Recyclable materials are picked out from mixed waste as in Option 2. However, the key player for recovery is not the MRF but the waste collection workers, which is commonly practiced today in the course of waste collection service. Recovered recyclable waste is then

brought to the dealers handling waste at the Dandora Dumpsite. Due to the picking out activity for recyclable materials in the course of loading waste to the vehicle, the efficiency of waste collection as a whole becomes low. In this option, the function of the MRF is the same with that of Option 1 since the recyclable materials are segregated by the waste collection workers.

Option 4:

Recyclable material in mixed waste is finally recovered by the waste pickers at the Dandora Dumpsite. The current system of resource recovery is carried out as a combination of Option 3 and Option 4 in addition to the recovery of waste of waste generators segregated by the waste pickers in town in Option 1. Since recovery work at the disposal site will influence the landfill work and waste picking will be banned at the new landfill site, accordingly, the MRF is not required anymore inasmuch as waste is hauled directly to the disposal site.

Among the above four (4) options, Option 1 is recommended as the most effective method of recovery of recyclable materials from municipal waste, because the segregation at source before mixing with other wastes is easier and more amounts of recyclable materials would be recovered. Option 3, recovery of recyclables by waste collection workers, may be acceptable as long as the waste picking would not disturb their waste collection work and the risks to collection workers are avoided as well.

(4) Initiatives of CCN for 3R Activities

In order to implement effective and efficient 3R activities, CCN shall take the primary role to set up the implementing policies, purposes, strategies, and the phased target levels in addition to taking a coordination role among the parties concerned. Establishment of a Special Task Force under DoE will be required. The Special Task Force shall formulate implementation plans and programmes of 3R including public campaign, school and formal education, encouragement of the people, support/assistance, and coordination to form a linkage among the residents, CBOs, NGOs, other community groups, waste pickers and junkshops in town. The members of the Special Task Force shall be composed of experts in the field of solid waste management and social services and the office staff to support the expert staff.

The role of CBOs is increasing especially in solid waste collection and the Special Task Force will be required to monitor, instruct and control their activities. The CBOs and other groups involved in the solid waste management services shall be registered with CCN, and updated annually to assure their activities to provide regular services to the communities.

(5) Enhancement of 3R Activities

More recyclable materials will be recovered as segregation is carried out at residential houses and workplaces of the establishment. However, the waste generators in Nairobi are still lacking awareness of limited natural resources or the worldwide saving earth movement. For the purpose to have recycling activities, the activities of recovery of recyclable materials shall be enforced as on of the social activities. Segregation and recovery of recyclable at waste generation sources need active participation of the waste generators. The following activities will be included for implementation of 3R including enhancement of resource recovery.

- Demonstration of 3R at pilot areas in communities involving waste generators, waste pickers, junkshops and CBOs.
- Demonstration of 3R at pilot workplaces participated by staff of establishments.
- Raising awareness through education and public campaign to activate the waste generators for participation in 3R activities.
- Support of CCN for the recovery activities to provide transportation of recyclable materials to junkshops or to the recycling factories.

- Promotion of recovery of food waste and biodegradable waste for home composting and community level composting.

(6) Collection, Storage and Transport of Recyclable Materials

After segregation of recyclable materials at sources, the waste generators store them until they are sold. The buyers, junkshops or CBOs go around the city to collect and buy the recyclables. Most of the junkshops and CBOs do not have collection vehicles and hence use hand carts or tricycles for collection and store the recyclable materials for a month or so until the volume is enough for one truck load transport to dealers or the recyclers. To facilitate the material recovery activities, the following measures will be effective:

- Support of CCN to the groups through provision of site for secondary segregation and temporary storage of recyclable materials.
- Provision of regular collection service of residual wastes after recovery of recyclable materials at site.
- Provision of CCN/Contractor's vehicles to the groups with minimal or free of charge transportation of recyclable materials to be sold.

(7) Setup of MRF, Waste Bank or Buy-back Centre for Waste Recovery

The current situation of recovery of recyclable materials by waste generators is not always active due to lack of recovery system to attract or benefit communities. The trading of recyclable materials through the MRF, Waste Bank or Buy-back Centre is considered as one of the solutions to activate waste recovery by initiating programmes, as follows:

- To open and manage the MRF, Waste Bank or Buy-back Centre by CCN or CBOs or NGOs or junkshop or dealer of junk materials where junkshop activities are relatively low.
- To stabilise the buying/selling price of recyclable materials by CCN or by the Ministry of Industrialisation.

With regard to MRFs, those owned and supported financially by some cities and municipalities in the Philippines are not always managed well, as shown by the small amount of recyclable materials recovered, so that they could not compete with the activities of private junkshops resulting in less income for the MRFs and financial burden to the cities and municipalities activities. The MRF to be managed by CCN will take an important role in the recovery of more recyclable materials. However, considering the cases in the Philippines, it is recommended that the MRF activities should be initiated through the strengthening of functions of private junkshops rather than developing MRFs to be managed by CCN. An exception to the development of MRFs by CCN is the optional plan of setting-up the MRF Centre in a corner of the existing Dandora Dumpsite. The plan for the MRF Centre at Dandora is as presented below.

(8) MRF Centre Option at Dandora as Relief Measure for Waste Pickers

One of the alternative plans of waste collection and transport include the plan to construct a transfer station at Dandora, functioning partly as a material recovery facility. This alternative is proposed aiming at giving relief to about 60 waste pickers who will lose their source of income after closure of the Dandora Dumpsite. Scale of the MRF Centre will be determined to avoid the financial overburden to CCN but accommodated to 60 waste pickers which is about 10 % of the waste pickers normally work at the dump site currently. In case the waste collection and transport alternative will not be implemented, one of the relief measures will not materialise. In line with the social considerations for implementing the solid waste management projects, construction of a material recovery centre at the closed area of Dandora Dumpsite is one of the options for the relief of waste pickers. The Dandora MRF Centre option is outlined as follows:

- The Dandora MRF Centre is proposed as the distribution centre with recycling facilities to be operated and maintained by the organised groups of waste pickers linking with the junk dealers, recyclers and assisted by CCN.
- The Dandora MRF Centre shall have the main functions of receiving only recyclable materials from collection vehicles, secondary sorting, shipping to recyclers/factories, and information centre of stocked recyclable materials through a home page.
- For the purpose of providing relief to more waste pickers, the Dandora MRF Centre may be provided with the additional function as a pilot compost plant to convert biodegradable waste collected from the neighbouring houses and hawkers' markets.

The conceptual plan of the Dandora MRF Centre consists of:

Required Site Area: Approximately 5,000 m^2

Total Floor Area: Approximately 1,900 m^2

Receiving Amount of Recyclable Materials: 20 tons per day, maximum

Receiving Amount of Biodegradable Waste: 4 ton per day, maximum

Storage of Recyclable Materials: 2 weeks

Number of Operation Staff: Approximately 60 persons

Component Facilities: Receiving Area, Secondary Sorting Area, Processing Area, Storage Area, Shipping Area, Composting Area, Management Office, Appurtenant Facilities

The project cost of the Dandora MRF Centre described above is estimated to be approximately KSh 116 million for investment cost including 10% physical contingency and KSh 119 million for operation and maintenance cost from 2017 to 2030, excluding land acquisition cost. For details, reference shall be made to the cost estimate given in **Section D of Volume 4, Data Book**.

(9) Legislative Measures for Promotion of 3R Activities

In Japan, the Ministry of Environment enforces several laws and regulations for establishing a recycling-based society. Those laws are as follows:

- The Basic Environment Law;
- The Basic Law for Establishing the Recycling–based Society;
- Waste Management and Cleansing Law;
- Law for Promotion of Effective Utilisation of Resources;
- Container and Packaging Recycling Law;
- Electric Household Appliance Recycling Law;
- Construction Material Recycling Act;
- Food Recycling Law; and
- Law on Promoting Green Purchasing.

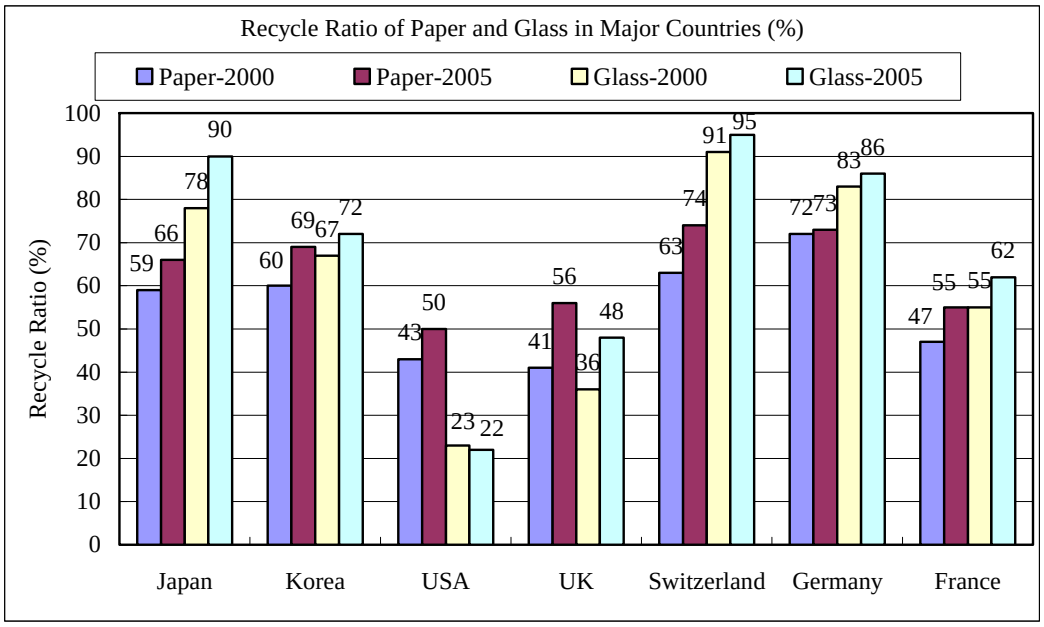
In Kenya, the Environmental Management and Coordination (Waste Management) Regulations of 2006, in relation to Sections 92 and 147 of the Environmental Management and Coordination Act, (No. 8 of 1999), is implemented by the National Environment Management Authority (NEMA). The said Waste Management Regulation of 2006 stipulates the responsibilities of waste generators concerning segregation, but it does not have a clear definition of the means of compliance by the waste generators. In order to establish a recycling-based society, the enactment of a comprehensive

legislative arrangement is required, together with the enforcement of relevant laws and regulations like the case in Japan. In order to promote the 3R activities proposed in the SWM Master Plan, initially, the following legislative measures are required together with the enforcement of national level regulations and/or the by-law of CCN for performing the required activities and achieving the target level:

- Enactment of a law which will clearly define the roles and responsibilities of CCN, waste generators including residents and owners of establishments, CBOs, junkshops, waste collectors and transporters, recycling industries, MoLG, NEMA and other relevant central government agencies regarding the 3R activities, including waste segregation at sources;
- Enactment of a law stipulating the provision of technical and financial assistance as well as support by CCN and/or the relevant government agencies to CBOs, junkshops, waste collectors and transporters, and recycling industries for sustainable 3R activities;
- Formulation and implementation of guidelines stating the target recyclable materials, target level of waste reduction and resource recovery, and the linkage and roles of stakeholders in the activities;
- Establishment of regular financial sources of CCN's annual budget for the implementation of 3R activities; and
- Establishment of systems for monitoring, inspection and improvement of the 3R activities.

(10) Recovery Ratio of Paper and Glass in Other Countries

Figure D.4.2 shows the various recycle ratio of paper and glass recorded in 2000 and 2005 in other countries. As for paper, the lowest recycling ratio was 41% in UK in 2000 and the highest recovery ratio was 74% in Switzerland in 2005. The lowest glass recycling ratio was recorded at 22% in the USA while the highest recovery ratio of glass was recorded at 93% in Switzerland in 2005. In Japan, paper recycling ratio was recorded at 66% and the glass recycling ratio was recorded at 90% in 2005.



Source: OECD Environmental Data Compendium 2006

Figure D.4.2 Recycling Ratio of Paper and Glass in Other Countries

(11) Target Recyclable Materials and Recovery Ratio

Based on the major recyclable materials recovered currently in Nairobi, the items proposed as recyclable materials for recovery and recycling as cited below.

(a) Target Recyclable Materials for Recovery

- Paper
- Plastics
- Glass
- Metals

(b) Ratio of Recyclable Materials and Biodegradable Waste in Municipal Waste

The ratio of major recyclable materials such as paper, plastics, glass and metals, and biodegradable waste was estimated from the results of the WACS conducted by the JICA Survey Team. **Table D.4.2** presents the results of estimation of the ratio of recyclable materials while **Table D.4.3** give the ratio of biodegradable wastes commingled in domestic waste. In order to determine the ratio of recyclables and compostables from the results of WACS, Assumption-1 for the period of wet/dry seasons and Assumption-2 for the ratio of population in 3 income groups were applied. Based on this analysis, the commingled ratio of each recyclable material and biodegradable waste was determined as follows:

- Paper: : 5%
- Plastics : 5%
- Glass : 1%
- Metals : 1%
- Biodegradable Waste : 64%

Table D.4.2 Estimation of Commingled Ratio of Major Recyclable Materials in Domestic Waste

Recyclable Materials	Waste Composition by Survey Sampling Area (%)			
	High/ Middle Income Group	Low-Middle Income Group	Low Income Group and Slum	Average
Wet Season Survey				
Recyclable Paper	4.11	4.62	4.97	4.57
Recyclable Cardboard	0.93	-	0.23	0.39
Recyclable Paper-Total	5.05	4.62	5.19	4.95
Recyclable Plastics	1.19	2.68	2.21	2.02
PET Bottles	1.40	-	0.53	0.64
Recyclable Plastics-Total	2.58	2.68	2.73	2.66
Returnable Bottles	0.73	-	1.25	0.66
Other Live Bottles	0.73	1.25	-	0.66
Recyclable Bottles-Total	1.46	1.25	1.25	1.32
Tin Cans (steel cans)	0.24	0.32	-	0.19
Aluminum cans	0.29	-	-	0.10
Copper	-	-	-	-
Other Metals	1.33	1.15	0.46	0.98
Recyclable Metals-Total	1.87	1.48	0.46	1.27
Recyclables-Wet Season	10.96	10.02	9.63	10.96
Dry Season Survey				
Recyclable Paper	3.24	2.87	4.13	3.41
Recyclable Cardboard	0.95	0.72	-	0.56
Recyclable Paper-Total	19	3.58	4.13	3.97
Recyclable Plastics	2.14	7.96	1.86	3.99
PET Bottles	0.81	0.18	0.56	0.51

Weighted Average Ratio (%)		
Annual Average Percentage	Weighted Average-Nairobi	Proposed Ratio for Planning
Recyclable Paper	4.2	
Recyclable Cardboard	0.3	
Recyclable Paper-Total	4.5	5.0
Recyclable Plastics	3.1	
PET Bottles	0.5	
Recyclable Plastics-Total	3.6	5.0
Returnable Bottles	0.4	
Other Live Bottles	0.6	
Recyclable Glass-Total	1.0	1.0
Tin Cans (steel cans)	0.1	
Aluminum cans	0.0	
Copper	0.0	
Other Metals	0.6	
Recyclable Metals-Total	0.7	1.0
Recyclables-Annual	9.8	
Assumption-2		
Zone	Pop-1999	Ratio (%)
Zone A Total	280,147	13.1
Zone B Total	751,826	35.1
Zone C Total	1,111,281	51.9

Recyclable Materials	Waste Composition by Survey Sampling Area (%)			
	High/ Middle Income Group	Low-Middle Income Group	Low Income Group and Slum	Average
Recyclable Plastics-Total	2.95	8.14	2.42	4.50
Returnable Bottles	0.17	-	0.13	0.10
Other Live Bottles	0.58	0.55	0.60	0.58
Recyclable Glass-Total	0.75	0.55	0.73	0.68
Tin Cans (steel cans)	0.40	-	-	0.13
Aluminum cans	0.16	0.07	-	0.08
Copper	-	-	-	-
Other Metals	0.17	0.14	0.58	0.30
Recyclable Metals-Total	0.73	0.22	0.58	0.51
Recyclables-Dry Season	8.62	12.49	7.85	12.49
Annual Average				
Recyclable Paper	3.67	3.74	4.55	3.99
Recyclable Cardboard	0.94	0.36	0.11	0.47
Recyclable Paper-Total	4.62	4.10	4.66	4.46
Recyclable Plastics	1.66	5.32	2.03	3.01
PET Bottles	1.10	0.09	0.54	0.58
Recyclable Plastics-Total	2.77	5.41	2.57	3.58
Returnable Bottles	0.45	-	0.69	0.38
Other Live Bottles	0.66	0.90	0.30	0.62
Recyclable Glass-Total	1.11	0.90	0.99	1.00
Tin Cans (steel cans)	0.32	0.16	-	0.16
Aluminum cans	0.23	0.04	-	0.09
Copper	-	-	-	-
Other Metals	0.75	0.65	0.52	0.64
Recyclable Metals-Total	1.30	0.85	0.52	0.89
Recyclables-Annual	9.79	11.26	8.74	9.93
Assumption-1	Wet Season	6	months	
	Dry Season	6	months	

Weighted Average Ratio (%)		
Annual Average Percentage	Weighted Average-Nairobi	Proposed Ratio for Planning
Nairobi City Total	2,143,254	100.0

Table D.4.3 Estimation of Commingled Ratio of Biodegradable Waste in Domestic Waste

Item	Waste Composition by Survey Sampling Area (unit: %)					Proposed Ratio for Planning
Income Group / Biodegradable (Compostable) Waste	High/Middle Income	Low-Middle Income	Low Income/ Slum	Average	Weighted Average	
Wet Season Survey						
Food Waste	59.45	68.81	58.91	62.39	62.5	
Yard Waste	3.30	0.00	0.00	1.10	0.4	
Total (Wet Season: Dec'09)	62.75	68.81	58.91	63.49	62.9	
Dry Season Survey						
Food Waste	73.31	63.09	58.97	65.12	62.3	
Yard Waste	2.05	0.00	0.00	0.68	0.3	
Total (Dry Season: Jan'10)	75.36	63.09	58.97	65.81	62.6	
Annual Average						
Food Waste	66.38	65.95	58.94	63.76	62.4	63.0
Yard Waste	2.68	0.00	0.00	0.89	0.3	1.0
Total (Annual Average)	69.05	65.95	58.94	64.65	62.7	64.0

(c) Planned Recovery Ratio and Amount of Recyclable Materials and Biodegradable Waste

Recovery ratio of major recyclable materials was determined in consideration of the practices of 3R activities in advanced countries. On the other hand, the recovery ratio of biodegradable waste was determined based on the current composting activities and the proposed plan.

Table D.4.4 shows the proposed recovery ratio and the planned recovery amount of each recyclable material and biodegradable waste summarised for 2030 as below. The recycle ratio shown in **Figure D.4.2** is one of the references for the determination of the recovery ratio. The recycle ratio in **Figure D.4.2** ranges from 41 to 74%, but the proposed recovery ratio is 80%. However, the recovery ratio of recyclable paper excluding dirty paper is set at 5% and the total ratio of paper obtained through the WACS survey is 14%. Accordingly, the 80% target recovery ratio of paper to the total ratio of paper is estimated to be 30% only, more or less, which means that the target set as the recovery ratio of paper and other recyclable materials is not so high compared to the practices shown in **Figure D.4.2**.

- Paper: 80% (124 ton/day in 2030)
- Plastics: 80% (124 ton/day in 2030)
- Glass: 80% (25 ton/day in 2030)
- Metals: 80% (25 ton/day in 2030)
- Biodegradable Waste : 5% (99 ton/day in 2030)
  (By Home, Community and Central Composting)

Table D.4.4 Planned Recovery Ratio and Amount of Recyclable Materials and Biodegradable Waste

Assumed Commingled Ratio of Recyclable Material (%)	**2009**	**2015**	**2020**	**2025**	**2030**
Recyclable Paper	5	5	5	5	5
Recyclable Plastic	5	5	5	5	5
Glass	1	1	1	1	1
Metals	1	1	1	1	1
Biodegradable Materials	64	64	64	64	64
Target Recovery Ratio of Recyclable Materials (%)					
Recyclable Paper	30	40	60	70	80
Recyclable Plastic	30	40	60	70	80
Glass	50	60	80	80	80
Metals	50	60	80	80	80
Biodegradable Materials	1	5	5	5	5
Recyclable Materials (t/d)					
Recyclable Paper	24	38	67	93	124
Recyclable Plastic	24	38	67	93	124
Glass	8	12	18	21	25
Metals	8	12	18	21	25
Total (Recyclable Materials)	63	100	171	227	297
Biodegradable Materials (t/d)					
Plan for House, Community, CBO Composting	10	21	32	45	59
Plan for Pilot Composting Plant	0	40	40	40	40
Total Recovery Amount of Biodegradable Waste	10	61	72	85	99

(12) Overall Target Level of 3R

The target level of each 3R activity is proposed by phase as shown in **Table D.4.5**. The target levels were determined based on the characteristic of municipal waste in Nairobi City and the practices in many other countries.

Table D.4.5 Proposed Target Level of 3R Activities

(Unit: %)

3R Activities	2009	2015	2020	2025	2030
Waste Reduction	0.0	5.0	7.5	10.0	10.0
Material Recovery	4.7	6.3	9.3	10.8	12.3
Biodegradable Waste Recovery	0.6	3.3	3.4	3.4	3.4
Waste Diversion for Final Disposal	5.3	14.6	20.1	23.2	25.7

The draft of the National and Municipal Solid Waste Management Strategies prepared by the Office of the Deputy Prime Minister and the Ministry of Local Government states that the local authorities must meet the statutory 30% recovery ratio of waste by 2018 for the short-term and middle-term targets and progressively increase to over 50% by 2030 for the long-term target. It seems, however, that the draft target level is too high for the large cities to realise and it is also a challenging level even for the small cities. Moreover, the equation for determining the recovery ratio or the draft target level is not clear, especially, for the waste amount used as the denominator. Although the proposed target level of waste diversion ratio of about 26% in 2030 for 3R activities was determined based on the denominator taken from the potential waste collection amount and proposed at a practical level for large cities like Nairobi City, the target level and the 3R programmes should be reviewed and the National and Municipal Solid Waste Management Strategies should be updated.

4.2.2 Intermediate Treatment Plan

(1) Outline for Development of Intermediate Treatment Plan

Considering the overall financial constraint for solid waste management by CCN, the SWM Master Plan is to be formulated with the required minimum system to be developed, especially, for waste collection services and waste disposal. Accordingly, the development of intermediate treatment shall be limited to the least cost options at this stage. However, the intermediate treatment facilities are indispensable for the establishment of an integrated solid waste management system for Nairobi. Therefore, studies should be carried out for several intermediate treatment options towards future development in consideration of the result of waste composition analysis, as described in the following subsections.

In view of the technical options commonly discussed nowadays among the people concerned, the four (4) technical options including incineration, incineration with power generation, methanisation with power generation and composting were selected for evaluating the most appropriate intermediate treatment facilities for Nairobi City. These technical options were evaluated according to factors such as waste characteristics, progress of “waste to energy” projects in Nairobi City, practices in other countries, cost factor, etc.

For the study on incineration facilities, no information on incineration facilities in developing countries was available and there is almost no incineration facility constructed to meet the scale for Nairobi City. Since there is a long history of development of intermediate treatment facilities by almost all the cities and municipalities in Japan, the information and data on practices in Japan were collected for evaluation especially of incineration facilities. The following items present the development of the plan and the evaluation for selecting the best option of intermediate facility.

(2) Proposed Technical Options of Intermediate Treatment for Nairobi City

There are many technical methods of intermediate treatment of municipal waste although some of them are effective only for small systems and some other options are technically sophisticated. Considering the waste characteristics, the waste amount for treatment and the technologies discussed with the people concerned, the following four technical options including incineration,

incineration with power generation, methanisation with power generation and composting as shown in **Figure D.4.3** were studied as possible intermediate treatment facilities for Nairobi City.

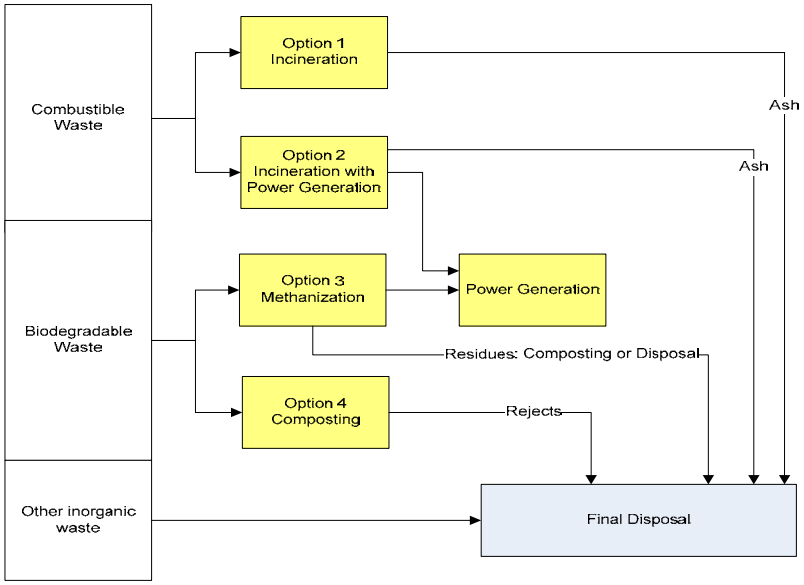


Figure D.4.3 Technical Option of Intermediate Treatment

(3) Waste to Energy Project by KenGen

The Kenya Electricity Generating Company (KenGen) concluded a consulting service contract in May 2010 to carry out a feasibility study for the Nairobi Urban Waste to Electricity Plant. The study is to be finished in six months and the project focuses on the utilization of waste from landfill sites as the source of renewable energy for generating electricity. Since the study report will not be completed by the time of submission of the updated SWM Master Plan in September 2010, an independent Waste to Energy study was carried out by the JICA Study Team taking into consideration the points mentioned below, hoping that the updated SWM Master Plan will be made as reference in the feasibility study for the Waste to Energy Project of KenGen.

- Careful study on the characteristics of combustible waste in terms of low calorific value.
- Waste collection ratio/amount for determining the plant scale and available power generation capacity.
- Involvement or roles of CCN in the Project's implementation.
- Availability of co-partner for implementation and financing agency(s).

(4) Intermediate Treatment Practiced in Japan

Table D.4.6 and Figure D.4.4 show the results of intermediate treatment practiced by 1,817 facilities of the local government units in Japan in fiscal year 2007. In Japan, municipal solid waste amount for treatment and disposal reaches approximately 150,000 tons per day at present. The incineration method is the most popular treatment method at 68% followed by recycling facilities, direct recycling, and bulky waste treatment facilities at 6%, 5% and 5% respectively. Waste incinerators are the major intermediate treatment facilities in Japan. Specifically, the reason is due to the government's policy notifying the local government units to take consideration of limited land area within the jurisdiction area and the necessity to reduce the waste volume for final disposal. In addition, the calorific value of waste in Japan is high enough and advantageous to introduce incineration plants in the local government units except for the municipalities in rural areas where agriculture is the major industry.

Table D.4.6 Intermediate Treatment and Disposal Practiced in Japan in Fiscal Year 2007

Treatment Facilities	Waste Amount (ton/day)	Ratio (%)	No. of Facilities
Self-disposal	153	0.10	227
Incineration	101,401	67.75	1,066
Direct-Disposal	3,225	2.16	808
Bulky Waste Treatment	6,744	4.51	1,195
Recycling Facilities	9,363	6.26	1,550
Composting Facilities	353	0.24	178
Production of Feeds	1	0.00	2
Methane Generation	68	0.05	27
Refuse-Derived Fuels	1,952	1.30	144
Other Facilities	428	0.29	202
Direct-Recycling	7,220	4.82	1,240
Total	149,662	100.00	6,639

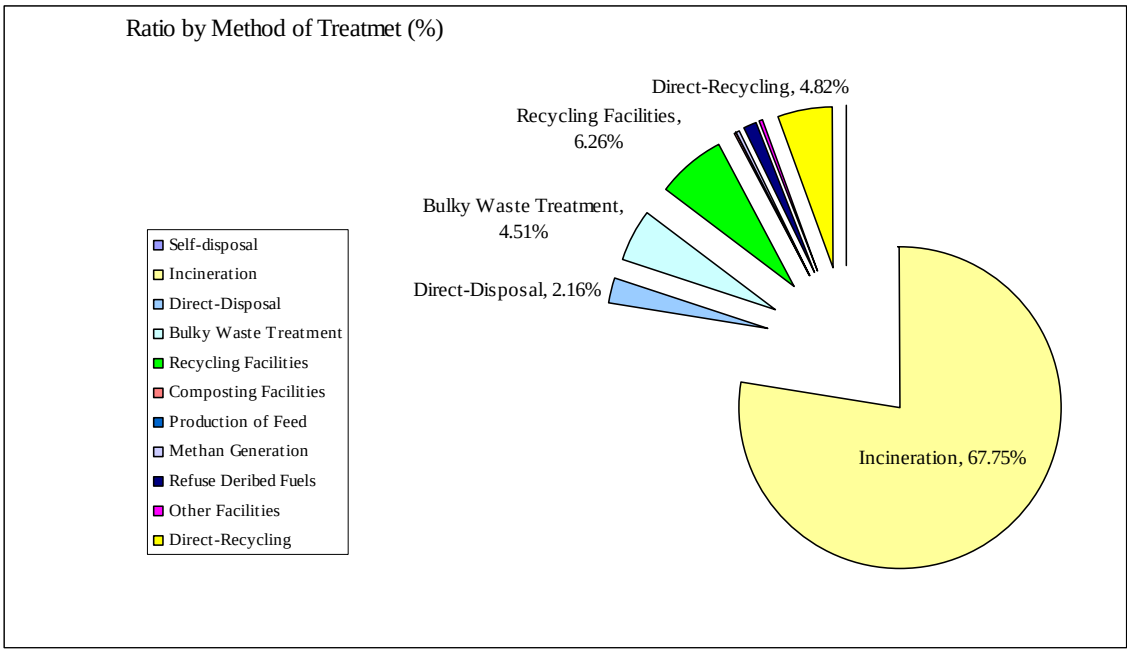


Figure D.4.4 Intermediate Treatment and Disposal Practiced in Japan in Fiscal Year 2007

(5) Incineration Plants in Japan

Table D.4.7 shows the total number of 1,066 incineration plants operated in Japan in fiscal year 2007. Specific features of incineration plants operated in Japan are summarised below.

- 224 plants with power generation having the maximum capacity at 1,800 ton/day, average plant size: 422 ton/day
- 842 plants without power generation having the maximum capacity at 900 ton/day, average plant size: 86 ton/day
- Maximum power generation efficiency is 26% and the average is 11%
- Among 224 incineration plants with power generators, the maximum generated electricity is 1.30MWh and the average is 0.27MWh
- Average generator capacity is 14kW per ton incinerator capacity

- Average generated electricity is 66MWh per ton incinerator capacity

Table D.4.7 Summary of Incineration Plants Operated in Japan in Fiscal Year 2007

Item	Unit	Incinerator with Power Generation			Incinerator without Power Generation		
No. of Plant	(plant)	224			842		
Incineration Plant Capacity - Total	(t/day)	94,489			72,563		
Incineration Plant Capacity - Max	(t/day)	1,800			900		
Incineration Plant Capacity - Mean	(t/day)	422			86		
Incineration Plant Capacity - Min	(t/day)	25			0.25		
Treated (Combusted) Waste Amount	(t/year)	21,156,477			14,092,714		
Generator Capacity - Total	(kW)	1,359,642					
Generator Capacity - Max	(kW)	50,000					
Generator Capacity - Mean	(kW)	6,070					
Generator Capacity - Min	(kW)	198					
Generated Electricity - Total	(MWh)	6,206,786					
Generated Electricity - Max	(MWh)	145,830					
Generated Electricity - Mean	(MWh)	27,833					
Generated Electricity - Min	(MWh)	170					
Power Generation Efficiency - Max	(%)	26					
Power Generation Efficiency - Mean	(%)	11					
Power Generation Efficiency - Min	(%)	1					
Generated Electricity per Treated Waste Amount - Max	(MWh/ton)	1.30					
Generated Electricity per Treated Waste Amount - Mean	(MWh/ton)	0.27					
Generated Electricity per Treated Waste Amount - Min	(MWh/ton)	0.02					
Average Generator Capacity per Incinerator Capacity	(kW/ton)	14.39					
Average Generated Electricity per Incinerator Capacity	(MWh/ton)	65.69					
Three Contents		**Moisture Content (%)**	**Combusti-bles (%)**	**Ash (%)**	**Moisture Content (%)**	**Combusti-bles (%)**	**Ash (%)**
No. of Data		224	224	224	800	800	800
Maximum		63.8	62.8	22.8	71.0	90.0	61.2
Mean		44.1	48.6	7.3	47.9	45.2	6.9
Minimum		19.7	25.9	3.0	6.0	4.6	0.9
Low Calorific Value (kJ/kg)		**Computed Value**	**Measured Value**		**Computed Value**	**Measured Value**	
No. of Data		215	201		735	554	
Maximum		22,057	18,789		51,618	21,212	
Mean		8,513	9,384		7,540	8,398	
Minimum		2,260	5,630		1,329	1,615	

Note: The data from above source were processed by the JICA Survey Team to clarify the status of incineration facilities with and without Power Generation
Source: www.env.go.jp/recycle/waste_tech/ippan/h19/index.html/

Table D.4.8 shows that the three contents, water content, combustibles and ash, for the incinerator with power generation are 44.1%, 48.6% and 7.3 % respectively; while, the incinerator without power generation are 47.9%, 45.2% and 6.9 % respectively. With regard to the average calorific value computed from the three contents, the incinerator with power generation indicates more than 8,000 kJ/kg-waste, while the incinerator without power generation indicates more than 7,500 kJ/kg-waste in Japan.

Table D.4.8 Calorific Value of Combustible Waste of 1,066 Incineration Plants in Japan in Fiscal Year 2007

Items	**Incineration with Power Generation**			**Incineration without Power Generation**		
Three Contents	Water Content (%)	Combustibles (%)	Ash (%)	Water Content (%)	Combustibles (%)	Ash (%)
Mean Value	44.1	48.6	7.3	47.9	45.2	6.9
Low Calorific Value(kJ/kg)	Computed Value	Measured Value		Computed Value	Measured Value	
Mean Value	8,153	9,384		7,540	8,398	

Planning of incineration for the major intermediate treatment facilities is largely dependent on the characteristics of municipal wastes, specially, of calorific value. **Table D.4.9** gives a summary of laboratory analysis of 30 samples from domestic waste in Nairobi conducted in January-March 2010 by the local consultant engaged by JICA Survey Team. Average water content reached almost 69.7%, Combustible 26.8% and Ash 3.5%. Waste in Nairobi has very high water content due to the higher commingled ratio of food waste in municipal waste. Accordingly, the ratio of combustible waste becomes low and the condition is disadvantageous for combustion of municipal waste. Low calorific value is computed from the three contents of waste by the following equation and the results.

Equation of Low Calorific Value (kcal/kg-waste): $45 \times V - 6W$

Where, V: Ratio of Combustibles in %

W: Water Content in %,

By inputting the laboratory test results in **Table D.4.9** to the equation, the low calorific value of 788kcal/kg-waste is obtained, which is equivalent to 3,302kJ/kg-waste. This value is lower than the self-combustion limits resulting in the need for feeding auxiliary fuel in the incineration of waste.

Table D.4.9 Result of Laboratory Test of Three Contents (Domestic Waste) , Jan-Mar 2010

Water Content	**Combustibles**	**Ash**
69.7%	26.8%	3.5%

(6) Methanisation and Composting in Japan

As shown in **Table D.4.6**, waste amount treated with methanisation is only 0.05% by 27 facilities and the largest plant treats about 12 tons per day[1]. On the other hand, waste amount treated with composting reached 0.24% by 77 facilities and the largest plant treats about 30 tons per day in Japan. Methanisation in Japan started only in recent years especially in food industry, for recycling of leftover food to comply with the Foodstuff Recycling Law enforced in 2000. In some cases, methanisation is practiced more popularly in farms where breeding hogs or cowshed use farm waste together with excrements of pigs and/or cattle. Generation of methan gas is carried out under the constant temperature of biodegradable liquid in the methanisation tank through bacterial reaction and it becomes difficult to enlarge the plant scale. The information of technological

reliability and the installed number of plants are still not enough to evaluate introduction of large scale methanisation plants for treatment of biodegradables in municipal waste. In Japan, composting of municipal waste is not a popular method for treatment of municipal waste. However, the number of composting facilities has been increasing in the last 10 years and the farmers in Japan are paying attention to compost for organic farming.

(7) Composting of Biodegradable Waste

Higher ratio of food waste, biodegradable waste, at more than 62% of municipal waste in Nairobi, composting will be the most practical means for intermediate treatment. The least cost composting methods will be developed taking into consideration of the premises summarised as follows.

- The Proposed Task Force under DoE shall prepare the implementation plan to promote home composting and community level composting, and explore the possibilities for central composting.
- Implementation of home composting in the pilot residential areas to provide training, instructions, information for home composting and expansion to the neighbouring areas,
- Involvement of CBOs or other community groups to provide/support/assist/instruct for running the community pilot plant and expansion the system in the neighbouring areas.
- Development of pilot central composting and management by CCN through involvement of the tenants of the target public markets on the segregation of biodegradable waste to supply raw materials.
- Evaluation of effectiveness of home compost, community compost and central compost for continuation of the programmes.
- Analysis of data on demand and supply of compost in Nairobi and the surrounding areas for ensuring that compost derived from waste is supplied for farming and gardening.

(8) Demand for Compost in Nairobi

According to the report "Horticulture Industry in Kenya 2005" by the Export Processing Zone Authority (EPZA) of Kenya, horticulture has grown in the last decade to become a major foreign exchange earner, source of employment and contributor to food needs in the country. Fruits, vegetables and cut flowers are the main products of horticulture in Kenya. Horticulture is the fastest growing agriculture sub-sector in Kenya recently ranked third in terms of foreign exchange earnings from export or over USD300 million in a year. In addition, the same report also shows the quantity of principal horticulture exports, which increased from 200,000 tons in 1999 to 350,000 tons in 2003.[2]

The horticulture farming area in the vicinity of Nairobi reported in page G-61, Supporting Report Sector G, is a little over 100,000 hectares as indicated in the JICA MP-98. Potential demand of compost was estimated at 1 million tons per year or 2,700 tons per day. The JICA Study Team estimated the production amount of compost at 1.5 ton per day as the maximum, only from the identified 15 composting groups. In addition, no enterprise was identified to be involved in the compost production business. Organic fertilisers derived from chicken manure and cow manure are also used together with chemical fertilisers by the farmers in Kenya. However, organic fertilizers could not substitute for compost in maintaining the healthy condition of soil. It is, therefore, concluded that the potential demand for compost is enormous, currently exceeding more than 2,700 tons per day in the vicinity of Nairobi, and the supply of compost will contribute to the further growth of horticulture in Kenya.

(9) Qualitative Evaluation of Intermediate Treatment Options

Table D.4.10 summarises the evaluation of the options of intermediate treatment which could be applicable for the intermediate treatment facilities of Nairobi. As a whole, waste characteristic is a

key to choose the best alternative. Higher water content due to high ratio of food waste commingled in municipal waste in Nairobi is disadvantage to waste incineration. On the contrary, this high commingled ration of food waste, biodegradable waste, gives an advantage to methanisation and composting. Considering the impacts to the environment, Option 4, composting, is more environment-friendly system. As stated earlier, development of intermediate treatment is obliged to take consideration of the financial situation of CCN. The costs for investment, operation and maintenance of Option 1, Option 2 and Option 3 are not affordable to CCN and only Option 4, composting of biodegradable waste, is recommendable for the intermediate treatment of Nairobi City. The options of waste to energy may be reviewed again as the waste calorific value increases and the financial situation improves.

Table D.4.10 Qualitative Evaluation of Intermediate Treatment Options

Evaluation Items	Option 1: Incineration	Option 2: Incineration with Power Generation	Option 3: Methanisation with Power Generation	Option 4: Composting
Objective Waste	Combustible Waste	Combustible Waste	Biodegradable Waste	Biodegradable Waste
Technical Reliability	Reliable	Reliable but complex in operation	Biological reaction is not stable	Biological reaction is not stable
Cost	Expensive	Very Expensive	Expensive	Cheaper
Environmental Aspect	Need removal of pollutants from combustion gas emission	Need removal of pollutants from combustion gas emission	Odor and risk of flammable gas	Odor in miss operation
Applicability	Small towns to large cities	Middle to large cities	Small towns, communities, farms or food waste treatment	Small town to middle cities
Recommendations for application to Nairobi solid waste intermediate treatment facilities	Future, wait for increase of calorific value of waste	Future, wait for increase of calorific value of waste and development/investment partner	Future, wait for the O&M information of large scale plants.	Implement home and community scale composting. Implement the pilot central compost plant for studying future development of practical scale central compost plant

4.3 Technical Evaluation of Alternative Options

4.3.1 Identification of Alternative Plans

The 3R scheme and intermediate treatment plan will be implemented with comprehensive interrelated programmes consisting of both software and hardware components to be identified in the following items.

(1) 3R Plan

Optional plans and programs developed and studied under **Section 4.4** were prioritised and the following programmes were selected for the major programmes of 3R activities to be implemented under the integrated SWM plan of Nairobi:

- Waste Generation Source Control for Waste Reduction
- Waste Discharge Control for Recovery and Waste Reduction
- Recovery of Recyclable Materials at Sources and Reuse
- Recycling of Recyclable Materials

(2) Intermediate Treatment Plan

Composting of biodegradable waste was selected for the prospective alternative for implementation of the intermediate treatment plan. The composting plan consists of the following programmes.

- Home Composting
- Community Composting
- Central Composting

4.3.2 Evaluation of Alternative Plans

(1) Outline of Proposed 3R Plan

The programmes under the 3R Plan shall be implemented through the initiative of the Special Task Force proposed to be organised in DoE, CCN through the actions taken on waste generators including residents, establishments, and all other stakeholders for participation to the programmes. The programmes to be implemented under the 3R Plan consist of the items shown in **Table D.4.11 to D.4.13**.

Table D.4.11 Programmes under 3R Plan (1)

Waste Generation Source Control for Waste Reduction			
	Planning Purposes	Actions by CCN & Government Agencies	Actions by Consumers, Communities & Establishment
Production Control			
	Use of more returnable bottle goods	Encouragement & assistance of makers	Use of returnable bottle goods by the consumers and production of returnable bottle goods by the manufacturers
	Use of eco-friendly goods and over-packaging	Encouragement & assistance of the makers	Use of eco-friendly goods by the consumers and development/ production of eco-friendly goods by the manufacturers.
Distribution & Sale Control			
	Marketing of more returnable bottle goods	Control of non-returnable bottle goods	Ensure recovery & deposit systems
	Reduction of over packaging	Control of over-packaging goods	Sale/Purchase of simple packaging goods
Consumer Control			
	Reduction of domestic waste generation rate	Save the Earth campaign & education	Participation & change of previous habit
	Reduction of plastic shopping bags	Campaign & education on use of own shopping bag	Participation & use of own shopping bag
Waste Charge Control			
	Application of progressive rate waste tariff	Establishment of fair waste charge system	Payment of waste bill
	Penalty to unpaid bills	Monitoring & collection of unpaid bills	Acceptance for payment of waste charge
Commercial & Institutional Waste Control			
	Reduction of business waste generation rate	Public campaign, monitoring & control	Participation & change of previous habit of staff
	Application of progressive rate waste tariff	Establishment of fair commercial waste charge system	Payment of commercial waste bill

Table D.4.12 Programmes under 3R Plan (2)

Waste Discharge Control for Recovery and Waste Diversion			
	Planning Purposes	Actions by CCN & Government Agencies	Actions by Consumers, Communities & Establishment
Promotion of Self-disposal & Recovery			
	Reduction of discharge amount at generation sources	Campaign for safe self-treatment/disposal	Participation in safe self-treatment/disposal
	Composting by individual house	Campaign, assistance & instruction of home composting	Participation in home composting
	Composting by community groups	Campaign, assistance & instruction of community composting	Participation in community composting
	Reduction of broken instrument & elect. appliances	Campaign, assistance, instruction of repair shops	Repair, sale and use second-hand goods
	Reduction of reusable waste	Campaign & assistance for garage/garden sale & exchange	Participation in garage/garden sale & exchange

Table D.4.13 Programmes under 3R Plan (3)

Recovery of Recyclable Materials at Generation Source and Reuse			
	Planning Purposes	Actions by CCN & Government Agencies	Actions by Consumers, Communities & Establishment
Recovery and Reuse by Residents & Communities			
	Establishment of resource saving society	Save the Earth campaign & education	Participation in the activities
	Increase of efficiency of resource recovery operations	Determine the phased target level for recovery of recyclable materials	Segregation of recyclable materials
	Securing of routes for recovery & trading of recyclable materials	Encouragement, assistance to junkshops/ dealers and recovery centre(s)	Utilisation of the recovery routes
	Recovery of recyclable materials from domestic waste	Campaign, education, encouragement & assistance for establishment of the system	Recovery of more recyclable materials by residents & CBOs
	Recovery of recyclable materials from commercial & institutional wastes	Campaign, education, encouragement & assistance to the establishments	Recovery of more recyclable materials by the establishments

Table D.4.14 Programmes under 3R Plan (4)

Recycling of Recyclable Materials			
	Planning Purposes	Actions by CCN & Government Agencies	Actions by Consumers, Communities & Establishment
Utilisation of Recyclables by the Recyclers/Factories			
	Enhancement of involvement of recycling industries	Encouragement & assistance to recyclers/factories	Participation in the waste recycling programme
	Regular recovery & shipping of recyclable materials	Assistance for linkage among the operators of recyclable materials	Participation in regular trading of recyclable materials
	Development of technologies for utilisation of recyclable materials	Encouragement & assistance to recyclers/factories	Production of new goods & use of recycling products

4.4.2 Outline of Proposed Intermediate Treatment Plan

The programmes to be implemented under the Intermediate Treatment Plan consist of the following:

- Home Composting
- Community Composting
- Central Composting

(1) Home Composting

Four hundred houses per year will be chosen in four (4) years from the high and/or middle income residential areas for the pilot/model houses for home composting. Home composting will be carried out extensively during the first four (4) years through provision of home composting units and regular visit for instructions to produce quality home compost. During the first 4-yearsperiod, a facilitator will promote the home composting in the neighbouring areas. From the fifth year thereafter, a facilitator will also promote home composting in the entire area of Nairobi. The cost of supply for the first 4-year period will be shouldered by CCN or by the technical assistance programme.

(2) Community Composting

Community composting will be carried out in collaboration with the Community Participation Promotion Plan. The CBOs or other community groups in eight (8) areas will be chosen for the operators of the community composting. The first two community compost plants having 200 kg per day will be constructed in 2012 and operated immediately for the pilot plant by the CBOs or other community groups. Then, these two pilot plants will be tested for two (2) years to study the appropriateness of the design of the community level composting in technical and economic point of view. After the two-year test period, six plants, two plants per year, will be constructed and operated. Investment costs of these eight (8) community compost plants will be shouldered by CCN or by the technical assistance programme. **Figure D.4.5** shows the conceptual layout of community type pilot compost plant for converting 200kg per day raw materials into compost.

(3) Central Composting

Central composting is carried out with four central compost plants basically targeted to input biodegradable waste discharged from city public markets. The first plant with 10 ton per day is scheduled to start construction and operation in 2014. This first plant, a pilot plant, will be tested for one (1) year in the following year to study the appropriateness of the design of the central compost plant in technical and economic point of view. After the one year evaluation, another three (3) central plants will be constructed with one (1) plant per year for further piloting for development of large scale central compost plants in Nairobi. The investment cost and operation and maintenance cost shall be borne by CCN through the project loan. **Figure D.4.6** shows the conceptual layout of central pilot compost plant for 10 tons per day.

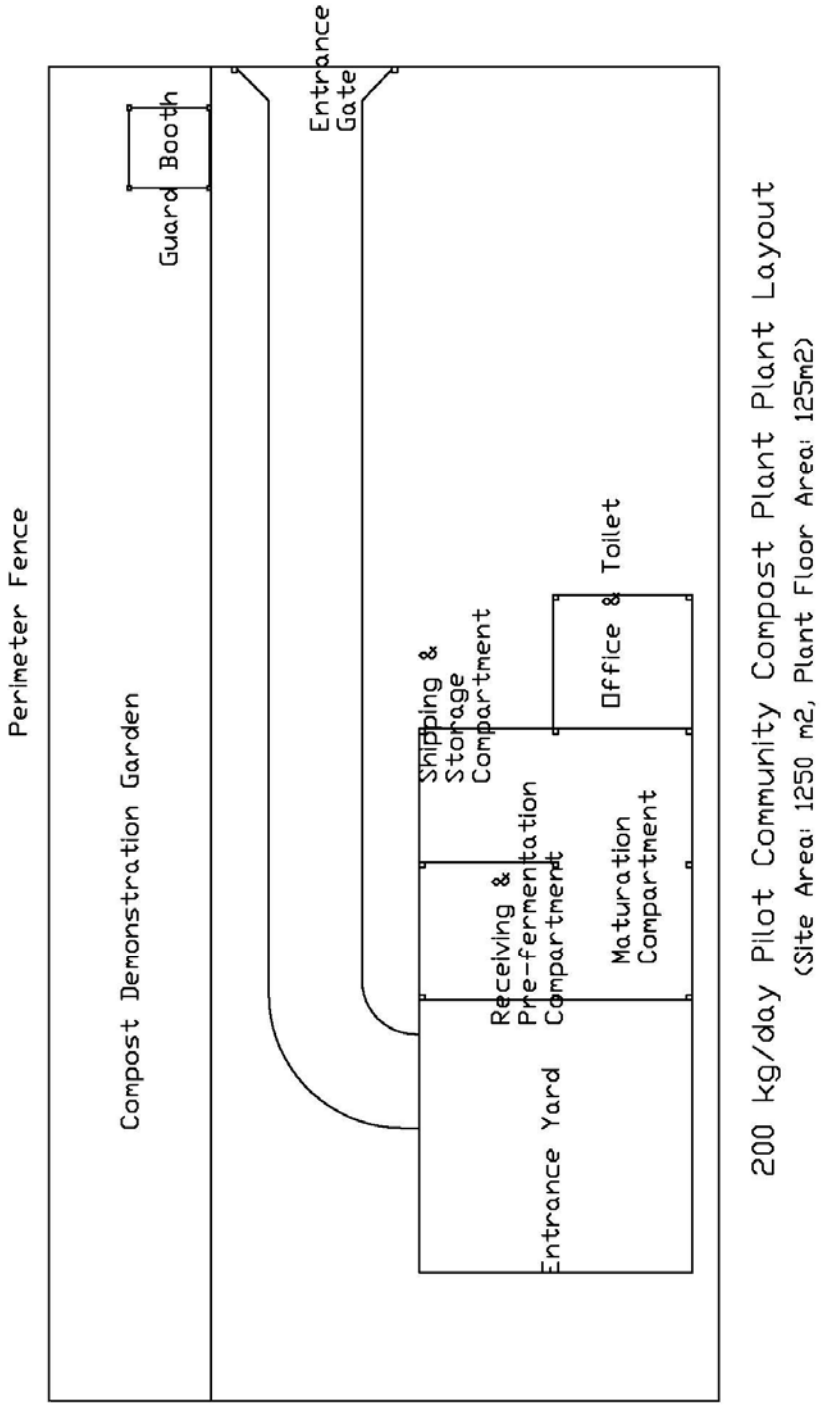


Figure D.4.5 Conceptual Layout of 200kg/day Community Compost Plant

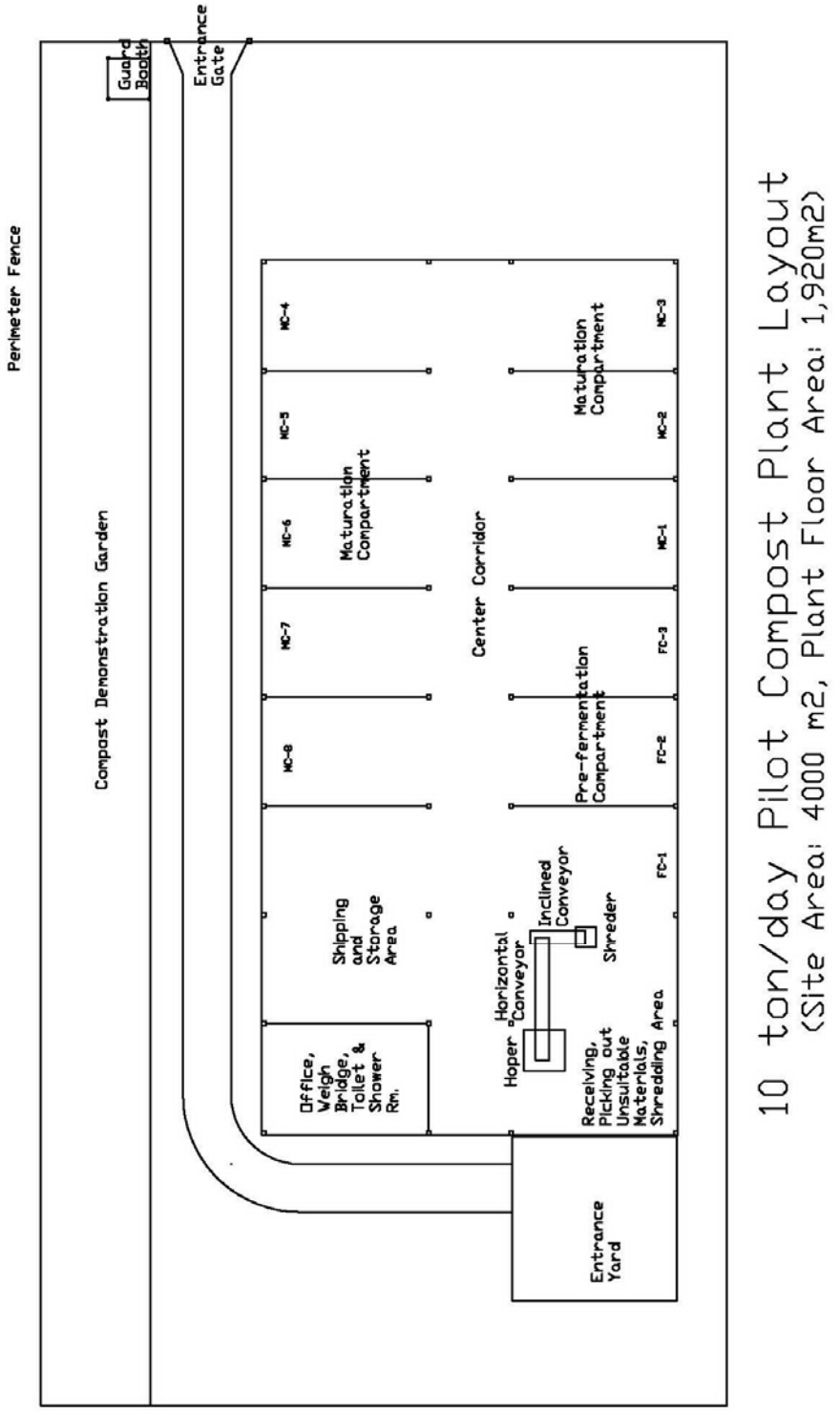


Figure D.4.6 Conceptual Layout of 10 ton/day Pilot Central Compost Plant

4.4.3 Action Plan and Programme

(1) Short-Term Action Plan

(a) Establishment of 3R and Intermediate Treatment Task Force

A Task Force shall be established in 2011 to play the primary role for implementing the 3R and Intermediate Plan.

(b) Formulation of Implementation Plan of 3R

(i) Formulation of Waste Reduction Implementation Plan

The Task Force shall formulate the implementation plan of 3R in 2011 and prepare the budget and the staff for implementation in the following year.

(ii) Formulation of Waste Recovery, Reuse and Recycling Implementation Plan

The Task Force shall formulate the implementation plan of the waste reduction plan in 2011 and prepare the budget and staff for implementation in the following year.

(c) Formulation of Implementation Plan of Intermediate Treatment

The Task Force shall formulate the implementation plan of the intermediate treatment plan in 2011 and prepare the budget and the staff for implementation in the following year.

(d) Monitoring of Implementation of 3R Plan (Phase I)

(i) Review of Target Level of 3R Activities

The Task Force shall setup a monitoring system for evaluating the target level of waste reduction ratio of 5% to the potential waste discharge amount in 2015. The Task Force shall setup a monitoring system for evaluating the total resource recovery amount of about 180 tons per day or the equivalent ratio of about 10% to the potential waste collection amount in 2015.

(ii) Review of Waste Reduction Implementation Plan

The Task Force shall review overall activities of waste reduction programmes and evaluate them in connection with the target waste reduction ratio. Outputs of the review shall be stated in the Annual Activity Report.

(iii) Review of Waste Recovery, Reuse and Recycling Implementation Plan

The Task Force shall review overall activities of waste recovery, reuse and recycling programmes and evaluate them in connection with the target recovery amount or the ratio. Outputs of the review shall be stated in the Annual Activity Report.

(e) Monitoring of Implementation Plan of Intermediate Treatment (Phase I)

(i) Review of Target Level of Intermediate Treatment Plan (Phase I)

The Task Force shall evaluate the progress of the activities for implementation of house composting (400 houses), community composting (4), and pilot central compost plant (1) by 2015.

(ii) Review of Intermediate Treatment Implementation Plan

The Task Force shall review overall programmes of composting activities. Outputs of the review shall be stated in the Annual Activity Report.

(f) Implementation of Waste Reduction Plan (Phase I)

(i) Promotion for Waste Generation Source Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste generation control.

(ii) Promotion for Waste Discharge Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste discharge control.

(g) Implementation of Waste Recovery, Reuse and Recycling Plan (Phase I)

(i) Promotion for Recovery of Recyclable Materials at Waste Generation Sources

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for recovery of recyclable materials at the waste generation sources.

(ii) Promotion for Reuse and Recycling of Recyclable Materials

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for reuse and recycling of recyclable materials.

(iii) MRF Centre

The Task Force shall procure the engineering consultant to start topographic survey, boring survey and design the MRF Centre sited in the corner of Dandora Dumpsite and prepare for the construction work in 2016 and start operation in 2017.

(h) Implementation of Intermediate Treatment Plan (Phase I)

(i) Home Composting

The Task Force and the facilitator shall implement the programme of home composting for 100 houses per year and 400 houses in 4 years by 2015 and expand the activities in the neighbouring areas.

(ii) Community Composting in Collaboration with Environmental Education Activities

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the construction and operation of the two 200kg per day pilot/model community compost plants in the period 2013-2015 and evaluate their effectiveness.

(iii) Central Composting

The Task Force shall procure the engineering consultant and the contractor to start design and construction of one 10-ton per day pilot compost plant in 2013 and prepare for the operation to be started in 2014.

(2) Middle-Term Action Plan

(a) Monitoring of Implementation of 3R Plan (Phase II)

(i) Review of Target Level of 3R Activities

The Task Force shall monitor and evaluate the target level of waste reduction ratio of 10% to the potential waste discharge amount in 2020. The Task Force shall monitor and evaluate the total resource recovery amount of about 270 tons per day or the equivalent ratio of about 12.5 % to the potential waste collection amount in 2020.

(ii) Review of Waste Reduction Implementation Plan

The Task Force shall review overall activities of waste reduction programmes and evaluate them in connection with the target waste reduction ratio. Outputs of the review shall be stated in the Annual Activity Report.

(iii) Review of Waste Recovery, Reuse and Recycling Implementation Plan

The Task Force shall review overall activities of waste recovery, reuse and recycling programmes and evaluate them in connection with the target recovery amount or ratio. Outputs of the review shall be stated in the Annual Activity Report.

(b) Monitoring of Implementation Plan of Intermediate Treatment (Phase II)

(i) Review of Target Level of Intermediate Treatment Plan (Phase II)

The Task Force shall evaluate the progress of the activities for implementation of house composting (400 houses), community composting (8), and pilot compost plants (4), by 2020.

(ii) Review of Intermediate Treatment Implementation Plan

The Task Force shall review the progress and overall programmes in composting activities. Outputs of the review shall be stated in the Annual Activity Report.

(c) Implementation of Waste Reduction Plan (Phase II)

(i) Promotion for Waste Generation Source Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste generation control.

(ii) Promotion for Waste Discharge Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste discharge control.

(d) Implementation of Waste Recovery, Reuse and Recycling Plan (Phase II)

(i) Promotion for Recovery of Recyclable Materials at Waste Generation Sources

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for recovery of recyclable materials at the waste generation sources.

(ii) Promotion for Reuse and Recycling of Recyclable Materials

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for reuse and recycling of recyclable materials.

(iii) MRF Centre

The Task Force shall procure the contractor for construction of MRF Centre at Dandora in 2016 and prepare for starting operation in 2017. About 60 waste pickers will be employed for the operation staff of the MRF Centre.

(e) Implementation of Intermediate Treatment Plan (Phase II)

(i) Home Composting

The Task Force and the facilitator shall continue the programme of home composting for 400 houses and expand the home composting in the neighbouring areas.

(ii) Community Composting in Collaboration with Environmental Education

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the construction and operation of the other six (6) 200kg per day pilot/model community compost plants in the period 2016-2018 and operate the total eight (8) plants from 2019.

(iii) Central Composting

The Task Force shall procure the engineering consultant and the contractor to start design and construction of another three (3) 10-ton per day pilot compost plants in the period 2016-2018 and operate four (4) plants from 2019. The pilot/model central compost plant shall be evaluated for effectiveness and possibility for expansion in the future.

(3) Long-Term Action Plan

(a) Monitoring of Implementation of 3R Plan (Phase III)

(i) Review of Target Level of 3R Activities

The Task Force shall monitor and evaluate the target level of waste reduction ratio of 10% to the potential waste discharge amount in 2030. The Task Force shall monitor and evaluate the total resource recovery amount of about 450 tons per day or the equivalent ratio of about 16% to the potential waste collection amount in 2030.

(ii) Review of Waste Reduction Implementation Plan

The Task Force shall review overall activities of waste reduction programmes and evaluate them in connection with the target waste reduction ratio. Outputs of the review shall be stated in the Annual Activity Report.

(iii) Review of Waste Recovery, Reuse and Recycling Implementation Plan

The Task Force shall review the progress and overall activities of waste recovery, reuse and recycling programmes and evaluate them in connection with the target recovery amount or ratio. Outputs of the review shall be stated in the Annual Activity Report.

(b) Monitoring of Implementation Plan of Intermediate Treatment (Phase III)

(i) Review of Target Level of Intermediate Treatment Plan (Phase III)

The Task Force shall review the progress and overall programmes of composting activities for implementation of house composting (400 houses), community composting (8), and pilot compost plants (4) by 2030. Outputs of the review shall be stated in the Annual Activity Report.

(ii) Review of Intermediate Treatment Implementation Plan

The Task Force shall review the progress and overall programmes of composting activities. Outputs of the review shall be stated in the Annual Activity Report.

(c) Implementation of Waste Reduction Plan (Phase III)

(i) Promotion for Waste Generation Source Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste generation control.

(ii) Promotion for Waste Discharge Control

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes under the waste discharge control.

(d) Implementation of Waste Recovery, Reuse and Recycling Plan (Phase III)

(i) Promotion for Recovery of Recyclable Materials at Waste Generation Sources

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for recovery of recyclable materials at the waste generation sources.

(ii) Promotion for Reuse and Recycling of Recyclable Materials

The Task Force shall collaborate with the Community Participation Promotion Plan to implement and promote the programmes for reuse and recycling of recyclable materials.

(iii) MRF Centre

MRF Centre at Dandora is operated and maintained continuously for a distribution centre of recyclable materials in town area. The operation shall be carried out in collaboration with CBOs, Junk Dealers and CCN. About 60 persons of operators will be recruited from the waste pickers currently working at the Dandora Dumpsite.

(e) Implementation of Intermediate Treatment Plan (Phase III)

(i) Home Composting

The Task Force and the facilitator shall continue the programme of home composting for 400 houses and expand the home composting in the neighbouring areas.

(ii) Community Composting in Collaboration with Environmental Education

The Task Force shall collaborate with the Community Participation Promotion Plan to operate and maintain the eight (8) 200kg per day pilot/model community compost plants. Annual activity report shall be prepared for the composting operation.

(iii) Central Composting

Four (4) 10-ton per day pilot/model central compost plants shall be operated continuously and evaluate them on the possibility for expansion of the central composting in Nairobi. Annual activity report shall be prepared for the composting operation.

4.4.4 Project Cost of 3R and Intermediate Treatment Plan

The programmes under the 3R plan shall be implemented in collaboration with the Community Participation Promotion Plan and the project cost of Community Composting shall refer to the Section

of the Community Participation Promotion Plan. The following **Table D.4.12** shows the project cost of the Intermediate Treatment Plan. The project cost is estimated to be KSh 964.1 Million. The project cost of each phase is summarised as follows:

Project cost of short term period (2011-2015)	: KSh 127.6 million
Project cost of Middle term period (2016-2020)	: KSh 522.7 million
Project cost of Long term period (2016-2020)	: KSh 313.8 million
Total	: KSh 964.1 million

The overall project cost of 3R and Intermediate Treatment Plan including 10% of physical contingency to the construction works will be KSh 1,018.1 million.

Table D.4.15 Project Cost of Intermediate Treatment Plan

Annual Cost for Implementation of 3R and Intermediate Plans (Unit: Ksh 1,000)

Action Plans on 3R & Intermediate Treatment	**Year**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Establishment of 3R & Intermediate Treatment Task Force	CCN Budget																				
Formulation of Implementation Plan of 3R	CCN Budget																				
Formulation of Implementation Plan of Intermediate	CCN Budget																				
Review of Implementation Plan of 3R	CCN Budget																				
Review of Implementation Plan of Intermediate Treatment	CCN Budget																				
Implementation of Waste Reduction Plan	CCN Budget																				
Promotion for Waste Generation Source Control																					
Promotion Cost (Pamphlet)	The cost include under the activities of "Community Participation Promotion Plan"																				
Promotion for Waste Discharge Control																					
Promotion Cost (Pamphlet)	The cost include under the activities of "Community Participation Promotion Plan"																				
Implementation of Waste Recovery, Reuse and Recycling	CCN Budget																				
Promotion for Recovery of Recyclable Materials at																					
Promotion Cost (Pamphlet)	The cost include under the activities of "Community Participation Promotion Plan"																				
Promotion for Reuse and Recycling of Recyclable																					
Promotion Cost (Pamphlet)	The cost include under the activities of "Community Participation Promotion Plan"																				
MRF Centre at Dandora																					
Civil Work	23,218						23,218														
Building Work	38,128						38,128														
Equipment	33,791						33,791														
Test Run	234							234													
Engineering Cost (Design: 6.6%; Supervision: 3.4%)	9,513		3,171	3171			3,171														
Maintenance Cost	22,778							1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627	1,627
Operation Cost (Personnel Cost)	79,632							5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688	5,688
Operation Cost (Electricity, Water & Internet	16,800							1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total	224,094		3171	3171			98,308	8,749	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515	8,515
Implementation of Intermediate Treatment Plan	**Year**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Home Composting																					
Cost of Supplies for 100 Houses per Year (400 houses in	10,504	2,626	2,626	2,626	2,626																
Promotion Cost of Composting (Facilitator/Instructor)	9,360	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468	468
Community Composting (200kg/day x 8 facilities)	The cost include under the activities of "Community Participation Promotion Plan"																				
Central Composting (Pilot Compost Plant, 10 ton/day x 4																					
Civil Work	36,712					9,178		9,178	9,178	9,178											
Building Work	152,512					38,128		38,128	38,128	38,128											
Equipment	205,064					51,266		51,266	51,266	51,266											
Test Run	936						234		234	234	234										
Engineering Cost (Design5%:Supervision5%)	39,428				9,857		9,857	9,857	9,857												
Maintenance Cost	102,561						2,011	2,011	4,022	6,033	8,044	8,044	8,044	8,044	8,044	8,044	8,044	8,044	8,044	8,044	8,044
Operation Cost (Personnel Cost)	121,737						2,387	2,387	4,774	7,161	9,548	9,548	9,548	9,548	9,548	9,548	9,548	9,548	9,548	9,548	9,548
Operation Cost (Electricity & Waster)	61,200						1,200	1200	2,400	3,600	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Total	720,150				9,857	98,572	15,689	114,027	119,859	115,600	22,626	22,392	22,392	22,392	22,392	22,392	22,392	22,392	22,392	22,392	22,392
Grand Total	964,108	3,094	6,265	6,265	12,951	99,040	114,465	123,244	128,842	124,583	31,609	31,375	31,375	31,375	31,375	31,375	31,375	31,375	31,375	31,375	31,375

4.4.5 Implementation Schedule of 3R and Intermediate Treatment Plan

Programmes of 3R plan and Intermediate Treatment Plan for the period from 2011 to 2030 shall be implemented based on the time schedule proposed in the following **Figure D.4.7**.

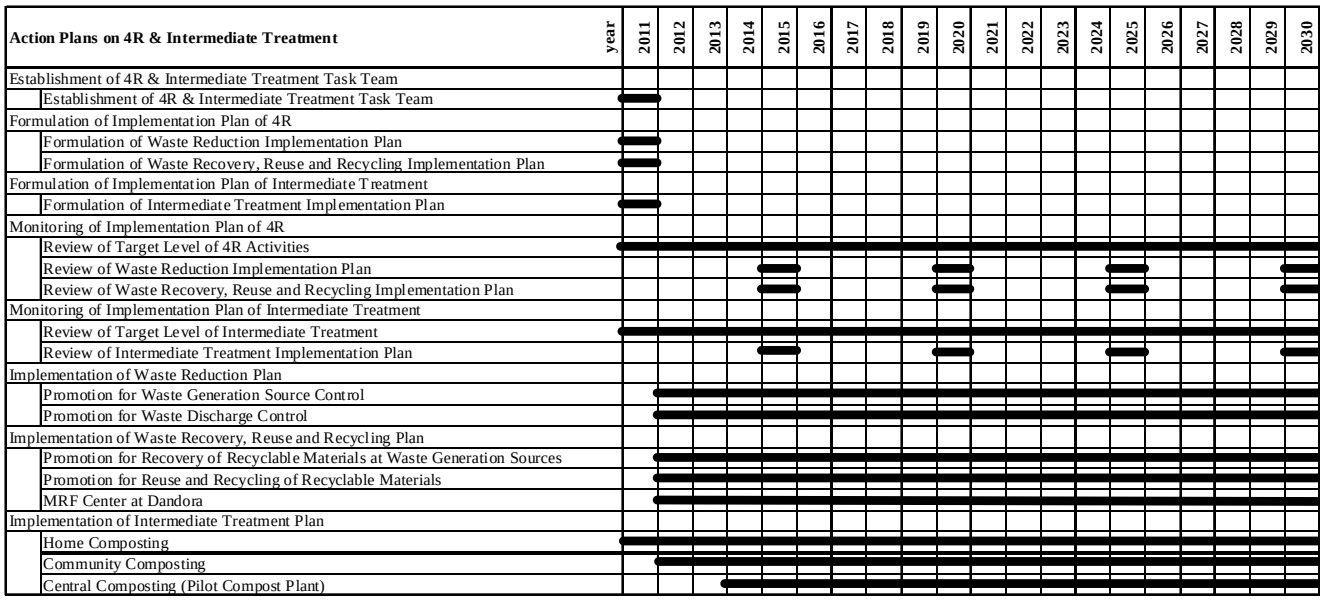


Figure D.4.7 Implementation Schedule of 3R and Intermediate Treatment Plan

4.4.6 Plan of Operation of 3R and Intermediate Treatment Plans

The plans and programmes under the 3R and intermediate treatment plans shall be implemented in accordance with the phased time schedules and the responsibilities indicated in **Figure D.4.8 to D.4.10.**

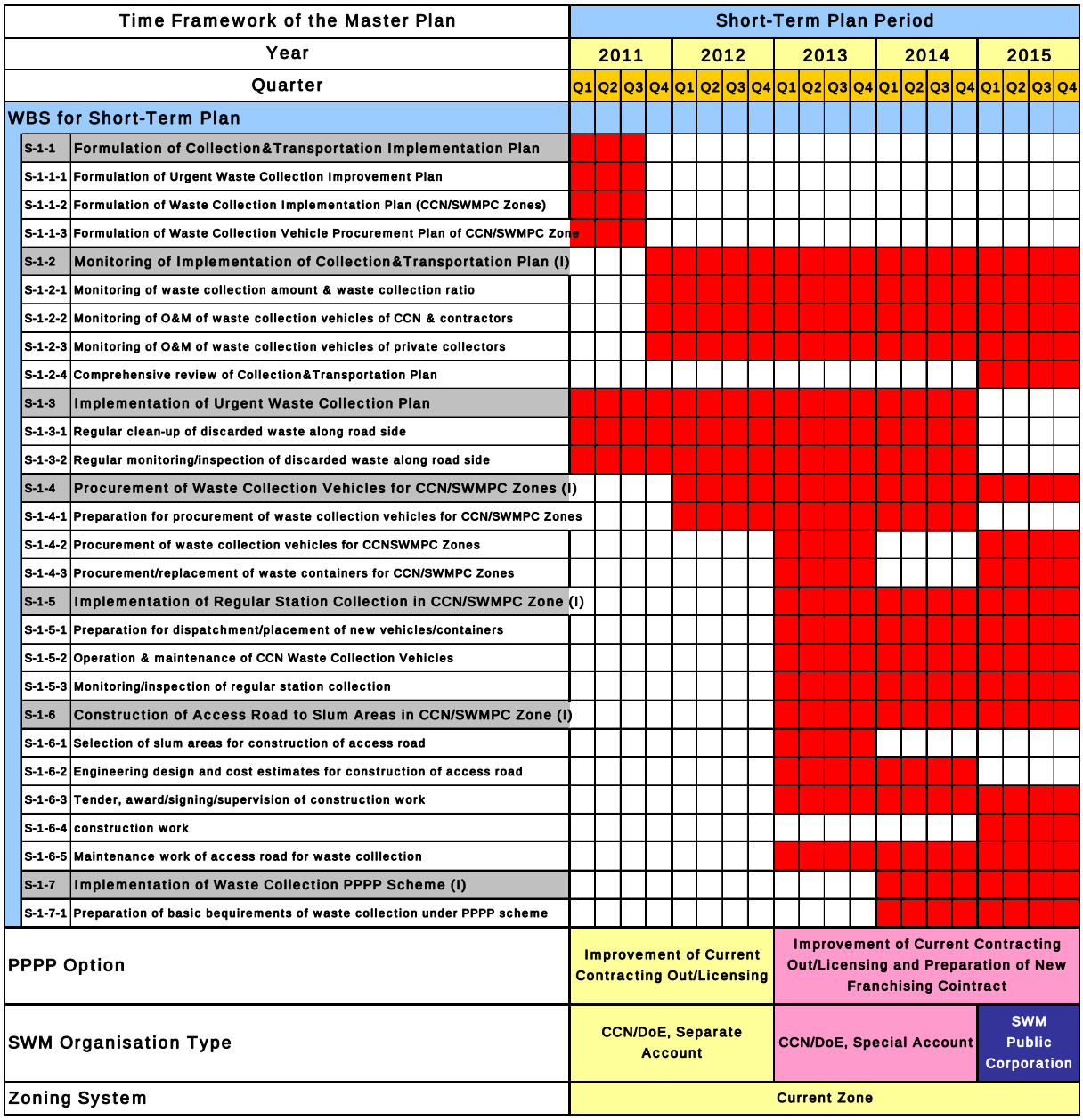


Figure D.4.8 Plan of Operation of 3R and Intermediate Treatment Plan (Short-Term Plan)

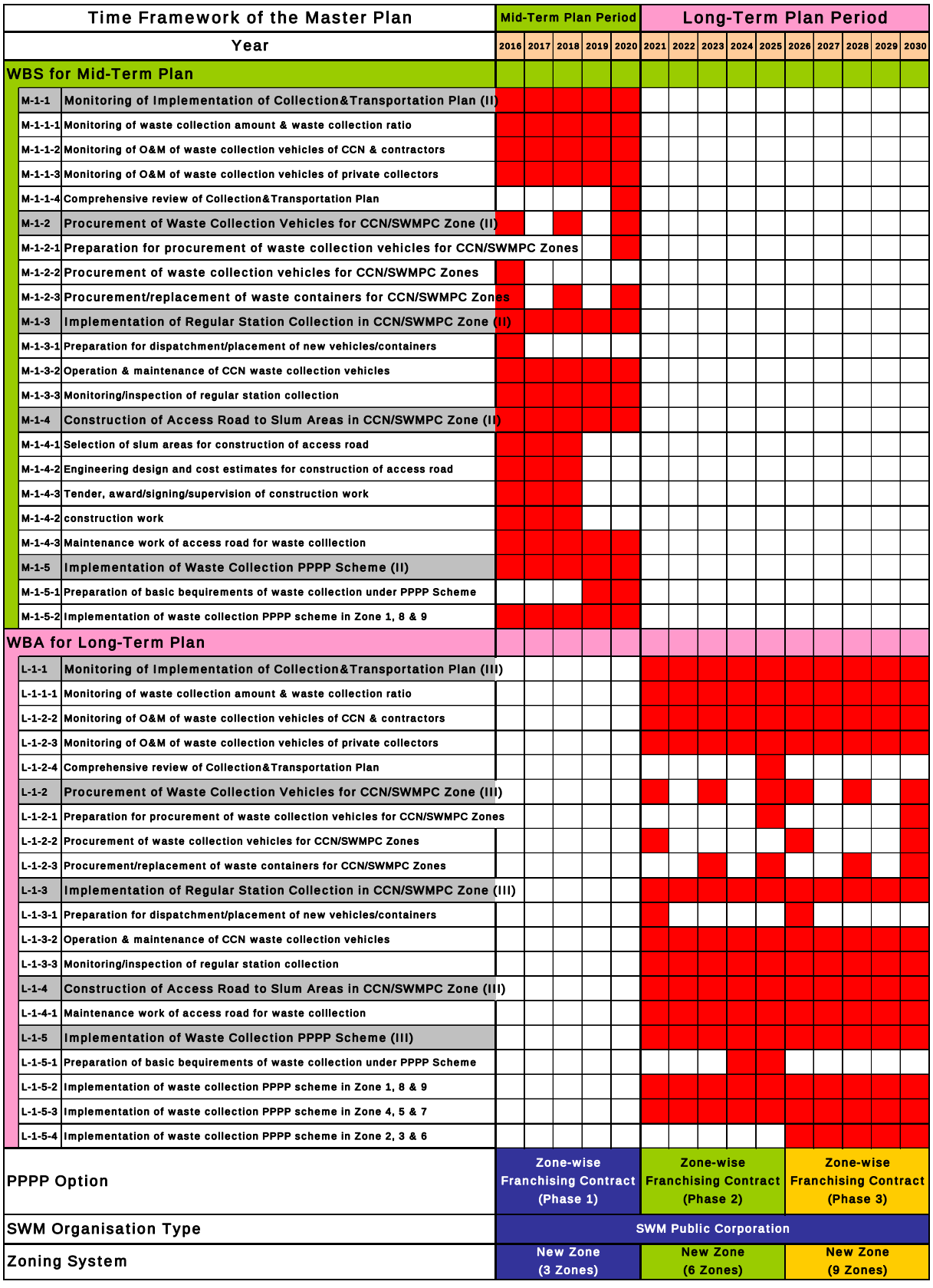


Figure D.4.9 Plan of Operation of 3R and Intermediate Treatment Plan (Mid- and Long-Term Plans)

Programme No.	WBS No.	WBS	Legal Action (Required=●)	Name of Act/Regulation/By-law	Budgetary Arrangment (Required=●)	Total Budget (Thousand Ksh)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																			
							CCN/Dept. of Environment	CCN/Dept. of Treasury	CCN/Dept. of Procurement	CCN/Dept. of Human Resources	SWM Peraparatory Committee	SWM Copporation	MoLG	MoNMD	NEMA	Office of Deputy Prime Minister and MoF	KRA	Donor Organisations	Private Contractors	Private Licensed Collectors	Recyclers	CBOs	Waste Pickers	PAPs around Dandora Dumping Site	PAPs around New Dumping Site	Nairobi Citizens
Programme 1: Collection and Transportation Plan (Case A-1: Direct Haul to Ruai)																									
Short-Term Plan																									
	S-1-1	Formulation of Waste Collection Implementation Plan			●	CCN	M	B											P	P		P				
	S-1-2	Monitoring of Implementation of Collection&Transportation Plan (I)			●	CCN	M	B											P	P						
	S-1-3	Implementation of Urgent Waste Collection Plan			●	7,344	M	B											P			P				
	S-1-4	Procurement of Waste Collection Vehicles for CCN/SWMPC Zones (I)			●	621,049	M	B																		
	S-1-5	Implementation of Regular Station Collection in CCN/SWMPC Zone (I)			●	204,820	M	B																		
	S-1-6	Construction of Access Road to Slum Areas in CCN/SWMPC Zone (I)			●	76,037	M	B														P				P
	S-1-7	Implementation of Waste Collection PPPP Scheme (I)			●	CCN	M				S		S						P	P						
		Sub-Total				909,250																				
Mid-Term Plan																									
	M-1-1	Monitoring of Implementation of Collection&Transportation Plan (II)			●	CCN	M	B				S							P	P		P				
	M-1-2	Procurement of Waste Collection Vehicles for CCN/SWMPC Zones (II)			●	310,151	M					S						P								
	M-1-3	Implementation of Regular Station Collection in CCN/SWMPC Zone (II)			●	671,568	M	B				S														
	M-1-4	Construction of Access Road to Slum Areas in CCN/SWMPC Zone (II)			●	268,187	M	B				S						P				P				P
	M-1-5	Implementation of Waste Collection PPPP Scheme (II)			●	CCN	M	B			S		S						P	P						
		Sub-Total				1,249,906																				
Long-Term Plan																									
	L-1-1	Monitoring of Implementation of Collection&Transportation Plan (III)			●	CCN	M	B				S							P	P		P				
	L-1-2	Procurement of Waste Collection Vehicles for CCN/SWMPC Zones (III)			●	1,043,383	M					S						P								
	L-1-3	Implementation of Regular Station Collection in CCN/SWMPC Zone (III)			●	2,360,646	M					S														
	L-1-4	Construction of Access Road to Slum Areas in CCN/SWMPC Zone (III)			●	27,450	M					S										P				P
	L-1-5	Implementation of Waste Collection PPPP Scheme (III)			●	CCN	M	B			S		S						P	P						
		Sub-Total				3,431,479																				
		Grand Total				5,590,635																				

Figure D.4.10 Cost and Responsibilities of 3R and Intermediate Treatment Plan

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