CHAPTER 12

SOLID WASTE MANAGEMENT AND SANITATION FACILITIES

12.1 SOLID WASTE MANAGEMENT

Population explosion, coupled with improved life style of people, results in increased generation of solid wastes in urban as well as rural areas of the country. At present, the municipal solid waste disposal methods followed in many of the cities and towns are unsystematic & unscientific and involve dumping in low-lying areas. Most of the disposal sites are just uncontrolled dumps where a mixture of domestic, commercial, industrial and hospital wastes is 'thrown away' at the dumping sites. Apart from creating air pollution, ground water contamination & soil contamination, open dumping of wastes generally becomes breeding ground for various dreadful disease causing pathogens and vectors, particularly in the vicinity of the disposal sites. Further, with increasing awareness of public on environmental and health issues, there is a general opinion that the standard of services with respect to collection and disposal of municipal solid waste is progressively declining. It is also true in many cities as half of the solid waste generated remains unattended.

The objective of Solid Waste (SW) Management is to maintain clean and hygienic conditions and reduce the quantity of SW, which has to be disposed of in Sanitary Landfill Facility (SLF) after recovery of waste materials and energy from it.

12.1.1 Population Generating Solid Waste

The residential colonies of the Dibang project will be located on the right and left bank of the Dibang River. The colonies will be of two types, one for the NHPC employees and their families, with an approximate population of 800, and, the other for labourers, with an approximate population of 5000 (peak

labour requirement). In addition to this, during construction stage it is expected that about 100-200 people from nearby villages will visit project site everyday for commercial purposes and constitute the regular floating population. This floating population may also generate Solid Waste Management System.

Number of labourers at the construction period will be quite high and after the commissioning of the project the population will be reduced substantially. However, during construction stage, the manpower population bears a significant role in the generation of SW.

12.1.2 Total Solid Waste to be Generated

The quantity of waste generated in Indian cities reported to be in the range of 0.2-0.6 kg/capita /day as per the "Manual on Solid Waste Management" prepared by Central Public Health & Environment Engineering Organisation (CPHEEO), Ministry of Urban Development, Govt. of India. The Waste Generation pattern is very much dependant on the living style of the population. As the major share of the population is labour force in Dibang, the waste generation factor of 0.3 kg/capita/day has been taken into consideration.

12.1.3 Approach for Scientific Solid Waste Management System

The recommended Solid Waste Management system for Dibang project has been based on the following principles and aspects:

i. It should follow 'Cradle-to-Grave' approach for Solid Waste Management.

ii. An effective Solid Waste Management system should aim at minimising manual handling and 100 % collection & transportation of solid wastes should be achieved.

iii. It should encourage segregation of wastes.

iv. Recyclable wastes should be put to effective use.

v. It should aim at minimising and ultimately eliminating adverse environmental and health impacts.

12.1.3.1 Recommended Solid Waste Management System

The recommended Solid Waste Management system for the project is presented below:

- ❑ Segregation of Solid Waste at source
- ❑ Storage & primary collection of waste from project colonies, offices, guest houses, labour colonies/sheds, minor commercial establishments, market, community centre, Hospitals, workshops, canteen/mess, school, garden, parks etc.
- ❑ Waste Transportation mechanism
- ❑ Waste Storage Depots/enclosures
- ❑ Waste Processing & Disposal

12.1.3.2 Administrative Set Up

Administratively, a Solid Waste Management Committee (SWMC) comprising of the project representatives will look after the management of solid waste. The SWMC may comprise of the following:

- In-charge of civil works, at least of the rank of Senior Manager/Manager (1 No.)
- Engineer/Environment Officer (2 Nos.)
- Supervisors/JEs (4 Nos.)
- Representative from project hospital (2 Nos.)
- Representative from project school (1 No.)

The SWMC will be supported by sanitary workers, sweepers etc., the number of which may be decided by the SWMC after assessing the work requirement.

12.1.4 Solid Waste Management Plan

An ideal solid waste management system works on four basic principles viz. segregation & primary storage at the source, collection, transportation, treatment & disposal.

12.1.4.1 Segregation at source

- Segregation of waste is one of the critical activities in the Solid Waste Management as it saves undue efforts on transportation and disposal of recyclable or inert wastes. The segregation of such wastes, before they are transported to the processing /disposal site, should be carried out.

- Waste segregation cannot be introduced without public awareness and should be implemented in a phased manner. In order to achieve this, the following strategy may be adopted for promoting public awareness:

  i. The residents should be educated about appropriate use of biodegradable waste like kitchen & garden wastes.

  ii. Extensive awareness campaigns have to be organized by SWMC for educating the public on the aspects related to impacts of solid waste on environment & health, ill effects of littering & burning of wastes, segregation of municipal solid wastes, proper primary storage within their house premises, etc. The awareness can be spread through posters, distribution of pamphlets etc. SWMC may involve NGOs for organizing awareness programs at project school, hospital etc.

  iii. Residents may be advised to develop the habit of segregating the biodegradable waste material like kitchen & garden waste and store in a separate bag or a bin installed at their respective houses.

- The SWMC would educate its sanitary workers about the revenue earning potential of recyclable waste and various options to earn revenue. The sanitary workers should be advised to collect such waste separately. To encourage collection of recyclables, SWMC may think of devising a plan which can provide some revenue opportunities for the sanitary workers. Market potential with respect to the forward linkages for effective disposal of recyclable waste is to be identified and exploited by the SWMC for the purpose.

- Collection & segregation of hazardous wastes from the workshops viz. used batteries, transformer oil, used oil, metal scraps etc. and selling them to CPCB registered vendors having Environmentally Sound Management (ESM) system.
- The operator of waste processing/disposal facility should be advised to carry out inspection of waste received to further segregate recyclables and sell them to recyclers. If it is not feasible to segregate recyclables on their own, the processing/disposal facility operator may allow registered scavengers to enter the premises of the compost plant and pick recyclable waste. This would ensure reduction in rejects, reducing burden on processing plant as well as landfill.
- SWMC may register the names of recyclers for the recyclables such as plastics, newspapers, glass, metals etc. from residential and commercial sources and the names of registered recyclers should be published or made known to the public residing in the project / labour colonies / labour sheds.
- SWMC may associate and involve residents, shop owners, hospital & school staff and NGOs/ Voluntary Organizations of the area working in the field of waste management in increasing awareness among the people to segregate recyclable material at source and hand it over to a designated waste collector identified by SWMC.

Primary Storage of Wastes

It is recommended to segregate waste into two categories & store the segregated wastes in two different containers:

- One container **(Green Coloured)** for the **"Biodegradable Waste"** or the **"Wet Waste"** and
- Other container **(Blue Coloured)** for the **"Non-biodegradable Wastes"** or the "**Dry Waste".**

Wet waste (Biodegradable) includes the following:

- Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones
- Flower and fruit waste including juice peels and house-plant waste
- Garden sweeping or yard waste consisting of green/dry leaves
- Sanitary wastes
- Green waste from vegetable & fruit vendors/shops
- Waste from food & tea stalls/shops etc.

Dry waste (Non-biodegradable) includes the following:

- Paper and plastic, all kinds
- Cardboard and cartons
- Containers of all kinds excluding those containing hazardous material
- Packaging of all kinds
- Glass of all kinds
- Metals of all kinds
- Rags, rubber
- House sweeping (dust etc.)
- Ashes
- Foils, wrappings, pouches, sachets and tetra packs (rinsed)
- Discarded electronic items from offices, colonies viz. cassettes, computer diskettes, printer cartridges and electronic parts.
- Discarded clothing, furniture and equipment

❑ The wet & dry wastes are to be stored in two different containers as mentioned above. As the biodegradable waste degrades and generates liquid, it is advisable to use non-corrosive container with lid for the storage of bio-degradable/wet waste.

- A **Green** coloured container of 10 liters capacity for a family of about 5-6 members would generally be sufficient for wet waste. However, it is advisable that a household should keep larger container or standby container to store the additional wastes produced in 24 hours. The household may have a spare capacity of 100% to meet unforeseen delay in clearance or unforeseen extra loads.
- Dry waste can be stored in another **Blue** coloured container of 10-12 litre capacity or plastic bag/Jute Bag/plastic/polymer containers.
- The containers are to be procured by SWMC and provided to individual households in the project colonies & labour colonies/camps. Some containers of bigger capacity (0.5 m^3) will also be kept at public places, as community bins, like offices, workshops, shops, community centre, school, canteens/ mess, guest houses etc. The places where community bins have to be placed away from drinking water sources and preferably on elevated areas where water stagnation is not there during rainy days.
- For the project hospital, separate storage bins are to be arranged, the wastes of which are to be disposed of through incinerators.
- In addition to the above wastes, another type of waste called **"Domestic Hazardous Waste"** may also be generated at household level. These include used aerosol cans, batteries, household kitchen and drain cleaning agents, car batteries and car care products, cosmetic items, chemical-based insecticides/rodenticides, light bulbs, tube-lights and compact fluorescent lamps (CFL), paint, oil, lubricant and their empty containers. These wastes are to be stored separately, whenever generated and sold for recycling or handed over to the sanitary workers who come for house-to-house collection.
- To enforce successful implementation, necessary rules/by-laws should be framed by SWMC to make segregation and storage at source compulsory and also to avoid littering and burning of wastes at the project sites.

12.1.4.2 Collection of Solid Wastes

- It is recommended to have a mechanism for door to door collection of waste from the staff/ labour colonies and labour sheds. The sanitary workers / sweepers) will have tricycle with containers or containerized handcarts having ringing bell and will go for waste collection from individual house at a fixed time every day. The sanitary workers would ring the bells at the time of reaching the particular area/locality, giving a signal for waste collection to the residents.
- In labour colonies also, the door-to-door collection of waste would be carried out. The containerized rickshaws or handcarts would be employed for collection of wastes. The labourers should be strictly advised to store the wastes in available plastic containers of suitable size. The waste bins including community bins are to be cleaned daily by the sanitary workers at an informed timing.
- During collection of wastes from the bins, care shall be taken to avoid waste spillage and it shall be the responsibility of the sanitary workers to clean & maintain hygienic conditions at the places where community bins are kept.

Waste Handling

- As per Municipal Solid Waste (Solid Waste Management & Handling) Rules, 2000; the manual handling of waste has to be avoided. As per the recommended system, the waste from their source of generation is either collected by sanitary workers during door-to-door collection from the colonies or from community bins.
- The sanitary workers, after primary collection, will transport the waste to the storage depots from where it will be lifted by dumper placers and transported to the processing & disposal sites.
- The community bins of size 0.5 m^3 are to be lifted manually and unloaded into the containers kept in the transportation vehicles.
- The sanitary workers involved in manual lifting are to be provided with gloves and masks and shall be instructed to use them compulsorily

while handling waste. It will be the responsibility of the sanitary supervisors to monitor the proper use of personnel protective equipment by the workers.

12.1.4.3 Transportation of Solid Wastes

- It is recommended to use tricycles/push carts/containerized handcarts, for primary collection of waste from the individual households, offices and other public places, as described above, up to the waste storage depots. The sufficient number of tri-cycles / push carts/containerized handcarts shall be arranged for effective door-to-door collection system.
- The wastes collected from the street sweeping & drain cleaning is to be shifted to the waste storage depots using tricycles/handcarts.
- The transportation of waste from the waste storage depots to the processing and disposal sites will be done in the covered trucks/dumpers etc. so that the waste is not exposed to the human population and there is no spillage of waste on the roads during transportation.
- To take care of certain unavoidable circumstances, if it is required to lift waste from some open place, front-end loaders and tractor trolleys may be used. However, the waste in tractor trolley has to be covered with LDPE sheet during its transport.

12.1.5 Treatment & Disposal of Waste

With the implementation of source segregation and door-to-door collection system, processing of the waste would be easier. SWMC shall invite interested parties who can take the segregated waste and establish suitable waste processing plant **(Composting Plant)**. The rejects from the processing plant and non-recyclable and other wastes would be disposed off in sanitary landfill facility.

The quantity of total Solid Waste has been estimated in **Table 12.1**.

Table 12.1: Quantities of SW & Biodegradable Waste

S. No.	Description	Data
During Construction Phase		
1.	Per capita SW generation	0.3 kg per capita per day
2.	Base year population	6000
3.	Total waste generation	1800 kg/day
4.	Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste expected (**for composting)**	810 kg/day
During O&M Stage		
5.	Projected average population that will be located at the project during O&M stage (assuming 30% of population during construction)	2000
6.	Total waste generation	600 kg/day
7.	Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste expected (**for composting**)	270 kg/day

12.1.5.1 Composting

For biodegradable part of SW, it is recommended to plan a Composting Plant of about 1 ton per day capacity. The land requirement etc. could be based on 1 ton per day capacity, but initially, the composting process may be started with requirement of present day only (0.8 ton/day capacity).The compost plant may follow Windrow Composting Technology which has been recommended as a suitable technology for Indian conditions. The windrow composting has the following advantages over other composting technologies:

- Easy to operate and does not require sophisticated equipment.
- Conventional equipments more familiar to sanitary workers, like front-end loader, can be used for turning, which are easy to maintain and repair.
- Maintaining the required conditions like temperature, moisture etc. is relatively easy in this process.
- Requires minimum training of operators.
- Due to use of simple machines, defects can be repaired locally without any delay.

In order to handle the present load of biodegradable waste (around 1 ton/day), around 267 m^2 of area would be required for windrow-platform.

12.1.5.2 Sanitary Land filling

Basic Design of Sanitary Landfill Facility (SLF)

As per the requirements of the Municipal Solid Waste (Solid Waste Management & Handling) Rules 2000, land filling would be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities (composting plant). Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Land filling shall be done following proper norms and landfill sites shall meet the specifications as given in these rules.

12.1.6 Estimation Of Total Land Requirements For Disposal Of Solid Wastes

Table 12.2: Estimation of Quantity of waste to be disposed to landfill

S. No.	Description	Data
1.	Per capita MSW generation at present (as per section 3.1.1 of this report)	0.3 kg per capita per day
2.	Population during construction stage of the project	6000

3.	Total Solid Waste (SW) generation at the rate of 0.3 kg/capita/day	1800 kg/day
4.	Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste to be generated (for composting)	810 kg/day
5.	Inorganic waste for disposal (48% of total waste) to landfill (considering that recyclable waste in form of paper, glass, metals, plastic etc. constitute 7 % of total waste)	864 kg/day
6.	Quantity of rejects generated from the compost plant to be disposed to landfill, assuming the rejects as 30% of waste going to compost plant	243 kg/day
7.	Hence total waste to be disposed in landfill (0.8 + 0.3 = 1.1), at present	1107 kg/day say 1.107 tons/day
8.	Waste to be disposed to landfill, annually, at current rate	405 tons/year

Considering the total life span of landfill as 20 years, taking in to account the available land space, total quantity of wastes to be disposed off to sanitary landfill for its entire life period has been estimated by using formula:

$$Q_f = Q_a * F * \{(1+ i)^n - 1\}/ i$$

where,

Q_f: Total quantity of wastes to be disposed of in sanitary landfill for its entire life period (tons)

Q_a: Actual quantity of waste generated at present per annum (tons per annum, in this case **Q_a = 405**)

F : The factor of safety, (e.g. for 10% , **F = 1.1**)

i : The growth rate of waste generation per annum (%), may be assumed to be equal to the yearly population growth of 0.9 % for year 1991-2001 (e.g. for 0.9% growth, **i = 0.009**)

n : Life span of the landfill in years, considered 20 yrs in this case (**n = 20**)

Hence, from the above equation, **total waste to be disposed off in the landfill in the span of 20 years has been estimated as Q_f;**

Q_f = 12089 tons

V_f = 12089/0.85 = **14223 m^3**

where,

H : Total Height of Landfill above the base = 8 meters (4 m below ground level + 4 m above ground level);

A_f: Total Filling Area (m^2);

F': The factor of Safety for additional spaces, **considered 10 %**

a: The bottom edge of landfill (500 m^2)

z: The inclination of side walls of landfill i.e. z = 1:2 (vertical : horizontal).

Note: Landfill Size: 40 × 45×8

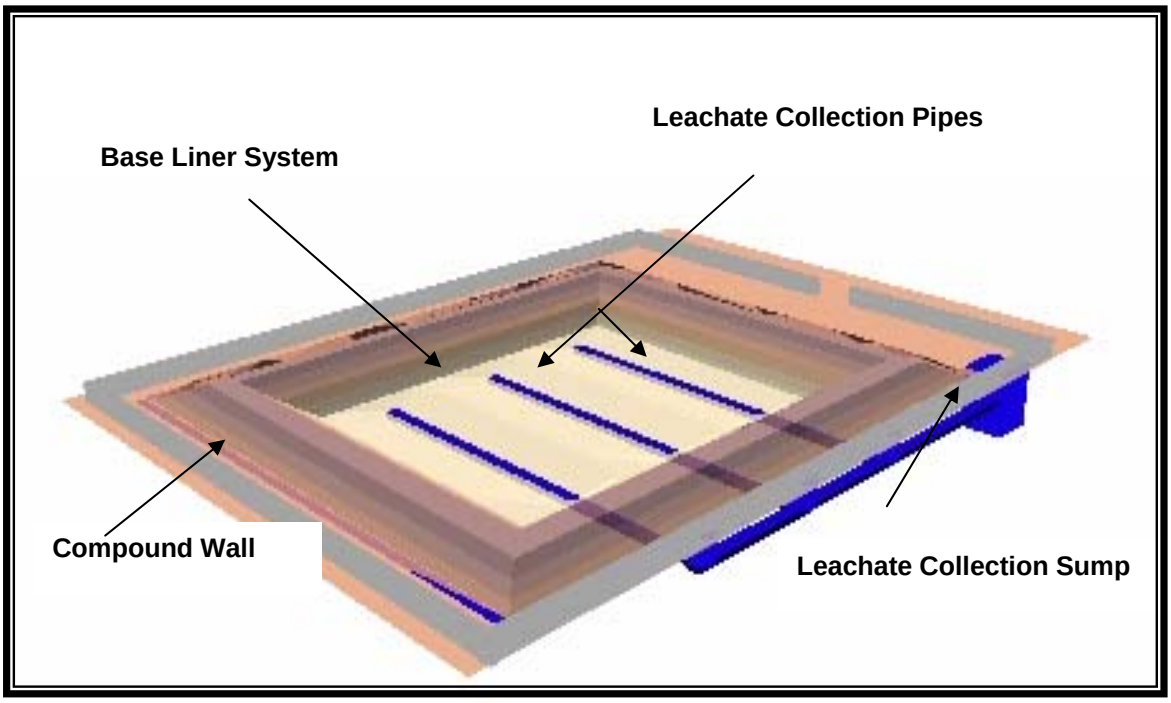
Therefore, **A_f = 1800m^2**

Therefore, the total area required for 20 years operation of site, with the present waste disposal rate of 1.1 tons/day and a growth rate of 0.9 % has been estimated to be **1800 m^2.**

12.1.7 Site Selection for Landfill Facility

SWMC may obtain the necessary approvals and clearances from State Pollution Control Board and other concerned regulatory authorities for the landfill sites. It is recommended that SWMC may take up necessary steps for getting the site notified for development of waste processing and disposal facility.

Figure 12.1: Perspective View of Sanitary Landfill Facility (Phase-1)



12.1.8 Construction of The Landfill Facility

Developed countries like U.S.A. and Germany have evolved international regulations and standards, for the construction of landfill sites. However, it would not be realistic to apply all these regulations to developing countries, which have neither the financial, and the technical means nor the special know-how to carry out the requirements of these regulations. Therefore, it is necessary to adapt the construction of landfill sites to local conditions, i.e. to apply appropriate and, as far as possible, cost effective technologies in compliance with the Rules without damaging the environment. Keeping this in view, the basic design of the sanitary landfill has been developed.

12.1.8.1 Foundation of the Landfill Site

Generally, the foundation of the landfill i.e. the bearing surface should have a minimum inclination of 3 % in order to enable leachate drainage by gravity. In flat areas, this inclination has to be made artificially or incorporated in the leachate collection pipe work.

The bearing surface must have a sufficient natural consolidation to minimize settling, and sufficient uniformity to minimise differential settlement, which would be destructive to the liner systems. The bearing surface has to be well compacted (Proctor density > 97-100%).

12.1.8.2 Filling of the Waste

The filling of waste should take place by building up horizontal layers, which have to be as lean in void as much as possible and are adequately compacted. The waste has to be disposed off in a layer of one meter thickness and well compacted. In order to get the minimum leachate generation and less interaction of wastes, it is suggested to dispose debris and construction/demolition waste initially above the lining system. This layer would act as leachate drainage layer also apart from providing protection to liner system against movement of heavy machinery in the landfill.

12.1.8.3 Lining Landfill Site

The principal aim of lining and capping a site is to contain the leachate, thus preventing pollution of surrounding land and waters. Lining may also assist in leachate control by reducing groundwater infiltration into the landfill. Lined landfill sites can usually accept a wider range of wastes than would otherwise be possible. Artificial liners are constructed of materials, which are to all intents and purposes impermeable. Natural lining materials, such as heavy clay soils, exhibit low permeability (for example 10^{-7} cm/sec).

12.1.8.4 Landfill Liners

A landfill should have a liner that is designed, constructed, and installed to prevent migration of wastes or by-products out of the landfill into adjacent subsurface soil, groundwater or surface water at anytime during the active life and after the closure of the landfill. The liner should be constructed of materials that have chemical properties and sufficient strength and thickness to prevent failure due to following:

- pressure gradients,

- physical contact with the waste for leachate to which they are exposed,
- climatic conditions,
- the stress of installation, and
- the stress of daily operation.

Therefore considering the above and as per the requirements of the Rules, 1.5 mm thick High Density Poly Ethylene (HDPE) laid over 90 cm thick clay liner is recommended as the bottom and side liners, having permeability coefficient not greater than 10^{-7} cm/sec.

12.1.8.5 Drainage System

These mineral lining layers in combination with a subsoil quality as specified above will be sufficient to prevent the seepage of leachate to deeper strata and aquifers. Nevertheless, the system will only work when the whole surface of the liner system has a sufficient inclination of >3% and when the whole surface of the liner system is covered by a 30 cm deep layer of coarse material (particle size 20-50 mm, with no fines) forming the drainage layer which is important for efficient leachate collection.

In the developing countries HDPE pipes for leachate collections and conveyance are very expensive. The use of concrete pipes is not recommended, as experience has shown that they will become corroded quickly by the leachate and break down. If plastic pipes are used, they have to be well covered by drainage material (cover depth at least twice the diameter of the pipes) in order to reduce the pressure from the waste, which will be filled on top of it. Also, they have to be strong enough to bear the pressure of the waste filled upon which can reach an elevation of 20 m and more. In view of this, it is suggested to provide a slope at the bottom and collection sump in the landfill to collect and remove the leachate.

12.1.8.6 Leachate Management System

Leachate Management is an important aspect in the landfill facility. The leachate will be generated during and after the operation of the facility. Since the leachate contains high total dissolved solids, high chemical oxygen demand and toxic

constituents, it has to be collected and treated properly to meet the wastewater discharge standards in the treatment unit. In order to minimise the leachate generation, it is suggested to avoid waste disposal during heavy rains. During this period, the active area of the landfill facility has to be covered with plastic/canvas sheet. The waste, in this period, may be stored at waste processing facility or otherwise the disposal may be continued only during dry period during monsoon.

12.1.8.7 Leachate Collection

A leachate collection and removal system at landfill site must be installed and managed in a manner that will allow it to be used for all of its projected life. A leachate collection and removal system must be:

- Compatible with the characteristics of the leachate to be collected.
- Of sufficient strength to resist collapse by pressure exerted by equipment used at the site and by the accumulated waste and materials, and
- Capable of withstanding the hydrostatic pressure.
- Precipitation and runoff are important factors affecting the volume of leachate. External run-off should be diverted from the landfill site and intermediate and final covers should help divert the precipitation that falls on the site. Assuming that there is no surface water infiltration or groundwater moving through the landfill, the only leachate production will come from the landfill wastes.

12.1.8.8 Leachate treatment

Once leachate has been collected, numerous alternatives exist for treatment and disposal. If the facility is not yet in operation, the quantity and characteristics of the leachate to be treated must be estimated. The leachate characteristics depend on the nature of the landfill wastes and on any fermentation that occurs in the landfill. The leachate treatment has to be provided as per the wastewater and the treated wastewater should meet the discharge standards.

12.1.8.9 Post Closure Plans

After completion of landfill (after providing 2% slope), a final cover shall be designed to minimize infiltration and erosion. It should have a barrier soil layer comprising of 60 cm of clay or amended soil with permeability coefficient less than $1x10^{-7}$ cm/sec. Above the barrier soil, there shall be a drainage layer of 15 cm, followed by a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

The following aspects have to be taken into account with regard to the re-cultivation:-

- ❑ The plant cover must be able to survive any meteorological conditions
- ❑ The plant cover must not decrease the impermeability of the clay layer (Rooting depth should not be more than 30 cm).
- ❑ The plant cover must ensure that the clay cover stays wet during extremely hot meteorological condition in order to avoid cracking.
- ❑ The plant cover must be able to prevent erosion by wind & water.

12.1.9 Cost of Construction Of Landfill (Phase-I)

The cost of construction of landfill has been taken as Rs. 20 lakhs. The cost includes common infra-structural/ancillary facilities, which would be useful for other phases of landfill development and for Composting Plant also.

The cost also includes expenses for covering of phase-I of landfill.

The cost of machinery and vehicles required for Composting Plant and Landfill facilities together has been estimated separately in **Table 4.**

12.1.10 LEACHATE SOLID WASTE MANAGEMENT

The leachate generated during the operation of the landfill due to rainfall and partly due to degradation of waste would be collected in sump and may either be used for composting or may be sent to the Sewage Treatment Plant (STP) for treatment.

12.1.11 Measures for Improving Solid Waste Management System

12.1.11.1 Discourage the use of Polythene /Plastic Bags

The use of plastic bags, which has grown exponentially in the last decade, poses a major problem as far as the Solid Waste Management is concerned. This is also important in the residential areas of Dibang floating population will be around 100-150 on normal day and the use of polythene bags by public and shops is prevalent for commercial activities. Another major use of plastic is the use of mineral water bottles and use of disposable plastic glass, which may not be fortunately so high in Dibang as the majority of the population will be of labour class and may not have these habits.

Apart from the fact that plastic waste chokes the drain, suffocates animals to death that eat them, it also makes Municipal Solid Waste (MSW) unfit for any biological treatment. Also, being non-biodegradable, the total quantity of plastic waste cumulatively increases with time. Also, combustion of plastic leads to air pollution related hazards.

Numerous measures, which can be taken to cut down the use of plastic items, include:

- Encourage the use of newspaper bags, wherever possible.
- Make jute, cotton bags and thick plastic bags available at the shops/cooperative stores.

12.1.11.2 Reduce, Reuse and Recycle

Reduce the waste generation at source, reuse it by making some other useful product out of the waste or in the same form but with different application or hand it over to recyclers for recycling. The Solid Waste Management Committee should emphasize on spreading awareness in general public on this account.

Following measures may be taken to reduce, reuse and recycle the waste:

- All residents should be asked to reduce generation of food waste as far as possible. They should be asked to hand over food waste to animal breeders for feeding animals, if possible.

- Usage of hard to recycle packaging material like PET bottles, metalised plastic films and multi film packs should be discouraged.
- Usage of thin polythene bags (less than 20 micron) should be prohibited.
- All floating population should be instructed not to liter any waste and minimize waste generation in the city to keep it clean and green. Such instructions may be given at bus stands, railway stations and other public places through display boards.
- All vendors and shops should be asked to request customers to use carry bags and they should desist from providing plastic bags, if the weight of purchases is less than 1 kg. Even for purchases weighing more than 1 kg, provision of free plastic bags should not be there. Each plastic bag should be charged up to 50 paisa.

12.2 SANITATION FACILITIES

The project authorities will take sufficient precautions for developing per system for sewage treatment in the labourer and worker colonies. For this purpose septic tanks and soak pits shall be provide for individual dwellings. The project authorities will ensure proper waste disposal by adopting various disposal methods like incineration, composting, etc.

No dumping of solid waste should be allowed near any water body or a stream. The organic waste will be suitably processed to form compost, which can be used as manure. In addition to the above-mentioned activities, proper sanitary facilities would also be provided at the labour / staff colonies. Septic tanks of appropriate size will be constructed. The wastewater generated from the colonies will be collected and disposed in specifically designed soak pits. Therefore, waste water and sewage generated will not be allowed to flow into the river, or any stream. Proper sanitary facilities will be provided at the colonies as the standard municipal design for hill areas. Ten community latrines of at least 8-seat facility each will be constructed at the suitable locations in the colony area. Adequate financial allocation towards the cost of solid waste management has been made in the overall project cost.

One community latrine can be provided per 20 persons. The sewage from the community latrines can be treated in septic tanks. For each 250 persons, one

septic tank should be provided. The effluent from these septic tanks can be disposed off through absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other. The total construction time for the project is about 5 years. At peak construction phase, there will be the population of 6000 persons. To ensure that the sewage from the labour camps do not pollute the river water it has been estimated that about 250 community latrines and 20 septic tanks need to be constructed. The total cost required will be Rs.67.50 lakhs (refer Table-1).

Table 12.3: Cost Estimate for sanitary facilities for labour camps

S. No.	Unit	Rate (Rs. unit)	Number	Total cost (Rs. in lakhs)
1.	Community latrines	15,000	300	45.00
2.	Septic Tanks	150,000	24	36.00
			Total	**81.00**

12.3 GENERAL SANITARY MEASURES

Sweeping of Streets, Public Spaces & Drain Cleaning

In the project colonies, office complexes etc. sweeping should be carried out by the sanitary workers daily. Sweeping should be carried out between 6 to 8 am in the morning and between 2 to 4 pm in the afternoon. The Sanitary workers will be allotted some specified area and after sweeping they would collect the waste in the form of heaps on the street side. These heaps would be loaded into handcarts and these handcarts will be emptied at waste collection points. For proper solid waste Solid Waste Management, suitable tools, equipment & vehicles in sufficient numbers are necessary for handling, lifting and transportation of waste. The equipments required for Solid Waste Management are mentioned under cost estimation table.

The sanitary workers involved in drain cleaning may be given tools like seamless handcarts and shovels. It is also recommended to maintain separate roster for cleaning of drains.

Burning of waste causes hazardous/toxic gaseous pollutants and must be avoided. The SWMC will discourage burning of waste along the roadside and/or on public places.

Table 12.4: Financial Requirement for Developing Recommended Solid Waste Management System and Sanitation

S. No.	Item		Total Amount (Rs.)
1	Waste bins & Community Bins	Lump sum	2,00,000
2	Waste Storage Depots	Lump sum	2,50,000
3	Vehicles	Lump sum	7,00,000
Total (A)			**11,50,000**
4	Sanitary facilities for labour colonies		81,00,000
5	Cost for development of Sanitary Landfill Facility (SLF) (Infrastructure development & Phase-I for 8 years)		20,00,000
6	Cost of Development of Composting plant		7,00,000
7	Machinery & vehicles for Landfill & compost plant		10,00,000
Total (B) Development of Sanitary facilities & Compost Plant			**118,00,000**
8	Manpower cost for 10 persons @ Rs. 5500=00 per month for 8 years		52,80,000
9	Training to officers & staff of implementation of proposed Municipal Solid Waste Solid Waste Management System	Lump sum	40,000
10	Detailed design of Sanitary Landfill Facility (SLF) for Phase-I (for 5 years tenure) including soil testing (by outside agency)	Lump sum	1,50,000
11	Supervision during construction &	Lump sum	80,000

	commissioning of SLF		
Total (C)			**55,50,000**
Grand Total (A+B+C)			**185,00,000**

(Rs. One crore eighty five lakhs only)