CHAPTER 10 UMBRELLA CONCEPT FOR FORMULATION OF ACTION PLAN

10.1 Umbrella Concept of Solid Waste Management in the Kathmandu Valley

Action plans (A/Ps) of each of the five municipalities should be developed reflecting their characteristics in terms of solid waste flow, waste quality and quantity, collection methods, waste minimization activities and the associated requirements such as promotion of public awareness and behavior change, and organizational and institutional arrangements. However, it is recommended that some activities to be included in the respective A/Ps should be conducted in a valley-wide in order to maximize the effect of these activities. In addition, in terms of facilities and equipment for intermediate treatment or landfill, the developments need to be done taking into consideration potential for inter-municipal coordination and sharing of these facilities and equipment so that development loads as well as investment and O&M costs be minimized. Table 10.1-1 indicates the components of the A/Ps that need to be discussed for each respective municipality or that may be combined for more than one municipality (zone).

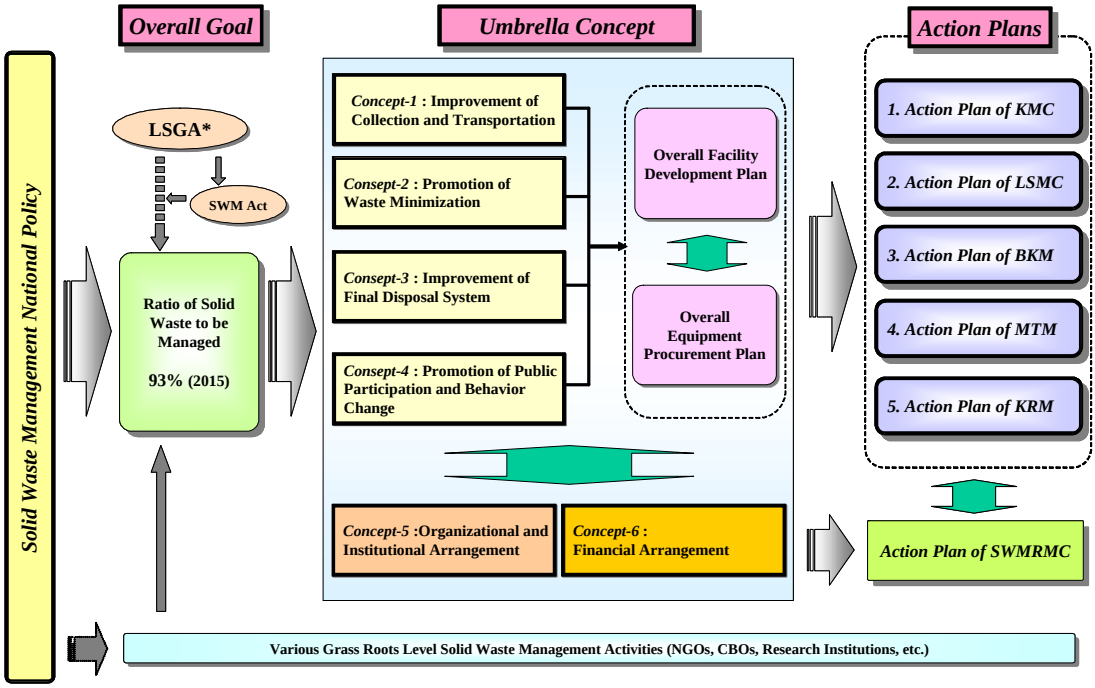
Table 10.1-1 Components of Action Plans

Components of A/Ps	Individual Municipality or Zone
1. Primary and secondary collection	Individual municipality
2. Transportation (transfer haul)	Individual municipality or zone
3. Waste minimization (composting and recycling)	Individual municipality or zone
4. Waste disposal	Zone
5. Public participation and behavior change	Individual municipality and zone
6. Organizational and institutional arrangement	Individual municipality and zone

Source: JICA Study Team

In this connection, a basic concept common for all five municipalities, ***an umbrella concept of slid waste management in the Kathmandu Valley (Umbrella Concept)***, has been proposed to clarify the administrative responsibilities of each municipality and to show a basic direction (road map) for effective solid waste management.

As parts of the Umbrella Concept, four basic concepts, i.e. improvements of collection and transportation and final disposal system, and promotion of waste minimization and public participation and behavior change have been proposed. In order to achieve these basic concepts, an overall facility plan (OFP) and overall equipment plan (OEP) in the Kathmandu Valley have been discussed. In addition, the directions for financial arrangement as well as organizational and institutional arrangement including the involvement of the private sector regarding SWM have been proposed. The overall framework of the Umbrella Concept is shown in Figure 10.1-1.



* Local-self Governance Act

Figure 10.1-1 Overall Framework of the Umbrella Concept of the Kathmandu Valley

Source: JICA Study Team

10.2 Basic Concept for Improvement of Collection and Transportation

10.2.1 Collection and Transportation Practices and Coverage Improvement

In the Study, technical collection and transportation terms are defined as follows:

- *Primary Collection*: The activity to collect the waste from the generation source or street to waste collection points
- *Secondary Collection/Transportation*: The activity to collect the waste from the waste collection points and transport these collected wastes to the transfer station, waste processing facility or the final disposal site.
- *Direct Collection/Transportation*: The activity to collect the waste from the generation source or street and transport these collected waste to the transfer station, waste processing facility, or directly to the final disposal site.
- *Secondary Transportation*: The activity to transport the waste from the transfer station or waste processing facility to the final disposal site.

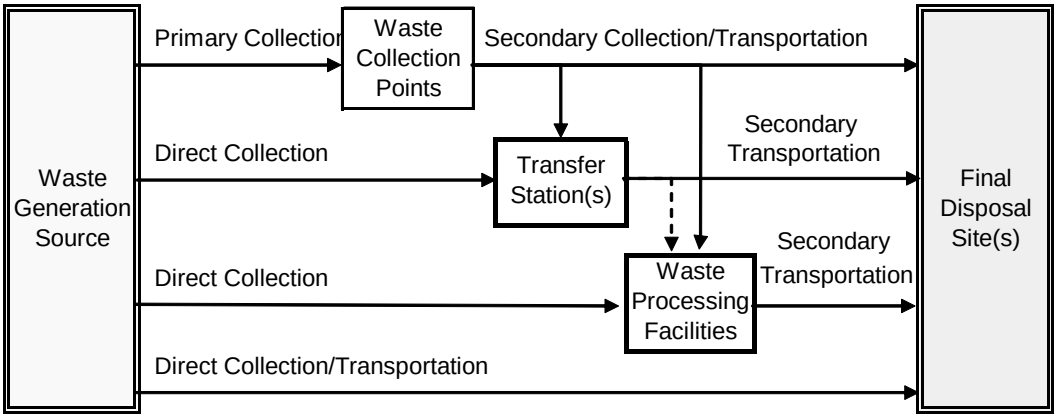


Figure 10.2-1 Collection and Transportation Definitions

Source: JICA Study Team

According to above mentioned definitions, the existing collection and transportation system in the Kathmandu Valley can summarized as shown in Table 10.2-1.

In terms of primary collection, improvement of the management system of waste collection points is quite crucial. Generally at the waste collection points, collected waste is unloaded on the ground directly or into designated containers with a volume capacity of 3 m^3 to 20 m^3. The waste collection points on the ground consume time and cause garbage littering and traffic congestion with unsanitary and severe working conditions. Littering is also a serious problem at the waste containers because the collected or carried waste can be thrown into or around the container any time. Therefore, the one of the concepts for improvement of waste collection points is to shift to a direct collection system like door to door collection.

Table 10.2-1 Summary of the Current Collection and Transportation System

Activity	Manners	Implementation Body		
		Generator	Municipality	Private Sector
Primary Collection	By hand	X		
	Handcart		X	X
	Tri-cycle for Door to Door collection			X
Secondary Collection/ Transportation	Tractor		X	
	Open truck		X	X
	Small container carrier		X	
Direct Collection/ Transportation	Tri-cycle for Door to Door collection			X
	Tractor		X	X
	Open truck for bell collection		X	
	Small compaction truck			
Secondary Transportation	Large compaction truck		X	
	Large Container carrier		X	

Source: JICA Study Team

From the financial view, the cost for street sweeping, including sweepers' wages accounts for a large portion of the municipal expenditure for SWM, for example in Kathmandu Metropolitan City (KMC), approximately 50% of total expenditure was for street sweeping

in 2001[1]. Therefore, the basic concept for street sweeping by the municipality should be to keep its capacity as it currently is, or slightly reduced considering the employment situation of sweepers even though the total generated waste quantity will be increased. Private sectors will take an important role for collection and transportation much more than at the present in order to tackle managing those increasing collected wastes without considerable increment of the municipality's expenditure. Accordingly, utilization of private sectors should be promoted by establishment of appropriate rules or regulations between the municipality and private sectors.

In addition, since most waste collection tractors used by municipalities in the Kathmandu Valley are useful to collect the waste from narrow and congested areas but very old and inefficient and hampered by lower speed, less capacity, frequent maintenance or more exhaust gas emissions, tractors should be replaced with another type of collection vehicle like small sized compaction trucks in the future.

Along with the promotion of waste processing such as composting or material recycling, attempts should be made to introduce source-separated collection to enhance efficient sorting at the facility.

A secondary transportation system with transfer stations should be considered necessary for transporting the collected waste to either the short-term or long-term landfill sites, especially from KMC, Lalitpur Sub-Metropolitan City (LSMC). The secondary transportation vehicles should be a common type for flexible operation through the Valley. Due to restrictions of road condition to the landfill site in Okharpauwa, large transportation trucks of more than 20 tons G.V.W[2] are not suitable. In this condition, the secondary transfer vehicles, both open dump trucks and container carriers should be equipped with 15 m^3 container beds for loading about 6 tons of waste. Container carriers are more flexible because they can also b used for picking up containers at the small transfer points though the cost is higher than the open dump trucks.

Another important concept is to develop a more flexible and smooth operation system to coordinate the different operating shifts, nighttime/early morning collection shift and daytime operation shift of the landfill operation in Sisdol short-term Landfill (S/T-LF) because of difficulties of nighttime operation and transportation.

Furthermore, a mechanical workshop for each municipality should be maintained with suitable equipment and manpower to handle the more frequent and tough operation of the waste collection and transportation vehicles.

The basic concepts for collection and transportation as mentioned above are summarized in Table 10.2-2.

[1] Unfinished Draft Paper of "Solid Waste Management in Kathmandu" prepared by the Solid Waste Management Section of KMC. Total operation cost for SWM in 2001 was Rs 146,994,779, in which the cost for street sweeping was Rs 71,599,885.

[2] Gross Vehicle Weight

Table 10.2-2 Basic Concepts for Improvement of Collection and Transportation

Activity	Basic Concept	Detail and Target
Primary Collection	Control of street sweepers	Number of street sweepers will be slightly reduced by curbing new hiring and promoting a change of occupation. Target number of municipal sweepers: less than present
	More utilization of private sectors	Private sector will take care of collection of increase in quantity of collected garbage in future as much as possible. Experiences of the private participation in KMC, LSMC and Kirtipur Municipality (KRM) should be reviewed and an appropriate rules or regulations for contracts/agreements should be established. Target utilization of private sectors for primary collection: 60% in KMC, LSMC, 100% in KRM.
	Improvement of waste collection points	Except for street sweeping, waste collection points on the ground that need manual loading to collection vehicle by shovel and dust-basket should be abolished. Such waste collection points will be replaced by door to door collection by private sectors or direct collection by small size collection vehicle or movable container. Target: No direct manual loading with shovels in the Valley
Direct Collection	Promoting of Door to Door collection	For promoting door to door collection, it is suggested to evaluate, including to measure the satisfaction of service acceptors, the existing private collection services in KMC, LSMC, Madhyapur Thimi Municipality (MTM) and KRM, and to establish appropriate rules or regulations. Target: Preparation of private door to door collection guidelines
	Promoting Bell collection system	Bell collection should be widely introduced in the Valley with close cooperation with residents by community development activities. Target: All the collection area except the area of Door to Door collection and container collection
Secondary Collection	Abolishment of municipal tractors	From the view of transportation efficiency and air pollution, it is suggested to introduce small sized compaction trucks with 2 to 4 tons of loading capacity when the existing old tractors will be replaced. Target: 100% of municipal tractors will be replaced with the small sized compaction trucks.
Secondary Transportation	Procurement of new secondary transportation vehicles	For transportation of waste from the transfer station in KMC and LSMC, it is suggested to procure new container carriers with 15 cubic meters of loading capacity and within 20 tons of Gross Vehicle Weight. Target: Necessary number of secondary transportation vehicles should be procured when Sisdol S/T-LF starts its operation. The existing equipment will also be replaced with the same type of new vehicles.
Others	Introduction of source-separated collection	Considering that Bhaktapur Municipality (BKM) has more than twenty years experience of operating the composting facility, BKM should start source-separated collection first and other municipalities will follow the system when they operate waste processing facilities or utilize the material recycling system. Target: In BKM as a pilot project, all waste to the existing composting facility should be separated at the generation source. In the future, including other municipalities, at least 50% of wastes are to be separated at the source and the rest are separated at the facility by waste pickers.

Activity	Basic Concept	Detail and Target
	Improvement of mechanical workshops	It is recommended that KMC, LSMC and BKM should improve their mechanical workshops with suitable equipment for regular maintenance only. On the other hand, KMC should also improve the workshop for major repair works and other municipalities can use KMC's workshop or entrust repairs to private workshops. Target: All the equipment should be maintained appropriately at minimum cost.

Source: JICA Study Team

10.2.2 Collection and Transportation Equipment

The existing waste collection and transportation tractors should be replaced with other small size collection equipment but other types of equipment can be used as is. The examples of collection vehicles that can be used in the Kathmandu Valley are shown in Table 10.2-3. In BKM at present, small pick up trucks without tipping devices are mainly used for waste collection. These trucks may be able to be used until around 2010 because they were purchased in 1997. However, by the time of replacement of those trucks, open dump trucks with tipping systems should be purchased.

Considering the experience of KMC that maintains the old equipment in its own way, the usage period of the waste collection and transportation vehicles can be considered to be 15 to 20 years.

Table 10.2-3 Collection and Transportation Vehicles

Type of Vehicle	Purpose of Use and General Specification	Example Photo*
Tri-cycle	- Primary collection - Direct collection + Loading capacity: 0.5 cubic meter + Easy to access Door to Door + Manual oriented and low speed	
Open dump truck	Primary collection Direct collection + Loading capacity: 3 - 4 cubic meter + Easy to load and unload the waste + Needs a cover when transporting	
Closed dump truck	Primary collection Direct collection + Loading capacity: 3 - 4 .5cubic meter + Easy to prevent littering and odor + Very troublesome to open and close the lid	

Type of Vehicle	Purpose of Use and General Specification	Example Photo*
Small size compaction truck	Primary collection Direct collection + Loading capacity: 2 - 4 tons + Easy to prevent littering and odor + High efficiency by compacting waste + Needs special mechanical maintenance	
Secondary collection truck (Small container carrier)	Secondary collection + Loading capacity: 4 – 6 cubic meter + Easy for quick loading + Needs careful management of container at the collection point	
Secondary transportation truck (Large container carrier)	Secondary transportation from transfer station or transfer point + Loading capacity: 15 cubic meter + G.V.W: approx. 20 tons + Chassis: 4 x 2 + Easy for quick loading + Mass transporting + Needs a suitable road condition (Photo shows 20 cubic meter on 6x4 Chassis as reference)	

Note: * Example photos show the typical suggested types of waste collection and transportation vehicles, which are currently used in the Kathmandu Valley.
Source: JICA Study Team

10.2.3 Collection and Transportation Facilities (Transfer Stations)

The streets of the five municipalities are mostly narrow and cannot accommodate large collection trucks. Use of small collection trucks, tractors and tri-cycles for waste collection makes it necessary to provide some transfer stations where these vehicles can unload to larger vehicles to transport the waste to the next destination.

These may be termed small transfer stations or mini transfer points and are directly related to the primary collection activities. A 4.5 to 6.0 m^3 container may also serve as a transfer point for the waste as is practiced at some locations along the ring road (KMC and LSMC).

Considering this, as a basic concept for collection and transportation facilities, KMC should push forward with improvement of construction of another transfer station in Balaju in addition to the Teku T/S improved by the Pilot Project under the Study and, and LSMC should secure the land and construct a transfer station in Afadole or should utilize the waste processing facility as a transfer station. It is also suitable for both cities to have another transfer station in the east part of cites along the ring road for technical and physical aspects, but the proximity to Tribhuvan International Airport may be an obstacle to this plan. Therefore, the waste collection concept in those zones is to set up several waste transfer points with large containers the same capacity as the container suggested for secondary transportation from transfer stations, which is 15 m^3, by strict container management rules.

The transfer stations should be improved/constructed under the following design criteria:

a) Direct load - Collection trucks with tipping devices should mount an elevated platform and discharge their waste directly into larger trucks waiting at a lower level.

b) Indirect load - Collection equipment without tipping devices will discharge their waste onto the concreted slab as is currently practiced at Teku T/S in KMC. For transfer stations that are restricted by area, this indirect loading method should be adopted so that construction cost can be lowered.

c) Transfer trucks should be arm-roll container type with 15 m^3 capacity

d) No compaction should be applied in the transfer process

e) Some working space should be allocated for the recyclable waste picking activities. However space allocation should be done considering the efficient operation of the station.

f) At the start the stations will be allocated two unloading platforms (i.e. space to service two transfer trucks simultaneously) and this should be upgraded to three platforms by the year 2015

g) One way traffic circulation should be applied at the station with minimum traffic interaction between collection trucks and transfer vehicles

h) A truck scale should be installed at each permanent station to weigh the incoming collection trucks (in principle transfer trucks will be weighed at the final destination which is the landfill)

10.3 Basic Concept for Promotion of Waste Minimization

10.3.1 Basic Strategy of 3Rs Activities

There is no doubt that to reduce the amount of solid waste to be handled is one of the most important issues from the view point of the environment, cost for SWM as well as the life span of final disposal site. Waste minimization activities can be categorized into the 3Rs i.e. "Reduce", "Reuse" and "Recycle". Table 10.3-1 shows the basic concept and strategies of 3R activities under the Umbrella Concept.

Table 10.3-1 Basic Concept and Strategy of 3R Activities

3R	Reduce	Reuse	Recycle
Basic Concept	*To minimize generated or discharged waste*	*To use goods or materials which still can be used a number of times*	*To recover waste as raw material and use it for production*
Local People (Generation source)	- To use own bag for shopping in order to avoid taking another shopping bag from the shop	- To think of an alternative utilization of goods before disposal - Repair of broken goods - To hand unnecessary goods over to somebody who needs them	- Home/community composting of organic materials - Separation of waste (paper, metal cans, glass bottles, used paper) to provide them to individual recyclers
NGOs/ CBOs	- Promotion of "Reduce" activities in cooperation with municipality e.g. plastic bags	- Promotion of "Reuse" activities e.g. holding of flea markets, implementation of public awareness campaigns.	- Conducting home composting training - Implementation of community based composting activities - Collection of recyclable materials to sell to scrap dealers - Promotion of recycled goods to be used, e.g. products from milk packages, compost.

3R	Reduce	Reuse	Recycle
Private Sectors	- Coordination with municipalities	- Promotion of reusable materials to the market - Activation of wholesale market for reusable goods	Activation of recycling businesses - Collection of recyclable materials to sell or recycle - Expansion of market for compost and recycled goods
SWMRMC /Municipalities	- Consideration of policy level strategy - Conducting of public awareness campaigns/ exhibitions	- Promotion of "Reuse" activities e.g. support of the related activities, conducting of exhibitions	- Promotion of recycling and home/community composting activities e.g. conducting of composting training, sale of compost kits and public awareness, expansion of recycle market - Operation of centralized waste processing facility - Operation of recycling centers - Coordination with private sectors and NGOs/CBOs

Source: JICA Study Team

As the first step, it is recommendable to minimize the amount of waste at the source level through 3Rs activities. When waste can be reduced as much as possible at the generation source, it means that waste collection and transportation cost, on which municipalities are currently expending a great deal of money, can be minimized.

After 3Rs activities at source level, several kinds of waste processing activities including composting and gas recovery could be considered before disposal at the final disposal site. Accordingly, the life of the final disposal site could be extended.

In the Kathmandu Valley, composting is the most recommendable waste processing initiative from the viewpoint of waste quality (more than 70% of wastes generated are organic), operation and maintenance technology, investment cost, and environmental impact.

On the other hand, recyclable materials, which include plastic, metal, bottles, paper, rubber and textiles should be collected to be recycled as raw materials.

10.3.2 Solid Waste Composting

(1) Objectives of Composting

Though, in general, when composting activities are to be promoted attention is mainly paid to the quality of the compost produced and its market, in reality, it is difficult to produce good quality if the compost is made from municipal solid waste because the municipal waste tends to contain impurities such as fragments of glass and plastics. Although the potential demand for compost is considered to be large in the Kathmandu Valley, actual its consumption greatly depends on the quality and price of produced compost.

In order to promote composting activities in the Kathmandu Valley, the objectives of composting should be prioritized as follows:

1. Minimization of waste
    i. Reduction of cost for waste collection and transportation
    ii. Reduction of cost for sanitary landfill
    iii. Prolongation of the lifetime of landfill sites

2. Recycling of waste
   i. Improvement of community mobilization and public awareness of the environment
   ii. Production of organic fertilizer

(2) Basic Concept for Planning of Composting

Approximately 70% of the generated solid waste is organic. Composting has been conducted actively as shown below:

- In BKM, a composting facility has been operated for twenty years and this has contributed to the buildup of basic know-how of composting of municipal solid waste.
- KMC operated a composting facility from 1986 to 1990 and surrounding farms used the produced compost at that time.
- In each municipality, composting activities have been distributed widely by NGOs/CBOs and municipalities, and public awareness and cooperation for composting has been promoted.

Composting activities in the Kathmandu Valley can be broadly divided into the following three types, i.e. composting facilities community composting and home composting, and their comparison is discussed in Table 10.3-2.

Table 10.3-2 Comparison of Composting Types

No.	Items	Composting Facility	Community Composting	Home Composting
1	Experience in the Kathmandu Valley	Composting facility in Bhaktapur Old composting facility in Teku	Compost chamber in Thimi 3,000 L compost bins in KMC	100 L compost bins in KMC Vermi-composting
2	Source separation of organic waste	Necessary for facility operation	Necessary for community composting operation	Necessary at each house
3	Waste collection and transportation to facility	Wide collection area and long distance transportation	Limited collection area and short distance transportation	Not necessary
4	Separation of non compostable material at facility site	To be required	To be required	Not necessary
5	Operating labor	Many exclusive operators are required.	Exclusive operator is required.	Family members operate
6	Operation and maintenance technique	Harder than community composting	Harder than domestic composting	Easy
7	Installation area	Large area with public consensus is required.	Limited area with community consensus is required	Small space is required in house
8	Investment cost	Very high	High	Low
9	Running cost	High	Low	Low
10	Advantage for public participation	Getting produced compost or revenue by selling compost	Getting produced compost or revenue by selling compost	Getting produced compost or revenue by selling compost
11	Other related Issues	Selection of installation area Financial balance	Cooperation of community	Expansion of number of corporative households

Source: JICA Study Team

Considering the necessary investment and O&M costs, ease of operation, and environmental impacts, home composting is considered to be a practical composting method in the Kathmandu Valley. As for community composting, a pit method is recommended because

of its ease in operation and maintenance. In addition to these local level composting activities, a field heaping method composting facility at the central level, is recommended.

For planning composting, a suitable method with a combination of the above three types of composting should be examined based on the following:

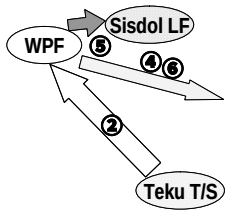
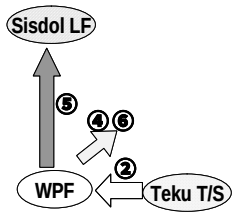
- Existing composting technologies should be utilized as much as possible for sustainable operation.
- Existing activities for distribution of composting should be enhanced.
- Composting facilities should be developed with affordable price.
- Operation and maintenance of composting facility should be easy.
- Environmental protection, especially measures for offensive odors, should be considered.

10.3.3 Planning of Large-scale Waste Processing Facility (Composting)

(1) Location of Waste Processing Facility

KMC, along with SWMRMC, entered into a contract with Luna Nepal Chemicals & Fertilizers (P.) Ltd. in September 2003. This contract stipulated construction of a 300 ton per day composting facility at Aletar in Okharpauwa. However, from the viewpoint of reduction of waste transportation cost, it was suggested that the composting facility should be constructed in or near the city area of KMC and LSMC. Table 10.3-3 shows comparison of the amount of waste to be transported to the final disposal site (Sisdol) if that waste processing facility is constructed at Aletar (Case I) located 28 km from Teku T/S or at Panga (Case II) located 4 km away. Total transportation volume is 9,498 t-km in Case I and 2,604 t-km in Case II, which is about one fourth of Case I. It is obvious that transportation cost in case I is more costly than that of Case II.

Table 10.3-3 Comparison of Transportation Amount

No.	Items		Aletar (Case I)		Panga (Case II)	
1	：Transfer Station ：Landfill Site ：Waste Processing Facility					
2	Amount of solid waste					
	Collected waste at transfer station	t/d,%	100%	300	100%	300
	①Recycle material at transfer station	t/d,%	0%	0	0%	0
	②Waste to composting facility	t/d,%	100%	300	100%	300
	③Waste to final disposal site directly	t/d,%	0%	0	0%	0
	④Recycle material at composting facility	t/d,%	12%	36	12%	36
	⑤Residue at composting facility	t/d,%	15%	45	15%	45
	⑥Compost	t/d,%	18%	54	18%	54
	Total weight of transported material	t/d,%		435		435

No.	Items		Aletar (Case I)	Panga (Case II)
3	Transportation distance (One way)			
	①Recycle material at transfer station	km	0	0
	②Waste to composting facility	km	28	4
	③Waste to final disposal site directly	km	0	0
	④Recycle material at composting facility	km	28	4
	⑤Residue at composting facility	km	2	28
	⑥Compost	km	28	4
	Total transportation distance		86	40
4	Transportation volume			
	①Recycle material at transfer station	t-km	0	0
	②Waste to composting facility	t-km	8,400	1,200
	③Waste to final disposal site directly	t-km	0	0
	④Recycle material at composting facility	t-km	1,008	144
	⑤Residue at composting facility	t-km	90	1,260
	⑥Compost	t-km		
	Total transportation volume	t-km	9,498 100%	2,604 27%

Source: JICA Study Team

2) Composting Method

Though Luna Nepal Chemicals and Fertilizers (P.) Ltd proposed the process which produces organic fertilizer in the fermentation kiln in a few hours by adding lime, phosphorus, ammonium phosphate, a field heaping method should be adopted because Nepal has experiences to operate a composting facility using this kind of method in BKM as follows:

i) Separated waste is received at the composting facility as much as possible.
ii) At the sorting area, non-compostable materials are removed manually, while compostable materials are piled up at the fermentation yard by using a wheel loader.
iii) During composting the heap is turned over and exposed to air for accelerating fermentation at several times.
iv) After about 60 days, raw compost is screened and then final product is harvested.

By pre-feasibility examination on large-scale waste processing facility conducted under the Pilot Project activities, capacity of the facility were agreed to be small (50 or 100 t/d) at the beginning and be increased to 300 t/d based on the experiences of operation and management of waste processing facility.

3) Compost Quality

For sale of produced compost, the constituting standards for compost quality should be taken into consideration; in particular contents of chemicals of compost should be specified clearly. Since there is no standard for compost quality in Nepal, it is recommended that following standards for compost quality from Japan Agricultural Cooperatives (JA) should be referred as shown in Table 10.3-4.

Table 10.3-4 Recommended Standards for Compost Quality

No.	Items	A	B	C	D	E
1	Organic component (min. % dry weight basis)	70	35	35	40	60
2	C/N ratio (less than %)	40	20	20	10	30
3	Total nitrogen (min. % dry weight basis)	1	1.5	2	2.5	1
4	Inorganic nitrogen (min. % dry weight basis)	25	-	-	-	-
5	Total phosphorus (min. % dry weight basis)	-	2	2	2	1
6	Alkalinity (max. % dry weight basis)	-	25	25	25	-
7	Total potassium (min. % dry weight basis)	-	-	-	-	1
8	Moisture content (max. % dry weight basis)	60	50	50	50	70
9	Electric conductivity (max. ms/cm)	3	-	-	-	5
10	Cation exchange capacity (min. meq per 100g dry weight)	70	-	-	-	-
11	pH (max. dry weight basis)	-	8.5	8.5	8.5	-

Note: 1) A. Burk compost, B. Sewage sludge compost, C. Night soil sludge compost, D. Food processing facility sludge compost, E. Livestock excreta compost
2) 1-7 Basic parameters which require quality label, 8-11 Basic parameters which do not require quality label
Source: JICA Study Team

As for standards related to safety, standards for concentration of heavy metals in compost products should be established based on following concepts:

- To avoid increase of concentration of heavy metals or other pollutants in the soil.
- To avoid potential risk for human beings, flora and fauna, and soil microorganisms.

As shown in Table 10.3-5, various standards for concentration of heavy metals in compost have been set in many countries. It is suggested that these standards should be considered for compost.

Table 10.3-5 Standards for Concentration of Heavy Metals in Compost

Countries	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)
Japan	50, (0.3)*	5, (0.3) *	-, (1.5)*	600	-, (0.3)*	2, (0.005)*
USA	75	85	300	4300	840	57
Canada	13	2.6	210	128	83	0.83
Austria	-	4	150	400	500	4
Belgium	-	5	150	100	600	5
Denmark	-	1.2	100	1000	80	1.2
Germany	-	1	100	75	100	1
Italy	-	3	150	200	200	2
Holland	-	0.7	50	25	65	0.2
Spain	-	40	750	1750	1200	25
Switzerland	-	3	150	150	150	2

Units: Amount of heavy metal content dry weight basis (mg/kg)
* No. in parentheses is standard for elution (mg/liter) which applies "standard for landfill disposal of industrial waste subject to special control in Japan."
Source: Eliot Epistein, The Science of Composting 1998

4) Operation Organization and Staff

Considering the lack of manpower and resources for SWM of the concerned government organizations, i.e. SWMRMC, KMC and LSMC, private sector(s) should be involved in development and operation of a waste processing facility. Necessary personnel for operation and maintenance of a composting facility of 100 t/d are about 40 persons.

10.4 Basic Concept for Improvement of Final Disposal System

10.4.1 Shortlist and Ranking of Long-term Landfill Sites

(1) Short List of Candidate Sites

As a first step, the CKV Study Team prepared a short list of candidates for long-term landfill sites (L/T-LFSs). With the on again off again situation at the former Gokarna landfill site, the decade of the nineties was spent in study after study to select a landfill site. Table 10.4-1 shows a list of the past studies and the main results.

Table 10.4-1 Review of Past Studies on Candidate Sites for Landfill Development

SN	Name of Candidate Site	Year of Study	Executing agency	Study Recommendations	Present Land Use
1	Lubhu (SE of Kathmandu Valley)	1991	SWMRMC	Site was deemed suitable for construction of a landfill, but it was recommended to study alternative sites as well for comparison.	Present agriculture and large development makes it difficult to develop landfill there.
2	Champi (S) and Bhimidhunga (NW)	1993/ 94	SWMRMC	Both sites found to be feasible with Champi favored because of its larger area and better access conditions. Work progressed on detailed design for road improvement development but was suspended because of Civil Aviation Authority of Nepal (CAAN) rejection. Site lies directly along the Tribhuvan runway approach.	Partial agriculture and private forest at Champi. In case of Bhimdhunga
3	Lubhu (SE)	1995	Kathmandu Brick Factory	Proposed to develop a landfill and utilize the landfill gas to power a brick factory	Agricultural land
4	Seti devi (SW) short term landfill	1993/ 94	MOLD Task Force	Recommended as a short term site	Agricultural land
5	Okharpauwa and Bhimdhunga (NW)	1994	Environmental Protection Council	Although the Study found Okharpauwa to have a slight advantage over Bhimdhunga, both sites were considered as not “ideal for a sanitary landfill”. The Study recommended performing an EIA for Okharpauwa and conducting quick assessments of other potential sites.	Some agricultural activity is located within the site at Okharpauwa.
6	Ramkot (NW) short term landfill	1995	SWMRMC	Recommended as a short term site. Road constructed. Later, residents objected to the project, which was then cancelled.	Depressed land and forest area
7	Okharpauwa (outside the Valley, NW)	1995	SWMRMC	IEE for Banchre Danda long-term Landfill and EIA for Sisdol short-term Landfill completed.	Infrastructure works under construction at Sisdol and road works to connect to long term site.

SN	Name of Candidate Site	Year of Study	Executing agency	Study Recommendations	Present Land Use
8	20 locations within the Valley	1998	DOMG – BGR	Based on past soil records and investigations done at that time, a map showing potential areas for waste disposal in KV was prepared. Out of 20 areas studied, 5 were considered to have soil with high barrier potential, and 9 with moderate barrier potential.	The only notable use of the Study has been by BKM to develop the Taikabu site. Most of the areas studied have since been developed and potential exists only in the south (refer to following section)
9	Syuchatar (NW) short-term	2000	SWMRMC	Recommended as feasible site for short term.	Presently surrounded by agricultural activity and housing development.
10	Chobhhar (SW)	2001	KMC – KVMP	Recommended for processing facility and land fill.	Abandoned limestone quarry for nearby suspended Himal cement works

Note: SE: Southeast, S: South, NW: Northwest, SW: Southwest
Source: SWMRMC and JICA Study Team

Considering the above candidate sites, the areas investigated in 1998 by the Department of Mines and Geology (DOMG) were re-visited by the CKV Study Team under the kind cooperation of DOMG in order to prepare a short list for long-term landfill candidate sites. It is noted that six years have passed since the implementation of that study by DOMG and in that period development has been rapidly progressing.

Figure 10.4-1 shows the locations of the areas divided into five spatial sectors considering the physical relationship between the municipalities (urban areas) and the areas investigated by DOMG including Banchare Danda in Okharpauwa. A brief analysis of each sector is given below:

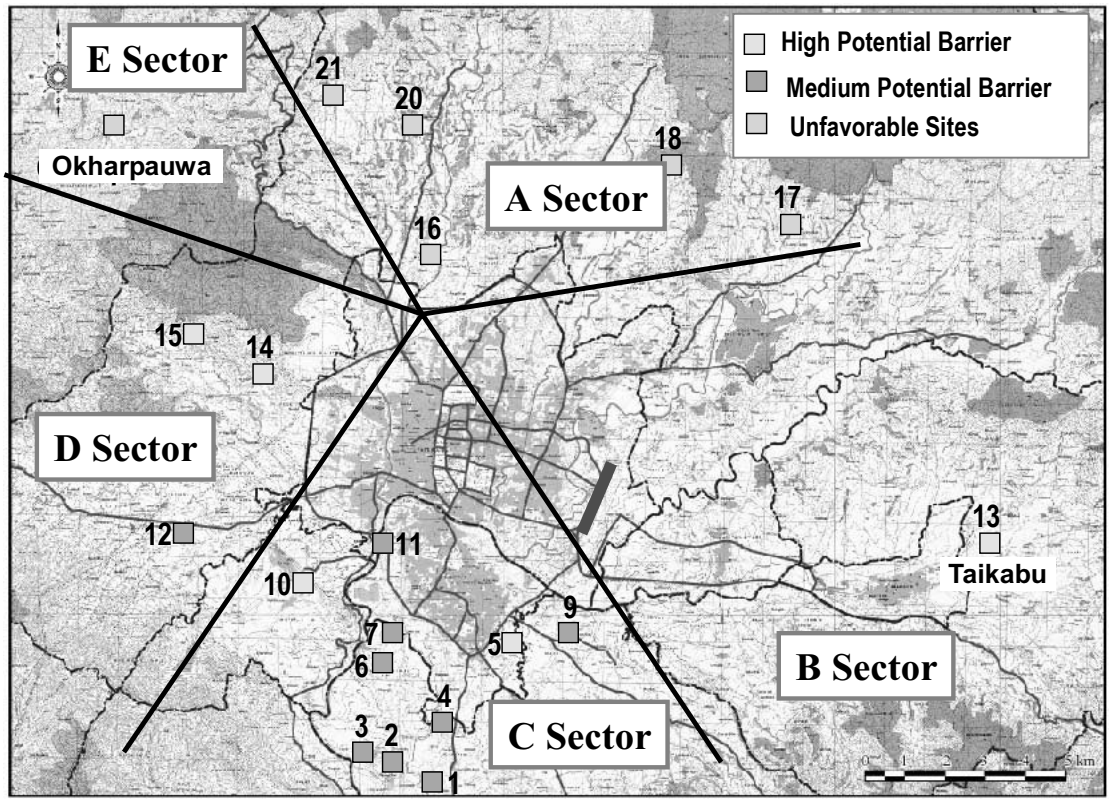


Figure 10.4-1 Locations of 1998 DOMG Study Areas

1) Sector A: (16. Bishnumati, 17. Bhadrabas, 18. Tupek (Chunikel), 20. Sanglatar, 21. Jitpur)

All areas are located north of KMC (north of the Ring Road). With the exception of Tupek (18), the top soil layers are mainly sand and gravel. Tupek (18) is a small area with topsoil composed of silt and loam. Topsoil has been characterized as having low barrier potential.

Agricultural activity is dominant in these areas and settlements have developed there. No sites could be found in these areas which are significantly secluded from residential areas where a landfill could be developed. It should be noted that a couple of potential sites for construction of a waste processing facility (WPF) in Tupek (18) and Jitpur (21).

It is concluded that *landfill development in this sector would not be feasible* because of the social implications involved and the lack of a site with large capacity. However there is room for investigation on construction of WPF for compost to serve the dominant agricultural activity.

2) Sector B: (13. Taikabu)

This area is located in the south east region of the Kathmandu Valley with top soil characterized by clay, silt and loam. The area is classified as having high barrier potential and is suitable for landfill construction. Presently there are many brick factories there making use of the suitable topsoil. BKM has commenced scooping and preparation of TOR for EIA for the Taikabu site. Therefore the Taikabu site has been included in a short list as a candidate site for sanitary landfill development in the Valley.

3) Sector C: (1. Champi, 2. Pharsidol, 3. Setadevi, 4. Bungamati, 5. Harisidhi, 6. Sano Khokana, 7. Magargau, 9. Lubhu, 10. Panga and 11. Sundarighat (Afadole))

These areas are all located south of the Ring Road (with the exception of area (11) Sundarighat) and have high to medium potential barriers (topsoil composed of clay, silt and loam). With the exception of areas (5) Harsidhi and (9) Lubhu, all the areas are located east of the Bagmati River. Both Harsidhi and Lubhu are located in populated areas and Harsidhi is in the airport runway flight pattern. Both are considered difficult for development as landfills.

The remaining sites are located to the south of the Valley. (11) Sundarighat (Afadole) has no capacity for landfill development and is located within the urban fabric. (10) Panga, located west of Kirtipur also has scattered agricultural activity and is surrounded by housing. The area is not sufficiently secluded to develop a landfill there, but its close proximity to KMC and LSMC makes it a strong candidate for development of a WPF. It has been reported by KRM officials, that there are some scattered small but potential land slides around the area. This should be checked in case that a large-scale facility will be constructed.

Areas (6) and (7) have been developed as residential areas since the 1998 study and there is no room for landfill development there. Further south, areas (4) and (1) are located in the airport runway flight pattern and (1) Champi has already been rejected by the Civil Aviation Authority of Nepal (CAAN).

Area (3) is on the west side of Bagmati Nagi and development of a landfill there would require road development. However the area's potential should be further studied. Area (2) and its surroundings offer good potential for securing a landfill site. Two specific sites have been identified in the proximity of Areas (2) and (3) in the course of the Study; one a secluded valley (Pharsidol South) and the second an open valley (Pharsidol North). Both have potential for development of landfills. From the environmental viewpoint, a water well for domestic purposes operated by Nepal Water Supply Cooperation is located at the edge of an alluvial fan in and for Pharsidol South, some examination and consideration may be necessary on the well.

4) Sector D: (12. Satungal, 14. Ramkhot, 15. Bhimdhunga)

These areas are located along the two roads leading westwards of the Valley. The sites have high to medium barrier potential due to the dominantly clay, silt and loam topsoil layer. While the 1998 study recommended these areas for further consideration, present field reconnaissance shows that agricultural activities have developed there along with residential areas. No sites with significant disposal capacities that are also sufficiently far from residential settlement could be observed. Furthermore SWMRMC tried before to develop a landfill at (14) Ramkhot, but was not successful because of residents' objections. It is concluded that these sites may not be considered for landfill development. However there is a potential for construction of a WPF there.

5) Sector E: (19. Okharpauwa (Banchare Danda))

The 1998 study was confined to areas within the valley and this site was added because of the MOLD intention to develop it as a landfill. The 1998 DOMG study did not execute any

new soil investigations in that area, but it was inferred from that study's report that the site had unfavourable geological conditions and excessive distance from the municipality. However this site has been considered further based on MOLD publicized intentions. Table 10.4-2 shows the result of the short listed areas based on the above discussions.

Table 10.4-2 Short Listed Candidate Sites

Sec	Area no.	Short listed	Comment
A	16	WPF	High residential and agricultural development. No site seems available for landfill development. Candidate site for waste processing facility may be investigated there due to favorable access and proximity to compost market area.
	17	X	Residential and agricultural development. No site seems available for landfill development.
	18	X	Same as above.
	20	X	Advanced residential and agricultural development. Access problems.
	21	X	Too distant from the valley and access problems.
B	13	X	Although highly rated by 1998 study, another site in the same vicinity; Taikabu is now under study. The area does not require two landfills.
	-	Y	Taikabu: EIA in progress
C	1	X	Interferes with airport runway pattern. Previously rejected.
	2	Y	Two potential areas (2a and 2b) identified. Capacity for long term landfill available.
	3	Y	Area should be investigated for potential sites. Extensive road development may be required.
	4	X	Same as 1 above.
	6	WPF	High residential and agricultural development. No site seems available for landfill development. Candidate site for waste processing facility may be investigated there.
	7	WPF	High residential and agricultural development. No site seems available for landfill development. Candidate site for waste processing facility may be investigated there.
	9	WPF	High residential density and difficult to develop landfill there. Site for waste processing may be investigated.
	10	WPF	Too close to urban areas and no secluded area for landfill development. Should be considered for waste processing facility.
	-	WPF	Chobhar: Abandoned quarry has a capacity of approx. 250 m^3 and can only serve as short-term landfill for KMC, LSMC and KRM. Further, limestone base is not suitable for landfill and elaborate liner system may be necessary. More ideal for consideration of the quarry surroundings for waste processing construction. May also be considered for Kirtipur waste only.
	11	WPF	Not enough capacity or suitable area for landfill development. Proximity to LSMC urban area and public land availability provides potential for construction of waste processing there.
D	12	X	High residential and agricultural development. No site seems available for landfill development.
	14	WPF	Residential and agriculture activity. No suitable site for landfill development. Previously, landfill development plan rejected by residents. Potential for construction of waste processing facility.
	-	WPF	Syuchatar: Residential and agriculture activity. No suitable site for landfill development. Potential for construction of waste processing facility.
	15	X	Although transport distance to that area is a problem and traffic congestion is observed.
E	19	Y	As the government has committed to this site, it is necessary to carefully study the geological and hydrological conditions there before progressing too much further.

Notes: Y means the sites is to be short listed, while N means no site seems available for landfill development.
WPF denotes areas where there is a potential for construction of waste processing facility only.
Area Nos correspond to the numbers in Figure 10.4-1. Areas without numbers are close to numbered areas covered by the 1998 study, and have been investigated in other studies.

Source: JICA Study Team

(2) Preliminary Comparative Evaluation of Possible Candidate Sites

Based on the above exercise, four candidate sites were identified for possible development of long term sanitary landfills. Preliminary comparative evaluation of these sites was made taking into account field visits and available information as shown in described in Table 10.4-3.

Table 10.4-3 Preliminary Comparative Evaluation of Possible Candidate Sites for Long-term Landfill Development

Evaluation Items	Pharsidol South	Pharsidol North	Taikabu	Banchare Danda
1. Haul Distance	A	A	B	D
2. Location restrictions				
- Airport	C	B	A	A
- Flood plain	B	B	B	C
- Faults	NA	NA	NA	D
3. Land area (Capacity)	B	A	B	A
4. Site Access	C	C	B	C
5. Soil conditions	B	B	A	C
6. Topography	A	B	B	A
7. Hydrology	B	A	C	D
8. Technical feasibility	A	B	A	D
9. Natural environment	B	B	B	B
10. Social environment	D	C	B	A

Note : A to D means favorable to less favorable. NA means not available.
Source: JICA Study Team

At this time Taikabu site appears to be the most promising candidate site. In the case of Pharsidol North and South sites, they are relatively highly ranked, mainly due to more favorable haul distances, potential impermeable soil layers, and topography and hydrology aspects. On the other hand, Banchare Danda has an advantage on social environment. The Pilot Project C-1 has studied the three candidate sites of Pharsidol South, North and Banchare Danda in detail and the results of the study are described in Chapter 8.

10.4.2 Sanitary Landfill System

The last landfill operated in the Valley, the Gokarna landfill, introduced such sanitary measures as collection of leachate, application of cover soil and installation of gas vents. However the concept under which the site was developed and operated is not clear. It is therefore proposed that the new landfills for the valley be constructed under clear standards. Two of these standards; landfill type and landfill level are described hereafter.

(1) Semi-aerobic Landfill System

Decomposition of the disposed solid waste, in particular the organic content, requires time. Although organic matter decomposes under either aerobic or anaerobic conditions, in the case of sanitary landfills, anaerobic decomposition is most common.

Anaerobic decomposition of organic matter produces methane and water, and the decomposition is slow and leachate content is large. On the other hand, under aerobic decomposition, organic matter decomposes into carbon dioxide and water and the

decomposition is rapid. Aerobic decomposition requires a supply of oxygen to be pumped into the landfill, but this is a costly system. To cope with these problems, a particular type of semi-aerobic landfill known as the "Fukuoka Method" was developed as a joint project of Fukuoka City and Fukuoka University in Japan.

In the semi-aerobic landfill, leachate is collected in a leachate collection pond through properly sized perforated pipes embedded in graded boulders. As the outlet of the main leachate collection pipe is always open to air, fresh air is drawn into the layers thereby introducing an aerobic condition around the pipes. Since leachate is removed as quickly as it is formed, the internal layers have lower water content. The differential temperature in the landfill creates natural ventilation and the supply of air to the landfill. The semi-aerobic system is schematically presented in Figure 10.4-2.

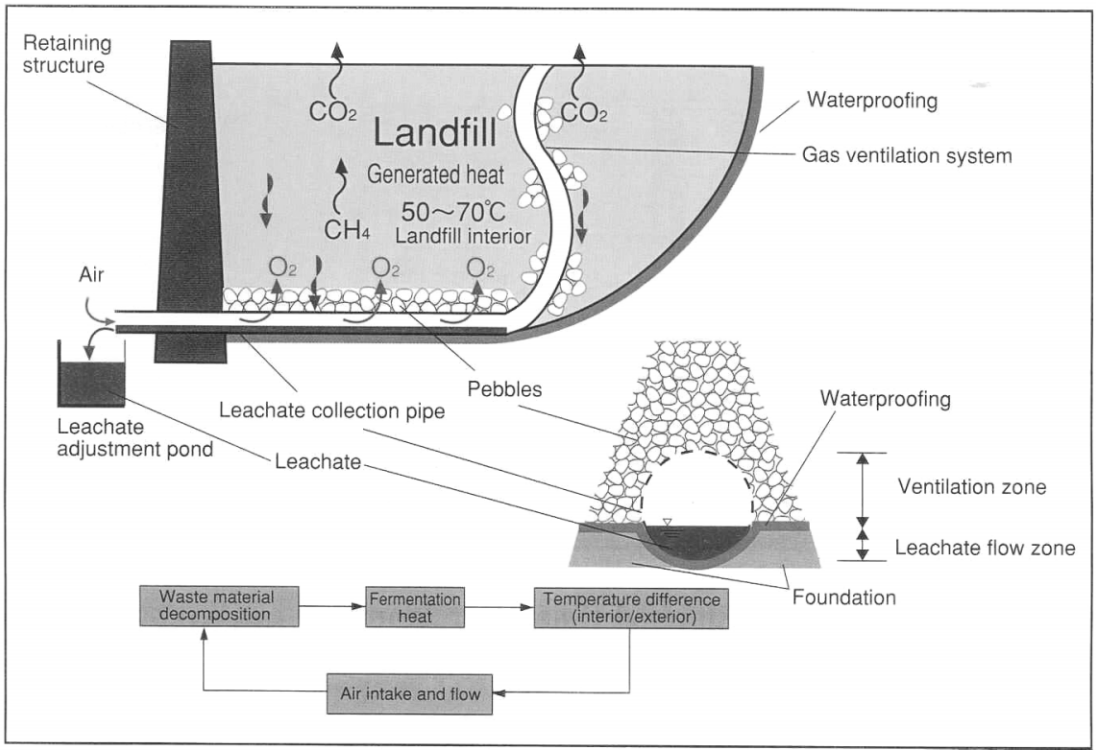


Figure 10.4-2 Schematic Presentation of Semi-aerobic System

Source: The Fukuoka Method, Fukuoka City Environmental Bureau

Landfill sites can be classified based on these microbial environments existing in the landfill layers. Table 10.4-4 compares semi-aerobic and anaerobic systems.

Table 10.4-4 Semi-aerobic and Anaerobic Landfill Systems

Items	Semi-aerobic Landfill	Anaerobic Landfill
Objective	Stabilization of waste by natural ventilation Reduction of leachate toxicity	Maintain the common situation at the landfill
Condition of waste layers	Large parts of the layers are anaerobic Layers surrounding the leachate collection pipes and gas removal pipes are semi-aerobic	Anaerobic condition throughout the waste layers
Leachate collection pipes	Open to air at the pipe outlet Connected with gas vents Larger pipe diameters	Pipe outlet immersed
Gases produced	Roughly divided into CH_4 and CO_2	Mainly CH_4 with some CO_2
Leachate quality	Lower BOD and COD values Rapid decrease in generated volume	Higher BOD and COD values Slower decrease in generated volume

Source: JICA Study Team

As discussed above, a semi-aerobic system has advantages in leachate improvement, reduction of methane gas generation and rapid stabilization of the site. In addition, the technology is cost effective and simple to construct and operate, and allows a high degree of freedom in the selection materials for pipes and accessories. It is therefore suggested to develop the landfills as semi-aerobic systems. Sisdol S/T-LF has been designed under this concept and started operation in June 2005. The results of this Pilot Project should be carefully monitored to determine the suitability of the semi-aerobic landfill system to the waste of the Valley.

(2) Landfill Level

In past JICA studies in other developing countries, four landfill levels have been discussed as shown in Table 10.4-5. Level 4 offers the best countermeasures for mitigation of impact on the environment and therefore it is proposed that the Nepali decision makers aim to achieve that level. However considering the issues of high construction and operation costs for leachate treatment facilities and liner installation, and difficulty in treating the resulting chemical wastes from the leachate treatment, level 3 may be acceptable in the short term.

Table 10.4-5 Sanitary Landfill Levels

Facility	Level 1	Level 2	Level 3	Level 4
Description	Controlled tipping	SLF* with bund and daily cover	SLF* with leachate recirculation	SLF* with leachate treatment facilities
Soil cover	○ (Periodic)	○	○	○
Embankment		○	○	○
Drainage facility		○	○	○
Gas venting		○	○	○
Leachate collection			○	○
Leachate re-circulation			○	○
Leachate treatment				○
Liners				○

Note: *Sanitary Landfill
Source: JICA Study Team

Sisdol S/T-LF is expected to be operated for only 3-4 years and therefore application of a natural liner and leachate re-circulation with natural attenuation treatment is recommended. This may be considered as Level 3 (+).

(3) Landfill Facilities

For the new landfills to be constructed in the Kathmandu Valley the semi-aerobic system and Level 3 are basically recommended. Subject to soil conditions it is also recommended to install a composite liner of geo-membrane sheet overlaying a clay liner. Table 10.4-6 describes the proposed type and facilities for the new landfill in the Kathmandu Valley.

Table 10.4-6 Recommended Facility for Landfill in the Kathmandu Valley

Sanitary Landfill System	Semi-aerobic, Level 3 + (composite liner)
Horizontal Liner	Geo-membrane (2 sheets) + Clay (1.0 m) with Groundwater Drainage
Slope Liner	Geo-membrane (1 sheet)
Leachate Treatment	Biological treatment (aeration and re-circulation) and Natural Reed Bed
Landfill gas	Passive venting
Waste Dams	RC
Perimeter Slope	Basically maintain present slopes with slight adjustment

Source: JICA Study Team

10.4.3 Post Closure Management of Landfill Site

(1) Post Closure Management Aspects

Management aspects with respect to closed landfills include collection and monitoring of landfill gas and leachate, landfill settlement, land use and access control and restrictions and dissemination of information on the use of the site as a landfill.

(2) Post Closure Facilities

For sites constructed and operated as sanitary landfills, the facilities to be provided at the time of closure are reduced to laying of a final cap (which may include a geo-membrane liner), storm water drains, and planting of vegetation. At these sites leachate collection and treatment systems should be continuously maintained and operated up to the period when the leachate quality stabilizes. Post closure management O&M periods may be anywhere between 3-10 years.

For old landfills in the Kathmandu Valley, which were basically operated as dump sites, in addition to the above facilities, it may be necessary to insert some gas vents, reform the waste slopes, insert leachate collection pipes, and install storm water drainage systems, as well as fencing and other measures.

(3) Post Closure Monitoring

Closed landfills will continue to emit gases and leachate for a considerable period, depending on the waste amounts disposed of at the site, waste quality and treatment system applied during the operation of the landfill. Sampling and monitoring of leachate, groundwater, any nearby surface water and landfill gas at least twice a year is recommended.

Monitoring should also cover landfill settlement, which may continue for 3-5 years after site closure.

(4) Situation in the Kathmandu Valley

Recently the SWMRMC has begun work on the safe closure of the Gokarna Landfill site. Since Gokarna was closed, the waste in the Kathmandu Valley has been disposed of along the banks of the Bagmati River. It is proposed that a detailed map of the sections along the river used as dump sites be prepared and the priority sections for safe closure be identified. Priority criteria may include surrounding land use, future potential section land use, potential pollution impacts, etc. For these sites, river bank slope reformation, and installation of leachate collection pipes, landfill gas vents and storm water drains is considered. Figure 10.4-3 shows a schematic diagram of this work.

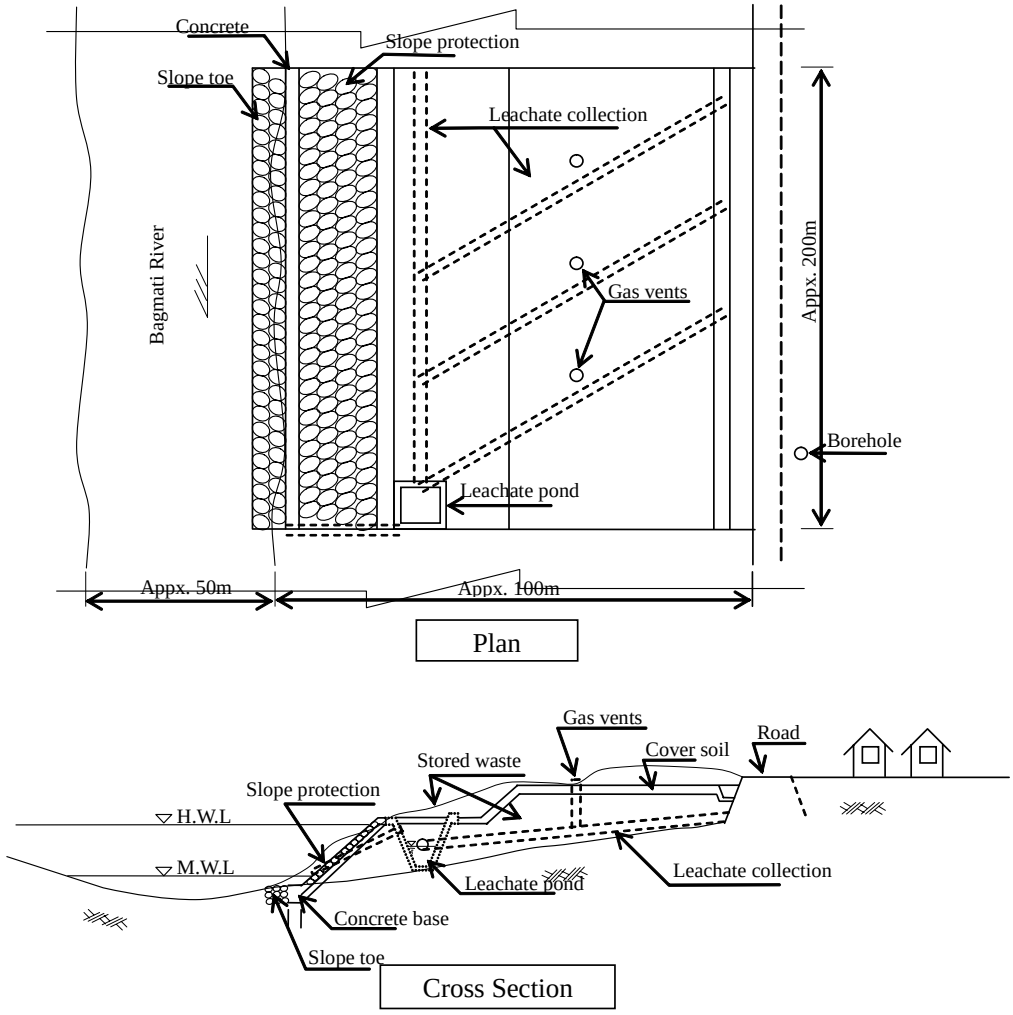


Figure 10.4-3 Schematic Safety Closure

10.5 Basic Concept for Promotion of Public Participation and, Behavior Change

10.5.1 Public Participation and Behavior Change for Effective SWM

A successful SWM program requires various forms of community mobilization and participation. Such community mobilization and participation can be best obtained through early and effective public awareness and education programs, which must continue even after the program is full swing. As revealed through the Household Behavior and Attitude Survey carried out by the Study, people who have a high level of awareness regarding SWM issues were not always involved in SWM activities in practice. People do not suddenly begin to do something they have never done before, although they are aware of a problem and its practical solution or alternative. The following Figure 10.5-1 provides a framework of stages of behavior change. Most people go through a series of these steps, sometimes moving forward or backward and sometimes skipping steps. Even when people adopt new behaviors, they may revert to old behaviors, at least under certain circumstances.

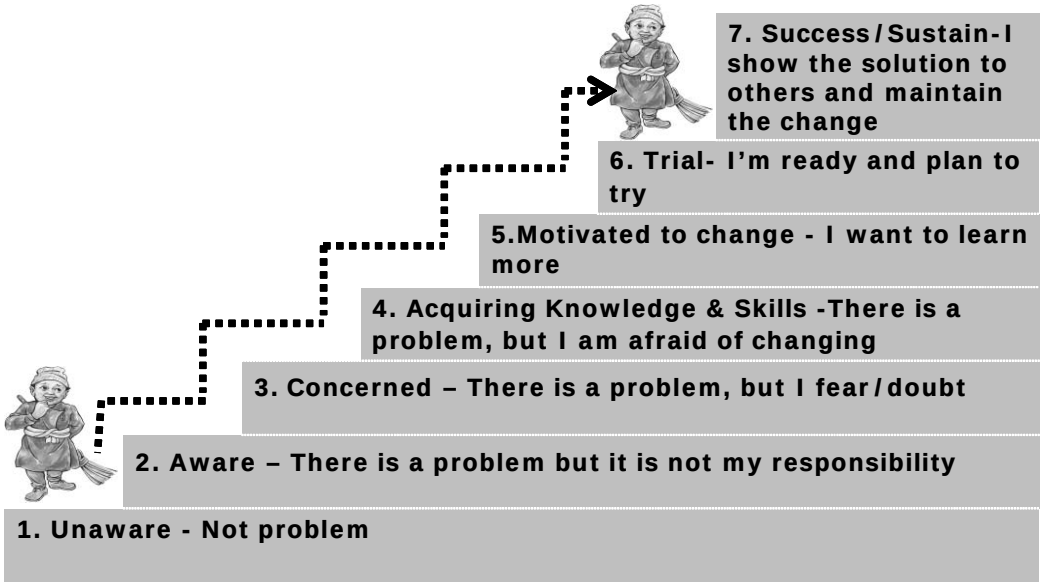


Figure 10.5-1 Behavior Change Stages

Note: The process of changing behaviors and attitudes may happen in sequence. Most people move back and forth between steps before achieving success.
Source: JICA Study Team, adopted from "A manual for communication for water supply and environmental sanitation programs" (UNICEF, 1999), and "How to create effective communication project" (The AIDS Control and Prevention (AIDSCAP)/Family Health International (FHI)/USAID)

Behavior Change Communication (BCC) is considered to be an effective component of a comprehensive SWM program that includes services (e.g. collection and training), commodities (e.g. buckets for collection and compost bins) and policies that promote community mobilization and involvement for SWM. It can impart information and knowledge regarding environmentally friendly behaviors and SWM issues and to promote essential attitude change. It can also contribute to creating a demand for relevant information and services related to SWM, and to improving skills and sense of self-efficacy, which are required to stimulate behavior change. Therefore, BCC is highlighted as one of the fundamental concepts for formulation of an A/P on SWM in the five municipalities.

For integrating a BCC component into an A/P effectively, the following steps[3] need to be taken.

(1) Program Goals and Identification of Target Group/Audience

Since BCC needs to be integrated with the SWM program goals from the start, it is essential to state the overall goals of the SWM program clearly. A series of dialogues with stakeholders and target group analysis can help to identify the target group/audience. Thus, from the design stage of BCC, stakeholders need to be involved as much as possible. If necessary, the target group/audience needs to be segmented.

(2) Formative BCC Assessment and Definition of Behavior Change Objectives

Once the target group is specifically determined, a formative BCC assessment should be conducted in order to grasp the needs, barriers to and supports for behavior change among the segmented target group. Through the formative BCC assessment, the desired attitude or desired behavior changes can be defined in view of the behavior change process (See Figure 10.5-1). At the same time, the BCC objectives need to be precisely developed. The BCC objectives need to be realistic and measurable and to include the following information; Who, What, To What Extent, and When.

(3) Development of Messages

After the BCC objectives are set, it is necessary to develop messages that will appeal to the target groups/audiences and help them to achieve the desired attitude or the behavior changes. The messages should be clear and simple so that the target group/audience can easily recognize and remember them. Effective messages also help the target/audience to create a supportive environment for practicing a variety of SWM activities at household and community levels.

(4) Communication Channels

In the process of incorporating a BCC component into A/P as well as Annual Work Plans, it is substantially important to determine the type of communication channels or media that would be most effective for the target group/audience. The following Figure 10.5-2 illustrates different types of communication channels in the framework of BCC.

[3] These steps have been developed by FHI ("BCC for HIV/AIDS A Strategic Framework, FHI/USAID, 2002) and adopted by a number of BCC programs and projects in the world. Since they can be applied to SWM programs, Interpersonal Communication and BCC Skill Training conducted as part of Pilot Project D-1 for municipal staffs also highlighted and recommended these steps.

Figure 10.5-2 Different Communication Channels/Interventions for BCC

Note: There are some overlapped among these channel /interventions.
Source: JICA Study Team

As the results of evaluation of Pilot Project D illustrate (See Chapter 8.10.1), Mass Communication and Interpersonal Communication as well as Community Mobilization are considered as particularly effective and useful approaches/methods for the five municipalities. It is also essential to use a combination of these ways and reinforce each other.

(5) Pre-testing

Before printing or producing materials and messages, pre-testing is required to determine a target group's reaction to and understanding of these. This is often undertaken by individual interviews or focus group discussion. It is important to revise the materials or messages based on the comments and reactions of the target group/audience.

(6) Implementation, Monitoring and Evaluation

For reaching the target group/audience with the developed materials and messages, specific intervention strategies need to be formulated. It is also critical to draw up a monitoring and evaluation plan for BCC with measurable indicators before implementation. The developed monitoring and evaluation plan of BCC need to be incorporated into the Annual Work Plans for SWM. Following the evaluation, the BCC interventions need to be revised.

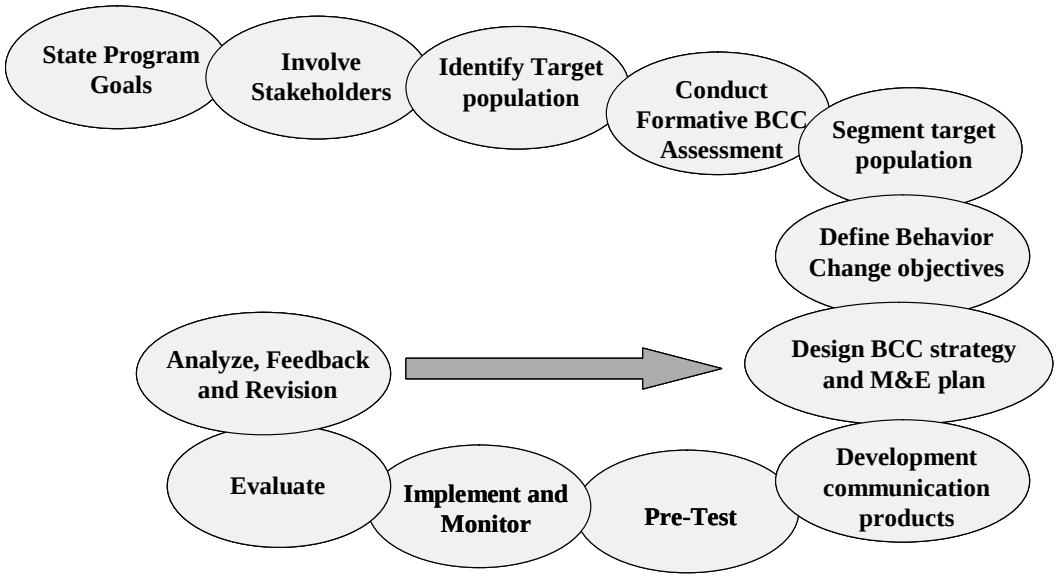


Figure 10.5-3 Behavior Change Communication Design Steps

Source: FHI/USAID, 2002 "Behavior Change Communication for HIV/AIDS, A Strategic Framework"

10.5.2 Mass Communication and Education

Mass communication and education is considered as a useful approach that reaches large groups of people quickly and effectively. Particularly, it helps to disseminate educational messages and basic information on SWM in order to raise awareness and impart knowledge of SWM problems and practical solutions. It includes mass media, small media including printing media, social marketing and public/educational events, as indicated below.

Table 10.5-1 Major Strengths and Weaknesses of Different Media in Mass Communication and Education

Method	Strengthens	Limitations
Mass media -Radio -TV -Films/videos -Audio cassettes -Newspapers -Magazines -Billboards/Hoarding boards :	-Radio, TV and films/videos can reach both literate and illiterate audiences with messages. -Broadcasts of radio and TV can be repeated many times. -Radios are relatively inexpensive and available to many people. -On TV, people can see and hear role models acting out positive behavior. -TV can show people how to do something. -Newspaper and magazines can deliver detailed information to large groups of people.	-Producing a TV or radio program, film/video or audio cassette can be more expensive than print media. -If listeners or readers do not hear or read the message correctly, they do not have an opportunity to ask for an explanation. -Some people do not have access to radio and TV. -Some people cannot read newspapers and magazines.
Print small media -Brochures -Posters -Flip charts -Slides	-Readers can read a message and information many times. -For future reference, print media can be kept. -Print media can be passed to other people. -Producing small media is less expensive than mass media.	-Print small media are only useful for people who can get and read them. -If readers do not read the message or information correctly, they do not have an opportunity to ask for an explanation.

Method	Strengthens	Limitations
Social Marketing	-It is useful to promote commodities with the necessary message and information to reach large audiences.	-It is largely based on appeals to individuals. Specific strategies for inspiring individual interest in adopting innovations are needed. -It is imperative for municipalities to provide subsidized commodities.
Educational/ Public Events -Exhibitions -Campaigns (e.g. clean up) -Rallies -Games -Theater/Songs -Competitions	-Events can deliver messages and information to reach large audiences. -Exhibitions and entertainment education can also demonstrate how to use and adopt new skills and behaviors. -Events and entertainment education promote interpersonal and group communication after exposure.	-It takes time to arrange logistic and coordination with stakeholders. -It costs more than printing small media.

Source: JICA Study Team

Mass media can get messages on SWM out to large groups of people quickly. However, producing awareness programs on SWM through mass media is relatively expensive, which inhibits each municipality from bearing the cost. Thus, it requires inter-municipality coordination among the five municipalities and technical as well as financial support from SWMRMC/MOLD, or other external organizations. Considering the financial constraints in each municipality, it is more realistic to deliver the messages and basic information on SWM to the public from time to time through existing TV and radio programs run by municipalities.

Since print media such as brochures, posters and flip charts is not so expensive, each municipality can produce them with their own financial resources. Several leaflets and booklets were produced during the implementation of Pilot Projects under the Study. It is important for each municipality to make effective use of these developed forms of print media when they implement relevant SWM activities according to the A/Ps. When one municipality produces new printing media, it is more effective to share them among the other municipalities.

Social Marketing, which uses similar commercial marketing techniques for stimulating public behavior change, is useful for promoting commodities with effective messages on SWM. These techniques can be particularly applied to municipalities which plan to promote compost bins at the household and community levels with the message of waste minimization in the A/Ps on SWM.

The experience of Public Events conducted as part of Pilot Project D reveals that these interventions are effective to disseminate basic information on SWM quickly and increase the level of knowledge of SWM among a large number of people. It is noted that such events should be carried out on a regular basis to help the public remember the key messages about SWM. It is expected that all municipalities, in coordination with SWMRMC, will carry out these events at least once a year on Earth Day or Environment Day according to the A/P on SWM. During these events, it is especially important to conduct and link a variety of mass communication and education activities such as exhibitions, campaigns, rallies, street dramas, competitions, and distribution of Information, Education and Communication (IEC) materials. A mix of these interventions is needed to maximize their effects in terms

of reaching a large number of the public. Furthermore, it is necessary to encourage various stakeholders such as NGOs, CBOs, local clubs, schools, media, universities/colleges and line agencies to be involved in these events. Once these events take place, follow-up activities need to be undertaken to reinforce and encourage the maintenance of newly acquired attitudes and behavior. For example, the provision of detailed information and skills on composting through training is one of follow-up activities for target groups who have been made aware of waste minimization at household or community levels during the events. As previously described, it is critical for municipalities to provide an enabling environment to the target group/audience in order to sustain the attitudes and behavior changes. Strengthening the networking among stakeholders is another example of follow-up activities to sustain the desirable attitudes and behavior changes among the public.

10.5.3 Interpersonal Communication and Education

As mentioned above, mass communication and education is an effective approach in terms of imparting information and knowledge on SWM to large groups of people quickly. However, it is a one-way communication channel, which is considered relatively ineffective for behavior change. The interpersonal communication and education approach is recognized as an effective two-way communication channel which encourages interactive dialogue between individuals or among group members. Figure 10.5-4 illustrates the difference between the two approaches. The interpersonal communication and education approach also allows for addressing diverse individuals and group concerns which may influence one's decision, attitude and behavior. The interpersonal communication and education approach, based on personal communication sources and channels, can disseminate, improve and reinforce the acquired knowledge, skills, attitudes and behavior between individuals or among group members.

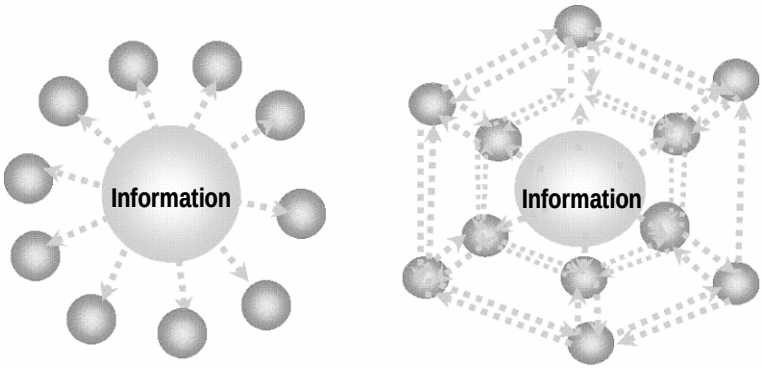


Figure 10.5-4 Difference between Mass Communication and Interpersonal Communication

Source: JICA Study Team

In the framework of the interpersonal communication and education approach, the interaction between trained people and individuals and groups stimulates discussion and the exchange of information. The interpersonal communication and education approach can be applied to any target groups. However, most municipalities have particularly identified the

youth and children as target groups in the process of formulating A/P on SWM since they have potential to be good mobilizers/facilitators for SWM activities among friends, families, and community members. Formation and mobilization of Nature Clubs, Eco Clubs or Children's Clubs is a common strategy for several municipalities in their A/Ps on SWM. The experiences of KMC and BKM show that the selected and trained children can take a lead in encouraging other friends, family members and community members to increase knowledge and skills in SWM, through informal interaction and communication channels, and to participate in awareness programs, clean up programs, compost making, and recycling activities. Mobilization of City Volunteers being conducted by KMC/CMU is also another potential mode of the interpersonal communication and education approach. Students who have a willingness to be involved in environmental activities undertaken by municipalities will be trained and mobilized as volunteers. It should be noted that behavior change among target groups can be brought about when these interpersonal communication interventions and mass communication efforts are well coordinated.

10.5.4 Community Mobilization

Effective community-based SWM activities call for community mobilization. Most of the five municipalities have integrated it into their A/P. As described in Chapter 6.3 (4), there have been inadequate community mobilization strategies in the past interventions. It is imperative for each municipality to take the BCC design steps described in Section 10.5.1 and consider the following aspects when promoting community mobilizations.

- In the beginning, small scale activities should be undertaken for community mobilization in relatively limited areas. These activities need to be formulated and carried out based on the behavior stages of target groups.
- Particular focus should be given to institutional building in newly-established groups through orientation and sensitization workshops at the initial stage of community mobilization. In Nepal, where a strong patrimonial culture and patriarchal system have existed for a long time, newly-formed groups and particularly deprived groups need to be facilitated or encouraged by external actors in order to take responsibility for what they are doing themselves. In addition to such facilitation, regular monitoring and follow up activities are required for the external actors to bring about the new ideas and change among target groups.
- In the process of mobilizing target groups, it is also essential to strengthen their interpersonal communication channels, which help to encourage each member of the groups to carry out community-based SWM activities and to share experience and confidence for their activities. Such interpersonal and group communication can be promoted by interaction activities including regular meetings with rules and regulations, home visits and regular activities among members.
- Community-based SWM does not imply that all the members of the groups are equally responsible for all aspects of activities and services. Further, it does not always mean that all activities related to community mobilization need to be done on a voluntary basis without any payment. If necessary, it is better to consider paying appropriate salaries to some responsible members of the groups. As financial resources, group funds distributed among members often play the role of a driving force in terms of ensuring sustainability of community-based SWM activities.
- To create successful and sustainable community-based SWM activities, it is necessary to ensure genuine participation by all group members, equity by sharing benefits of

activities, transparency through an accounting system as well as consensus-based decision making, and accountability. External organizations, including municipalities, need to put in place effective mechanisms for facilitating and supporting such community mobilization efforts.

Basically, each municipality will carry out community mobilization activities based on their A/P. Unlike Public Events and other mass communication and education activities, the inter-municipal and collective action is not necessarily taken at the planning and implementation stages. On the other hand, most Focal Points who had been involved in Pilot Project D felt that it was very useful and relevant for them to share the experiences of municipal activities related to community mobilization and exchange their own views on some issues through a series of sharing meetings. Some municipalities have acquired new ideas from these meetings that took place eight times covering a variety of topics, and integrated them into their A/P on SWM. As revealed in the evaluation of Pilot Project D, sharing meetings have provided an enabling environment that encourages interactive dialogue among the five municipalities and SWMRMC. Besides the Pilot Project activities, they formally and informally contacted one another and coordinated several activities such as provision of compost bins and resource persons for community-based SWM training. Through discussions at the 8th Sharing Meeting, it was confirmed that opportunities for sharing such as the "Community Mobilization Network" would be continued even after the completion of the Study. It is expected that the five municipalities and SWMRMC will take turns serving as facilitator for the Community Mobilization Network and meet jointly as necessary in order to discuss particular issues and concerns related to a BCC component including community mobilization and community-based SWM activities.

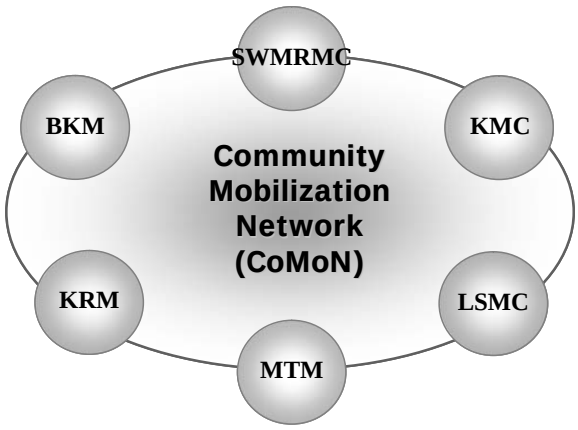


Figure 10.5-5 Concept for the Community Mobilization Network

Source: JICA Study Team

10.6 Overall Facility Development Plan in the Kathmandu Valley

10.6.1 Basic Concept of Overall Facility Plan in the Kathmandu Valley

The principles adopted to develop the Overall Facility Plan (OFP) were threefold:

Principle 1 : Waste Hierarchy

It is understood worldwide that solid waste management practice needs to give priority to waste reduction and resource recovery from the waste stream. Figure 10.6-1 depicts the waste hierarchy under this recognition. Accordingly SWM facilities should contribute to a more balanced SWM system that first works to reduce the waste at the source, re-use, recycle and recover, treat and finally dispose of the waste.

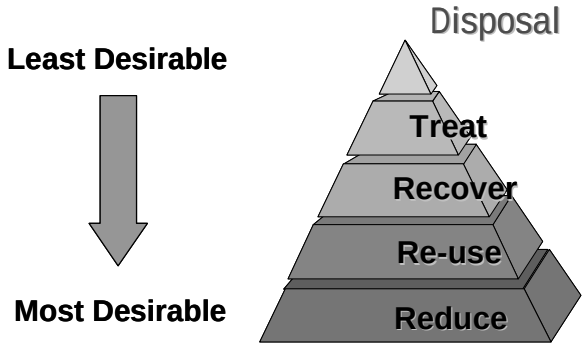


Figure 10.6-1 Waste Hierarchy for Overall Facility Plan (OFP)

Source: JICA Study Team

Principle 2 : Sustainable Facilities

Facilities should be sustainable financially, technically and environmentally, and should suit the existing Nepalese conditions.

Principle 3 : Urgent Implementation

To avoid delays in providing needed facilities, a step-wise approach should be adopted. The past studies and plans were taken into consideration as much as possible.

Consequently, SWM facilities to be covered in the OFP are T/Ss, WPFs, and sanitary landfills (LFs), while T/Ss may include material recovery facilities as well. The process for the development of OFP is shown in Figure 10.6-2. The functions of each type of facility and basic considerations in relation to the Umbrella Concept are shown in Table 10.6-1.

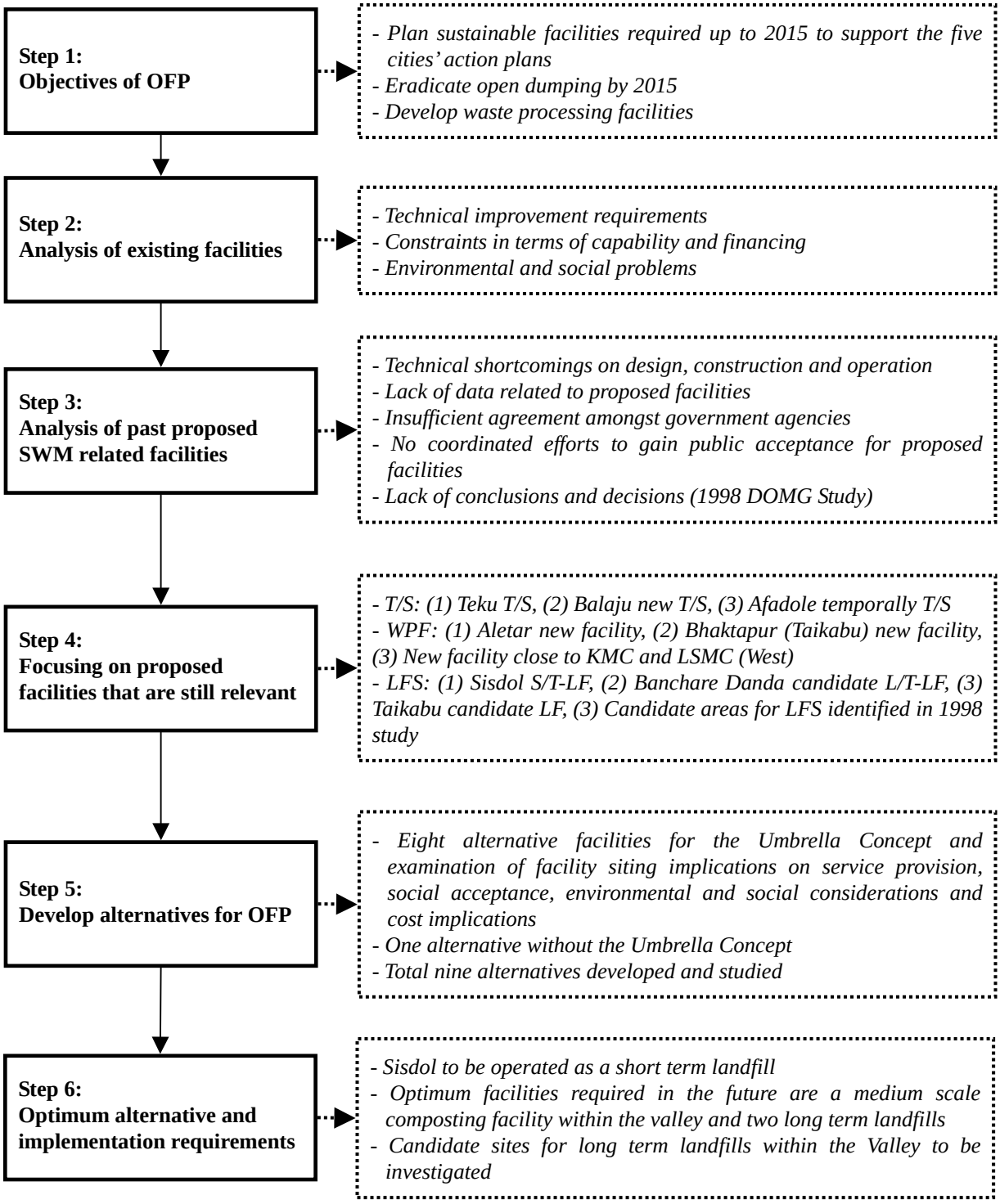


Figure 10.6-2 Process for Development of OFP

Source: JICA Study Team

Table 10.6-1 SWM Facilities Incorporated into OFP

Type	Function	Suitability to Umbrella Concept
1. Transfer Stations (T/Ss) (may include Material Recovery Facilities)	- Important for efficient operation of the collection trucks - May include processing for removal of recyclable components of the wastes - In Nepal important site for scavengers activities - Facilities should be direct loading at split levels and compaction is presently not considered.	- This facility should be located close to the waste generating area and/or recyclables market in order to provide cost efficient transport. Therefore it is more suitable to consider requirements, construction and operation by individual cities.
2. Waste Processing Facility (WPF)	- To support the recycling and resource recovery activities and decrease the waste volume to be disposed of. - Financial constraints and high organic content of the waste in Nepal favor the selection of composting facilities (C/Fs) as WPFs over other systems.	- Waste processing facilities should be located away from residential areas but within easy access of waste generating areas and the compost market. The selected technology should be simple but sustainable. - These factors favor inclusion of these facilities under the Umbrella Concept.
3. Sanitary landfill sites	- To dispose of the collected waste remaining after recycling and volume reduction in an environmentally sound manner	- Land area selection and acquisition requirements, sustainable operation and monitoring during and post operation are very important factors associated with this facility.

Source: JICA Study Team

10.6.2 Alternative Evaluation of OFP

(1) Alternatives Formulation

Observing the waste hierarchy, providing sustainable facilities, and the flow process for preparing the OFP (Figure 10.6-2), a number of alternatives was prepared for analysis.

The alternatives consider the projected solid waste amount in 2015 and determine the ease of implementation and cost implications associated with each alternative. The alternatives are based on the number of landfills to be developed. Alternatives 1a, 1b and 1c call for one sanitary landfill to serve the whole of the Kathmandu Valley with provision of waste processing facilities (WPFs). Alternatives 2a, 2b and 2c call for two landfills to be developed at different locations. Alternative 2c is an offshoot of Alternative 2b but without the waste processing facilities. Alternatives 3a and 3b provide three landfills, and once more Alternative 3b is an offshoot of Alternative 3a but without the waste processing facilities. Alternative 4 portrays the situation where each individual municipality develops its own SWM facilities in the absence of the Umbrella Concept.

(2) Facilities Incorporated in the Alternatives

Table 10.6-2 and Figure 10.6-3 show proposed facilities incorporated in Alternatives 1-3 with comments on their status.

Table 10.6-2 Facilities Incorporated in Alternatives 1-3

No	Facility	Status	Remarks
1	Teku T/S	Presently operated as a transfer site for waste from KMC to the Bagmati River dumping site. Waste is emptied on the ground and then loaded onto transfer trucks by wheel loader. Around 100 scavengers operate here. Presently handles 100-120 t/d. There is no truck scale.	In 2015 the waste amount to be handled here may reach 300 t/d. There is a need to provide a split level direct loading system to increase the handling capacity. Compaction system is not recommended because of high costs involved and leachate treatment problem.
2	Balaju T/S	The site sits along the Bagmati River in an area where waste has previously been disposed of. A plot of land, area 0.6 ha, is available in the Balaju area, north of KMC and near the ring-road. A fence, gates and recording room have been constructed there. The road adjacent to the site is presently being widened (some part of the land has been taken and the fence destroyed) The site is not used presently.	It is reported that the site itself does not rest on reclaimed waste. Construction of this site should be preceded by necessary EIA studies. The adjacent road is presently under improvement with two connections to the ring road being constructed. With these new constructions, access to the proposed station will be much facilitated. However the site is surrounded by residential area and their consent may not be easily obtained.
3	Afadole T/S	LSMC has included this facility in its Action Plan. The site is reported to be located in an area where waste has been dumped for the last few months along the Bagmati River, at Balkhu. It is reported to be on public land.	Site location is conveniently close to LSMC urban area. However the feasibility of constructing the station over reclaimed waste has to be studied. It is also necessary to prepare an IEE and identify the exact location of the site.
4	West WPF	There have been many discussions in the past of the need to construct a waste processing facility near KMC and LSMC. Both the Chobhar quarry site and Afadole site were proposed before. However there seems to be no related detailed study implemented.	It is clear that a facility located closer to the two municipalities (compared to Aletar) would provide much greater advantages in terms of transport costs. The two sites proposed may not be suitable for the required 5 ha to construct a 300 t/d facility. Table 10.4-2 lists eight sites that may be investigated for this purpose. For the purpose of alternative analysis a location west of the two cities was adopted. It was further considered to start with a facility of 100 t/d capacity and gradually expand to 300 t/d by 2015.
5	Taikabu WPF	BKM is now studying two options to replace its existing composting facility. One is to construct a new facility west of the municipality, adjacent to the wastewater treatment area, and the second is to construct the facility inside the new Taikabu LF. The ongoing EIA for Taikabu incorporates this facility but is not clear on specifics.	It is preferable that BKM construct the waste processing facility within the proposed Taikabu LF because of the short distance from the municipality to the landfill and the difficulty to secure a site for the waste processing facility within the densely populated city area.
6	Banchare Danda LF	Site identified. Access road construction in progress.	EIA, land acquisition, natural surveys, detailed design and construction remain.
7	Taikabu LF	Site identified. EIA in progress.	High potential for landfill for BKM and MTM.
8	Pharsidol LF	One of the two sites located near Pharsidol of LSMC may be suitable as landfill based on the preliminary study in Section 10.4.	Detailed studies are required to confirm the suitability of these sites. The airport obstacle should be studied and any impact on the Pharsidol well fields should be studied.

Source: JICA Study Team

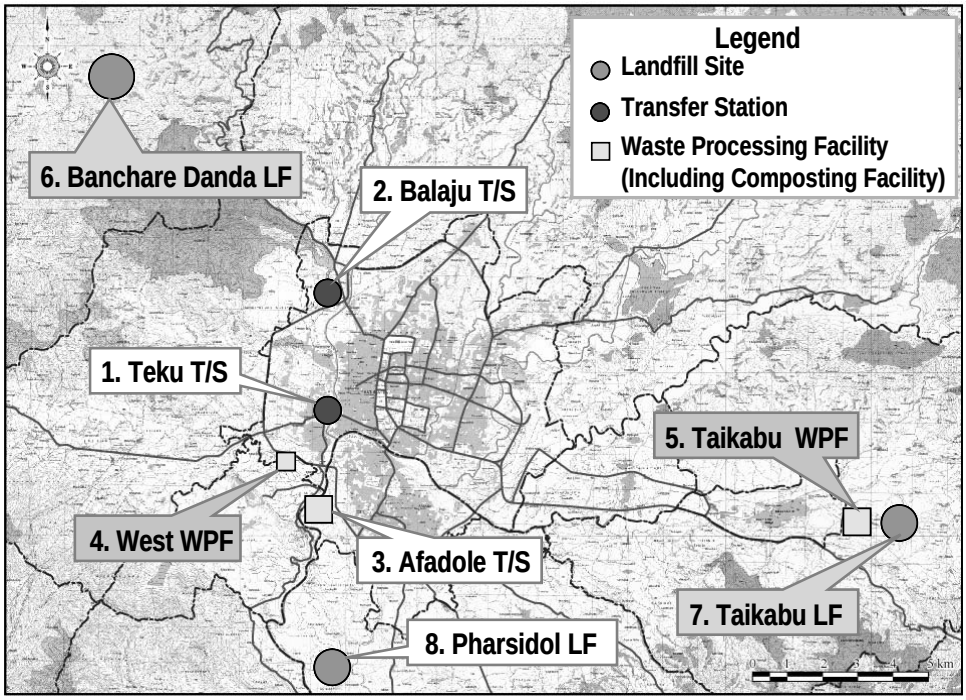


Figure 10.6-3 Facilities Incorporated in the Alternatives 1-3

Source: JICA Study Team

(3) Alternatives Analyzed

The developed alternatives 1-3 and 4 are described in Table 10.6-3.

Table 10.6-3 Alternatives Formulation

Alt	LF	WPF	T/S	Comments
1a	Banchare Danda	West Taikabu	Teku Balaju Taikabu	Alt.1a examines the impact of one LF for the total valley, located outside the valley and the effect of waste reduction by two WPFs. Three T/Ss are proposed due to the distance of the LF. One T/S for both BKM and MTM is proposed to be located at Taikabu where LF is proposed.
1b	Taikabu	West Taikabu	Teku Balaju	Alt.1b locates one landfill within the Valley at Taikabu LF candidate site which is under EIA process. WPF is proposed on an unidentified site west of the two cities to reduce transfer haul distances.
1c	Pharsidol	West Taikabu	Teku Balaju	Alt.1c locates the sole LF for the Valley at a site proposed in the Pharsidol area, Pharsidol of LSMC, and close to the municipalities.
2a	Banchare Danda Taikabu	West Taikabu	Teku Balaju	Alt.2a proposes two landfills, one in Okharpauwa outside the Kathmandu Valley and one in Taikabu. Two WPF are also proposed.
2b	Taikabu Pharsidol	West Taikabu	Teku Balaju	Alt.2b proposes two landfills, Taikabu and Pharsidol, both located within the Valley, and two waste processing facilities.
2c	Taikabu Pharsidol		Teku Balaju (West)	Alt.2c is an offshoot of Alt.2b without the waste processing facilities, in order to study the effect of waste reduction.

Alt	LF	WPF	T/S	Comments
3a	Banchare Danda Taikabu Pharsidol	West Taikabu	Teku Balaju	Alt.3a proposes three landfills and two waste processing facilities.
3b	Banchare Danda Taikabu Pharsidol		Teku Balaju Afadole	Alt.3b is an offshoot of Alt.3a without the waste processing facilities, in order to study the effect of waste reduction.
4	Banchare Danda Taikabu Pharsidol Thimi Kirtipur	Aletar Afadole Bhaktapur Thimi Kirtipur	Teku Balaju	Alt.4 proposes that each municipality achieves its targets through construction of its own individual waste processing facility and sanitary landfill.

Source: JICA Study Team

Figures 10.6-4 (a) to (i) show the waste flows in the case of each alternatives in the year 2015. For the sake of convenience, transportation requirements of the solid waste, in term of ton-km, of each alternative were calculated without any reduction amount at sources. Table 10.6-4 shows the comparative analysis of the nine alternatives, which include eight alternatives under the Umbrella Concept and one alternative without the Umbrella Concept. The main comparison items considered were:

- SWM aspects: How the alternative reflected the proposed waste hierarchy and satisfied the "Proximity Principle"[1]
- Transport aspects: The continued successful operation of the system may be hampered by excessive O&M costs. The transfer haul costs represent the largest portion of the O&M cost and this is reflected in the ton-km produced by each alternative

Supporting items which were analyzed are the technical aspects and environmental countermeasures, extent of land acquisition and social features. Each of the proposed facilities was analyzed under these main five aspects and given a score. Then for each alternative the related facilities were grouped and the total scores were obtained. For example Banchare Danda LF was analyzed individually and then incorporated in alternatives 1a, 2a, 3a, 3b and 4 with the other related facilities.

Alt.4 (without Umbrella Concept) means that each municipality should operate a separate landfill as well as WPF on their own so that not only the above proposed facilities but also other four alternative facilities, i.e. WPF for KRM, WPF for MTM, LF for KRM and LF for MTM, are to be developed at different locations. Consequently it is clear that Alt.4 (without Umbrella Concept) is the least favorable. The burden would be very heavy to construct such a large number of facilities from all the aspects. The capability of the individual municipalities to construct, O&M their respective facilities in a sound manner is much in question. Therefore this Alt.4 is not recommended.

Considering the two main comparison aspects of SWM and transportation, Alt.2b is the best, followed by Alt.1c. The common denominator in both alternatives is the proposed Pharsidol LF, which provides the clear advantage of being very close to the waste generation areas. Alt.2b is better than Alt.1c because it provides two landfill sites for the Kathmandu Valley, and therefore a more dependable SWM system with a back-up landfill. While

[1] The principle whereby waste should be treated and disposed of near the generation area as much as possible to nourish the responsibility of the waste generator for its management, uphold environmental justice, and decrease transportation costs

Alt.3a provides three landfills, two within the Kathmandu Valley and one at Okharpauwa outside the valley, the higher costs associated with construction and operation of three sites may de-stabilize the SWM system. It is therefore considered that alternatives offering two landfills are more favorable.

Alt.2c analyzes the influence of WPFs. As there is no waste reduction in Alt.2c, an increase in the waste transportation of 1,200 ton-km daily over Alt.2b is observed. However the waste amount transported under Alt.2c remains better than Alt.2a, where WPFs are included.

Table 10.6-4 Comparative Analysis of the OFP Alternatives

Alt	Main Items		Supporting Items		
	SWM	**Transportation**	**Technical and Environmental Countermeasures**	**Land Acquisition**	**Social Acceptance**
	Reflects the waste hierarchy, service sustainability and proximity principle	Reflects the costs associated with the waste transport	Reflects the technical difficulties, required extra works and environmental protection countermeasures	Reflects the extent of private land to be acquired	Reflects the facilities' surrounding residential density and cultural aspects
1a	C Landfill far from waste generation areas and lack of back-up landfill site	D 16,500 t-km daily	B Although landfill is technically challenging and requires environmental mitigation measures, only a small number of facilities are required	**A** Landfill is mostly on public land and small number of facilities required	**A** Landfill is in parsely populated area
1b	C Landfill within valley but far from major waste generation areas (KMC and LSMC) and lack of back-up landfill site	C 12,000 t-km daily	**A** Landfill on easy terrain and overlying impermeable soil, and only a small number of facilities are required	B Two facilities on private land	C Sole landfill located in the vicinity of world heritage city
1c	B Landfill closer to waste generating areas but lack of back-up site	B 8,100 t-km daily	B Only one facility, Pharsidol LF lying on impermeable soil but topography features require extensive earthworks	C Three sites on private land	C Landfill located close to culturally important village
2a	B Two landfills and waste processing facility provide balanced SWM although one landfill is far away	C 14,300 t-km daily	C Banchare Danda LF technically challenging and requires environmental countermeasures, and a total of five facilities	B Two sites will require land acquisition	B Taikabu LF located close to BKM (world heritage site) but Banchare Danda LF located in sparsely populated area

Alt	Main Items		Supporting Items		
	SWM	**Transportation**	**Technical and Environmental Countermeasures**	**Land Acquisition**	**Social Acceptance**
2b	**A** Two landfills, both in the Kathmandu Valley and waste processing facility can provide balanced and sustainable SWM	**A** 7,300 t-km daily	C Pharsidol LF lying on impermeable soil but topography features require extensive earthworks and protection for Pharsidol wellfields needs to be considered	C Three sites on private land	C Both Pharsidol and Taikabu LF sites located adjacent to culturally significant sites
2c	D Although two landfills are provided, lack of intermediate treatment defies waste hierarchy principle	B 8,500 t-km daily	C Pharsidol LF lying on impermeable soil but topography features require extensive earthworks and protection for Pharsidol wellfields needs to be considered	C Three sites on private land	C Both Pharsidol and Taikabu LF sites located adjacent to culturally significant sites
3a	C Three landfills may impose financial problems and one landfill is located outside the Kathmandu Valley	C 11,200 t-km daily	D Banchare Danda LF technically challenging and requires environmental countermeasures, and a total of six facilities	C Three sites on private land and only Banchare Danda on public land	C Both Pharsidol and Taikabu LF sites located adjacent to culturally significant sites
3b	D Although three landfills are provided, lack of intermediate treatment defies waste hierarchy principle	C 12,700 t-km daily	D Banchare Danda LF technically challenging and requires environmental countermeasures, and a total of five facilities	B Out of four sites, two (Banchare Danda and Afadole) are on public lands	C Both Pharsidol and Taikabu LF sites located adjacent to culturally significant sites
4	D Too many facilities, no consideration for economies of scale and system will be a financial burden	C 13,700 t-km daily	D Banchare Danda LF technically challenging and requires environmental countermeasures, and a total of 11 facilities	D Too many facilities requiring land acquisition	D Locating so many sites within the Kathmandu Valley is bound to create social problems

Note: A to D; Favorable to less favorable
Source: JICA Study Team

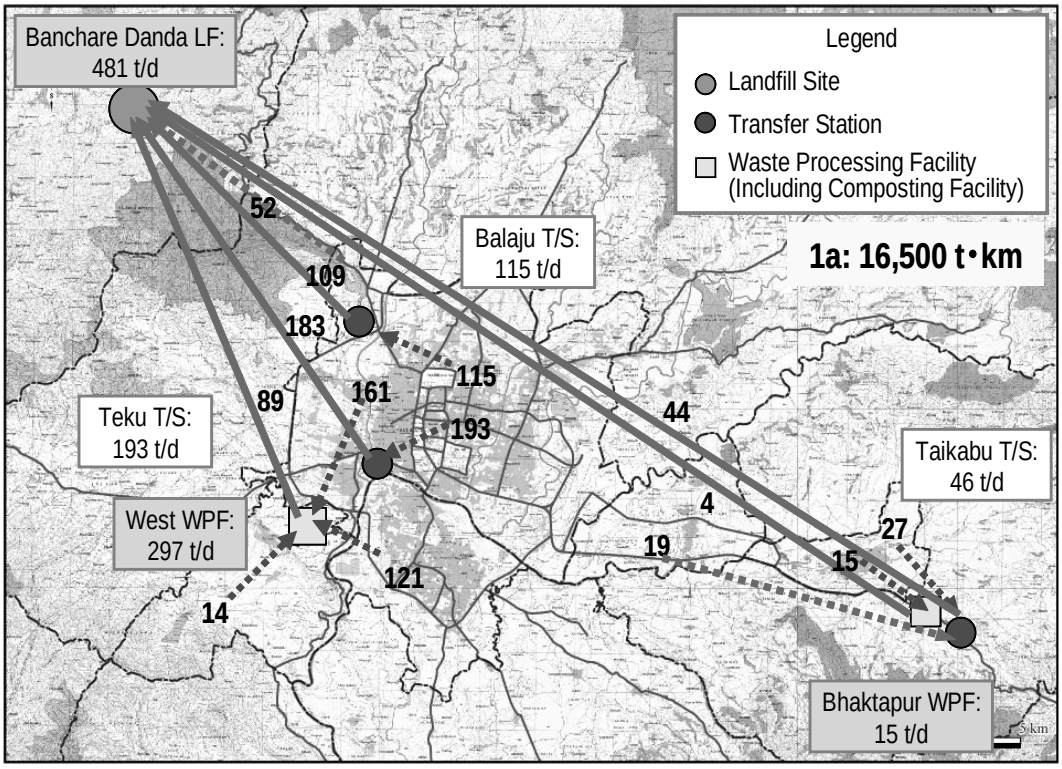


Figure 10.6-4 (a) Alternative 1a of OFP (2015)

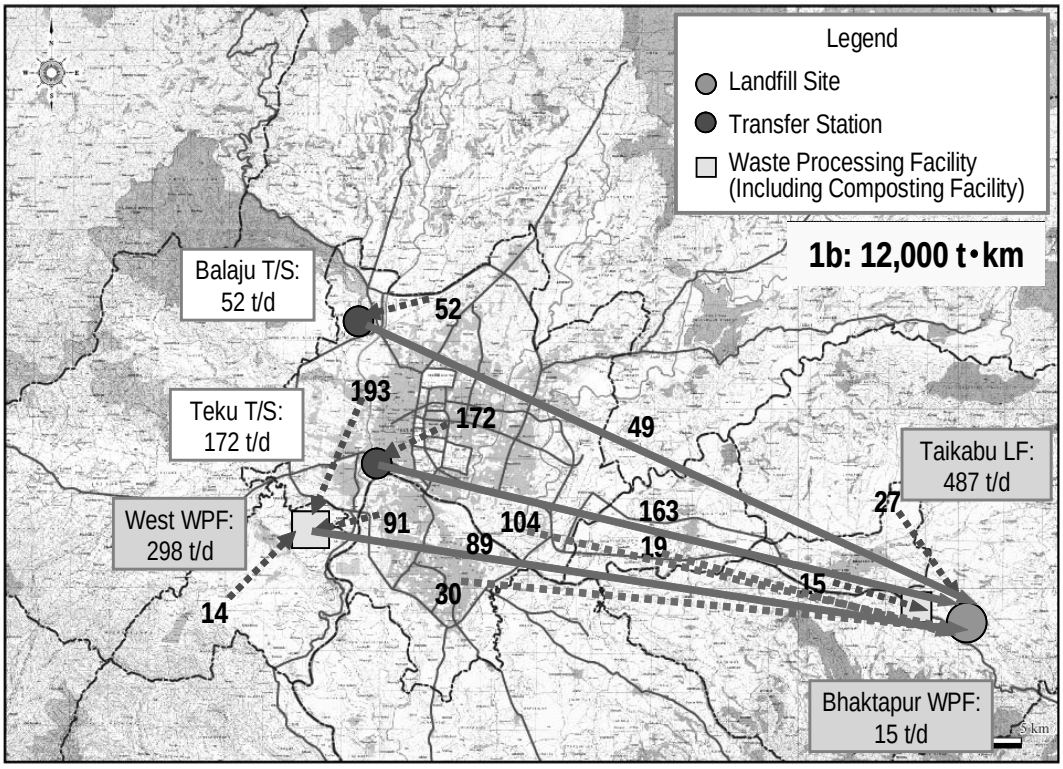


Figure 10.6-4 (b) Alternative 1b of OFP (2015)

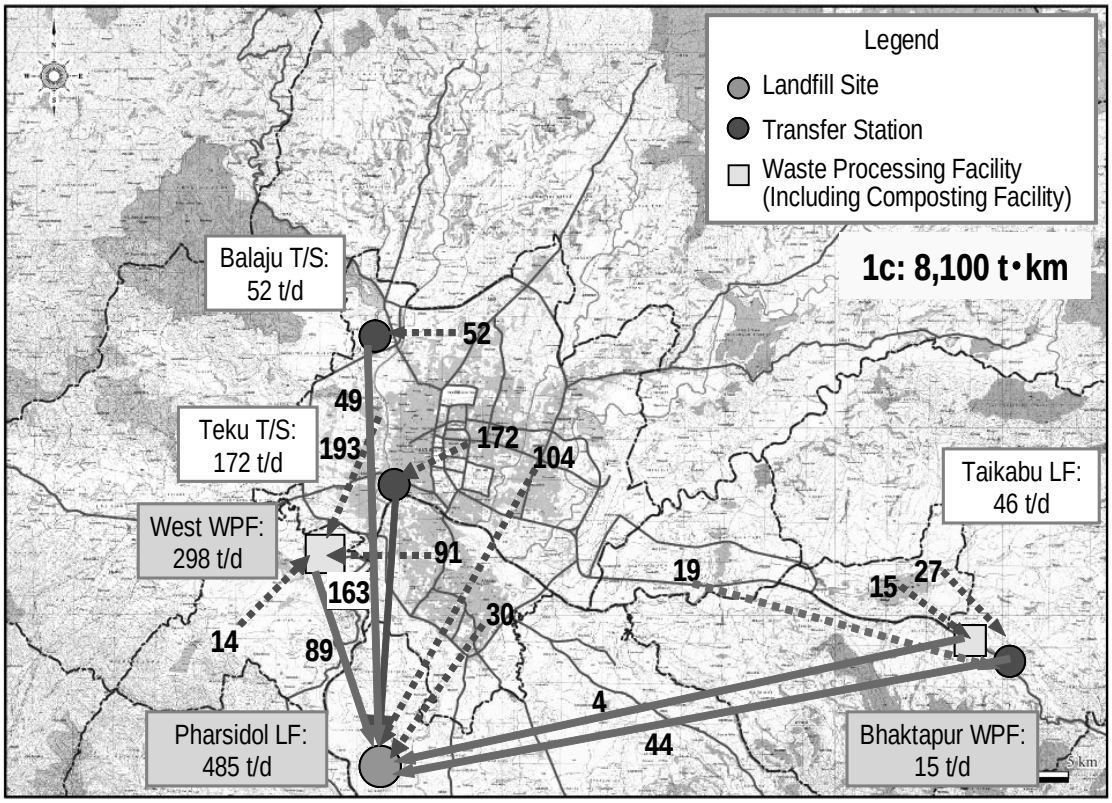


Figure 10.6-4 (c) Alternative 1c of OFP (2015)

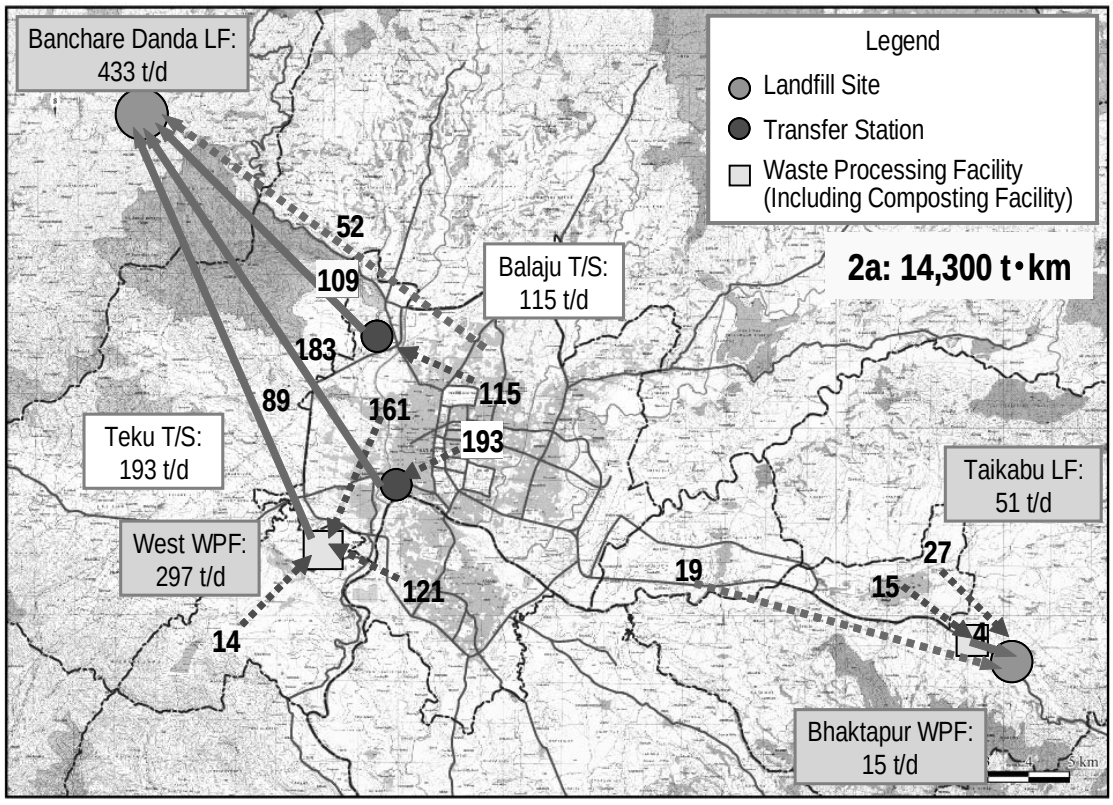


Figure 10.6-4 (d) Alternative 2a of OFP (2015)

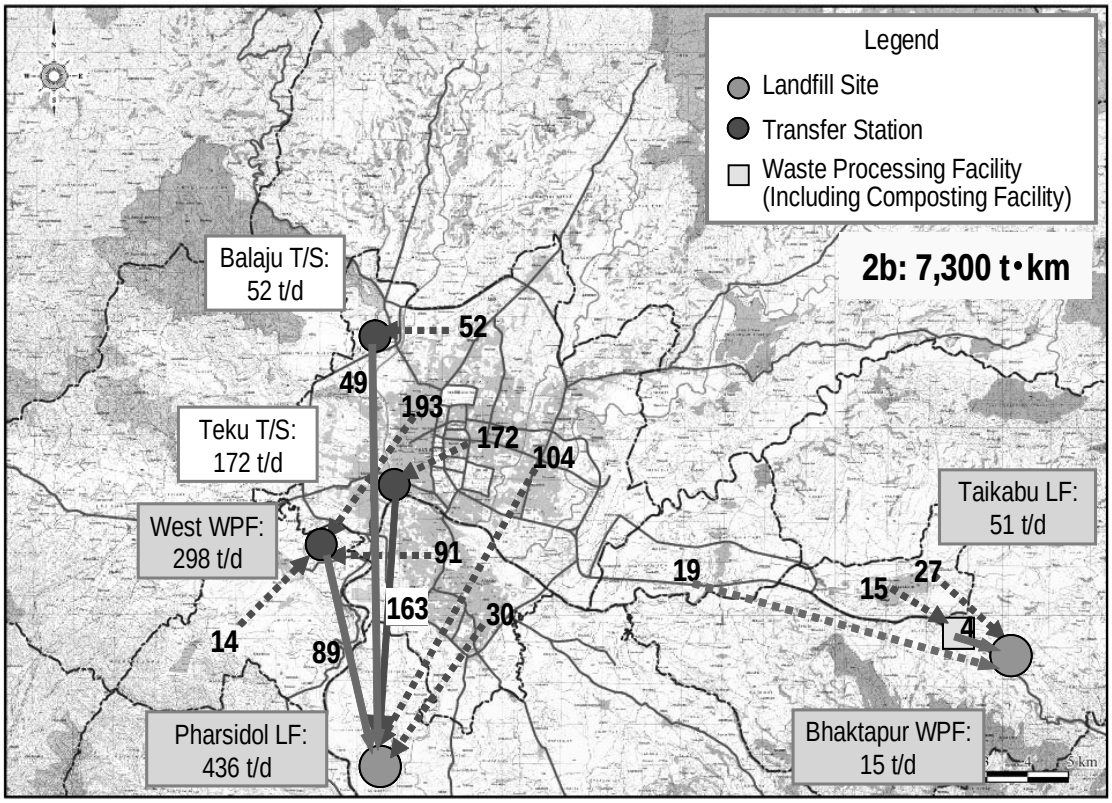


Figure 10.6-4 (e) Alternative 2b of OFP (2015)

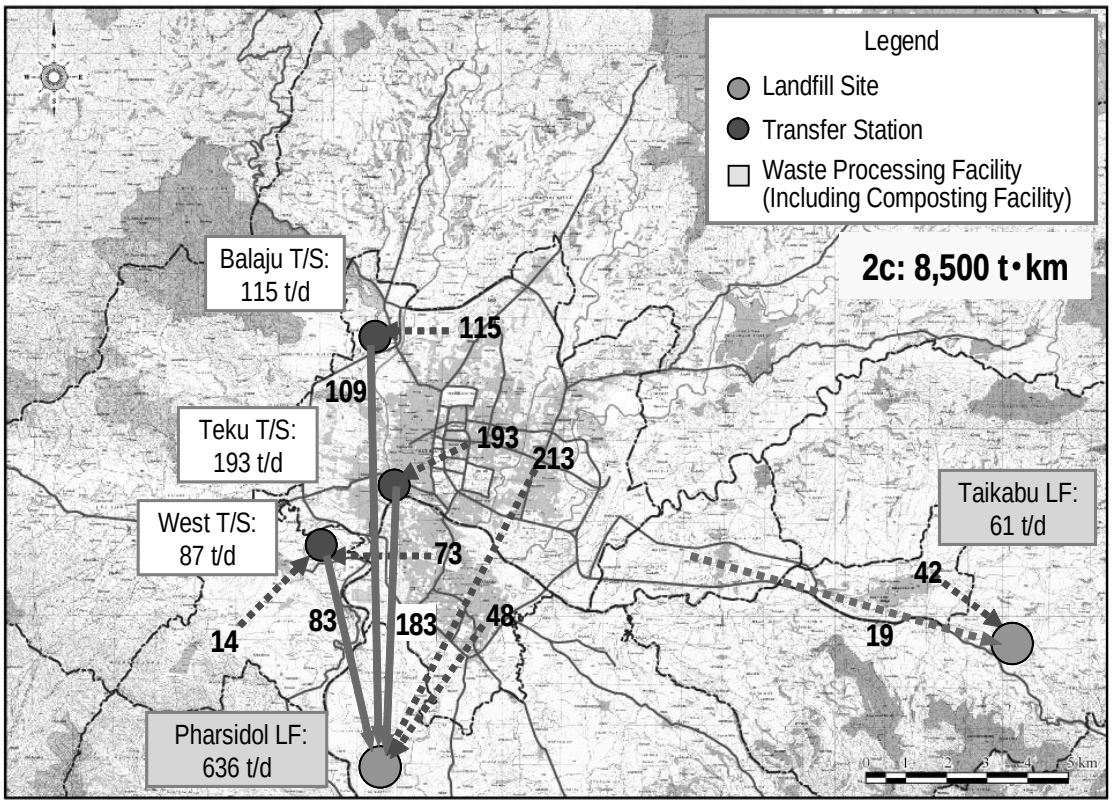


Figure 10.6-4 (f) Alternative 2c of OFP (2015)

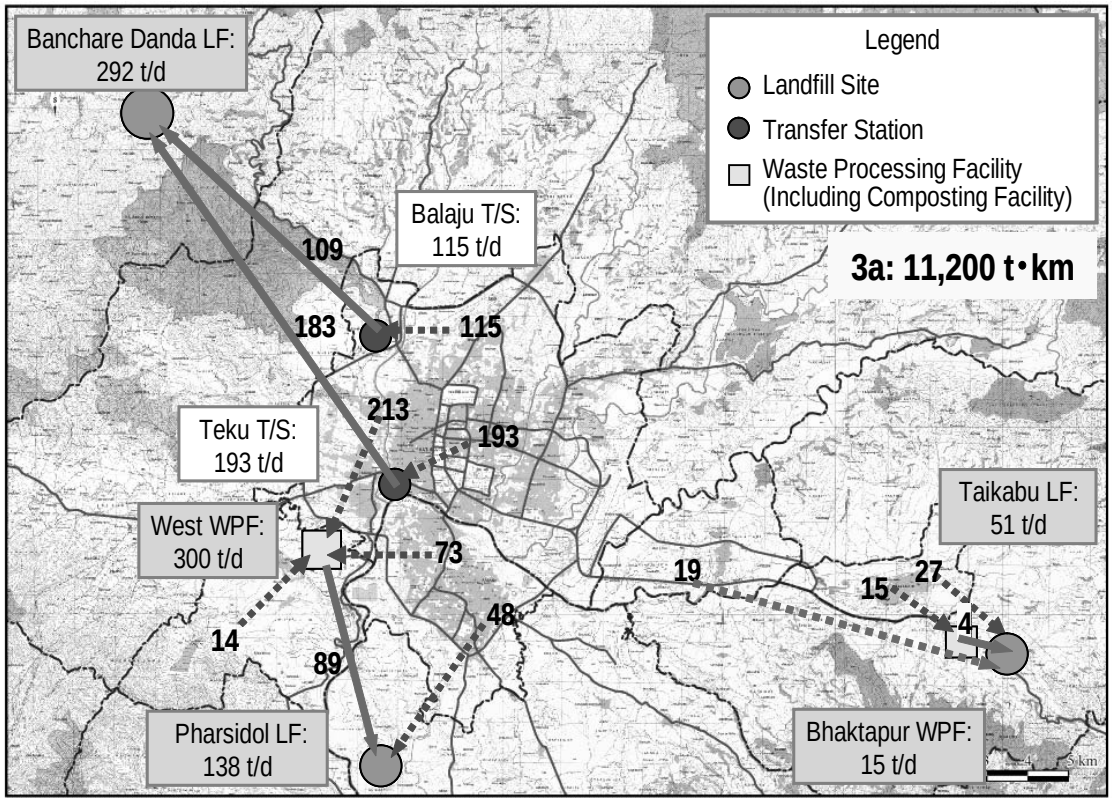


Figure 10.6-4 (g) Alternative 3a of OFP (2015)

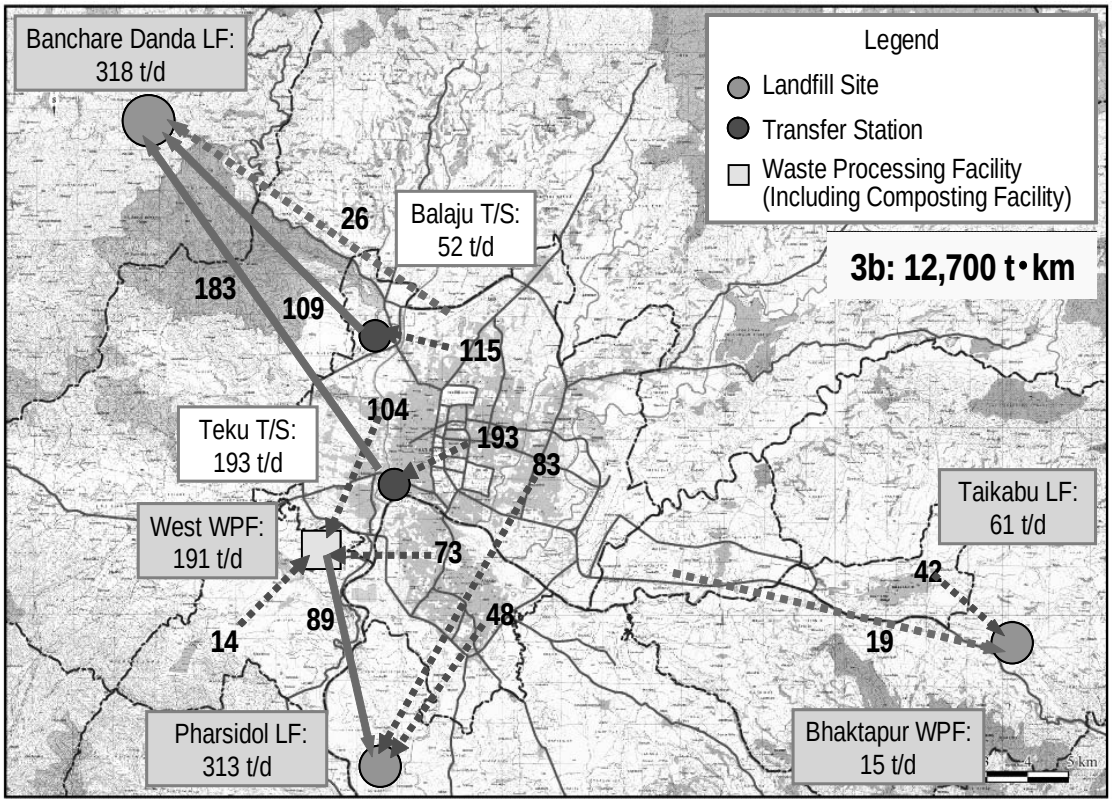


Figure 10.6-4 (h) Alternative 3b of OFP (2015)

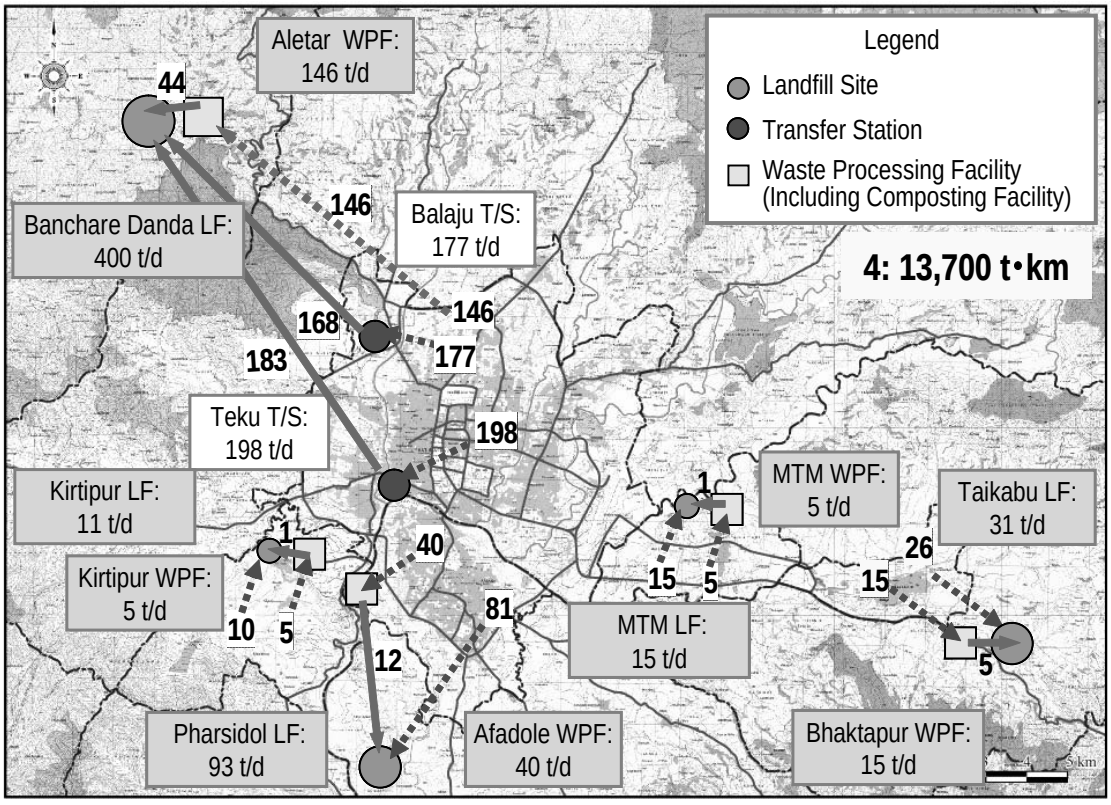


Figure 10.6-4 (i) Alternative 4 of OFP without Umbrella Concept (2015)

10.6.3 Overall Facility Plan (OFP)

(1) Components of the OFP

The above analysis indicated that two landfills and two waste processing facilities would provide stable and sustainable SWM service for the Kathmandu Valley. Therefore either Alt.2a or 2b should be considered.

In terms of waste transportation (waste transfer haul) and related costs adoption of Alt.2a would entail an additional O&M cost of Rs 278.9 million over the period of 2007 to 2015 or an average Rs 24.9 million annually. Table 10.6.5 shows the estimated O&M costs for transfer stations and secondary transportation vehicle (STV) for both Alternatives 2a and 2b. For capital investments the difference is not so large because most of the required STVs with containers have already been decided to be procured by the Non Project Grant Aid of the GOJ.

Table 10.6-5 Alternatives 2a and 2b Waste Transfer Haul O&M Costs (million Rs)

Transfer Haul O&M Costs	2008	2009	2010	2011	2012	2013	2014	2015
Alt.2a								
Transfer Stations	5.6	5.6	7.6	7.6	7.6	9.6	9.6	9.6
STV operation	40.9	44.2	48.4	48.4	51.7	53.3	55.9	55.9
(STV (million Rs/month))	(3.4)	(3.7)	(4.0)	(4.0)	(4.3)	(4.4)	(4.7)	(4.7)
Alt.2b								
Transfer Stations	5.2	5.2	7.2	7.2	7.2	9.0	9.0	9.0
STV operation	14.3	15.7	16.0	16.0	16.0	15.0[2]	15.0	15.0
(STV (million Rs/month))	(1.2)	(1.3)	(1.3)	(1.3)	(1.3)	(1.3)	(1.3)	(1.3)
Difference (million Rs/month)	(2.2)	(2.4)	(2.7)	(2.7)	(3.0)	(3.2)	(3.4)	(3.4)

Source: JICA Study Team

On the other hand, Alt.2a holds an edge over Alt.2b in terms of site allocation. Out of the two sites required, an EIA for Taikabu site is already in process and barring any unforseen cirumstances is expected to be found suitable for construction of the landfill there. The study has narrowed the candidates for the remaining landfill site to two sites; in Pharsidol and Banchare Danda site in Okharpauwa. Table 10.6-6 shows the major characteristics of each site.

Table 10.6-6 Characteristics of Banchare Danda and Pharsidol (N) Sites

Item	Unit	Pharsidol North	Banchare Danda
Area	ha	45	23
Waste maximum height	m	50	100
Waste disposal volume	m^3	6.6 million	9.7 million
Approx. life span	years	22	25

Source: JICA Study Team

A more detailed comparative analysis of these sites has been prepared under Pilot Project C-1 and is discussed in Section 8.7. Pharsidol North site is preferred over Banchare Danda in terms of the shorter transport distance. However there are three major issues which may delay the development of this site. These are the Pharsidol wellfields upon which the site is located and which account for a major share of the drinking water supply of the Kathmandu Valley inhabitants, the direction of Tribhuvan Airport runway and the close proximity of the culturally important village of Khuipa. A great deal of time may be required to resolve these issues and proceed with the development of the landfill there.

On the other hand, the major advantage that Banchare Danda site has over the Pharsidol site is the commitment of the Central Government to develop this site as a landfill (as underlined in the Government's National Plan). Social and cultural issues are much less critical here than in Pharsidol and development may be expected to be much faster. However the Government needs to carefully discuss with the beneficiaries of the site, namely KMC and LSMC on how to bridge the relatively higher haulage costs that are expected from using this site. The OFP, therefore, has been developed based on Alt.2a in order to expedite the process of developing long-term landfill by building on all the effort that has been applied so far and also to clarify the costs incurred.

[2] As the capacity of WPF is gradually expanded the increased waste reduction is expected to reduce the required transfer haul.

Accordingly, the OFP is discussed in Zone A (KMC, LSMC and KRM) and Zone B (BKM and MTM) as shown in Table 10.6-7 based on the covering area by respective landfill sites.

Table 10.6-7 Overall Facility Plan under the Umbrella Concept

Facilities		Description
ZONE A - KMC, LSMC and KRM		
1	Sisdol S/T-LF	
	(1) Valley 1	Valley 1 (PP C-2) will be operated for about 12-14 months
	(2) Valley 2	Valley 2 to be developed and operated for about 12 months
	(3) Post closure	Upon completion of disposal operations at Sisdol, proper site closure will be implemented and environmental monitoring will continue as required
-	Bagmati River Dumping Site	Bagmati River dumping site will cease operation once the new transfer trucks arrive (around Oct. 2005) and all the waste is transported to Sisdol S/T-LF. For a couple of years thereafter, safe closure works will be implemented along the Bagmati River banks where waste has been disposed.
2	Banchare Danda L/T-LF	This LF is expected to be developed within the next three years. It will be operated as a Level 3, semi-aerobic landfill.
3	West WPF	A WPF, basically for compost production but that will also include recyclable materials separation facilities to be developed west of KMC and LSMC and within 7-10 Km distance. The facility will be developed in three phases, starting with an input capacity of 100 t/d and reaching 300 t/d. Residues will be transported from the facility to the landfill.
4	Teku T/S	Teku T/S has been improved with a capacity of 200 t/d (40 t at peak hour). Tipping at the station will continue to be mixed with some loading by wheel loaders.
5	Balaju T/S	Balaju T/S will be developed on the allocated land within 2006. It will be a split level unloading system without compaction. It will have a capacity of 120 t/d.
6	Afadole Temporary T/S	For the first 2-3 years of the Action Plan period, a temporary T/S will be developed for LSMC waste at Afadole. Upon completion of the waste processing facility the LSMC waste will be transported there.
Zone B - BKM and MTM		
1	Hanumante River dumping site	For the next 2-3 years waste will continue to be dumped at Hanumante River bank, with the application of cover soil.
2	MTM temporary LF	The solid waste collected in the central area will be transported to Teku T/S, while remaining waste will be disposed of a temporary landfill with the application of cover soil.
3	Taikabu LF	The Taikabu LF will be developed within the next 2-3 years as a Level 3, semi-aerobic landfill.
4	Taikabu WPF	Within the same Taikabu LF site, a WPF will also be developed. The WPF will have an initial capacity of 10 t/d and expand to 15 t/d.

Source: JICA Study Team

(2) Operation Schedule

With an eye on the short life of Sisdol S/T-LF, the operation schedule for the overall facilities in the Kathmandu Valley was prepared as shown in Figure 10.6-5.

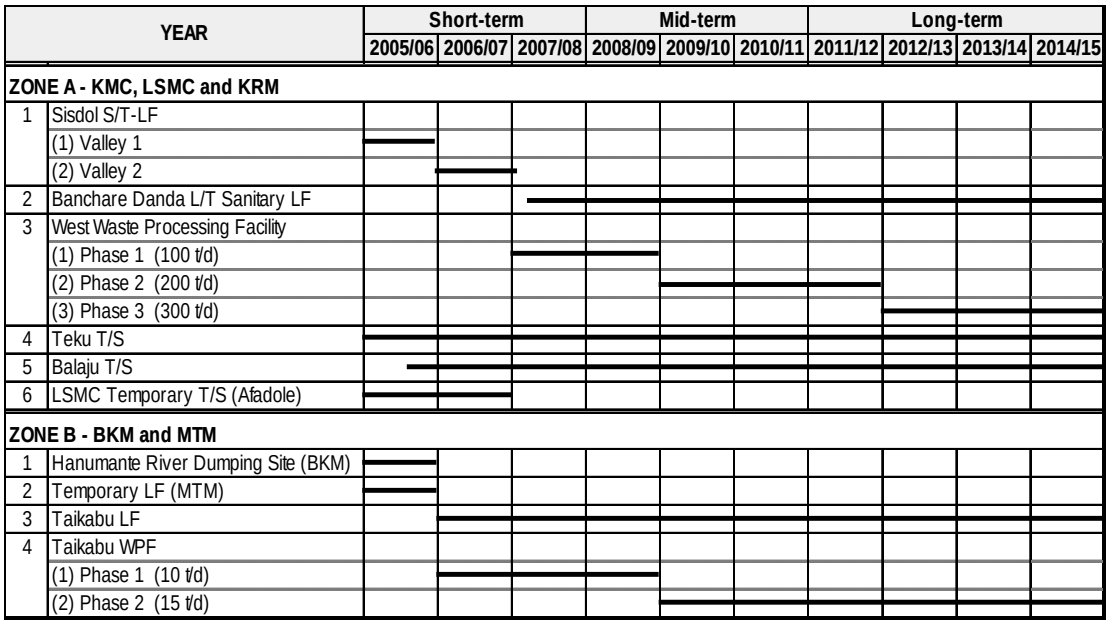


Figure 10.6-5 Operation Schedule of Overall Facilities in the Kathmandu Valley

Source: JICA Study Team

(3) Cost Estimation

The estimated investment costs for the OFP for the period of 2005 to 2015 are shown in Table 10.6-8.

Table 10.6-8 Estimated Costs of the OFP (million Rs)

SN	Facility	Investment Costs
1	**Improvement/Development of Transfer Station**	
	1.1 Teku T/S (Improvement)	2.0
	1.2 Balaju T/S	44.2
	1.3 Afadole Temporary T/S	19.7
	Sub-total 1	**65.9**
2	**Development of Waste Processing Facility**	
	2.1 West WPF (including equipment)	219.8
	2.2 Taikabu WPF (including equipment)	80.2
	Sub-total 2	**300.0**
3	**Development/Closure Landfill Site**	
	3.1 Sisdol S/T-LF (Closure of Valley 1 and development of Valley 2)	26.4
	3.2 Banchare Danda L/T-LF (including equipment)	906.1
	3.3 Taikabu LF (including equipment)	272.0
	Sub-total 3	**1,204.5**
4	**Dumping Site Closure Works**	
	4.1 Bagmati River dumping site (Closure)	5.0
	4.2 Hanumante River dumping site (Closure)	0.5
	4.3 MTM temporary LF (Closure)	0.2
	Sub-total 4	**5.7**
Total		**1,576.1**

Source: JICA Study Team

10.7 Overall Equipment Procurement Plan in the Kathmandu Valley

10.7.1 Basic Concept of Equipment Procurement Plan (OEP)

(1) Consistency with OFP and Budget

Under the Umbrella Concept, it has been agreed among municipalities concerned and SWMRMC to use Sisdol S/T-LF for the short-term, especially for the solid waste from KMC and LSMC. Both municipalities have recognized the necessity to construct additional T/S in each municipality in addition to Teku T/S. During the operation period of Sisdol S/T-LF, Banchare Danda L/T-LF will be developed as Zone A and West WPF near the city area will also be built in order to reduce the amount of the waste to be hauled to Banchare Danda L/T-LF. In addition, Taikabu L/T-LF will be developed for covering BKM and MTM as Zone B. Therefore, the procurement plan of necessary equipment is to correspond with the implementation of the above mentioned OFP.

On the other hand, considering the budget constraints in the municipalities and that the solid waste management cost as a percentage of total expenditures is relatively high which financially affects each municipality, the investment cost for procurement of the equipment should be minimized.

(2) Prioritization of Equipment Procurement

The equipment to be procured is mainly divided into the equipment for secondary transportation, operation of T/Ss, WPFs and LFs, and maintenance for that equipment.

Considering the urgent situation that KMC and LSMC should transport all collected waste to Sisdol S/T-LF and then Banchare Danda L/T-LF, not to the Bagmati River dumping site, the first priority should be given to the procurement of STVs to run from KMC and LSMC to the both landfill sites because no suitable large-capacity vehicles for effective secondary transportation are available in those municipalities at the moment.

As for the equipment for landfill operation, the equipment that is currently utilized in the Bagmati River dumping site could be utilized in Sisdol S/T-LF. It can be said that the priority for its procurement is a little bit lower than the STVs. However, considering some of the existing heavy equipment is too old to use longer than the coming few years and their capacity would be not enough for increasing the waste quantity to be transported to the L/T-LF year by year, the replacement of old equipment and addition of new equipment will be necessary in early stages. As for Taikabu LF and associated WPF, the new equipment to operate them is needed corresponding with their development schedule.

In addition, workshop equipment for the maintenance activities of SWM equipment is also very important in order to keep them in appropriate condition. The improvement of the existing workshops KMC and LSMC including cleaning/tidying and contracting major maintenance work to outside sources was considered.

10.7.2 Secondary Transportation Vehicles

(1) Existing Equipment for Waste Collection and Transportation of KMC and LSMC

KMC and LSMC have various kinds of equipment for primary and secondary collection as described in Tables 10.7-1 and 10.7-2, on which, only the multi compacter truck, dumper placer and tipper can be used for transportation to Sisdol S/T-LF. As total capacity of these vehicles is not enough to transport all the waste collected from KMC and LSMC, new STVs were decided to be procured (see Section 4.3).

Table 10.7-1 Collection and Transportation Equipment of KMC

No.	Types of Vehicle	Procurement Source	Number currently held	Operational Condition	Year of Starting Operation
1	Container Carrier for 20cum container	Meiller on Mercedes Chassis	1	△	1988
2	Dumper Placer for[KM1]	Meiller on TATA Chassis	2	1: △ 1: × (repair needed)	1988
3	Tractor – 1.7cum	China	35	30: △ 5: ×	1988
4	Tipper – 3.5cum	Mitsubishi Canter	12	△	1993
5	Tipper – 3.5cum	Eicher	2	△	1993
6	Dumper Placer for 4cum container	D.C.M. Toyota	8	△	1994
7	Dumper Placer for 6cum container	Ashok Leyland	4	△	1995
8	Multi Compactor Truck– 14cum	Ashok Leyland	7	△	1994
9	Mini Compactor – 6 cum	TATA	1	△	1996
10	Mini Compactor – 4 cum	Daihatsu	1	△	1989
11	Mini Compactor – 6 cum	Isuzu	1	△	1989
12	Mini Compactor – 4 cum	Mazuda	1	×	NA

Note: △: Weak condition, ×: Not in use, NA: Not available
Source: KMC

Table 10.7-2 Collection and Transportation Equipment of LSMC

No	Types of Vehicle	Procurement Source	Number currently held	Operational Condition	Year of Starting Operation	Remarks
1	Small Dumper Placer for 3 m^3-skip	Eicher	1	○	March 8, 1998	Four small dumper placers were donated by the Indian government but three of them are used for other purposes (not for SWM)
2	3 m^3-skip (garbage containers)	Ditto and repaired at LSMC workshop	4	○	ditto	Placed at Senepa, Jwagal, SATA office in Jawalakhel and B&B hospital
3	Large Dumper Placer for 4.5m^3-skip	TATA with Meiller hydraulic system	2	1: ○ 1: ×	NA	This equipment was purchased by SWMRMC and transferred to LSMC in August, 2001.

No	Types of Vehicle	Procurement Source	Number currently held	Operational Condition	Year of Starting Operation	Remarks
4	4.5 m^3-skip (garbage container)	ditto	10	○	ditto	To be repaired at LSMC workshop. With ten containers
5	3.5 m^3 tipper	Eicher	16	11: ○ 5: Stand-by	March 8, 1998	There are two types of tippers, one is just dump truck and the other is used with the closed containers.
6	2.3 m^3 tipper trailer	Eicher	4	2: ○ 2: ×	1994	Container capacity should be measured.

Note: ○: Good condition, ×: Not in use, NA: Not available
Source: LSMC

(2) Transportation Requirements of Waste to Long-term Landfill

1) Projection of Waste Quantity to be Transported to LF

Total transportation requirements, which can be calculated by the following formula, change with the implementation of the OFP as shown in Figure 10.7-1.

Total transportation requirements [ton-km/day]
= Transportation Quantity [ton/day] x Transportation Distance [km]

The requirements are projected to be increased explosively to about 9,000 ton-km per day when Sisdol S/T-LF starts accepting all solid waste collected from KMC and LSMC. Then, the requirements will be decreased by the commencement of operation of Balaju T/S and West WPF due to the shortened transportation distance. However, total transportation requirements are projected to be increased again in proportion to the urbanizing of the municipalities of the Kathmandu Valley.

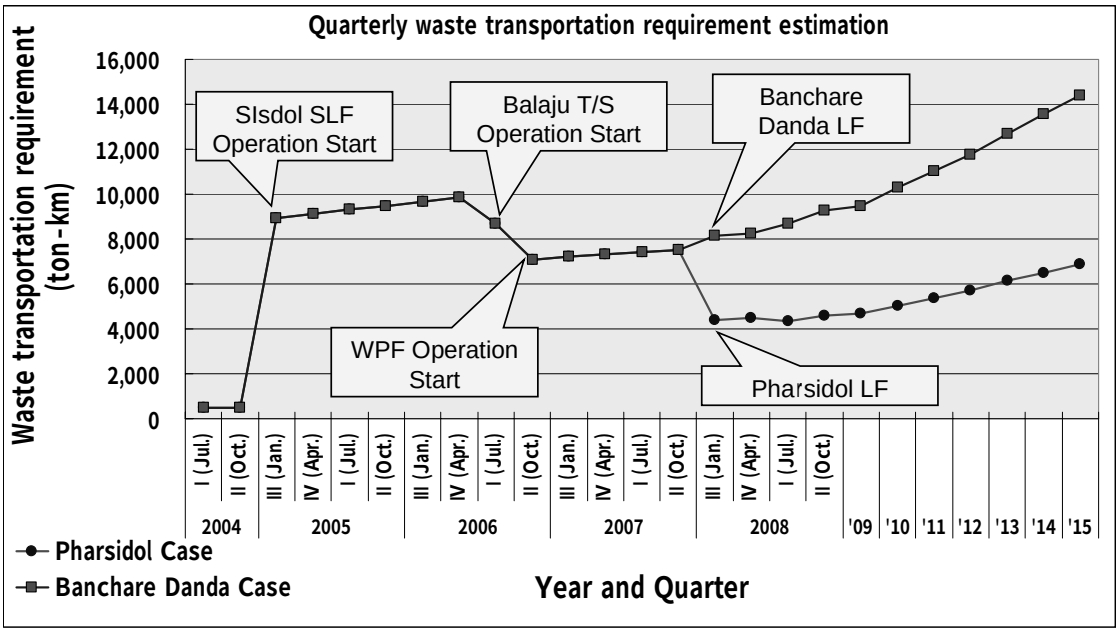


Figure 10.7-1 Future Projection of Transportation Requirements

Note: Phasidol case is just for reference.
Source: JICA Study Team

(2) Optimal Required Number of STV

Considering the above mentioned future changes of transportation requirements, the necessary number of STV was estimated as follows:

Firstly, necessary number of STV by the time of commencement of long-term landfill (Banchare Danda) was estimated. Secondary, assuming that the above estimated number of STV will be operated as much as possible with some overtime operation, and also that the existing equipment will be used for transporting the remaining waste that can not be covered by STVs to be procured for Sisdol S/T-LF operation (17 STVs for KMC and 4 STVs for LSMC), the optimal required number of STV were estimated.

For the estimation, the waste stream at the time of commencement of long-term landfill (Banchare Danda) operation was prepared as shown in Figure 10.7-2 with the following conditions.

- Long-term LF will be constructed at Banchare Danda and Taikabu
- Generation of residual waste from the WPF is 30% of waste transported to the facility
- Operation time is about 8 hours for one shift
- Container capacity of STV is 15 m^3 on G.V.W.16 ton chassis
- No use of multi-pack compactor trucks of KMC due to obsolescence in 2008
- No direct transportation by the primary collection vehicles

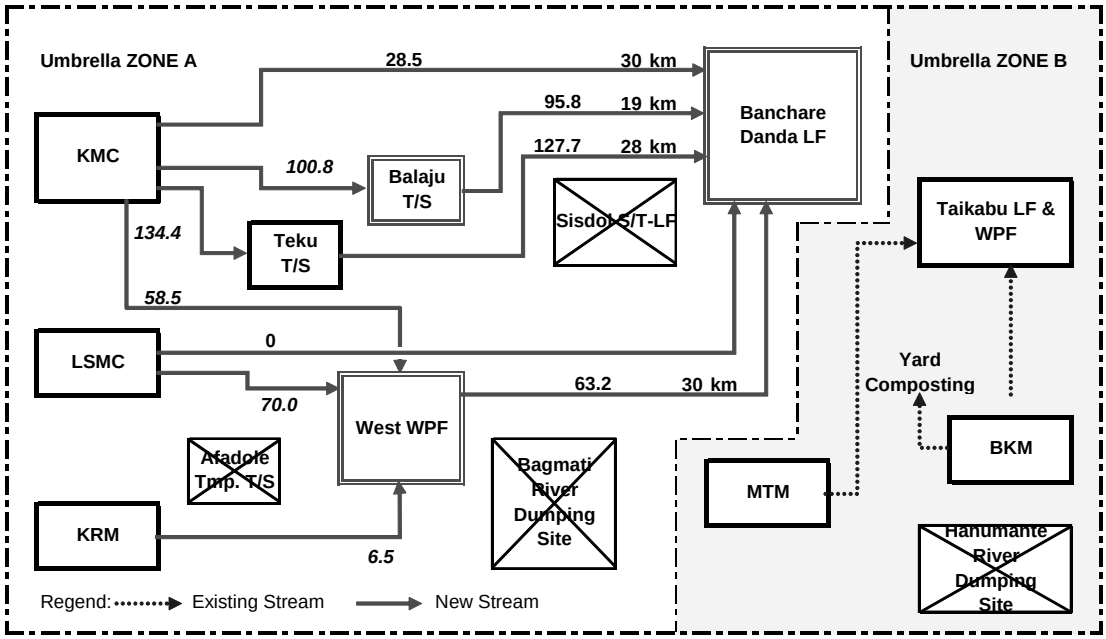


Figure 10.7-2 Waste Stream at the Commencement of Long-term LF

Source: JICA Study Team

Since total required STVs can be estimated at 27 to 28 units at the time of commencement of long-term landfill as shown in Table 10.7-3, additional STVs are planned to be procured until then.

Table 10.7-3 Required Equipment for Transport from KMC to WPF

SN	Vehicle Type	Unit	Waste Transport to L/T-LF (ton/day)	Waste Transferred (ton/day/veh.)	Total Transferred (ton/day)	Waste Balance (ton/day)
Teku T/S						
1	Container Carriers	13	127.7	9.7	126.1	1.6
Balaju T/S						
2	Container Carriers	5	95.8	19.4	97.2	(1.4)
WPF						
3	Container Carriers	7	63.2	9.7	68.0	(4.8)
Direct Transportation by KMC						
4	Container Carriers	3	28.5	9.7	29.2	(0.7)
Total		28	315.2	48.6	320.5	(5.3)

Source: JICA Study Team

(3) Type and Specification of STV

In general, a STV with larger loading capacity is more efficient for transportation of the waste for longer distances. However, there are some conditions to restrict or influence the loading capacity of the vehicles, especially the physical conditions of the roads, bridges and T/S. In this connection, the following conditions were considered in order to determine the loading capacity of the STV to be procured.

- The minimum loading capacity in volume of STV should be the same or similar to the existing multi-pack compactor trucks of KMC which are 12 or 14 m^3.
- Gross Vehicle Weight (G.V.W.) and dimensions of STV should correspond to the existing road conditions to the Sisdol S/T-LF.
- Engine and chassis of STV should be the manufacturer's standard model and available in India.

According to the survey in India in June 2004 and interviews with the local agents for truck companies in Nepal, the major truck manufacturers in India, TATA and Ashok Layland, are manufacturing two types of engine and chassis combinations that satisfy the above conditions. One is for G.V.W. 16 tons and the other is G.V.W is 25 tons. The characteristics of available chassis for STV in India are as shown in Table 10.7-4.

Table 10.7-4 Available Chassis for STV in India

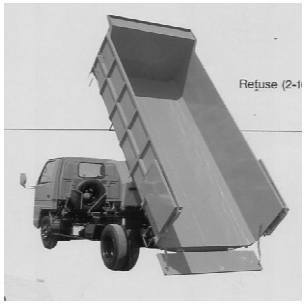
G.V.W.	16 ton	25 ton
Weight of Cab and Chassis	Approx. 4.5 t	Approx. 6.5 t
Weight of Tipping System	Approx. 3.0 t	Approx. 3.5 t
Weight of Container Bed	Approx. 1.5 t	Approx. 2.0 t
Max Payload (weight)	Approx. 6.5 t	Approx. 13.0 t
Max Payload (volume)	Approx. 12 – 15 m3	Approx. 15 – 30 m3
Traction	4 x 2	6 x 4
Photos (as for reference)		

Source: JICA Study Team

As the result of technical comparison of both types of chassis, the chassis with a G.V.W 25 ton, which is similar in size to the existing Meiller container carrier of KMC with 20m^3 container, was not considered suitable to drive the existing access road to Sisdol due to its heavy weight. Therefore, the chassis with a G.V.W. 16 ton was selected for STV.

Regarding the type of STV, ordinary dump trucks and container carriers (hook lift truck) are suitable to transport the large volume of waste and unload it onto the dumping area at the LF with a mechanical tipping device. The comparison of those types is summarized in Table 10.7-5.

Table 10.7-5 Comparison of STV Type

Type of STV	Container Carrier	Dump Truck
Previously used in Kathmandu	Yes	Yes
Flexibility	Container can set anywhere	Only from T/S to LF
Maintenance	Can be done separately for body and container	Can be done at once, Not use at maintenance[KM2]
Investment cost	More expensive	Less expensive
Photos (as for reference)		

Source: JICA Study Team

It was concluded that the container carrier would be more suitable for STV for the both municipalities. The reason is that the container carrier is quite flexible in its use. For example, due to the difficulty for KMC and LSMC to find an area for another T/S soon, both municipalities have an idea to set up small transfer points along the Ring Road. The container can be placed at these transfer points and be picked up by the container carriers. If the additional T/Ss at Balaju in KMC and Afadole in LSMC do not have a split level platform, but rather, have a flat level platform, the container carrier can unloaded the container on the platform so that the heavy equipment can easily load the waste into the container because of the height of the container edge is much lower than that of a dump truck.

10.7.3 Heavy Equipment for T/S and LF Operation

(1) Existing Heavy Equipment

Although KMC has equipment for landfill activity and for loading and unloading in the transfer station, the operation condition of some of equipment is not so good because of its excessive age or unsuitable design or capacity. The list of equipment of KMC is described in Table 10.7-6.

Table 10.7-6 Heavy Equipment of KMC

SN	Types	Name of Manufacture	Number currently held	Place of operation	Operational condition	Year of starting operation
1	Back hoe Loader-1cum.	J.C.B.	2	Teku T/S	Good condition	1994
2	Shavel Loader-0.75cum.	Shavel (Germany)	1	Teku T/S	Weak condition	1988
3	Sheepsfoot Compactor	Hanomag	1	Bagmati River Dumping Site	Weak condition	1988
4	Excavator 0.5cum.	Eder	1	Teku T/S	Not in use	1988
5	10-c Bulldozer	Fait Alis	1	Not operated	Not in use	About 15 years ago
6	Bulldozer	Komatsu	1	Bagmati River Dumping Site	Weak condition	1996
7	Skid steer loader	208A Amkoder	2	Teku T/S	Good condition	2003
8	Backhoe loader - 0.75cum.	702 Amkoder	3	Teku T/S	Good condition	2003
9	Excavator-0.5cum	Daewoo	1	Bagmati River Dumping Site	Good condition	2003

Source: KMC

On the other hand, LSMC have only two wheel loaders which are used alternately for landfill activity in the Bagmati River dumping site. The list of existing landfill equipment of LSMC is described in Table 10.7-7.

Table 10.7-7 Heavy Equipment of LSMC

SN	Types	Name of Manufacture	Number currently held	Place of operation	Operational condition	Year of starting operation	Remarks
1	Loader-0.5cum. (4WD)	J.C.B.	1	Bagmati River Dumping Site	Good condition	March 8, 1998	Operated at the disposal site every about 15 days by turns
2	Loader-0.5cum. (2WD)	J.C.B.	1	Stored in Workshop	Good condition		

Source: LSMC

(2) Necessary Heavy Equipment for LF Operation

The functions of the heavy equipment for landfill activity includes carrying, spreading and compacting solid waste or cover soil at the dumping area. Dump trucks are carrying of cover soil and water tankers are spraying water for prevention of dust or wind blown litter or spraying insecticide or aromatics onto the surface of dumped waste. The equipment to be used for landfill activity is generally described as follows.

Table 10.7-8 Work Contents at LF and Required Equipment

Work contents	Plan	Required Heavy Equipment
Spreading and compaction of waste	Spreading and compaction of 300-350 [ton/day] from 06:00 to 16:00 except lunch time	Bulldozer, Compactor
Spreading and compaction of cover material	After spreading and compaction of waste, a 15 to 25cm thickness of soil will be used for cover depending on the soil characteristics	Bulldozer, Wheel loader,
Packing and transporting of cover material	In case of a need for transportation of cover material to the landfill site, a transportation vehicle will be needed.	Excavator, dump truck, wheel loader
Transporting and spraying of liquid (including water)	Spraying water	Water tanker
Maintenance of the equipment	Minor maintenance including daily inspection will be carried out at the landfill site.	Tool box, lifter, etc

Source: JICA Study Team

In the case of Zone A, although the quantity of solid waste generated in KMC and LSMC is projected to increase, the waste received at the Bancahre Danda L/T-LF will not increase conspicuously because of the waste reduction at introduced WPF and at sources. Therefore, the number and specifications of required equipment will not be so changed from that at Sisdol S/T-LF, although the existing equipment should be replaced because the general usage period of heavy equipment is approximately 5 to 10 years depending on the operational condition.

As the quantity of the waste received in Sisdol S/T-LF is almost same as at the Bagmati River dumping site, the number and specification of required equipment for Sisdol S/T-LF operation can be comparatively similar to existing equipment. The equipment needed for operation of Sisdol S/T-LF is described in Table 10.7-9.

Table 10.7-9 Required Heavy Equipment for Sisdol S/T-LF

Heavy Equipment	Number	Specification
Compactor	1	Steel type foot,
Bulldozer	1	-
Wheel loader	1	Bucket capacity : less than 0.75m3
Excavator	1	Bucket capacity : less than 0.25m3 Max digging depth of cut : approx. 5m-6m
Dump truck	2	Max loading capacity of dump truck : 3.5m3
Water tanker	1	Capacity of water tank : 3m3

Source: JICA Study Team

Similarly, almost same type of heavy equipment is needed for operation of planned Taikabu L/T-LF in Zone B such as a compactor, bulldozer, wheel loader, excavator, dump truck and water tanker.

(3) Necessary Heavy Equipment for Transfer Stations and WPFs

When Sisdol S/T-LF starts its full scale operation, waste received in Teku T/S will increase to approximately 220 to 230 ton/day which is twice as much as currently. However, some of the waste, approximately 120 to 130 ton/day, will be directly transferred to STVs at the

developed loading platform. A wheel loader will only be used for loading the remaining waste, which has been the dumped on the ground from small collection equipment which dose not have a tipping system, into the STVs indirectly. Therefore, the amount of waste handled by the wheel loader is expected to be similar both before and after improvement of Teku T/S. Similarly, a wheel loader will be used at the planned Balaju T/S and Afadole temporary T/S.

As for the WPFs, wheel loader(s) will be used in principle because a yard-type of composting method, which needs waste loading and unloading, is proposed to be adopted for the WPFs.

(4) Procurement Schedule of Heavy Equipment

In the case of Zone A, the existing wheel loaders and excavators of KMC and LSMC can be used continuously for operation of Bancahre Danda as well as L/T-LF Sisdol S/T-LF. However, KMC is planning to procure a bulldozer which has a larger capacity than the existing one for more effective operation of the LFs. The procurement of another landfill compactor was also proposed for the replacement of the existing one because it is nearing the end of its useful life. Regarding the specification of another landfill compactor, the model adopted was considered for operation in the rainy season.

The proposed procurement schedule of heavy equipment for Zone A is as follows, while the heavy equipment procurement for Zone B is scheduled according to the facilities development schedule.

Table 10.7-10 Procurement Schedule of Heavy Equipment (Zone A)

Heavy Equipment	Proposed procurement year	Remarks
Compactor	2005 (by the full-scale operation of Sisdol S/T-LF)	Budget for next year should cover the equipment
Bulldozer	2005 (by the full-scale operation of Sisdol S/T-LF)	KMC is now planning
Wheel loader	2008 (by the operation of a long-term LF)	Procurement plan should be prepared by July, 2007
Excavator	2008 (by the operation of a long-term LF)	Procurement plan should be prepared by July, 2007
Dump truck	Utilize existing equipment	Procurement should be considered soon
Water tanker	Utilize existing equipment	Procurement should be considered soon

Source: JICA Study Team

10.7.4 Workshop Equipment

(1) Existing Workshop Equipment

1) KMC

In the mechanical workshop of KMC, not only daily maintenance but also emergency maintenance and minor repair of existing collection and transportation vehicles or heavy equipment are carried out. However, most of the heavy equipment such as wheel loaders,

excavators and multi-pack compactors, they have been repaired outside. In term of daily maintenance, basic equipment such as mechanical tool kits, battery chargers and multi testers are available but some of them are incomplete. Major annual or monthly maintenance can not be carried out with the existing mechanical equipment.

The existing mechanical workshop of KMC has general workshop equipment such as a hydraulic press, air compressor and mechanical tools for maintenance of small transportation vehicles but needs more area protected from the elements in which to store spare parts or to repair the equipment. Spare parts along with second-hand parts and old spare parts which can not be utilized anymore are still stored in a small storehouse in disarray. Therefore, it is too difficult to find required spare parts. The existing equipment for maintenance and repair activity is described in the following table.

Table 10.7-11 Existing Main Equipment of Mechanical Workshop of KMC

SN	Classification	Name of Equipment
1	Electric Equipment	Battery Charger
2	Diesel Equipment	-
3	Inspection Equipment	Lisle Vacuum Testing
		Multi Tester
		Hydraulic Meter
		Armature Tester
4	Hydraulic Equipment	Hydraulic Jack
		Hydraulic Press
5	Cutting and Grinding Equipment	Drill
		Table Vise
		Power Hacksaw
		Lathe
		Cutter
		Grinder
		Sander
		Hack Saw
6	Oiling Equipment	-
7	Air machine	Air compressor
8	Measuring equipment	Surface level gauge
		Dial Gauge
		Micrometer
		Surface level gauge
9	Tool	Tool Box
		Socket Set
		Screw driver
		Monkey Pliers[KM3]
		Chisel
		Clamp
		Ratchet
		Monkey Pliers[KM4]
		Hammer
		Spanner
10	Others	Lisle Carburetor Adjusting Tool
		Welding Machine
		Chain pulley with Frame
		Tire Changing Machine

Source: KMC, 2005

2) LSMC

The mechanical workshop in LSMC is conducting only regular maintenance and minor repair work of light vehicles such as tractor trailers and tippers, but repair or maintenance work for large vehicles or heavy equipment is carried out outside or in the workshop of KMC. The main workshop equipment in LSMC is described in the following table.

Table 10.7-12 Existing Main Equipment of Mechanical Workshop of LSMC

No.	Classification	Name of Equipment	Quantity	Operational condition	Year of starting operation	Procurement source
1	Cutting and Grinding Equipment	Drill (Bench Mounted)	1	Good condition	2003	Local Market
		Hand Grinder	1	ditto	2000	Local Market
		Electric Grinder	1	ditto	2003	Local Market
		Cutter	1	ditto	2004	Local Market
2	Oiling Equipment	Hand Operated Grease gun,	1	ditto	1998	J.C.B.
3	Air machine	Electric Air compressor	1	ditto	2003	Local Market
4	Tool	Bench Vice, Mechanical	1	ditto	2003	Local Market
		Torque Wrench	1	ditto	2001	Local Market
		Tool Kit (socket, screw driver, wrench, hammer, hacksaw, etc)	1	ditto	2001	Local Market
5	Others	Water Pump	1	ditto	2000	Local Market
		Welding Machine	1	ditto	2000	Local Market

Source: LSMC

(2) Equipment Maintenance Plan

KMC had prepared a "Proposal for the Improvement of the Kathmandu Metropolitan City Office in the Mechanical Section" and proposed getting donor assistance to procure workshop equipment and to construct facilities but no actual request has been submitted to anyone yet. On the other hand, SWMRMC prepared a plan for KMC and LSMC titled "Upgrading of the Existing Mechanical Workshop and Improvement & Development of other Infrastructure Facilities". This plan mentioned that the upgrading of infrastructure facilities, together with organizational structure and manpower and staff training, is needed for improvement of the existing mechanical workshop. As the result of review of those existing plans and of the discussion with Mechanical Section of KMC, it was proposed that the following equipment would be procured for the improvement of maintenance and repairing works in addition to effective and accurate utilization of the existing equipment.

Table 10.7-13 Required Workshop Equipment for Mechanical Workshop of KMC

SN	Classification	Name of Equipment
1	Electric Equipment	Battery Charger, Quick Charger, others
2	Diesel Equipment	Not required
3	Inspection Equipment	Multi meter, Battery hydro meter, others
4	Hydraulic Equipment	Hydraulic Lifter, Sliding hydraulic Jack, Four post hydraulic lift, Hydraulic press, others
5	Cutting and Grinding Equipment	Vise, Drilling machine, Grinding machine (table and hand), Metal cutting machine, Power Hacksaw, Lathe machine, others
6	Oiling Equipment	Not required
7	Air machine	Heavy and light compressor machine, Pneumatic machine, others
8	Measuring equipment	Screw gauge, others
9	Tool	Pulley, Socket, Wrench, Hammer, Grease gun, Pliers, Scraper, Puller, others
10	Others	Mobile workshop vehicle, Welding machine, Tire Changer, Safety set, Workshop shed, others

Source: KMC and JICA Study Team

(3) Cooperation between KMC and Other Municipalities

The scale of the workshops of KMC and LSMC is quite different because KMC has much more equipment for collection and transportation of solid waste than LSMC. Some major maintenance work at LSMC could be entrusted to KMC if the existing workshop will be suitably upgraded. Similarly, it was proposed that maintenance and repair works for equipment to be used in Zone B should be entrusted to KMC or private sector because it is heavy burden for BKM to develop and keep the mechanical workshop.

(4) Maintenance of STV

The equipment for the maintenance of STV is not particularly different than that of general compactors or waste collection trucks, which are currently serviced in the existing workshop. However, some special devices for STV such as the hydraulic parts for the hook lifts may require specific equipment for maintenance. Therefore, it should be considered to entrust the private sector or the manufacturer from which the equipment was procured with this kind of maintenance and repair works.

10.7.5 Equipment Procurement Schedule and Cost Estimation

(1) Typical Tender Procedure in Nepal

The procurement method depends on the contract size in Nepalese Rupees and the type of manufacturer or supplier based on the Public Works Directive of Nepal 2002 as shown in Table 10.7-14. According to this Directive, international competition bidding (ICB) or national competitive bidding (NCB) takes 310 to 335 days in general, for the entire tendering process from commencement of establishment of procurement strategy to completion of award of contract. This necessary time for the tendering process should be considered for the timely procurement.

Table 10.7-14 Type of Procurement Method and Recommended Standard Bidding

No.	Procurement Method	Contract Size in Rs.	Type of Manufacturer/Supplier	Recommended Bidding Document
1	International Competitive Bidding	Over 50 million	International Manufacturers/Suppliers	Standard Biding Documents (SBDs)
2	National Competitive Bidding	Over 1 million	National or International Manufacturers/Suppliers	SBDs
3	Limited International Bidding	Depends on the specialized goods	-	SBDs
4	Sealed Quotation	Depends on the specialized goods to be procured	International Manufacturers/Suppliers	Sealed Quotations
5	Public Bidding	Up to 100,000	Depends on contract amount	Agreement depends on contract amount
6	Direct Purchase/Negotiation	Depends on special circumstances	Local Suppliers/Shop Keepers	-
7	Reserved Procurement	-	Depends on Contract Amount	Agreement depends on contract amount

Source: Public Work Directive, 2002

(2) Procurement Schedule and Cost Estimation

Equipment procurement schedule is summarized below.

Table 10.7-15 Procurement Schedule of Equipment

Items	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1. Transfer Equipment										
(1) Transfer Trucks	6								1	
(2) Containers	9				18		21		2	
2. Heavy Equipment										
2.1 L/T Landfill (Zone A)										
(1) Compactor			1						1	
(2) Wheel Loader			1							
(3) Excavator			1							
(4) Dump Truck			1			1			1	
(5) Bulldozer						1				
(6) Water Tanker						1				
2.2 L/T Landfill (Zone B)										
(1) Compactor		1								
(2) Wheel Loader		2						1		
(3) Excavator		1						1		
(4) Dump Truck		1						1		
(5) Bulldozer		1						1		
(6) Water Tanker		1						1		
2.3 T/Ss (Zone A)										
(1) Wheel Loader	4				1					
2.4 WPF (Zone A)										
(1) Wheel Loader		1		1				2		

Source: JICA Study Team

Estimated cost for procurement of equipment is shown in Table 10.7-16.

Table 10.7-16 Estimated Cost for Equipment Procurement (Rs)

Year	1. Transfer Equipment	2. Heavy Equipment			
		2.1 L/T-LF (Zone A)	2.2 L/T-LF (Zone B)	2.3 T/Ss (Zone A)	2.4 WPF (Zone A)
2006	28,665,421				
2007			33,700,000	8,000,000	4,000,000
2008		21,000,000			
2009					4,000,000
2010	7,166,355			2,000,000	
2011		11,200,000			
2012	8,360,748				
2013			20,220,000		8,000,000
2014	4,976,636	13,000,000			
2015					

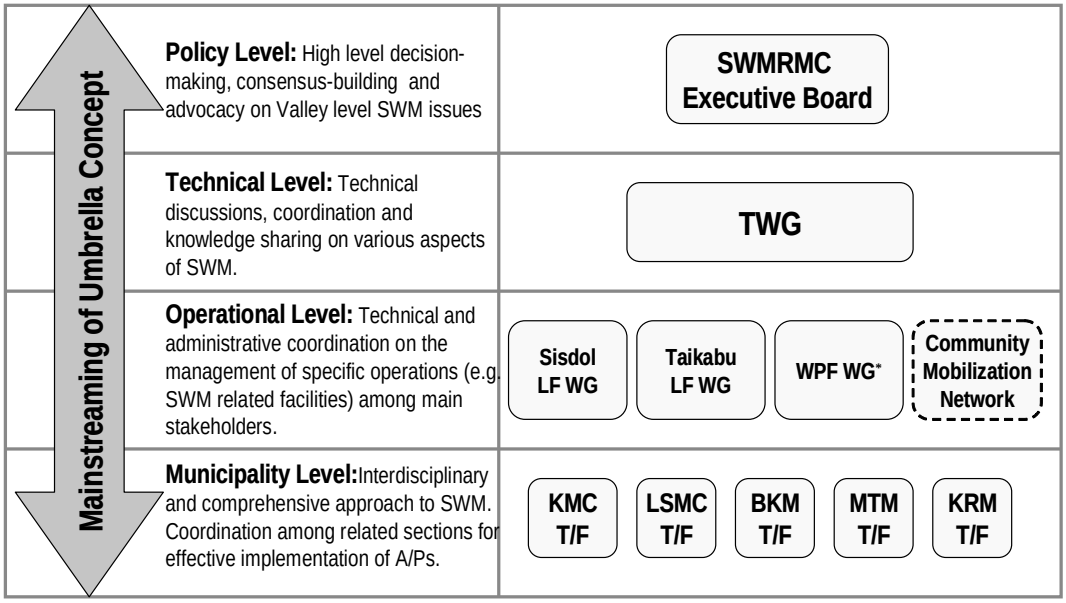
Source: JICA Study Team

10.8 Basic Concept for Organizational and Institutional Arrangement

Institutionalization of the Umbrella Concept in SWM is critical in ensuring the sustainability of its operation, and subsequently its implementation through the municipal Action Plans (A/Ps) up to 2015. Establishing an effective and feasible institutional arrangement is all the more significant with reflection on the past lessons learnt from the history of various efforts to mange solid waste within the Kathmandu Valley. It is worthy to highlight here the fact that lack of institutional mandates and unclear demarcation of responsibilities among SWMRMC, KMC, and LSMC was one of the major constraints that lead policy dialogue on SWM astray for over a decade, especially after the departure of the GTZ project. With this consideration, the following should the underlying principles of the Basic Concept for the Organizational and Institutional Arrangement for the Umbrella Concept:

- Institutional/organizational arrangements should build on the existing organizational set up. New institutions should be established only when there is a clear and practical need for its existence; or it would not be sustainable.
- There should be clarity in the mandate and terms of reference for each of the institutions, especially in regards to its functions, as well as its linkages to other organizations within the institutional/organizational arrangements. Its modality of operation (e.g. how many times a month should the organization convene) should also be agreed upon by the members and briefly summarized in the TOR.
- Linkages among various levels of institutions should be identified, and issues should be delegated to other institutions for discussion, when deemed appropriate.
- The specific role and mandates of SWMRMC should be determined as a priority matter. Its presence is prerequisite for the implementation of the Umbrella Concept.

Based on the above principles, the basic concept is conceptualized in Figure 10.8-1 below. Institutional and organizational arrangement is divided into four complementary levels, each with respective significance in guaranteeing the smooth implementation of the Umbrella Concept.



* In case of adoption of public-private partnership approach in development and operation of WPF, this WG will be responsible for Supervision and Management of operations.

Figure 10.8-1 Basic Concept for Institutional and Organizational Arrangement for the Umbrella Concept

Source: JICA Study Team

10.8.1 Policy Level Institutions

In Nepal, as in many other parts of the world, it has been proven that SWM is a topic that is highly prone to politicization both by the politicians and the public. In this regard, for any major decision-making or consensus building to take effect in reality, especially at the policy level, institutions responsible for such decisions should have adequate political authority. However, political authority itself is not sufficient. Such high level decisions should be based on sound technical assessments and reliable data. In this regard, the policy level institutions for the Umbrella Concept should act as the forum for its members to be exposed to and be educated about the technical aspects for informed decision-making.

As of June 2005, the only institution that is active in the field of SWM at the policy level is the Executive Board of SWMRMC, chaired by the Secretary of MOLD, with the membership of the Mayors (or CEOs in their absence) of the five municipalities in addition to some other representatives of the line ministries. The main mandate of this Executive Board is to review the various programs of the SWMRMC, although the agenda sometimes includes topics of SWM in general. If the mandate of this Executive Board could be adjusted, one of its main functions should shift to policy making on the Umbrella Concept, and to monitor the various stakeholders so that policy decisions are mainstreamed and operationalized for implementation. From the membership, if the Board members actually commit themselves to the decisions taken under this framework, there is no doubt that it would carry enough political weight both at the central and local levels. Furthermore, the SWMRMC should ensure technical soundness in those decisions.

10.8.2 Technical Level

As one of the achievements of the Study, the Technical Working Group (TWG) chaired by the SWMRMC General Manger and composed of the Focal Points from the five municipalities and SWMRMC developed into a regular forum where technical aspects of various SWM areas covered under the Study were discussed. The TWG was also the forum in which the reports produced under the Study were reviewed by the Nepalese side without the JICA Study Team. Recently, hosting of such meetings has been rotated among the member municipalities, and the level of both formal and informal interaction among the Focal Points has increased substantially.

Based on this best practice, TWG should continue to function as the institution for regular coordination, and technical and operational knowledge sharing on all aspects of SWM within the Valley. It also should serve to link the best practices and lessons learned through the A/P implementation at respective municipalities and make concrete recommendations not just limited to the Umbrella Concept, but covering all SWM related issues, targeting policy level institutions such as the SWMRMC Executive Board, or other organizations such as MOLD and MOEST. The agenda for discussion by the TWG may be framed as follows:

- A common topic could be jointly identified from the Umbrella Concept for further deliberation and planning (e.g. Planning of the Central Waste processing facility, Selection of the long-term Landfill site, or the Valley level joint mass education campaign)
- Policy recommendations on management of hazardous waste, inter alia medical waste and industrial waste
- The hosting municipality may update other municipalities on the status of implementation of their A/Ps including various constraints and lessons learned
- Regular confirmation of the demarcation of responsibilities between the central government and local bodies regarding SWM, with realistic assessment of individual capacities for managing solid waste

Since the current members still perceive the TWG as a coordination mechanism under the framework of the Study, a new mandate and TOR for TWG should be developed so that it could independently sustain its functions.

10.8.3 Operational Level

With the opening of Sisdol S/T-LF, numerous occasions called for intensive coordination among the main parties (SWMRMC, KMC and LSMC) involved in its operation. However, a basic agreement was signed on March 21, 2005 among KMC, LSMC, SWMRMC detailing the requirements and responsibilities for its operation, issues regarding the division of labor for site management responsibilities, cost sharing for landfill operation and transportation, provision of staff, provision of equipment and its maintenance, and most importantly, management of the expectations of the local committee (Sanitary Landfill Site Main Coordination Committee). To facilitate such discussions and introduce systematic coordination among the concerned parties at the operational level, working level initiatives for specific initiatives need to be established.

Previously, a working group for the development of Sisdol S/T-LF was convened in March 2004, which included the Mayors of both KMC and LSMC with respective Focal Points.

However due to the unavailability of the Mayors, who subsequently left office with the turn of the political situation in mid 2005, the working group became defunct. If a working group is to be revived, the focus of discussions should be on the day-to-day operation and management of Sisdol S/T-LF in alignment with the commitments stipulated in the aforementioned agreement, and the members should be comprised of working level to senior technical staff of the municipalities and SWMRMC.

Similarly for the Taikabu Landfill site where a joint operation arrangement is envisaged among BKM, MTM and surrounding VDCs, existence of such an operational level working group would be beneficial.

In regards to the development and operation of the Central waste processing facility, which is still at the conceptual stage under the Umbrella Concept, a working group should be formed to take the initiative on planning, assessing the various existing options for feasibility, and supervise detailed designs and other necessary studies (e.g. IEE, EIA). In case of the participation of the private sector in the Facility's development and operation, the responsibilities of this working group will then be shifted to formulating the PPP modality and agreement.

Under the Study, within the area of Community Mobilization for SWM, an informal but vibrant network has emerged among the community-related staff of the five municipalities. Already on their own initiative, staff from one municipality is being invited to another as resource persons for various trainings and meetings. Furthermore, with the facilitation of the Study, best practices in Community Mobilization, such as the introduction of City Volunteers, are being shared and replicated in other municipal programs. Such inter-municipal initiatives should be encouraged to the greatest extent that is possible, and systematically practiced under a loose institutional setup. Under Section 10.5.4, the basic concept for a Community Mobilization Network is described.

10.8.4 Municipality Level

Task Force (T/F) established under the Study in each municipality had several positive impacts on SWM administration. Most notably in municipalities such as BKM, LSMC and MTM, where the SWM responsibilities were dispersed among several sections, the practice of discussing municipal SWM matters within the T/F is now well established. Institutionalization of the T/F effectively enhanced inter-sectoral coordination and cross-fertilization of SWM initiatives especially between the Planning and Technical Sections and Community Mobilization Sections. As the main body to formulate, implement and monitor municipal A/Ps, the existence of T/F would be a prerequisite in all five municipalities to make the Umbrella Concept operational in the respective municipal contexts.

One of the common weaknesses of the T/F observed in all five municipalities was its' weak linkages with external institutions. For example, the technical discussions held in TWG were often not reported back to the T/F for knowledge sharing and dissemination. Consequently, this hampered the timely reflection of TWG decisions onto the municipal A/Ps on matters regarding the Umbrella Concept. In view of such lessons learnt, TWG Focal Points within respective municipal T/Fs should make sure that all technical and

operational discussions held within TWG or operational Working Groups be reported back to T/F.

Furthermore, another important linkage that T/F members need to initiate within respective municipalities is the validation process for overall municipal development plans with the Umbrella Concept. Each municipal T/F is responsible for advocating within their municipalities, the prioritization of SWM initiatives among a range of municipal programs. For this, the municipal leadership must be kept well informed of the discussions regarding the Umbrella Concept by the T/F members in order for municipal resources to be allocated. A summary of key linkages that need to be maintained by the municipality, especially the T/F, is conceptualized below in Figure 10.8-2.

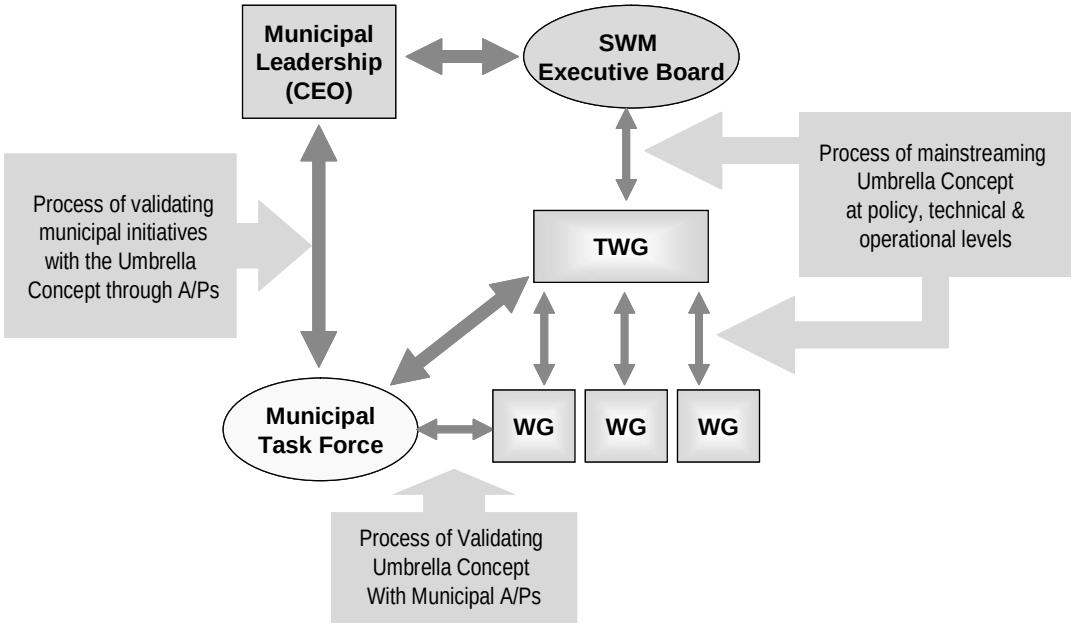


Figure 10.8-2 Necessary Institutional Linkages and Processes that need to be Sustained by Municipal Task Force

Source: JICA Study Team

10.8.5 SWMRMC

The cornerstone that underpins the institutional and organizational arrangement for the Umbrella Concept is the existence of SWMRMC. Since its beginnings as the Solid Waste Management Board, and especially after the departure of the GTZ project, its legal status and mandate remains ambiguous. Arguments for and against its continued existence that surface at MOLD and subsequently at the National Planning Commission every year during the budget formulation period have undermined its legitimacy as an organization. Nevertheless, no other organization at this time, or in the near future, could be foreseen to be in a position to take its place to adequately facilitate various arrangements under the Umbrella Concept.

Recognizing the above situation, HMG/N should assess the capacities of SWMRMC and provide a new mandate in view of its role and responsibilities within the context of

operationalizing[KM6] the Umbrella Concept. The experience of the development of Sisdol S/T-LF has underscored the de facto demarcation of responsibilities between SWMRMC and the municipalities; they should endorse this emerging paradigm of SWM institutions, and formalize it as soon as possible.

10.8.6 Solid Waste Data Management

One of the most fundamental activities of the Umbrella Concept is the solid waste data management, because all the activities could be better to be monitored by the quantitative data for further improvement.

Solid waste data can be considered to divide into two aspects, one is the operation data of the daily solid waste management activities to understand the operational situation and the other is the basic data as the design condition to be utilized for future planning. The former data is, for example, the solid waste quantity to be collected, transported or disposed of at the managed landfill site. The quantity of the collected recyclable materials or the material balance of composting activities is also included to this data. One the other hand, for example, the latter is the result of waste quantity and quality survey.

Considering the necessity of the management of such solid waste data, computerized database program has been developed in each municipality and SWMRMC thorough the Pilot Project of the Study. That program has common used software, which is MS-Excel and MS-Access, with semi-manual but user friendly man-machine interface.

Each municipality is keeping some operation data of solid waste management. For example, KMC is now recording the daily data of waste quantity measured by the electric weighbridge at Teku Transfer Station and Sisdol Short-term Landfill. This standard program developed in the Study will have to be customized based on the actual situations of each municipality in future under the Umbrella Concept. Present semi-manual system may be upgraded to an online system or other advanced system step by step depending on the progress of development of the data management capacity.

By using this data base, various kinds of reports regarding the solid waste management activities can be prepared so that the municipalities could understand the existing situation quantitatively.

Besides the daily operational data, basic solid waste data will have to be monitored through the periodical solid waste quantity and quality survey. Due to the characteristic of solid waste changes year by year its unit generation rate and its physical composition, each municipality will carry out the waste quantity and quality survey at least once a year by the municipality staff themselves or by contracting out to private sector. In addition to the surveyed solid waste data, other social and economic statistics such as population, hotel and restaurant inventory, and business directory will be also maintained as the basic data.

The following Table 10-8-3 shows the flow diagram of the solid waste data management system.

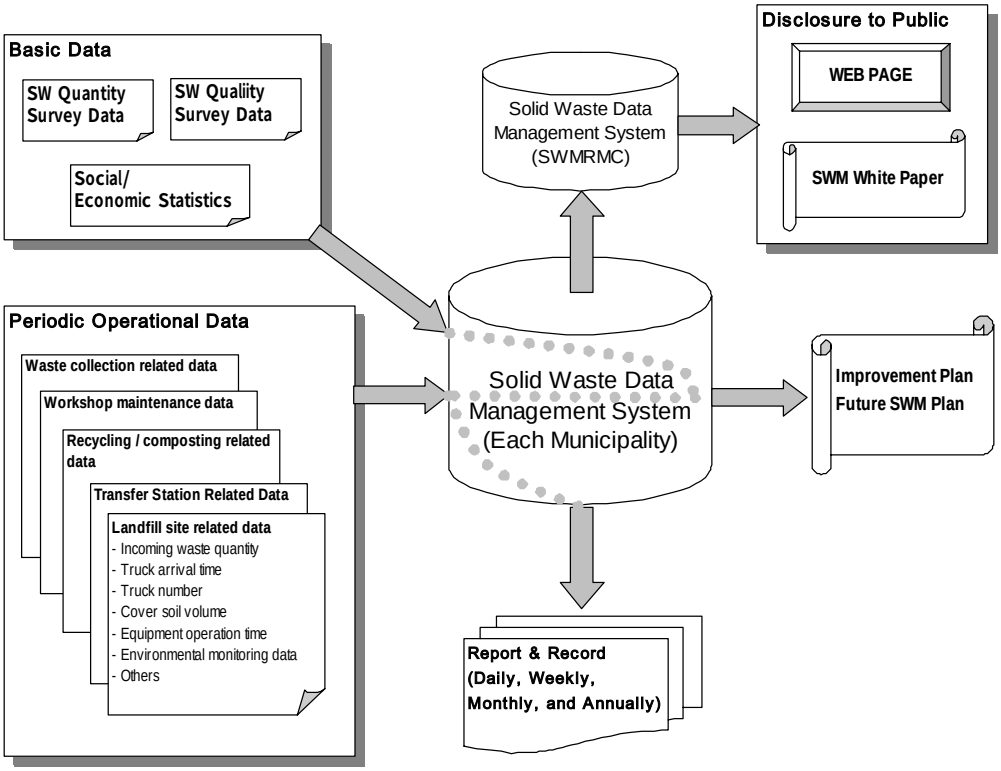


Figure 10.8-3 Conceptual Waste Data Flow Diagram

Source: JICA Study Team

Once the solid waste data of both operational data and basic data at the municipal level, then the data will be submitted to SWMRMC. SWMRMC will prepare the white paper shows the latest information regarding solid waste management activities and will upgrade its web page so that various stakeholders can access and understand the situations.

10.9 Basic Concept for Financial Arrangement

10.9.1 Estimated Costs to be Allocated for the Umbrella Concept

The Umbrella Concept consists of two areas, namely Zone A (KMC, LSMC and KRM) and Zone B (BKM and MTM). Costs for the Umbrella Concept consist of investment cost and incremental operation and maintenance (O&M) cost which are estimated separately by each zone and summarized in Table 10.9-1. The total cost until FY2014/15 is estimated at Rs 2,559 million; consisting of Rs 1,742 million on investment and Rs 817 million on incremental O&M.

Table 10.9-1 Summary of Estimated Cost for Umbrella Concept (million Rs)

Cost Items	Zone	2005/06 (2062/63)	2006/07 (2063/64)	2007/08 (2064/65)	2008/09 (2065/66)	2009/10 (2066/67)	2010/11 (2067/68)	2011/12 (2068/69)	2012/13 (2069/70)	2013/14 (2070/71)	2014/15 (2071/72)	Total
I. Investment Cost	A	129.0	859.4	141.2	78.8	89.1	18.4	0.0	17.6	13.0	5.0	1351.5
	B	298.3	34.1	18.0	3.8	2.1	3.2	6.4	24.5	0	0	390.4
	Total	427.3	893.5	159.2	82.6	91.2	21.6	6.4	42.1	13.0	5.0	1,742.0
1. Collection & Transportation	A	6.3	59.9			33.8	7.2		8.4		5.0	120.5
	B			17.7	3.8	2.1	3.2	6.4	4.3			37.5
	Total	6.3	59.9	17.7	3.8	36.0	10.4	6.4	12.6	0	5	158.1
2. Transfer Station	A	65.9										65.9
	B											0
	Total	65.9	0	0	0	0	0	0	0	0	0	65.9
3. Waste Processing Facility	A	14.3	150.4		45.9				9.2			219.8
	B	80.2										80.2
	Total	94.5	150.4	0	45.9	0	0	0	9.2	0	0	300.0
4. Landfill (including closure works)	A	34.8	649.1	141.2	32.9	55.3	11.2			13.0		937.6
	B	218.1	34.1	0.3					20.2			272.7
	Total	252.9	683.2	141.5	32.9	55.3	11.2	0	20.2	13.0	0	1210.2
5. Workshop	A	7.8										7.8
	B											0
	Total	7.8										7.8
II. Incremental O & M Cost	A	45.5	56.1	59.2	74.7	78.2	70.2	77.2	78.7	72.1	75.0	686.8
	B	2.8	9.7	13.9	14.7	15.4	14.4	14.8	15.2	14.6	15.2	130.6
	Total	48.3	65.8	73.0	89.4	93.7	84.6	92.0	93.9	86.7	90.1	817.5
1. Collection & Transportation	A	27.8	36.8	43.2	58.7	63.9	57.0	63.6	67.1	60.1	63.0	541.1
	B	2.3	2.6	6.8	7.7	8.4	7.7	8.0	8.5	7.9	8.4	68.2
	Total	30.0	39.4	50.0	66.4	72.2	64.7	71.6	75.6	68.0	71.4	609.3
2. Transfer Station	A	3.2	4.9	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	36.5
	B											0.0
	Total	3.2	4.9	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	36.5
3. Waste Processing Facility	A			-1.6	-1.6	-3.3	-3.3	-3.3	-4.9	-4.9	-4.9	-27.9
	B		-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-5.6
	Total	0	-0.6	-2.3	-2.3	-3.9	-3.9	-3.9	-5.5	-5.5	-5.5	-33.5
4. Landfill	A	12.4	12.4	12.0	12.0	12.0	12.0	12.4	12.0	12.4	12.4	122.3
	B	0.0	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	64.3
	Total	12.4	19.6	19.2	19.2	19.2	19.2	19.6	19.2	19.6	19.6	186.6
5. Public Awareness /Community Mobilization	A	1.8	1.8	1.8	1.8	1.8	0.9	0.9	0.9	0.9	0.9	13.5
	B	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	3.0
	Total	2.2	2.2	2.2	2.2	2.2	1.1	1.1	1.1	1.1	1.1	16.5
6. Institutional/ Organizational Strengthening	A	0.3	0.3	0.3	0.3	0.3						1.3
	B	0.2	0.2	0.2	0.2	0.2						0.8
	Total	0.4	0.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	2.0
III. Total (= I + II)	A	**174.5**	**915.5**	**200.4**	**153.5**	**167.3**	**88.6**	**77.2**	**96.3**	**85.1**	**80.0**	2038.3
	B	**301.1**	**43.8**	**31.8**	**18.5**	**17.6**	**17.6**	**21.2**	**39.7**	**14.6**	**15.2**	521.1
	Total	**475.6**	**959.3**	**232.2**	**172.0**	**184.9**	**106.2**	**98.4**	**136.0**	**99.7**	**95.1**	2559.4

Source: JICA Study Team

Detail cost of the Umbrella Concept in Zone A is presented in Table 10.9-2 and Table 10.9-3.

Table 10.9-2 Estimated Cost for Umbrella Concept in Zone A (million Rs)

Cost Items			2005/06 (2062/63)	2006/07 (2063/64)	2007/08 (2064/65)	2008/09 (2065/66)	2009/10 (2066/67)	2010/11 (2067/68)	2011/12 (2068/69)	2012/13 (2069/70)	2013/14 (2070/71)	2014/15 (2071/72)	Total
I. Investment Cost			129.1	859.4	141.2	78.8	89.1	18.4	0.0	17.6	13.0	5.0	1351.5
1-1. Collection & Transportation	Vehicles	KMC	6.3	31.2			33.8						71.3
1-2. Haulage	Container Carrier			25.1								4.2	29.3
	Container			3.6				7.2		8.4		0.8	19.9
	Total		0	28.7	0	0	0	7.2	0	8.4	0	5.0	49.2
2. Transfer Station	Teku	Improvement Works	2.0										2.0
	Balaju	IEE	0.5										0.5
		Construction	43.7										43.7
		Total	44.2	0	0	0	0	0	0	0	0	0	44.2
	LSMC Temporary	IEE	0.5										0.5
		Construction	19.2										19.2
		Total	19.7	0	0	0	0	0	0	0	0	0	19.7
	Total		65.9	0	0	0	0	0	0	0	0	0	65.9
3. Waste Processing Facility	IEE, EIA and DD		12.5										12.5
	Land acquisition		1.8										1.8
	Construction	Phases I, II and III		146.4		41.9				1.2			189.5
	Heavy equipment			4.0		4.0				8.0			16.0
	Total		14.3	150.4	0	45.9	0	0	0	9.2	0	0	219.8
4. Landfill	Bagmati DS	Closure Works	1.0	1.0	1.0	1.0	1.0						5.0
	Sisdol LF	Valle 2 Development	21.4										21.4
		Closure Works			5.0								5.0
		Total	21.4	0	5.0	0	0	0	0	0	0	0	26.4
	Banchare Danda	IEE, EIA and DD	11.7										11.7
		Land acquisition	0.7										0.7
		Construction		648.1	114.2	31.9	54.3						848.5
		Heavy equipment			21.0			11.2			13.0		45.2
		Total	12.4	648.1	135.2	31.9	54.3	11.2	0	0	13.0	0	906.1
	Total		34.8	649.1	141.2	32.9	55.3	11.2	0	0	13.0	0	937.6
5. Workshop	Facility	KMC	5.4										5.4
	Machinery & Equip	KMC	2.4										2.4
	Total		7.8										7.8
II. Incremental O & M Cost			45.5	56.1	59.2	74.7	78.2	70.2	77.2	78.7	72.1	75.0	686.8
1-1. Collection & Transportation	(See Table 10.9-3 for details of the cost)		1.8	-2.4	3.9	11.1	12.0	6.5	12.2	11.5	6.8	7.1	70.6
1-2. Haulage			25.9	39.1	39.3	47.6	51.9	50.5	51.4	55.6	53.3	55.9	470.5
2. Transfer Station			3.2	4.9	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	36.5
3. Waste Processing Facility			0	0	-1.6	-1.6	-3.3	-3.3	-3.3	-4.9	-4.9	-4.9	-27.9
4. Landfill			12.4	12.4	12.0	12.0	12.0	12.0	12.4	12.0	12.4	12.4	122.3
5. Pub. Awareness/ Com. Mobilization			1.8	1.8	1.8	1.8	1.8	0.9	0.9	0.9	0.9	0.9	13.5
6. Institutional/ Org. Strengthening			0.3	0.3	0.3	0.3	0.3						1.3
III. Total (= I + II)			174.6	915.5	200.4	153.5	167.3	88.6	77.2	96.3	85.1	80.0	2038.4

Note: O&M cost of workshop is included in the incremental O&M cost of 1 to 5 of the table.

Source: JICA Study Team

Table 10.9-3 Details of Estimated Incremental O&M Cost in Zone A (million Rs)

Cost Items			2005/06 (2062/63)	2006/07 (2063/64)	2007/08 (2064/65)	2008/09 (2065/66)	2009/10 (2066/67)	2010/11 (2067/68)	2011/12 (2068/69)	2012/13 (2069/70)	2013/14 (2070/71)	2014/15 (2071/72)	Total
Incremental O & M Cost			45.5	56.1	59.2	74.7	78.2	70.2	77.2	78.7	72.1	75.0	686.8
1-1. Collection & Transportation	KMC	Personnel	0.8	-5.0	-3.1	0.2	0.6	-2.6	-0.6	-1.5	-4.3	-4.7	-20.1
		Repair & Maintenence	0.4	-2.8	-1.8	0.1	0.4	-1.5	-0.3	-0.8	-2.4	-2.6	-11.4
		Fuel	0.4	-2.8	-1.7	0.1	0.4	-1.5	-0.3	-0.8	-2.4	-2.6	-11.3
		Others	0.0	-0.2	-0.1	0.0	0.0	-0.1	0.0	-0.1	-0.2	-0.2	-0.9
		Total	1.6	-10.9	-6.7	0.3	1.4	-5.6	-1.2	-3.2	-9.3	-10.2	-43.7
	LSMC	Personnel	0.1	4.3	5.4	5.4	5.4	6.1	6.8	7.4	8.1	8.7	57.7
		Repair & Maintenence	0.0	1.8	2.2	2.3	2.2	2.6	2.8	3.1	3.4	3.6	24.0
		Fuel	0.1	2.3	2.8	2.9	2.8	3.2	3.6	3.9	4.3	4.6	30.3
		Others	0.0	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	2.3
		Total	0.2	8.5	10.6	10.8	10.6	12.1	13.4	14.7	16.1	17.3	114.3
Total			1.8	-2.4	3.9	11.1	12.0	6.5	12.2	11.5	6.8	7.1	70.6
1-2. Haulage	KMC (from Teku)	Personnel	2.8	2.9	2.9	2.6	3.0	2.6	2.6	3.0	2.3	2.6	27.1
		Repair & Maintenence	5.8	6.1	6.1	5.4	6.2	5.4	5.4	6.2	4.8	5.4	56.7
		Fuel	16.1	16.9	17.0	15.0	17.2	15.0	15.0	17.2	13.4	15.0	157.9
		Others	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	4.9
		Total	25.2	26.4	26.5	23.5	26.8	23.5	23.5	26.8	21.0	23.5	246.7
	KMC (from Balaju)	Personnel		0.9	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	9.5
		Repair & Maintenence		1.9	1.9	2.3	2.3	2.3	2.3	2.3	2.3	2.3	19.8
		Fuel		5.4	5.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3	55.1
		Others		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.7
		Total		8.4	8.4	9.9	9.9	9.9	9.9	9.9	9.9	9.9	86.1
	LSMC (from Afadole)	Personnel	0.1	0.5	0.5								1.0
		Repair & Maintenence	0.2	1.0	1.0								2.2
		Fuel	0.5	2.8	2.8								6.1
		Others	0.0	0.1	0.1								0.2
		Total	0.8	4.3	4.3								9.5
	LSMC (from WPF)	Personnel				0.7	0.8	0.2	0.3	0.4			2.6
		Repair & Maintenence				1.5	1.8	0.5	0.7	0.9			5.4
		Fuel				4.3	4.9	1.4	1.9	2.5			14.9
		Others				0.1	0.2	0.0	0.1	0.1			0.5
		Total				6.7	7.6	2.1	3.0	3.9			23.3
	ALL (from WPF)	Personnel				0.8	0.8	1.6	1.6	1.6	2.5	2.5	11.5
		Repair & Maintenence				1.7	1.7	3.4	3.4	3.4	5.2	5.2	24.1
		Fuel				4.8	4.8	9.6	9.6	9.6	14.4	14.4	67.1
		Others				0.1	0.1	0.3	0.3	0.3	0.4	0.4	2.1
		Total				7.5	7.5	15.0	15.0	15.0	22.5	22.5	104.9
Total			25.9	39.1	39.3	47.6	51.9	50.5	51.4	55.6	53.3	55.9	470.5
2. Transfer Station	Teku	Personnel	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	8.3
		Repair & Maintenence	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.5
		Fuel	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.4
		Others	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.0
		Total	2.1	2.1	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	19.3
	Balaju	Personnel		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6.5
		Repair & Maintenence		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.0
		Fuel		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3.5
		Others		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3.2
		Total		1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	15.0
	LSMC (Afadole)	Personnel	0.5	0.5									
		Repair & Maintenence	0.1	0.1									0.3
		Fuel	0.3	0.3									0.5
		Others	0.2	0.2									0.5
		Total	1.1	1.1									2.2
Total			3.2	4.9	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	36.5
3. Waste Processing Facility	Cost	Personnel			1.2	1.2	2.3	2.3	2.3	3.5	3.5	3.5	19.8
		Others			0.8	0.8	1.7	1.7	1.7	2.5	2.5	2.5	14.3
		Subtotal			2.0	2.0	4.0	4.0	4.0	6.0	6.0	6.0	34.1
	Sale of Products				-3.7	-3.7	-7.3	-7.3	-7.3	-11.0	-11.0	-11.0	-62.1
Total			0	0	-1.6	-1.6	-3.3	-3.3	-3.3	-4.9	-4.9	-4.9	-27.9
4. Landfill	Sisdol LF	Personnel	2.2	2.2									4.4
		Repair & Maintenence	2.7	2.7									5.4
		Fuel	4.9	4.9									9.8
		Others	2.7	2.7									5.4
		Total	12.4	12.4									24.9
	Banchare Danda	Personnel			2.1	2.1	2.1	2.1	2.2	2.1	2.2	2.2	17.1
		Repair & Maintenence			2.6	2.6	2.6	2.6	2.7	2.6	2.7	2.7	21.1
		Fuel			4.7	4.7	4.7	4.7	4.9	4.7	4.9	4.9	38.2
		Others			2.6	2.6	2.6	2.6	2.7	2.6	2.7	2.7	21.1
		Total			12.0	12.0	12.0	12.0	12.4	12.0	12.4	12.4	97.5
Total			12.4	12.4	12.0	12.0	12.0	12.0	12.4	12.0	12.4	12.4	122.3
5. Public Awareness /Community Mobilization	KMC		1.4	1.4	1.4	1.4	1.4	0.7	0.7	0.7	0.7	0.7	10.5
	LSMC		0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.3
	KRM		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Total			1.8	1.8	1.8	1.8	1.8	0.9	0.9	0.9	0.9	0.9	13.5
6. Institutional/ Organizational Strengthening	KMC		0.1	0.1	0.1	0.1	0.1						0.5
	LSMC		0.1	0.1	0.1	0.1	0.1						0.5
	KRM		0.1	0.1	0.1	0.1	0.1						0.3
Total			0.3	0.3	0.3	0.3	0.3						1.3

Note: 1) Assumption for sale of compost; sale price at Rs 1.0/kg, and half of the products are considered as marketable volume and the rest for the municipalities' own use.

Source: JICA Study Team

Detail cost of the Umbrella Concept in Zone B is presented in Table 10.9-4.

Table 10.9-4 Estimated Cost for Umbrella Concept in Zone B (million Rs)

Cost Items			2005/06 (2062/63)	2006/07 (2063/64)	2007/08 (2064/65)	2008/09 (2065/66)	2009/10 (2066/67)	2010/11 (2067/68)	2011/12 (2068/69)	2012/13 (2069/70)	2013/14 (2070/71)	2014/15 (2071/72)	Total
I. Investment Cost			218.1	34.1	18.0	3.8	2.1	3.2	6.4	24.5	0	0	390.4
1. Collection & Transport	Vehicles	BKM			16.1	2.1	2.1	3.2	6.4	4.3			34.3
		MTM			1.6	1.6							3.3
	Total		0	0	17.7	3.8	2.1	3.2	6.4	4.3	0	0	37.5
3. Waste Processing Facility	Taikabu	Construction	38.2										38.2
		Equipment	42.0										42.0
	Total		80.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.2
4. Landfill	Hanumante DS	Closure Works		0.3	0.3								0.5
	MTM LF	Closure Works		0.2									0.2
	Taikabu LF	IEE, EIA and DD	4.9										4.9
		Land acquisition	10.5										10.5
		Construction	202.7										202.7
		Heavy equipment	0.0	33.7						20.2			53.9
		Total	218.1	33.7	0	0	0	0	0	20.2	0	0	272.0
	Total		218.1	34.1	0.3	0	0	0	0	20.2	0	0	272.7
II. Incremental O & M Cost			2.8	9.7	13.9	14.7	15.4	14.4	14.8	15.2	14.6	15.2	130.6
1. Collection & Transportation	BKM	Personnel	0.8	1.1	2.5	2.8	3.1	2.5	2.3	2.3	1.9	2.1	21.3
		Repair & maintenance	0.1	0.2	1.3	1.5	1.7	1.7	2.0	2.3	2.1	2.2	15.2
		Fuel	0.2	0.3	0.8	0.9	1.0	0.9	0.9	0.9	0.8	0.8	7.4
		Others	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9
		Total	1.2	1.6	4.7	5.3	6.0	5.1	5.3	5.5	4.8	5.2	44.8
	MTM	Personnel	0.7	0.6	1.3	1.5	1.5	1.6	1.7	1.8	1.9	2.0	14.5
		Repair & maintenance	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	3.6
		Fuel	0.2	0.2	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	4.8
		Others	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.5
		Total	1.1	1.0	2.0	2.4	2.4	2.5	2.7	2.9	3.1	3.2	23.4
	Total		2.3	2.6	6.8	7.7	8.4	7.7	8.0	8.5	7.9	8.4	68.2
3. Waste Processing Facility	Cost	Personnel		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6.3
		Others		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.6
		Subtotal		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10.8
	Sale of Products			-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-16.4
	Total			-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-5.6
4. Final Disposal		Personnel		1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	11.3
		Repair & maintenance		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	13.9
		Fuel		2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	25.2
		Others		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	13.9
		Total		7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	64.3
5. Public Awareness /Community Mobilization	BKM		0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.3
	MTM		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8
	Total		0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	3.0
6. Institutional/ Organizational Strengthening	BKM		0.1	0.1	0.1	0.1	0.1						0.5
	MTM		0.1	0.1	0.1	0.1	0.1						0.3
	Total		0.2	0.2	0.2	0.2	0.2						0.8
III. Total (= I + II)			220.9	43.8	31.8	18.5	17.6	17.6	21.2	39.7	14.6	15.2	521.1

Source: JICA Study Team

10.9.2 Concept for Cost Sharing Among the Organizations Concerned

(1) Concept for Cost Sharing between the Municipalities and the Government

The municipalities have been continuously facing financial difficulties because the size of revenue is not enough to satisfy the increasing demand for municipal services. Also the municipalities have to face the serious financial problem of the loss of a Local Development Fee that will fade out by December 2013. Some municipalities such as KMC and LSMC have already started to strengthen their revenue systems; however there are no concrete measures to cure it. So it may be too much for the municipalities to be burdened with all the cost of the Action Plans. Meanwhile, the need is rising to develop an SWM infrastructure, which is indispensable for the growing Metropolitan area of the Kathmandu Valley.

Considering the above, the Government must be burdened with all the cost for development of the landfills, transfer stations, waste processing facilities and closure of the LF. On the

other hand, in principle, municipalities should bear the rest of the cost from their own revenues, that is, equipment procurement and incremental O&M cost.

Thus, criteria for a cost sharing concept for the Action Plans is summarized as shown in Table 10.9.5

Table 10.9-5 Cost Sharing Concept

Activities	Component	Municipality	Government	Ref: External Funding Sources
Transportation	Vehicles and Container Carriers	Full	-	Expected
	Containers	Full	-	-
	O&M	Full	-	
Transfer Station	Construction	-	Full	-
	Improvement works	-	Full	-
	Equipment	Full	-	Expected
	O&M	Full	-	-
Waste Processing Facility	Land acquisition	-	Full	-
	Construction	-	Full	-
	Equipment	Full	-	Expected
	O&M	Full	-	
Landfill	Land acquisition	-	Full	-
	Construction	-	Full	Expected
	Equipment	Full	-	Expected
	Closure	-	Full	-
	O&M	Full		
Workshop	Facilities	Full	-	-
	Machinery & equip.	Full	-	-
Public Awareness/community mobilization		Full	-	-
Institutional/organizational strengthening		Full	-	-

Note: Full – full share, and Expected –financial support be expected
Source: JICA Study Team

Table 10.9-6 shows an overview of the cost that would be shared by the municipalities and the Government according to the above criteria;

- Municipalities: Rs 1,114 million (44%)
- Government: Rs 1,419 million (56%)

External financial support may be expected for some areas of the Action Plans as described above.

Table 10.9-6 Costs for SWMRMC and Municipalities (million Rs)

Zone	Activities	SWMRMC	Municipalities			
		Facilities	Equipment	O&M	Total	Reference
A	Transport/Haulage	-	120.5	541.1	661.6	Own revenue of KMC, LSMC and KRM in FY2003/04 (2060/61)
	Transfer Station	65.9	-	36.5	36.5	
	Waste Processing Facility	203.8	16.0	-27.9	-11.9	
	Landfill	892.3	45.2	122.3	167.5	
	Workshop	-	7.8	-	7.8	
	Public Aware.	-	-	13.5	13.3	
	Institutional	-	-	1.3	1.3	
	Total	1,162.0	189.5	686.8	876.3	656.9
B	Transport	-	37.5	68.2	105.7	Own revenue of BKM and TMT in FY2003/04 (2060/61)
	Waste Processing Facility	38.2	42.0	-5.6	36.4	
	Landfill	218.8	53.9	64.3	118.2	
	Public Aware.	-	-	3.0	3.0	
	Institutional	-	-	0.8	0.8	
	Total	257.0	133.4	130.7	264.1	143.9
Total		**1,419.0**	322.9	817.5	**1,140.4**	800.8

Source: JICA Study Team

(2) Concept for Cost Sharing among the Municipalities

Although equipment procurement cost and incremental O&M cost become the burdens of the municipalities, each municipality has to bear the cost originally generated by the municipality itself, in principle. Meanwhile, the costs generated by joint work among municipalities should be principally discussed and decided among the municipalities concerned. In this connection, it is proposed that the costs generated by joint work should be separated to each municipality concerned on the basis of solid waste amount transported from the municipality to the transfer station, waste processing facility and landfill as shown in Table 10.9-7.

Table 10.9-7 Cost Sharing Ratio for SWM Joint Work (%)

Activities	Municipality	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72
Zone A											
Haulage from Teku	KMC	97.4	97.0	96.6	96.6	96.6	96.6	96.6	96.6	96.6	96.6
	KRM	2.6	3.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Haulage from WPF	KMC	-	-	-	57.4	56.2	60.0	59.7	59.3	64.2	62.5
	LSMC	-	-	-	35.0	35.0	35.0	35.0	35.0	31.8	31.8
	KRM	-	-	-	7.6	8.8	5.0	5.3	5.7	4.0	4.2
Waste Processing Facility	KMC	-	-	57.4	57.4	56.2	60.0	59.7	59.3	64.2	62.5
	LSMC	-	-	35.0	35.0	35.0	35.0	35.0	35.0	31.8	31.8
	KRM	-	-	7.6	7.6	8.8	5.0	5.3	5.7	4.0	4.2
Transfer Station	KMC	-	-	-	57.4	56.2	60.0	59.7	59.3	64.2	62.5
	LSMC	-	-	-	35.0	35.0	35.0	35.0	35.0	31.8	31.8
	KRM	-	-	-	7.6	8.8	5.0	5.3	5.7	4.0	4.2
Landfill	KMC	82.7	82.2	81.7	86.2	85.7	89.2	88.7	88.2	90.2	90.4
	LSMC	15.9	16.3	16.6	13.1	13.6	9.9	10.4	10.9	8.7	8.5
	KRM	1.4	1.5	1.7	0.7	0.7	0.9	0.9	0.9	1.1	1.1
Zone B											
Landfill	BKM	-	70.5	69.7	69.4	64.6	63.4	62.5	61.7	60.5	59.7
	MTM	-	29.5	30.3	30.6	35.4	36.6	37.5	38.3	39.5	40.3

Source: JICA Study Team

(3) Cost for Each Municipality after Cost Sharing

Based on the concept, the estimated cost is separated for each municipality, which is summarized in the following Tables from 10.9-8 to 10.9-12.

Table 10.9-8 Action Plan Cost: KMC (million Rs)

Activity	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72	Total
I. Investment cost	14.1	50.8	18.4	2.4	33.8	14.1	0	9.8	11.4	3.0	157.7
1. Transport Vehicles	6..3	31.2	-	-	33.8	-	-	-	-	-	71.3
2. Container Carriers	-	17.2	-	-	-	4.3	-	5.0	-	3.0	29.5
3. Equipment for WPF	-	2.4	-	2.4	-	-	-	4.8	-	-	9.6
4. Heavy Equip. for LF	-	-	18.4	-	-	9.8	-	-	11.4	-	39.5
5. Workshop	7.8										7.8
II. Increm. O&M Cost	40.0	38.5	41.1	51.5	54.7	48.7	53.4	53.2	47.4	48.7	477.4
1. Transportation	1.6	-10.9	-6.7	0.3	1.4	-5.6	-1.2	-3.2	-9.3	-10.2	-43.7
2. Haulage	24.5	34.0	34.0	36.9	40.0	41.6	41.5	44.7	44.6	46.6	388.6
3. Transfer Station	2.0	3.7	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	33.2
4. Waste Processing Facility	-	-	-0.9	-0.9	-1.8	-2.0	-2.0	-2.9	-3.2	-3.1	-16.8
5. Landfill	10.3	10.2	9.8	10.3	10.2	10.6	10.9	10.5	11.1	11.2	105.1
6. Public Awareness	1.4	1.4	1.4	1.4	1.4	0.7	0.7	0.7	0.7	0.7	10.5
7. Institutional Strength.	0.1	0.1	0.1	0.1	0.1						0.5
III. Total of Cost	54.1	89.3	59.5	53.9	88.5	62.8	53.4	63.0	58.8	51.7	**635.1**

Source: JICA Study Team

Table 10.9-9 Action Plan Cost: LSMC (million Rs)

Activity	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72	Total
I. Investment cost	0.0	11.2	2.4	1.4	0.0	3.7	0.0	5.6	1.5	1.7	27.6
1. Transport Vehicles	-	-	-	-	-	-	-	-	-	-	0
2. Container Carriers	-	9.8	-	-	-	2.5	-	2.9	-	1.4	16.6
3. Equipment for WPF	-	1.4	-	1.4	-	-	-	2.7	-	-	5.5
4. Heavy Equip. for LF	-	-	2.4	-	-	1.3	-	-	1.5	-	5.2
II. Increm. O&M Cost	4.5	16.4	16.8	21.6	21.9	19.8	22.0	23.7	23.0	24.4	194.0
1. Transport	0.2	8.5	10.6	10.8	10.6	12.1	13.4	14.7	16.1	17.3	114.3
2. Haulage	0.8	4.3	4.3	9.3	10.3	7.4	8.2	9.1	7.1	7.5	68.4
3. Transfer Station	1.1	1.1	-	-	-	-	-	-	-	-	2.2
4. Waste Processing Facility	0	0	-0.6	-0.6	-1.1	-1.1	-1.1	-1.7	-1.6	-1.6	-9.5
5. Landfill	2.0	2.0	2.0	1.7	1.7	1.3	1.4	1.4	1.2	1.1	15.8
6. Public Awareness	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.3
7. Institutional Strength.	0.1	0.1	0.1	0.1	0.1						0.5
III. Total of Cost	4.5	27.6	19.2	23.0	21.9	23.5	22.0	29.3	24.5	25.9	**221.6**

Source: JICA Study Team

Table 10.9-10 Action Plan Cost: BKM (million Rs)

Activity	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72	Total
I. Investment cost	42.0	23.8	16.1	2.1	2.1	3.2	6.4	18.5	0	0	114.2
1. Transport Vehicles	-	-	16.1	2.1	2.1	3.2	6.4	4.3	-	-	34.3
2. Container carriers	-	-	-	-	-	-	-	-	-	-	0
3. Equipment for WPF	42.0	-	-	-	-	-	-	-	-	-	42.0
4. Heavy Equip. for LF	-	23.8	-	-	-	-	-	14.3	-	-	38.0
II. Increm. O&M Cost	1.6	6.4	9.5	10.0	10.4	9.2	9.3	9.5	8.7	9.0	83.6
1. Transport	1.2	1.6	4.7	5.3	6.0	5.1	5.3	5..5	4..8	5..2	44.8
2. Haulage	-	-	-	-	-	-	-	-	-	-	0
3. Transfer station	-	-	-	-	-	-	-	-	-	-	0
4. Waste Processing Facility	-	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-5.6
5. Landfill	5.0	5.0	5.0	4.6	4.5	4.5	4.4	4.3	4.3	41.6	5.0
6. Public Awareness	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	2.3
7. Institutional Strength.	0.1	0.1	0.1	0.1	0.1						0.5
III. Total of Cost	43.6	30.2	25.6	12.2	12.5	12.4	15.7	28.0	8.7	9.0	**197.8**

Source: JICA Study Team

Table 10.9-11 Action Plan Cost: MTM (million Rs)

Activity	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72	Total
I. Investment cost	0	9.9	1.6	1.6	0	0	0	6.0	0	0	19.2
1. Transport Vehicles	-	-	1.6	1.6	-	-	-	-	-	-	3.3
2. Container Carriers	-	-	-	-	-	-	-	-	-	-	0
3. Equipment for WPF	-	-	-	-	-	-	-	-	-	-	0
4. Heavy Equip. for LF	-	9.9	-	-	-	-	-	6.0	-	-	15.9
II. Increm. O&M Cost	1.2	3.3	4.4	4.7	5.1	5.2	5.5	5.7	5.9	6.1	47.1
1. Transport	1.1	1.0	2.0	2.4	2.4	2.5	2.7	2.9	3.1	3.2	23.4
2. Haulage	-	-	-	-	-	-	-	-	-	-	0
3. Transfer Station	-	-	-	-	-	-	-	-	-	-	0
4. Waste Processing Facility	-	-	-	-	-	-	-	-	-	-	0
5. Landfill	-	2.1	2.2	2.2	2.5	2.6	2.7	2.7	2.8	2.9	22.7
6. Public Awareness	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8
7. Institutional Strength.	0.1	0.1	0.1	0.1	0.1						0.3
III. Total of Cost	1.2	13.2	6.0	6.3	5.1	5.2	5.5	11.7	5.9	6.1	**66.3**

Source: JICA Study Team

Table 10.9-12 Action Plan Cost: KRM (million Rs)

Activity	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72	Total
I. Investment cost	0	1.7	0.4	0.3	0	0.5	0	0.9	0.2	0.3	4.2
1. Transport Vehicles	-	-	-	-	-	-	-	-	-	-	0
2. Container Carriers	-	1.7	-	-	-	0.4	-	0.5	-	0.3	2.9
3. Equipment for WPF	-	-	-	0.3	0.0	0.0	0.0	0.5	-		0.8
4. Heavy Equip. for LF	-	-	0.4	-	-	0.1	-	-	0.2	-	0.6
II. Increm. O&M Cost	1.0	1.2	1.1	1.6	1.7	1.7	1.7	1.8	1.7	1.8	15.4
1. Transport	-	-	-	-	-	-	-	-	-	-	0
2. Haulage	0.7	0.8	0.9	1.4	1.6	1.5	1.6	1.8	1.6	1.7	13.5
3. Transfer station	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1
4. Waste Processing Facility	-	-	-0.1	-0.1	-0.3	-0.2	-0.2	-0.3	-0.2	-0.2	-1.6
5. Landfill	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.3
6. Public Awareness	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8
7. Institutional Strength.	0.1	0.1	0.1	0.1	0.1						0.3
III. Total of Cost	1.0	2.8	1.4	1.9	1.7	2.2	1.7	2.7	1.9	2.1	**19.6**

Source: JICA Study Team

10.9.3 Concept for Necessary Financial Procurement

A concept for the preliminary solution to the most crucial issues on financial resources of municipalities, the Local Development Fee and other financial resources, are discussed with the expectation to make up for the loss of the Local Development Fee.

(1) Projected Local Development Fee until Year of 2013

As previously mentioned in Section 3.3.4, the Local Development Fee (LDF) will fade out gradually (practically, year-wise and industrial sector-wise abolishment according to the Harmonized System (HS) codes) by December 2013. However, the Government has not

transmitted any information on the yearly predicted amount of LDF until year 2013 to the municipalities. In this connection, the Study Team projects the yearly LDF amount for each municipality until year 2013 according to the following assumptions by referring to the information from the Government. The projection includes a Government subsidy that is to be studied by the Government to relieve the municipalities.

< Assumptions to project the yearly LDF >

Items	05/06-07/08 (2062/63-2064/65)	08/09-10/11 (2065/66-2067/68)	11/12-13/14 (2068/69-2070/71)
LDF to municipality	To continue at the same amount	90% of previous year for each year	75% of previous year for each year
Government subsidy (to make up for reduced amount)	none	Half of amount of reduction in the LDF compared with 2004/05 (2061/62) amount	

Projected LDF of each municipality is summarized in Table 10.9-13.

Table 10.9-13 Projected Yearly LDF and Subsidy (million Rs)

Municipality	Items	05/06 62/63	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72
KMC	LDF	237.5	213.8	192.4	173.1	129.9	86.6	43.3	0.0
	Subsidy	0	11.9	22.6	32.2	53.8	75.5	97.1	118.8
	Total	237.5	225.6	214.9	205.3	183.7	162.0	140.4	118.8
	Change	**0**	**-11.9**	**-22.6**	**-32.2**	**-53.8**	**-75.5**	**-97.1**	**-118.8**
LSMC	LDF	52.4	47.2	42.4	38.2	28.6	19.1	9.5	0.0
	Subsidy	0	2.6	5.0	7.1	11.9	16.7	21.4	26.2
	Total	52.4	49.8	47.4	45.3	40.5	35.7	31.0	26.2
	Change	**0**	**-2.6**	**-5.0**	**-7.1**	**-11.9**	**-16.7**	**-21.4**	**-26.2**
KRM	LDF	11.9	10.7	9.6	8.7	6.5	4.3	2.2	0.0
	Subsidy	0	0.6	1.1	1.6	2.7	3.8	4.9	6.0
	Total	11.9	11.3	10.8	10.3	9.2	8.1	7.0	6.0
	Change	**0**	**-0.6**	**-1.1**	**-1.6**	**-2.7**	**-3.8**	**-4.9**	**-6.0**
BKM	LDF	21.4	19.3	17.3	15.6	11.7	8.8	6.6	0.0
	Subsidy	0	1.1	2.0	2.9	4.8	6.3	7.4	10.7
	Total	21.4	20.3	19.4	18.5	16.6	15.1	14.0	10.7
	Change	**0**	**-1.1**	**-2.0**	**-2.9**	**-4.8**	**-6.3**	**-7.4**	**-10.7**
MTM	LDF	11.9	10.7	9.6	8.7	6.5	4.9	3.7	0.0
	Subsidy	0	0.6	1.1	1.6	2.7	3.5	4.1	6.0
	Total	11.9	11.3	10.8	10.3	9.2	8.4	7.8	6.0
	Change	**0**	**-0.6**	**-1.1**	**-1.6**	**-2.7**	**-3.5**	**-4.1**	**-6.0**

Note: 1) Half of the amount of the reduction compared to FY 04/05 LDF is expected as Government subsidy. 2) Change means difference between FY 2004/05 and respective FY.
Source: JICA Study Team

(2) Financial Resources necessary to be Generated

Judging from the above LDF and actual financial capacity of the municipalities, it is difficult to expect the municipalities to cover the entire cost. In order to accomplish the Action Plans smoothly, the municipalities themselves have to develop and diversify the sources of funds as follows:

1. To enhance revenue generation capability especially Property Tax
2. To utilize the Reserved Fund that is currently the only Government tool of financial support to the municipalities
3. Other alternatives to be studied
   a. To introduce Public Private Partnership in SWM to reduce the SWM cost
   b. To create new charges for SWM services

1) Enhancement of Revenue Generation Capability

LDF, which will end by December 2013, is a crucial concern for every municipality. The Government has shifted the Property Tax, which was previously entirely Government revenue, to the municipalities since FY2000/01 (2057/58). The Property Tax is considered as the optimum revenue mobilization because it is expected to increase in line with growing urbanization and population. However, in reality, the municipalities have not reformed or improved the system of the Property Tax enough to catch up with growing urbanization, increasing population and demand for municipal services from the community. Accordingly, now it is the most crucial matter for every municipality to strengthen it to make up for the reducing LDF.

As previously mentioned in Section 6.5.3, KMC and LSMC have already started to implement revenue enhancement measures envisaging the financial constraint in future. On the other hand, BKM, MTM and KRM have not yet started their own enhancement measures, so that these municipalities have to study them as soon as possible.

< Preliminary Projection of Yearly Property Tax >

Preliminarily, the Study Team projected the yearly Property Tax amount of each municipality until the target year of 2014/15 (2071/72) applying the following assumptions based on information from the municipalities as shown in Table 10.9-14.

Table 10.9-14 Assumptions for Estimate of Future Property Tax

Municipality	Base Data	Base Year	Projection		
		2004/05 (2061/62)	2005/06 (2062/63)	2009/10 (2066/67)	2014/15 (2071/72)
KMC	Persons/residential building	8.2	8.2	8.2	8.2
	No. of residential buildings	90,000	93,821	109,104	128,208
	% of residential buildings that pay property tax	44%	54%	**90%**	**90%**
	Tax / residential building	Rs 3,250	Rs 3,250	Rs 3,250	Rs 3,250
LSMC	Persons/residential building	6.9	6.9	6.9	6.9
	No. of residential buildings	25,822	26,973	31,576	37,330
	% of residential buildings that pay property tax	32%	44%	**90%**	**90%**
	Tax/ residential building	Rs 1,810	Rs 1,810	Rs 1,810	Rs 1,810
KRM	Persons/residential building	6.5	6.5	6.5	6.5
	No. of residential buildings	6,726	6,896	7,576	8,426
	% of residential buildings that pay property tax	20%	34%	**90%**	**90%**
	Tax/ residential building	Rs 740	Rs 740	Rs 740	Rs 740
BKM	Persons/residential building	9.0	9.0	9.0	9.0
	No. of residential buildings	8,973	9,385	11,031	13,088
	% of residential buildings that pay property tax	20%	34%	**90%**	**90%**
	Tax/ residential building	Rs 560	Rs 560	Rs 560	Rs 560
MTM	Persons/residential building	7.4	7.4	7.4	7.4
	No. of residential buildings	7,264	7,666	9,276	11,289
	% of residential buildings that pay property tax	20%	34%	**90%**	**90%**
	Tax/ residential building	Rs 690	Rs 690	Rs 690	Rs 690

Note: Following Criteria is applied for assumptions of the table:
Source: JICA Study Team

Items	Base Year 2004/05 (2061/62)		Projection
	KMC	Other municipalities	
1. Persons/residential building	Calculated from household size and number of residential buildings		Same as base year's data
2. Number. of residential buildings	information from KMC	1.5 households/residential building	To consider population growth
3. % of residential buildings that paid property tax	information from KMC, currently 44 %	assumed based on the actual amount collected, 32 % in LSMC, and 20 % in KRM, BKM and TMT	To set target of 90 % by 2009/10
4. Tax/residential building	calculated from data of actual collected amount and assumed number of residential buildings that paid property tax,		Same as base year's data

Thus, the future Property Tax of each Municipality until the target year FY2014/15 (2073) is projected and summarized in Table 10.9-15.

Table 10.9-15 Estimated Yearly Property Tax of Each Municipality (million Rs)

Municipality	05/06 62/63	06/07 63/64	07/08 64/65	08/09 65/66	09/10 66/67	10/11 67/68	11/12 68/69	12/13 69/70	13/14 70/71	14/15 71/72
KMC	163.3	198.9	236.7	276.8	319.1	330.3	341.5	352.7	363.8	375.0
Change	**+33.3**	**+68.9**	**+106.7**	**+146.8**	**+189.1**	**+200.3**	**+211.5**	**+222.7**	**+233.8**	**+245.0**
LSMC	21.3	28.1	35.4	43.2	51.4	53.3	55.2	57.1	58.9	60.8
Change	**+6.3**	**+13.1**	**+20.4**	**++28.2**	**+36.4**	**+38.3**	**+40.2**	**+42.1**	**+43.9**	**+45.8**
KRM	1.7	2.5	3.3	4.2	5.0	5.2	5.3	5.4	5.5	5.6
Change	**+0.7**	**+1.5**	**+2.3**	**+3.2**	**+4.0**	**+4.2**	**+4.3**	**+4.4**	**+4.5**	**+4.6**
BKM	1.8	2.6	3.5	4.5	5.6	5.8	6.0	6.2	6.4	6.6
Change	**+0.8**	**+1.6**	**+2.5**	**+3.5**	**+4.6**	**+4.8**	**+5.0**	**+5.2**	**+5.4**	**+5.6**
TMT	1.8	2.7	3.6	4.7	5.8	6.0	6.3	6.5	6.8	7.0
Change	**+0.8**	**+1.7**	**+2.6**	**+3.7**	**+4.8**	**+5.0**	**+5.3**	**+5.5**	**+5.8**	**+6.0**

Note: change means difference between FY 2004/05 and respective FY
Source: JICA Study Team

2) Utilization of Reserved Fund

As previously mentioned in Section 3.3.3, the Reserved Fund is considered as a possible financial source for SWM for the municipalities with the limit of Rs 5 million for one municipality or for each municipality in a joint project. The Reserved Fund should be utilized for effective implementation of the Action Plans.

3) Other Alternatives to be studied

a. Introduction of Public Private Partnership

Since Municipalities' responsibilities for SWM are expected to expand and increase by implementing the A/Ps, the financial burden of the municipality will become heavier than ever. Privatization of various SWM operations should also be considered as an effective measure to reduce the financial burden of the municipalities. The following privatization can be preliminary suggested.

Table 10.9-16 Suggestions for Privatization by Type

Type of Privatization	Contents of Agreement
Contract-out	- Simple contract - Operation by contractor - Management & supervising by municipality
Management Contract	- Operation and management by contractor - Equipment & facility owned by municipality, also can be rented or leased to contractor - Profit can be shared
BOT, BTO or BOO	- Long-term concession - BTO; facilities transferred and owned by municipality, and leased to contractor - BOO; after the termination of concession period, the facility to be demolished
Joint Management	- Operation and management jointly by municipality and contractor

Source: JICA Study Team

Since the involvement of private sectors needs to be financially sustainable and cost-effective, the agreements for privatization of SWM services should be made as follows:

- For a period that is long enough to allow full depreciation of investment
- Large enough to accrue benefits from economy of scale, and
- Competitive enough to ensure efficiency

Moreover, competitive bidding should be adopted to select contractors and the eligibilities based on sufficient experience, skilled manpower, technical skill, and financial soundness should be taken into consideration.

b. Creation of Service Charges for SWM

The Local Self Governance Act, 1999-Article 145 stipulates that "the Municipality may impose service charges for solid waste management facilities provided by it." Actually the municipality have already imposed and collected several kinds of taxes, fees and charges from taxpayers of the area. Accordingly, the taxpayers may not understand and conform easily to another charge to be imposed. However, the problem is that the current revenue system of the municipalities can not keep pace with the growing demand for SWM services. The creation of a SWM service charge system has to be studied by the municipalities.

Meanwhile various private sectors actually collect different charges by their own system, which may cause another problem giving rise to unfairness and inequity among dwellers and simultaneously leading to default on their duty. To cope with these problems, establishment of an integrated SWM charge system is necessary as follows:

- To create service charges for SWM imposed by the municipality
- To formulate a table of charges to be reviewed periodically
- To unify the collecting system
- To investigate the possibility of privatization on collecting charges