7.3.3 *Assigning Importance to Attributes*

All the rating parameters do not assess the same magnitude of potential environmental impact. Consequently, a numerical value called weightage has been assigned to each parameter in accordance with the relative magnitude of the impact it assess using ranked pair wise comparison technique based on Delphi within the institute, importance/weightage to the categories and then to individual attributes were assigned.

7.3.4 *Development of Site Sensitivity Index*

For each of the attributes, four level sensitivity scales has been considered ranging from 0 (Indicating no potential hazard) to 1 (Indicating highest potential hazard). The rating parameters and sensitivity levels are listed in table 7.2.

7.3.5 *Proposed Site Assessment*

As per CPHEEO Requirements

The following table brings out the compliance of the proposed site at Guwahati with regard to the requirements stipulated by CPHEEO manual for municipal land fill facilities

Table 7.3 Compliance with CPHEEO Manual

Sr. No.	Criteria	CPHEEO Manual requirements	Description of the site	Compliance by Proposed site
1	Lake/Pond	200 m away from the Lake/Pond	Dopar beel 1.5 km away	Complies
2	River/streams	100 m away from the river/stream	Small stream (Mora Nallah) passes through the site	Does not comply
3.	Flood plain	No land fill within a 100 year flood plain	Within flood plains	Does not comply
4	Highway	Away from 200 m NHAI/State	NH 37, 1 km away	complies
5	Public parks	300 m away from public parks	No parks within 0.3 km	Complies
6	Wet lands	No landfill within wet lands.	Wet land	Does not comply
7	Habitation	500 m away from the notified habitation area	No habitations observed within 500 m from the site	Complies
8	Ground water table	Ground water table > 2m.	At the ground level	Does not comply
9	Critical habitat area	No landfill within the Critical habitat area. It is defined as the area in which 1 or more endangered species live.	No critical habitat	Complies
10	Air ports	No landfill within	Guwahati airport –	Do not comply

Sr. No.	Criteria	CPHEEO Manual requirements	Description of the site	Compliance by Proposed site
		20 km	10 km	
11	Water supply schemes/ wells.	Minimum 500 m away	There are no schemes/wells in the area.	Complies
12	Coastal regulatory zone	Should not be sited	Not applicable	Not applicable
13	Unstable zone	No landfil	Not applicable	-
14	Buffer zone	As prescribed by regulatory	None prescribed	Not applicable
15	Nalahs	Not prescribed	As mentioned in Sr. no. 2-	
16	Check dams	Not prescribed	-	-

From the above table, it can be seen from the above that out of 11 applicable criteria, the site does not comply for 5 items as given by CPHEEO manual.

Site Evaluation - Estimation of Score for Individual Attributes

Based on the attributes related to the site, the corresponding site sensitivity index is found out and presented in table 7.4. The value of the site sensitivity index multiplied by corresponding weightage results in score for each of the attributes as given below:

Table 7.4: Site Evaluation

S. No.	Attributes	Attribute measurement	Sensitivity Index	Weightage	Attribute score
1.	Type of road	National Highway	0.2	25	5.00
2.	Distance from collection area	1 km	0.1	35	3.50
Total				60	8.50
Accessibility Related					
3.	Population within 500 m	250-1000	0.5	50	25.00
4.	Distance to nearest drinking water source	1000-2500 m (Deepar Beel)	0.65	55	35.75
5.	Use of site by nearby residents	Moderate (agriculture), fishing (not commercial)	0.6	25	15.00
6.	Distance to nearest building	IASST (<500 m)	0.9	15	13.50
7.	Land use/Zoning	Agricultural(Only 3-4 months in a year)	0.25	35	8.75
8.	Decrease in property value with respect to distance	>5000 m	0.1	15	1.50

TRUE COPY

S. No.	Attribute	Attribute measurement	Sensitivity Index	Weightage	Attribute score
9.	Public utility facility within 2 kms	Small-scale industries (tea ware ... salt factory etc.)	0.2	25	5.00
10.	Public acceptability	Not Known		30	
Total				250	104.50
Environmental Related					
11.	Critical environment	Wetland & Floodplains	0.75	45	33.75
12.	Distance to nearest surface water	1500-8000 m	0.50	55	27.50
13.	Depth to ground water	~ 0 m	1	65	65.0
14.	Contamination	No contamination	1.0	35	35.00
15.	Water quality	Potable	0.75	40	30.00
16.	Air quality	Not Known (But perception is confirming the standards)	0.95	35	33.25
17.	Soil quality	Not contaminated	1	30	30.0
Total					254.50
Socio – economic Related					
18.	Health	No Problem	0.15	40	6.00
19.	Job opportunities	Low	0.70	20	14.00
20.	Odour	No odor	0.10	30	3.00
21.	Vision	Site is Fully Seen	0.90	20	18.00
Total				110	41.00
Waste Management Practice Related					
22.	Waste quantity/day	=< 250 tonnes	0.15	45	6.75
23.	Life of site	20 years	0.25	40	10.0
Total				85	16.75
Climatologically Related					
24.	Precipitation effectiveness index	Not Known		25	-
25.	Climatic features contributing to Air pollution	No Problem	0.1	15	1.5
Total				40	1.50
Geological Related					
26.	Soil permeability	Mainly clay	0.4	35	14.0

TRUE COPY

S. No.	Attribute	Attribute measurement	Sensitivity Index	Weightage	Attribute score
27.	Depth to bedrock	10-20 m	0.3	20	6.0
28.	Susceptibility to erosion and run-off	Susceptible Moderate	0.75	15	11.25
29.	Physical characteristics of rock	Not Encountered		15	-
30.	Depth of soil layer	> 5 m	0.1	30	3.0
31.	Slope pattern	< 1%	0.1	15	1.5
32.	Seismicity	Zone V	1	20	20.0
Total				**150**	**46.00**
Grand Total				**1000**	**482.50**

The following table given the interpretation of the total score and the ranking of the site

<300	Less sensitive to the impacts (Preferable)
300 to 750	Moderate
>750	Highly sensitive to the Impacts (undesirable)

By ranking exercise as carried out above, the proposed site scored a total score of 482.50. This score when compared to ranking of the site, indicates that the hazard potential of the site is Moderate.

7.4 INTEGRATED FACILITY DEVELOPMENT OPTIONS

As already highlighted earlier the main disadvantage of the site is, it is located in the flood plains of Brahamputra River. Thus main criteria for landfill design would be protecting the landfill from periodic floods. In the draft report, the consultants had suggested two options for the development of site to protect the land from floods as presented below,

Option I	Option II
Construction of Retaining Wall around the landfill and protecting it from flooding. The enclosed land would be filled with waste (MSW), as per the MoEF guidelines.	Elevating the entire land above HFL and developing landfill above it as per MoEF guidelines.

Based on the cost assessment and estimation of life cycle for both options, it has been observed that option 1 is more practical and economical, hence opted for site development.

TRUE COPY

7.5 INTEGRATED FACILITY DEVELOPMENT STRATEGY BASED ON OPTION I

7.5.1 *Provision of Retaining Wall*

At the time of preparation of Draft detailed project report, two pieces of land termed as Site 1 and Site 2 having total area of 12.19 Ha were allocated for integrated facility development. Life of the landfill with option-I was estimated to be only 10 years. It was suggested by the consultants in the Draft Report that if some extra land adjoining the allocated sites could also be provided for integrated facility development, the life of landfill would increase with very marginal increase in the cost. Accordingly, after the meeting with the Chief Minister, GOA have agreed to allocate additional to the tune of 110 bigha for integrated facility development. The land which has been made available belonged to Industrial Exhibition Ground (50 bigha), LIC (50 bigha) and Tea manufacturing company (10 bigha). This implies that total land available for sanitary landfill and compost plant is now 180 bigha (24.12 Ha). The smaller piece (Site 2- 2.8 Ha) of land which was alloçated earlier, is not being considered now.

As per the revised proposal, the entire site of 24.12 Ha has been divided into two parts:

- Part 1 of 9 Ha for development of compost plant of 200 TPD capacity in phase 1(in the first year) and 300 TPD capacity plant in second phase (in the eleventh year) and
- Part 2 of 15.12 Ha for the development of sanitary landfill.

It is proposed to develop 200 TPD compost plant along with sanitary landfill as integrated facility in phase 1 In addition, provision for development for additional 300 TPD of compost plant is also kept in the eleventh year of the project. Requirement of about 6.2 Ha of land has been proposed for the development of the compost plant of 200 TPD + 300 TPD capacities. In order to obtain 6.2 Ha of elevated land after filling of 8 m at the slope of 1:3, 9 Ha of land is required at the ground level(base dimension). A schematic representation of the proposed layout is presented in Drawing 7.2R1.

A RCC retaining wall of height 8 m is to be constructed around the periphery of 15.12 Ha of the allocated land for sanitary landfill. In the first phase, the land for 200 TPD adjacent to the retaining wall, 6 Ha of land need to be elevated for 8 m for development of compost plant.

Based on this concept, an assessment has been carried out for the volume of landfill, life of landfill and site development cost The space enclosed within retaining wall shall be filled with inert waste and compost rejects and also a 15 m height landfill will be created above retaining wall height. In addition, an access road (8 m wide) of 1.3 km length shall be constructed to connect the existing road with the elevated proposed integrated facility. The cost of construction of the access road has been estimated around Rs. 452.73 Lakhs. Table 7.5 presents the details of integrated facility development

Table 7.5 Details of Integrated Facility Development

Total Volume of Landfill	24,12,800 m^3
Life of Landfill	20 Years (2006 – 2036)
Cost of Site Development for Landfill + 200 TPD compost plant in phase I w/o access road	Rs. 2366.73 Lakhs
Cost of Access road	Rs. 452.73 Lakhs
Cost of Site Development with Access road in Phase-I (to be invested in the first year)	Rs. 2819.46 Lakhs
Cost of Site Development for 300 TPD Compost Plant in Phase-II (to be invested in the 11th Year)	Rs. 949.63 Lakhs

CHAPTER – 8
COMPOST PLANT PLANNING & DESIGN

8.1 BACKGROUND

As already discussed in Chapter-6, Composting has been found to be the feasible waste processing technology for the MSW of Guwahati city. The establishment of a successful composting facility depends on making correct choices between environmental and economic aspects.

All activities associated with composting operations need careful selection of design and control to produce good quality product while minimizing environmental impacts. Activities which should be considered for composting include,

- Transportation of raw material/feed
- Raw material handling
- Windrowing of the waste material
- Weekly turning
- Screening, Sorting, Grinding, Blending, Mixing
- Curing, Storage, Packing, Loading, Dispatch
- Disposal/landfilling of residual waste

One of the main criteria for marketing of the product relates to the consistency in the quality of the compost which in turn is dependent on the input MSW characteristics. It is therefore important to ensure that the characteristics of the compost remain more or less the same throughout the year. The composting process can be marginally adjusted to ensure uniformity of the product in case of slight variation in the quality of the MSW. Blending of various batches of compost is a good alternative to achieve uniform and consistent quality.

8.2 TECHNOLOGY OPTIONS FOR COMPOSTING

Table 8.1 presents the description of various technology options available worldwide in the field of composting and the experience with such technologies in India and other developing countries in the Afro-Asian region. It would be very

critical to establish the relevance of various technologies and their application in the Indian context of waste characteristics and climate.

Table 8.1 Technology Options for Composting

Technology	Description	Countries using
1. Centralized Aerobic Composting: Windrow system		
Agitated Pile Windrow System	Waste is heaped into elongated piles which are turned at set intervals. The process takes 12-16 weeks.	India, Sri Lanka
Static Pile Beltsville aerated rapid composting (BARC) system or Chinese composting piles	Waste is heaped in piles with perforated pipes or bamboo poles running through the heap which provides aeration and no turning is required. Surface is covered to prevent heat loss. The process takes eight weeks. In BARC developed by USDA has air forced through the pipes	USA, China, Italy
2. Centralized Aerobic Composting: In vessel System		
a. Vertical Flows		
Jersey system	Facilities with multiple floor construction. The feedstock is loaded onto the uppermost floor and aeration occurs as the material moves downward. Composting takes 8-21 days and maturing upto 3 weeks. Site area can be relatively small that Windrow or BARC system. In silo system perforated stainless steel tanks upto 30 are used in each floor thus facilitating higher degree of aeration.	Bangkok, Thailand
Silo-cage system		
Packed bed silo reactors	Processing of solid and liquid feedstock together in form of slurry. Composting in silo like containers. The resultant digested slurry is filtered, dried and formed into pellets. Require minimal area of 1 acre and a completely automated process.	North Vancouver, Canada

b. Horizontal Flows		
Tumbling solids (rotating drums) (Bedminster co-composting process)	Composting of MSW and sewage sludge together. Digesters can handle 60 tons of MSW and 30 tons of sludge per day. Feedstock transferred into digesters with three compartments, enabling continuous batch processing. Aeration through pumping of air into the digesters. Two days for composting, 28 days for maturation.	NSW, Australia
Combined Rotating Drum and Static solid aerated pile	Uses the Bedminster drums to ,mix the feedstock (MSW+ sewage) and composting is done in compost bays in aerated conditions	Edmonton, Canada
Aerated in vessel	Feedstock is loaded in a reactor to a depth of six feet and waste is moved through the container continuously enabling an uninterrupted process. Composting process takes 21 days.	Bedfordshire, UK
Agitated bins	This is an enclosed system where shredded and blended waste is moistened and loaded into an agitated container with temperature, CO2 and air circulation controls. Air enters through the base of the container into the compost mass and exits through the roof via a filter. The process takes between 7-14 days followed by maturation of 12 weeks	Germany Austria Luxembourg Belgium
Tunnel shaped static solids	The tunnels are semi open with sloped floor for collection of leachate. The feedstock is fed into the tunnel. A rail runs along the tunnel for with a mounted shredder /turner. Shredding/turning every second day. Process takes 28 days, drying and maturing 3 weeks.	Manchester, UK Orleans Council, France

8.3 CHALLENGES IN COMPOSTING

- **Availability of Good Quality of Waste (Biodegradable Waste):** For effective composting of MSW, it is very important that the waste received for composting should be rich in biodegradable component and, do not contain waste from other streams. In case of MSW generated at Guwahati, the biodegradable content resonably high (70 %), and therefore, availability of

good organic waste for composting may not be a significant issue in Guwahati.

- **Marketing of Compost:** Marketing of compost has been a key challenge in India. There are many drawbacks e.g. price vis-à-vis chemical fertilizers and farmyard substitutes, absence of a strong market maker, transportation, customer resistance, quality and standards (no standards exist for certifying nutrient content of compost and suitability to a particular application). Because of existence of large tea gardens in the north east states within 200-300 km range from the proposed compost plant location, it is expected that there would be good demand for the organic compost.

- **Customer Resistance:** The slow action of compost vis-à-vis fertilizers creates inherent barriers to sales of compost. A key aspect of consumer resistance is the perception of MSW based compost being "dirty". This perception will have to be changed production of odour free compost that conforms to certain nutrient standards. IL&FS Ecosmart produced compost from Delhi MSW and was tested in the agricultural fields of Agra by Chambal Fertilizer and Chemicals Ltd. The field trial revealed that when compost is mixed with chemical fertilizers, the yield in the agriculture increases by 15% to 25%.

- **Pricing:** Due to relatively slow release of nutrient in compost in comparison to chemical fertilizer, the sale price of compost cannot exceed a certain limit. Moreover the retail price of fertilizers is highly subsidized. Further, it is not viable to transport the compost beyond a radius of about 200-300 km from the factory gate due to its bulky nature.

8.4 LEGAL COMPLIANCES AND REGULATIONS – MSW (MANAGEMENT & HANDLING) RULES 2000

Composting is a means of processing waste, which is a legal requirement provided under the Municipal Solid Waste Management (MSW) Rules 2000 for all municipal bodies in the country. The MSW Rules 2000 requires that "biodegradable wastes shall be processed by composting, vermi-composting, anaerobic digestion or any other appropriate biological processing for the stabilization of wastes". The specified deadline for setting up of waste processing and disposal facilities was 31 December 2003 or earlier.

As per the Municipal Solid Waste (Management and Handling) Rules, 2000 composting facilities should meet the following criteria,

- The incoming wastes at site shall be maintained prior to further processing. To the extent possible, the waste storage area should be covered. If, such storage is undertaken in an open area, it shall be provided with impermeable base with facility for collection of leachate and surface water run-off into lined drains

TRUE COPY

leading to a leachate treatment and disposal facility;

- Necessary precautions shall be taken to minimize nuisance of odour, flies, rodents, bird menace and fire hazard. In case of breakdown or maintenance of plant, waste intake shall be stopped and arrangements be worked out for diversion of wastes to the landfill site;

- Pre-process and post-process rejects shall be removed from the processing facility on regular basis and shall not be allowed to pile at the site. Recyclables shall be routed through appropriate vendors. The non-recyclables shall be sent for well designed landfill site(s).

- In case of compost plant, the windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay, 50 cm thick, having permeability coefficient less than 10^{-7} cm/sec. The base shall be provided with 1 to 2 per cent slope and circled by lined drains for collection of leachate or surface run-off.

- Ambient air quality monitoring shall be regularly carried out particularly for checking odour nuisance at down-wind direction on the boundary of processing plant.

- In order to ensure safe application of compost, the following specifications for compost quality shall be met, namely:-

Table 8.2 Quality Standards of Compost Produced

Parameters	Concentration not to exceed (mg/kg dry basis, except pH value and C/N ratio)
Arsenic	10.00
Cadmium	5.00
Chromium	50.00
Copper	300.00
Lead	100.00
Mercury	0.15
Nickel	50.00
Zinc	1000.00
C/N ratio	20-40
pH	5.5-8.5

Compost (final product) exceeding the above stated concentration limits should not be used for food crops. However, it may be utilized for purposes other than growing food crops.

TRUE COPY

8.5 COMPOSTING PROCESS

Aerobic composting is the process of degradation of biodegradable waste matter into simple organic compounds by certain microorganisms in the presence of air. The process begins at ambient temperature by the activity of mesophilic bacteria which oxidize carbon to CO_2, thus liberating large amount of heat. Usually, the temperature of the waste piles reaches 50^0C within two days, and this represents the limit of temperature tolerance of the mesophilic organisms. At this point the process is taken over by thermophilic bacteria and the temperature continues to rise. Most of the thermophilic phase, which lasts about two weeks, takes place in the temperature range 55^0C – 65^0 C , should the temperature increase beyond 650C , activity temporarily declines . The process is dependent of course, on the provision of a suitable environment for the bacteria, in addition to the nutrients provided by the wastes. The main requirements are adequate supplies of air and moisture. Compared to anaerobic process, aerobic conversion process is preferable as it is fast, exothermic and free from odour. Aerobic process also helps to eliminate pathogenic bacteria weed seeds, larva etc. as a result of high temperature developed during the process. Main factors affecting the composting through aerobic process are listed in Table 8.3.

Table 8.3 Factors Affecting Composting

Factors Affecting Composting	Desirable ranges
Moisture content	50% to 60% optimum
Temperature	50 to 60 ^{0}C (for 5 to 7 days, pathogens get killed)
C/N ratio	Between 20- 40
	If C/N ratio is less -straw, saw dust, paper to be added
	If C/N ratio is more -sewage sludge, slaughter waste etc. to be added
	At the end of composting C/N =20. As per MSW regulations C/N permitted is 20-40
Aeration	Adequate oxygen through out the mass-normally ensured by turning every 5-7 days

However this should always be kept in consideration that aerobic composting is a natural process and the final product's quality (Chemical, Physical & Biological) and quantity (end product) both may vary from time to time depending on various factors as

- Physical & chemical composition of raw waste input
- Seasonal variations
- Yard management and monitoring efficiencies

The complete process of MSW Composting can be summarized as follows:

1. Reception of raw MSW
2. Visual Inspection of waste
3. Weighing of Vehicle
4. Manual Sorting of Inert and removal of rejected material to landfill
5. Sorted material moved to Compost pad to form windrows
6. Yard Management activities
   a. Periodic Turning of Windrows
   b. Process Monitoring & Controlling activities
7. After two turnings, shifting of material to Monsoon Shed
8. After two weeks stabilization in the monsoon shed, feeding of material to coarse segregation section
9. Over sized rejects (+35 mm) to be sent to landfill
10. Over sized rejects (+16 mm) either sent to landfill or for windrow covering
11. Undersized material (-16 mm) stocked in Curing section godown
12. After two further weeks, cured material to be fed to refinement section
13. Over sized rejection (+ 6 mm) to be ground and mixed in curing section.
14. Under sized fine compost to be enriched with useful microbes, herbal extracts (optional)
15. Final Product (Compost) to be packed in 50 kg bags and stacked in finished goods godown
16. Compost to be picked up by marketing agency for distribution in market.

8.6 DESIGN OF COMPOST PLANT AND ITS ELEMENTS

As presented in the chapter 4, the total quantity of waste generated by the GMC areas is about 315 tons/day. Out of which around 50 tons/day is from drain cleaning and street sweeping and around 15 tons would be recycled by rag pickers. In the remaining 250 tons, it is assumed that 20 % of waste comprising of large objects (tyres, metal scrap), inerts (boulders, wood pieces), recyclables (glass, plastic, leather, rags), etc. would be segregated at tipping area before composting. Thus 200 tons/day of waste shall be composted in the plant everyday. The compost plant has been designed for a capacity of 200 tons/day. The infrastructure for the plant has been proposed in such a way so that the capacity of the plant in future can be increased up to 250-275 tons/day. The compost plant is based on the concepts for open windrow aerobic composting of organic (biodegradable) component of solid waste.

The total land allocated for the MSW operation is 24.12 ha. This land will house two compost plants and the associated landfill area. The composting operation has been divided in two phases. In the Phase-I, a 200 TPD plant will be commissioned. This plant will have some flexibility to treat up to 250-275 TPD of organic waste if required. In the 11th Year, one more additional compost plant (Phase-II) of 300 TPD will be commissioned. The life of the compost plants have been taken as 20 years. The land for the landfill will last for 20 years. That precisely means that an additional land will be required after 20 years of operation.

Out of 24.12 Ha of land, 15.12 Ha has been kept for sanitary landfill. In the remaining 9 Ha of land, filling is to be done for compost plant upto 8 m above ground level. The site development for compost plant will be done in two phases. In the first phase, land required for 200TPD of compost plant is developed. The minimum land required for setting up of a compost plant of 200 TPD capacity has been estimated to be about 3 ha as specified by the Ministry of Urban Development (MoUD), GoI. Developed area for 200 TPD plant after soil filling has been taken as 3.2 Ha. (for detail, refer to chapter-7). In the remaining land, site development will be done in the 10th year of the project for the commissioining of another compost plant of 300 TPD capacity in the 11th year.

The layout of different components of the proposed compost plant of 200 TPD capacity is shown in Drawing 8.1R1. The complete process of compost plant can be divided into number of components, which are explained as below:

8.6.1 Material Intake System:

All incoming vehicles containing MSW would be visually inspected and weight of the same will be recorded with the weighbridge at the entry gate. If the vehicle contains more than permissible impurities, it will be directed to the landfill site.

8.6.2 *Pre-processing System*

The material accepted for composting is spread on the tipping area, where the unwanted materials like plastics, rags, inert, tyres, boxes, plastics, batteries and all the other large sized recyclables / inert-etc shall be sorted out manually Sorted waste containing mostly the organic fraction of the fresh garbage is taken to the compost pad for Windrow formation, by JCBs.

8.6.3 *Yard Management System*

In the yard, the fresh MSW is stacked on the compost pad (a non-permeable concrete platform) in the form of Trapezpidal Heaps called Windrows*. Here, the waste is sprayed with inoculums and water to accelerate the digestion process Windrows are periodically turned using front-end loader with backhoe arm to provide proper aeration and temperature control. This waste is then stacked in a form of Windrows. The cross sections of the windrows are so adjusted that it would get optimum surface area to volume ratio. In total, eight spaces are allotted for the Fresh Garbage.

On compost pad, digestion of composting mass is achieved and for further stabilization the material is shifted to monsoon shed using a backhoe unit and dumper. The material is kept in monsoon shed for 15 days for further stabilization.

1. During windrowing, water is added to windrow using water tanker to maintain requisite moisture level.

2. Just after windrowing, bacterial activity starts within 2-3 days. Inside, temperature of the windrow may go up to 65°C.

8.6.4 *Assessment of Windrow Size*

The compost plant is designed for 200 tons (335 m^3 @ bulk density of 0.6 t/m^3) of municipal solid waste everyday. This waste would be placed in the first windrow of size 26.6 m (L) X 8.6 m (W) X 1.75 m (H) and left for aerobic decomposition. After one week, the waste would be transferred from windrow one to windrow two of size 22 m (L) X 8.6 m (W) X 1.75 m (H) and again left for decomposition. Again after one week, the waste from windrow two would be transferred to windrow three of size 18 m (L) X 8.6 m (W) X 1.75 m (H) and left for decomposition for one week. The details and drawings of windrows have been presented in the Drawing 8.1. However, as per the site conditions, the proposed dimensions of the windrows can be modified.

8.6.5 *Monsoon Shed*

Material after digestion needs further stabilisation and loss of moisture so that it can be segregated in to different fractions. Also this shed protects feed material from rain. Decomposed material coming from the Compost Pad is kept here for about 15 – 20 days. The shed will be 8 m high open shed covered with fiber glass/ sheet roof. The shed must be open from all sides for easy vehicle movement and for ventilation.

8.6.6 *Coarse Segregation System*

Material from Monsoon shed is then fed to the Coarse Segregation Section using a Skid Steer Loader for intermediate screening. This is completely automated section with single point feeding. After processing, material is conveyed to the curing section. The equipment line-up contains a Feeder Conveyor and two Trommel Screens (screen 1= 35 mm perforations, screen 2 = 16 mm perforations) with their associated conveyors. The two stage screening system is adopted to achieve maximum screening efficiency. Cascading action in Trommel ensures better screening of the lumpy and highly heterogeneous material. Equipments in this section are hydraulically driven to ensure greater safety against breakdowns and to reduce power consumption. Hydraulic drive also introduces features like on-load starting, centralised control etc. PLC based controls allows automatic shutdown in case of any emergency.

Screened material coming out of this section is below 16 mm, uniform in texture and contains semi – stabilised organic compost, which is further transferred to curing section for complete stabilization

Rejection from Trommel mainly consists of undigested organic matter and inert material. This material can be used as masks on the fresh garbage windrows. This masking prevents bird attraction and also assist in digestion process.

A RCC structure with 6m high AC roofing and concrete flooring is required for placement of coarse segregation equipments. The building must be properly ventilated for sufficient light & air circulation. Proper side cuts are to be provided to allow removal of rejects off – line.

8.6.7 *Curing System*

Material coming out of the Coarse Segregation Section is stored in curing section for 15 days for further stabilisation and moisture control. Some additives as rock phosphate may be added at this stage to improve quality of final product.

A RCC structure with 9.5m high AC roofing and concrete flooring is required for storage of material. The building must be properly ventilated for sufficient light &

~~107~~ 2889

air circulation. A centrally hanging platform is provided to support storage conveyors

8.6.8 *Refinement System*

A refinement section is incorporated in the machine line to remove impurities such as glass, plastic, leaves, inerts etc. and to maintain the size below 6 mm, as per compost quality norms.

In this section, cured material is firstly fed to a drag feeder conveyor which in turn gradually feeds the same to the Trommel Screen 6/4 mm at a controlled rate. The screened material coming out of the Trommel screen is sent to the gravity separator, which further removes the impurities such as glass, metals, sand, silica etc. from the compost. From here, the compost is passed through a liquid add mixer where quality enhancer in powder or liquid form is added.

A Two storied RCC structure with 5.25m high floor and concrete flooring is required for placement of refine section equipments. The building must be properly designed for dynamic loads

8.6.9 *Grinding Section for recovery of organic compost*

Grinding Section ensure recovery of material which is otherwise rejected from the Plant. Rejects coming out of the Refinement section or any other section containing organic matter can be passed through this section for recovery of useful material Here undigested organic material are fractionised and re – added to the Curing Section for further digestion. Grinded material will be added to the curing section material and passed through the refinement section to recover Organic Compost.

A strong RCC structure with 1.5m high floor is required for placement of grinding section equipments. The structure must be properly designed for dynamic loads. Proper louvers must be provided to avoid dusty atmosphere.

8.6.10 *Packing and Storage System*

From the refinement section, high quality compost is then passed through the packing spout for final packing. At packing spout, material is packed in 50 kg bags and then weighed. Bags are then stitched using a portable sewing machine and finally stacked in the finished goods godown.

A RCC structure with 4.5m high fiberglass roofing is required for storage of finished goods. Proper louvers must be provided to have sufficient light and air circulation.

8.6.11 *Testing Laboratory*

To achieve efficient composting various process parameters must be periodically monitored and controlled in time. A well equipped laboratory helps in In-house testing of parameters as Temperature, moisture, C/N Ratio etc. For this following equipments are required:

8.6.12 *Leachate, Litter and Odour Management System*

During Composting, some liquid / concentrated wastewater may percolate through the MSW due to leaching, known as Leachate. For environmental reasons the leachate should not be allowed to percolate in the soil or ground waters. To avoid this, proper impermeable concreting of the Compost Pad is undertaken and a peripheral drains are provided to collect the Leachate generate during the process. Collected leachate finally lead to a R.C.C. tank provided in the adjoining landfill site. The leachate will finally be treated in the proposed centralized leachate treatment plant.

The air borne litter is controlled by providing a dense green belt around the plant. In green belt creepers are provided to act as green curtain.

To control odour the sanitizer is added at the concrete pad. Sanitizer suppresses the odour generating from the waste. This control also helps in creating a workable environment for the people working at the Sorting Station.

8.6.13 *Process Monitoring & Control Systems:*

i) <u>In Yard Management</u> – Yard management process needs to be monitored in order to achieve proper digestion and obtaining right quality finished product. For Aerobic Composting, proper temperature, moisture and aeration is required in the windrows. Temperature in the core of the windrow may reach up to 75°C and a moisture level of 35 – 40 % should be maintained in the windrows. These things will ensure proper growth of the bacteria and, thus, ensuring proper digestion. An inspector will take temperature readings of the Windrows and also check the moisture level of the Windrow. C to N ratio of the waste must also be checked by sampling method, so that corrective measures can be taken at the initial stage if the ratio is found not inline with the requirement. If heavy metals are found in the waste with the values exceeding the stated ones, the waste material should not be processed further.

ii) <u>In Segregation Plant</u> – Segregation plant is centrally controlled by a control panel. Central panel shuts down the plant automatically in case temperature, pressure and current reading exceeds the stated value. An Inspector will take these three readings of the Control Panel periodically and see if all the readings are within limit.

8.6.14 *Removal of Oversize Rejects*

Oversize rejects (mainly from Trommel – 35 and Gravity Separator) must be regularly removed from the Rejection Yard. All rejects will be loaded in Dumpers or Tractor Trolleys and will be directed to adjoining sanitary landfill site.

8.7 CIVIL STRUCTURES AND UTILITIES

The civil structures designed in the compost plant are as follows,

- Entry Gate
- Guard Office at Entrance
- Weighbridge at Entrance
- Control Room
- Tipping Platform
- Compost Pad
- Monsoon Shed
- Processing Plant with Sorting, Screening, Grinding and Refinement Sections
- Packing Facility and Finished Product Storage Godown
- Office Complex
- Laboratory
- Diesel Filling Facility
- Transformer
- Open Drains
- Internal Roads
- Barbed Wire Fencing
- Green Belt

The details of the civil structures and utilities with cost are presented in the Table 8.3

Table 8.3 Details of Civil Structures and Utilities

Structure / Utility	Details
Guard cum Security Room	5 m X 5 m (25 m^2)
Weigh Bridge Room	5 m X 5 m (25 m^2)
Compost Pad with 80 % coverage with monsoon shed	10000 sqm 4125 sqm
Monsoon Shed	10000 m^2
Coarse Segregation Section	30m x 10 m (300 m^2)
Refuse Shed with Platform (2 no)	10m X 5 m (50m^2).
Panel Room (2 no)	5 m X 5 m (50 m^2)
Curing Section	50 m x15 m (750 m^2)
Refinement Tower	8 m X 9 m (72 m^2)
Office Complex, Lab, Kitchen, etc.	25 m X 20 m (500 m^2)

Transformer station	5 m x 10 m (50 m²)
Overhead Storage Tank	100000 lit. Capacity
Storm Water Drains	400 m
Vehicle Shed (2 no.)	15 m X 10 m (300 m²)
Car Parking Shed	10 m X 10 m (100 m²)
Barbed Wire Fencing	870 m
Finished Goods Godown	750 sqm.
Internal Roads (8 m wide)	715 m
Green Belt	4000 sqm

8.8 MACHINERY AND EQUIPMENT

Different machinery and equipment have been designed for the compost plant. Separate machinery and equipment to suit the requirements for various sections like yard management, segregation, refinement and packing have been designed. Apart from these control panels and accessory equipment also designed. The details of machinery and equipment have been detailed out in the Table 8.4.

Table 8.4 Details of Machinery and Equipment

S. No.	Machinery & Equipment	Quantity	Details
1	**Yard Management**		
i)	Loader - Backhoe / Turning Equipment	3 No.	Turning of Windrow / Material shifting
ii)	Dumper (8 cum)	3 No.	For material movement .
iii)	Water Tanker with slurry pump	1 No.	For sprinkling of water & slurry on garbage
iv)	Front Wheel Loader (4 m³)	2	
v)	Other Utilities like Sprayer, Wheel Barrows, etc	Lump Sum	
2	**Coarse Segregation Section**		
i)	Pay Loader (0.4 m³)	1 No.	For shifting material in rain shed & feeding material to feeder
ii)	Feeder	1 No.	For feeding material at controlled rate
iii)	Trommel - 35mm	1 No.	For screening
iv)	Process - 35 Conveyor	1 No.	For feeding material to next Trommel
v)	Reject - 35 Conveyor	1 No.	For removal of rejection off-line
vi)	Trommel - 16mm	1 No.	For screening
vii)	Transfer Conveyor	1 No.	For transfering material to curing area

TRUE COPY

viii)	Reject - 14 Conveyor	1 No.	For removal of rejection off-line
ix)	Storage Conveyor	1 Set	For stacking material in curing area
3	Refinement Section		
i)	Pay Loader (0.4 m^3)	1 No.	For feeding material to feeder and shifting of oversize rejects
ii)	Drag Chain Feeder	1 No.	For feeding material at controlled rate
iii)	Elevator	1 No.	For lifting material & feeding it to rotary screen
iv)	Trommel Screen - 4 mm	1 No.	For screening
v)	Gravity Separator with Aspirator	2 No.	For separation of heavy impurities
vi)	Reject Conveyor	1 No.	For removal of rejection off-line
vii)	Add-mixer	1 No.	For adding additives to improve quality of end product
viii)	Packing Elevator	1 No.	For feeding finished compost to packing spout
ix)	Packing Spout	1 No.	For filling of compost in packing bags
4	Packaging Section		
i)	Bag Stiching Machine	2 No.	For stitching bags
ii)	Weighing Scale (100 kg)	2 No.	For weighing bags
iii)	Pellet Trucks	4 No.	For stacking & moving packed material
5	Control Panel		
i)	Hydraulic Power Pack	4 Set	Push Button station along with hydraulic system to improve
ii)	Central Control Panel	1 Set	Control and safety of equipments against continuously
6	Accessory Equipment		
i)	Air Compressor (5 H.P)	1 No.	
ii)	Maintenance Tools	1 No.	
iii)	Vehicle Washing Machine	1 No.	
iv)	Water Pump	2 No.	
v)	Slurry Pump	1 No.	
vi)	Laboratory Equipments	1 No.	
vii)	Office Equipment	1 No.	

8.9 ELECTRICAL POWER REQUIREMENTS

Electrical power is required for the machinery and equipment to run in different sections. It is estimated that about 200 H.P power is required for running of main plant and whereas additional 60 H.P power is required for miscellaneous equipment like pumps, air compressor and lighting.

As estimated a total load of 270 H.P equivalents to 210 K.W is required to operate the entire compost plant. Thus a High Tension (HT) substation of 210 KVA required with a stand by DG set of 100 KVA for uninterrupted operation of the proposed compost plant of Phase I.

8.10 MANPOWER REQUIREMENT

Human resources with perfect combination of skilled, semi-skilled and unskilled manpower are required for successful operation of the compost plant. A total manpower strength of 46 is required including 61 % qualified & skilled employees. 9 % semi-skilled employees and 30 % unskilled workers for the operation of the phase –I of the compost plant. Table 8.5 presents the profile of the manpower required for the 200 TPD compost plant.

Table 8.5 Manpower Requirement for the Proposed Compost Plant

S. No.	Man Power Profile	Qualification	Number
1	General Manager	B.E.	1*
2	Shift Incharge	Diploma	2
3	Mechanic	ITI	2
4	Mechanic Helper	Semiskilled	2
5	Plant Operator	H.S.C.	2
6	Chemist	B.Sc.	1*
7	Accounts Officer	B.Com.	1
8	Office Assistant	Graduate	1
9	Office Peon	H.S.C	1
10	Store Keeper	Graduate	1
11	Security	Semiskilled	2
12	Weighbridge Operator	Graduate	2*
13	Inspection Supervisor	Graduate	1*
14	Packing Personals	Unskilled	6
15	Drivers	Skilled	13
16	General Helpers	Unskilled	8
	Total		46

** Common for both Compost and Sanitary Landfill Facilities.*

Table 8.6 Cost Summary for the Compost Plant

(Rs. In Lakhs)

Item	200 TPD in Phase I	300 TPD in Phase II*
Civil works and Utilities	600.06	747.90
Plant & Machinery	120.00	135.00
Vehicle and Equipments	134.80	178.70
Total	826.29	981.34

*The cost for 300 TPD compost plant in Phase II is taken at current price levels (2006-07)

CHAPTER – 9
LANDFILL DEVELOPMENT CONCEPT

9.1 INTRODUCTION

Discussions and analyses in the earlier sections of the report clearly bring out the deficiencies in the existing solid waste management system of Guwahati and establish the need for developing a scientific waste disposal facility. Currently, the total waste generated by the city is being transported to the disposal site where waste is being dumped indiscriminately. In the light of the above, it becomes imperative for GMC to develop a scientific waste disposal facility for the safe disposal of compost rejects and non-biodegradable components of solid waste.

9.2 INSTITUTIONAL AND LEGAL FRAMEWORK

The Ministry of Environment and Forest (MoEF) as per the directives of The Supreme Court of India has formulated ***Municipal Solid Wastes (Management and Handling) Rules, 2000***. As per these guidelines every municipal authority shall set up waste processing and disposal facility by December 2003 or earlier. These guidelines also specify,

- criteria for the selection of the site, authorities responsible, environmental considerations, design period (life of landfill site), etc.
- infrastructure such as approach and internal roads, weigh bridge, fencing, monitoring of vehicles, etc. required at the disposal site
- design specification such as liners, daily cover type of covering material, barriers, etc.
- pollution prevention measures like storm water drains, non – permeable lining, leachate management, air and water quality monitoring, plantation, etc.
- post closure specifications

A summary of these rules is discussed in the following section and full extract is presented in Annex 9.1.

9.2.1 *Municipal Solid Wastes (Management and Handling) Rules, 2000*

The draft of the Municipal Solid Wastes (Management and Handling) Rules, 1999 was published under the notification of the Government of India in the Ministry of Environment and Forests on 27th September, 1999 in the Gazette of India, Part II under Section 3 and Sub-section (II).

TRUE COPY

The objections and suggestions received from the public in respect of the draft rules have been duly considered by the Central Government and in exercise of the powers conferred by section 3, 6 and 25 of the Environment (Protection) Act, 1986, the Central Government hereby made the Municipal Solid Wastes (Management and Handling) Rules, 2000. These rules states that.

- Any municipal solid waste generated in a city or a town, shall be managed and handled in accordance with the compliance criteria and the procedure laid down in Schedule – II.

- The municipal authority shall comply with these rules as per the implementation schedule laid down in Schedule I.

- The municipal authority or an operator of a facility shall make an application in Form-I, for grant of authorisation for setting up waste processing and disposal facility including landfills from the State Board or the Committee in order to comply with the implementation programme laid down in Schedule I.

- The municipal authority shall furnish its annual report in Form-II (a) to the Secretary – incharge of the Department of Urban Development of the concerned State or as the case may be of the Union territory, in case of a metropolitan city; or to the District Magistrate or the Deputy Commissioner concerned in case of all other towns and cities, with a copy to the State Board or the Committee on or before the 30th day of June every year.

- The State Board or the Committee shall monitor the compliance of the standards regarding ground water, ambient air, leachate quality and the compost quality including incineration standards as specified under Schedules II, III and IV.

- The State Board or the Committee, after the receipt of application from the municipal authority or the operator of a facility in Form I, for grant of authorisation for setting up waste processing and disposal facility including landfills, shall examine the proposal taking into consideration the views of other agencies like the State Urban Development Department, the Town and Country Planning Department, Air Port or Air Base Authority, the Ground Water Board or any such other agency prior to issuing the authorisation.

- The State Board or the Committee shall issue the authorisation in Form – III to the municipal authority or an operator of a facility within forty + five days stipulating compliance criteria and standards as specified in Schedules II, III and IV including such other conditions, as may be necessary.

- The Central Pollution Control Board shall co-ordinate with the State Boards and the Committees with particular reference to implementation and review of standards and guidelines and compilation of monitoring data.

TRUE COPY

9.3 LANDFILL DEVELOPMENT STRATEGY

Deposition of waste in conical heaps over the landfill site and spreading these heaps using a tracked bulldozer is a low cost and easy option. However this practice will lead to highly unacceptable environmental conditions. The lower levels of waste are permanently saturated and free flow of water into and out of the dumped waste will lead to the migration of leachate into the surrounding surface and sub-surface water and thereby contaminating the ground water aquifers.

The other major issue of simple deposition waste will be the formation of anaerobic conditions at the site as the waste deposition thickness increases, giving rise to the generation of landfill gas and thereby creating serious safety concerns in the immediate project influence area.

Considering these aspects, the landfill development strategy for Guwahati is formulated to satisfy the regulatory requirements of MoEF, the guidelines of CPHEEO and with the following objectives.

- Environmental Protection and protection from the flooding
- Physical Acceptability
- Technical Standards of Site Engineering Required
- Operational and Management Standards Desirable
- Appropriateness and Sustainability of the Method
- Volumetric Capacity of the Site
- Longevity of the Method and
- Cost Effectiveness of the Recommended Measures

Sections below discuss various measures recommended for developing the scientific sanitary land fill with the above objectives.

9.3.1 Recommended Measures of Containment Engineering

Protection of surrounding environment of landfill site is effectively achieved through segregation and isolation of potentially polluting waste from the surrounding strata of surface water and ground water. The principle means of achieving this are, provision of sealing layers at the base, side walls and top of the landfill. Appropriate and secure operational management of the site to minimise the following aspects will further supplement these measures.

- Water ingress into the landfill
- Leachate generation and uncontrolled dispersion and

TRUE COPY

- Accumulation and uncontrolled release of land fill gas into the surrounding atmosphere

A number of alternative methods are available for constructing sealing and containment layers with varied demands for expertise levels both for liner formation and installation. These include,

- The use of in situ strata with a very low permeability, typically specified as less than $1.0x\ 10^{-9}$ m / sec
- Excavation and /or importing low permeability natural clay
- Improvement of in situ material to achieve the minimum required permeability characteristics by bentonite enrichment or natural soils or other means and
- Use of an engineered artificial lining system such as flexible synthetic geo-membrane, geo-synthetic clay liner or composite geo-membrane.

The use of single or multiple synthetic liners in combination with an in situ mineral liner or improved in situ soil will provide high levels of site containment. Considering the capital cost and containment levels required it is recommended to have

- A single mineral liner formed in situ and re-compacted clay on the base of the landfill
- A capping layer of re-compacted clay above the final lift of solid waste
- A core clay in peripheral phase to form lateral containment and
- A maximum permeability of sealing layers no greater than $1x\ 10^{-9}$ m / sec.

While the above measures are expected to provide desired levels of containment and environmental safety, it is to be noted that no industrial or biomedical wastes are allowed to mix with the solid waste being disposed off at the site. The mix of any of these wastes will render the waste hazardous there by requiring the use of highly expensive synthetic liners for containment.

9.3.2 *Leachate Generation and Treatment*

Water that percolates through the placed solid waste is known as leachate. During its progress through the waste the water entrains suspended solids, extracts soluble constituents of the waste and soluble products of the waste degradation process. The composition of leachate depends up on the stage of waste degradation and the types of waste within the landfill. The main components of leachate will comprise:

- Major elements and ions including Calcium, Magnesium, Iron, Potassium, Sodium, Ammonia, Carbonates, Sulphates, Chlorides, etc.

- Trace metals including Manganese, Chromium, Nickel, Lead, Cadmium, etc.
- Organic Compounds including Phenols, Poly Aromatic Hydrocarbons, etc. and
- Microbiological Components

Since the waste that goes to landfill will contain less of organic matter, the organic compounds and the microbial components will be less in concentration.

The quantity of leachate generated will depend on the annual precipitation rates and active area of the landfill. This requires preparation of complete water balance of the landfill site in accordance with the development phases of the project. It is now too early to anticipate a detailed phasing of the landfill site and hence it is assumed that an area equivalent to the total waste generated in a year would be the active area for the landfill site in the particular year.

However it is to be noted that the leachate generation trends vary drastically depending up on the quantity of waste deposited every day and the actual quantity shall be estimated by considering the cumulative quantity of waste deposited in the landfill. The quantity estimated here will just give an idea for the area requirements of leachate treatment.

9.3.3 *Landfill Gas Generation, Control and Management*

The landfill gas is generated due to the degradation of the organic matter in the wastes. Since the landfill material will be basically inerts, the landfill gas generation will be minimal. However, a minor portion of un-composted material will also go to the landfill and therefore adequate gas ventilation system has been provided as apart of the design.

9.3.4 *Storm Water Control and Management*

The drains of storm water form the active landfill area and composting area, adequate drainage facilities are recommended for landfill area for Guwahati. As a part of this, drainage arrangements in each phase of the landfill will have to be constructed and drain towards the existing ravine side of the disposal site. Temporary and permanent drainage ditches will be installed in waste reception area, topsoil storage plant, haul roads, floor preparation areas and waste placement areas.

Clean and contaminated waters will be segregated and discharged to the nearby ravine and treatment facility respectively.

9.4 SPECIFICATIONS OF LANDFILL DEVELOPMENT, OPERATION AND MANAGEMENT

Development of landfill site should be subjected to rigorous planning. Key elements in developing a scientific landfill for Guwahati will comprise,

- Reorganising and enhancing the present waste collection and transportation practices
- Detailed plans outlining the site development activities and
- Detailed designs of all the engineering works
- The overall control on the development and operation of each landfill site will be the requirement to adopt a cellular approach to land filling. The landfill development activities will comprise
- Site Clearance
- Sub-division of site into major operational phases
- Progressive excavation for landfill earthworks
- Ordered development of operational phases in working land filling cells
- Advance preparation of the lining system on the landfill base
- Sequential infilling of land filling cells and operational phases and
- Early and timely capping of land filled cells

The following sections present the specifications of developing each of the landfill components.

9.4.1 *Buffer Zones*

A vegetative cover will have to be provided as buffer zone between landfill site and the nearby localities. This is in addition to the suitable buffer zone as stipulated by the Ministry of Environment and Forests. While the ministry's guide lines provide protection to the near by residential and other zones, the vegetative cover will provide visual and noise screening effects of the site activities. In addition to the buffer zone a compound wall/rigid fencing all round the land fill site to a height of 3m or as suitable shall also to be constructed to totally seclude site from outside activities.

The proposed vegetative cover shall comprise trees and shrubs that improve the visual and aesthetic appearance of the site. In addition the waste reception area, administrative area and segregation areas shall also be provided with vegetative cover to the extent possible.

9.4.2 *Site Infrastructure*

In addition to the landfill area, the site shall be provided with the following infrastructure.

TRUE COPY

- Waste Reception Facilities
- Haul roads
- Weigh bridge
- Site office
- Top Soil Storage
- Support Services such as electricity, water supply telephones, etc
- Site Security
- Vehicles and Equipment
- Vehicle and Equipment Maintenance workshops and
- Site Staff

Waste Reception Facilities

The waste reception facilities shall comprise of the following

- An approach road to permit two way traffic, metalled and of adequate length to permit the queuing of vehicles
- Site notice board displaying licence conditions, hours of operation and site regulations
- Secure, lockable gates at the entrance to the site .
- Cattle grid at the entrance to the waste reception area
- A weigh bridge of 20 ton capacity capable of weighing 50 vehicle per hour
- Weigh booking office with all amenities and preferably computer logging facilities
- By pass lane for non-waste vehicles and emergency services
- Site administration office for site management with all support services
- Amenity block with dining room, toilets and washing facilities
- Small testing laboratory with first aid facilities
- Designated car park area
- Adequate store room

- Work shop for the first line on site maintenance with all spares and support services

- Adequate site lighting covering all traffic routes

Since the compost plant and the landfill site will be adjacent to each other, many of the facilities will be on a common sharing basis. It is preferable to have concrete apron pavement for most of the operational areas of waste reception area.

Waste Segregation and Recycling Centre

Waste from the reception area is carried to the waste segregation zone. The incoming waste is off loaded and segregated here before being sent for landfilling. It is recommended that this area be provided with access to local rag pickers for segregation and collecting the useful recyclable materials. The entire segregation area shall be paved with concrete and provided with easy access for incoming vehicles.

Haul Roads

The entire stretch of access road shall be upgraded / paved to a minimum of 8 m width (for two way traffic). All the primary haul roads from the public high way to the waste reception area and the landfill operational area shall be treated as permanent roads and should be constructed as per the standards.

The secondary arterial roads and temporary roads within the site can be of lesser standards, as the locations of these roads will be changing following the landfill development.

Support Services

The entire area of waste reception area and landfill site shall be provided with electricity and backup generators, potable water supply, communication facilities such as phones and efficient surface water drainage. The exact requirements of all these facilities shall be worked out during the detailed engineering phase of the project, before execution.

Site Security

Security to the whole of landfill area shall be provided for all 24 hours the day. A compound wall all round the site shall be constructed to provide integrity to the site and also serve as noise barrier to the adjoining areas. The wall can be of masonry or any other suitable material / rigid fence. As unauthorised access to the site may pose significant health and safety risks, warning notices and access control shall be provided at the following locations of the site.

- Plant and equipment compounds

- Waste Segregation zone

TRUE COPY

- Leachate and Land fill gas collection and treatment locations and
- Parts of site undergoing construction

Vehicles and Equipment

The vehicle and equipment envisaged for the plant operations are as listed below. The number of pumps required shall be estimated as per the pumping needs of the facility operator.

- Weigh Bridge
- Tracked Bulldozer
- Tracked Loading Shovel
- Tracked Backhoe / loader
- Grader
- Compactor
- Dump Truck
- Tractor and Bowser / Sweeper
- Van / Pick up
- Pumps

In addition to the above, adequate fire fighting equipment shall also be installed to meet the unforeseen fire accident

Vehicle and Equipment Maintenance and Spares

In keeping with good working practice regular machinery inspections shall be undertaken on weekly basis and preventive maintenance be practised. Workshop facilities will be provided on site for routine maintenance and servicing as required. Sufficient holding of spare parts should be maintained to keep each landfill facility operational on a continuous basis.

Site Staff

Adequate manpower is required to ensure that the site is constructed and operated successfully. The staff employed shall be sufficiently qualified and trained, competent and adequately supervised to ensure efficient functioning of the plant. The number and type of staff requirement anticipated for the study are presented below.

- Site Manager supervising all aspects of construction and operation
- Supervisors overseeing the landfill operations and maintenance
- Resident Engineers supervising landfill construction
- Unit Cashiers
- Clerk / Typists
- Weigh Bridge Clerks
- Stores In-charges
- Vehicle Drivers
- Vehicle Fitters and Mechanics
- Electricians
- Lab Technicians
- Environmental Monitoring Technicians
- Medical and First Aid Personnel
- Security Guards and
- General Labour

However, the designations and number would change according to the specific requirements of the landfill site.

9.4.3 *Landfill Foundation Level*

Landfill foundation is one of the most critical aspects of the landfill development activities. This exerts fundamental control over the

- Measures required for site engineering
- Stability of landfill foundations
- Provision of materials on site for site engineering and
- Overall gross and net capacity of the site

However, detailed geo-technical investigations shall be carried out to confirm the stability and design appropriate foundation for the landfill site.

9.4.4 *Containment of Potential Pollutants*

Containment measures such as double liners at the bottom and lateral sides of the landfill, and surface capping after the land filling is completed, are required to control the pollutants and mitigate subsequent impacts on environment.

Basal and Lateral Containment

The basal and lateral containment at the site shall be provided by using in situ natural soils and geological strata of permeability less than 1×10^{-9} m/sec. Detailed geo-technical investigations, by excavating top soil should be carried out to assess the permeability of the soil. The site preparation and construction of liner will comprise of

- Site Clearance
- Grading and dozing of the floor at foundation level to provide suitable slope for gravity drainage of leachate
- Placement and compaction of excavated clay in minimum of four lifts of 250 mm thick with clay placed at or within +4% of optimum moisture content
- Within each major phase the mineral liner will be laid as to be continuous at foundation level and will form as the primary containment layer

If the geo-technical investigations conclude soil permeability not suitable for liners, clay either has to be imported or in situ sandy materials has to be improved though addition of bentonite under controlled application rates.

Surface Capping

To minimise the ingress of water into the site after completion, it is proposed to form an engineered capping layer. This will comprise a multi layer system comprising,

- A protective layer of graded fine granular material of 100 mm thick and free from objects larger than 10 mm size, placed above the gas drainage layer over the last lift of waste
- Sealing layer with a maximum permeability and an equivalent layer of clay 1m thick with a permeability of 1×10^{-9} m/sec and
- A second protective layer with same specifications as mentioned above, placed above the sealing layer

9.4.5 *Ground and Surface Water Interception and Drainage*

Conventional dewatering measures shall be employed within the landfill area to discharge and maintain groundwater levels below landfill foundation level. This will be ensured through

- Pumping from perimeter trench drains installed on the bunds or from sumps installed below the landfill foundation level for areas undergoing preparation and

- Installation of temporary or permanent surface water interception drainage ditches to carry peak rainfall runoff and prevent flooding of landfill site

9.4.6 *Leachate Collection and Removal*

The leachate collection shall be achieved through the following measures

- Gravity drainage and grading of the floor of the landfill cell to fall into a sump located at the lowest point of the cell. The gradients shall be 2 per cent for main drainage with 1 per cent cross fall.

- Installation of leachate drainage blanket above the basal mineral liner over the floor of each cell and partially up the side walls, constructed of free drainage coarse granular fill comprising of graded 50mm crushed rock laid to a depth of 400mm with a permeability of 1×10^{-4} cm/sec.

- Inclusion of perforated HDPE pipes in the drainage blanket to facilitated leachate flow with pipes laid on a typical spacing of 50m.

- Overlaying granular drainage blanket with 100m thick free draining fine granular fills of medium to coarse sand to act as a filter and protective layer.

Removal of leachate is effected by leachate collection chambers built up with successive lifts of waste and side slope risers located on the site perimeter.

The submersible pumps or adductor pumps should be used to remove leachate from the sumps and the collection chambers should be linked by permanent pipe work to the treatment plant.

The precise methods and degree of treatment shall accommodate the fluctuations in leachate generation. However the following steps shall be followed to meet the standards prescribed by the ministry.

- Balancing of leachate flows and volumes

- Redistribution and recirculation of leachate to dry absorptive waste to reduce volume and to enhance the rates of stabilisation and

- Aerobic processing through lagoons.

9.4.7 *Landfill Gas and Management*

The primary measures to restrict the uncontrolled migration of landfill gas from the site will comprise,

- Low permeability containment layers and systems installed on the base and side walls
- Permeable gas drainage blanket of 0.3m thickness laid beneath the capping layer and
- Vertical gas chimneys vents and extraction wells

The gas drainage blanket will be formed of a layer of fines free, graded granular fill overlain by a layer of fine sand 100 mm thick and provide protection to the capping layer. Chimneys, Vents and Extractions wells shall be constructed by drilling from the surface of the capping layer. The extraction wells will have an outer diameter of 0.3 to 1 m and a HDPE well pipe of 0.1 to 0.15 m within well body.

9.4.8 *Surface Restoration*

The landfill will be brought up to its pre-settlement level in stages and capped off in a program of progressive restoration to limit the ingress of water into the site and to facilitate the control of landfill gas. The capping will be a composite structure comprising of four layers of an engineered seal designed to prevent water ingress and egress of landfill gas and an agricultural cap comprising of subsoil drainage layer.

A suitable vegetative cover will have to be established on the closed site to ensure slow surface runoff, promote evapo-transpiration of rainfall, retain moisture in the cap and enhance the formation of a soil structure in the agriculture soil.

9.4.9 *Other Measures*

Specific attention shall be paid to mitigate the following undesirable and potentially deleterious effects of

- Litter blown from the disposal / tipping area
- Scavenging animals, vermin and insects attracted to the sites
- Flies and Bird attraction
- Odour arising out of waste deposition and degradation
- Dust from landfill operations
- Mud generated from waste, cover, capping materials and site excavation works
- Fire and smoke control and
- Noise of operating plant.

These effects can be minimised by providing local litter arrestor fencing strategically placed in relation to the discharge point, erecting site security fencing for excluding scavenging animals, bird scaring techniques for avoiding bird nuisance, etc.

CHAPTER – 10
SANITARY LANDFILL PLANNING & DESIGN

10.1 INTRODUCTION

This chapter of the report presents the design of engineered landfill site at proposed location. The basic concepts for planning and design of sanitary landfill are derived from the MoEF Guidelines and CPHEEO recommendations and inputs from topographical and geotechnical studies and secondary data. The landfill site is developed based on standard approaches complying MoEF guidelines and containment engineering measures. The basic proposals for site engineering encompass,

- To improve and upgrade the site progressively to sanitary landfill site
- To check the ground water contamination
- To ensure the safe disposal of municipal solid waste

10.2 PRINCIPAL DESIGN CONSIDERATIONS

Constraints for obtaining suitable land for land fill site:

The current disposal site at Saccbal is utterly unsuitable and GMC has received notice from the Pollution Control Board to shift the existing site. Guwahati is located on the Brahamputra flood plains. A significant area in and around Guwahati gets occasionally flooded during the monsoon and the water often stands for about 8 months along the low lying tracts. Because of expansion of the city over the years, the entire area above the flood level within the Guwahati municipal limits is fully habited. In view of the above, selection of a suitable site, conforming to the MSW rules is difficult.

Earlier two land pieces were considered; one was in Panikheti on the banks of Brahamputra and the other at Garchug on the foothills. The Panikheti land is unsuitable for SLF as most of the time this land is submerged under water. Moreover, due to the vicinity of the river, the hydraulic force of the flood water is enormous and the cost of making the land suitable with be very high. The Garchug land is very small in size (about 3-4 ha) and spending money to make the site suitable which will last only for a few years is not economical. In addition, this site also has rehabilitation and resettlement problems.

After considerable deliberations, the present site in Boragaon has been earmarked by the Government for the MSW disposal. Though this site is also not particularly suitable for MSW disposal, GMC indicated in several meetings that no other suitable site is available for this purpose. The constraints of finding a suitable high-level land free of habitation are appreciated and under these constraints, IL&FS Ecosmart has attempted to design the engineered integrated facility at the present site in Boragaon. The land needs to be protected from the flood waters and

adequate measures are to be adopted for a safe and environmentally sustainable disposal of MSW.

Landfill planning and design

Planning and design of sanitary landfill is site specific and are largely controlled by site conditions. Before proceeding for planning and design it is important to understand the site characteristics and site specific factors to be considered. This section of the chapter presents the principal design considerations, proves to be significant in planning and design.

- The site is located in a flood plain and it is observed that the flood is 6 m – 6.5 m above the ground level
- The ground water table is just few feet below the ground level and during monsoon it touches ground level
- The proposed site is located in seismic zone IV.
- The proposed site remains water logged during a part of the year .

10.3 ASSESSMENT OF LANDFILL VOLUME AND LIFE

Assessment of volume of the waste to be landfilled is the preliminary design requirement in terms of area and landfill life estimation. Since the area of the landfill is fixed it is thus imperative to assess the landfill volume requirements at different periods of time. Table 10.1 presents the landfill volume requirements.

Table 10.1 Volume and Area Required for Core Landfill

Year	Amount of Waste to be Disposed, tons	Volume of Landfill Required, m^3
2016	6,89,268	8,91,993
2021	11,62,449	15,04,346
2026	17,79,074	23,02,331
2031	25,82,214	33,41,688

Annexure 10.1 presents the detailed calculations of volume required.

As presented in the previous chapter 7 the volume of the landfill site is estimated to be 24.12 lakh m^3 and thus design life of the landfill is around 20 years (2006-2026). Two compost plants having capacity of 200 TPD and 300 TPD has been suggested in two phases. The second compost plant will have to be commissioned on the 11th year of the project cycle. Since the life of the proposed landfill site is for 20 years, between 2026 and 2031 a new site will have to identified for the disposal of the compost rejects.

10.4 PLAN AND CROSS-SECTION OF SANITARY LANDFILL

The landfill is being developed in the area of about 15.12 Ha . Since the HFL is about 6.5 m from the ground level it is proposed to construct the retaining wall of height 8 m around the landfill site to protect the sites from flood. The space with in retaining wall would be filled with inert waste and compost rejects up to 8 m and above 8 m a trapezoidal pyramid shape landfill shall be created. The slope of the landfill above 8 m shall be 1:5 with height of 15 m. The plan and cross-section of the landfill has been presented in Drawing 10.1.

10.5 DESIGN OF LEACHATE COLLECTION SYSTEM

10.5.1 Assessment of Quantity of Leachate Generated

Post closure leachate generation is mainly due to infiltration of surface runoff and guides the designing of liner system. The leachate generation has been estimated considering the maximum daily rainfall of 194.3 mm for 24 hrs and runoff coefficient 0.95.For the collection of leachate, total area of landfill site has been divided into two parts of area 8.43 Ha and 6.68 Ha respectively. Accordingly, two leachate collection tanks have been provided.

Parameter	Quantity		Unit
Coefficient of Runoff	0.95	0.95	
Rainfall (Maximum Daily)	194.3	194.3	mm/day
Exposed Surface Area	84329	66794	m^2
Leachate Volume	820	649	m^3/day
No. of Days of Storage	2	2	days
Quantity of Leachate to be Stored	1640	1298	m^3
Size of Leachate Collection Tank	13.5(L)	18 (L)	m
	13.5(W)	18 (W)	m
	9 (H)	9 (H)	m

Thus the peak leachate generation rate works out to 1469 m^3 per day. The leachate from the landfill area would be collected in 'Leachate Collection Tank' and pumped out.

10.5.2 Leachate Collection System

The primary function of leachate collection system is to collect and to convey the leachate out of the landfill unit and to control the depth of the leachate above the liner. As per USEPA Manual the leachate collection system should be designed to maintain a leachate depth or head of 30 cm or less above the liner. The design leachate head is very important as flow of leachate through imperfections in the liner system increases with an increase in leachate head above the liner. Maintaining a low leachate level above the liner helps to improve the performance of the composite liner system. The main components of leachate collection system are leachate collection tank, feeder mains and header main.

TRUE COPY

Leachate Collection Network

Leachate Collection Network comprising header pipe and feeder pipe/laterals has been proposed. The feeder pipes shall be of 200 mm diameter at a spacing of 10 m centre to centre at a slope of 2 per cent and connected to header pipe. Similarly the header pipe shall be 260 mm diameter at a slope of 2 per cent connected to leachate collection tank.

Leachate Collection Sump

The purpose of leachate collection tank is to collect the leachate from header pipe and active landfill area. The leachate collection tank would be supported by the pump to lift the collected leachate. Two leachate collection tanks of capacity 1640 m^3 and 1298 m^3 have been proposed.

Feeder and Header Pipe Material

A leachate collection system is a network consisting, 200 mm diameter feeder pipe at lateral spacing of 10m connected to 260 mm diameter header pipe. The pipes shall be HDPE perforated pipes with sufficient strength (minimum 6 kgf) and should be safe from particulate and biological clogging and deflections.

The generated leachate will be transported to Common Effluent Treatment Plant (CETP) which is under proposal for the Guwahati city. The cost for treatment of leachate has been taken as Rs 70.00 per cum.

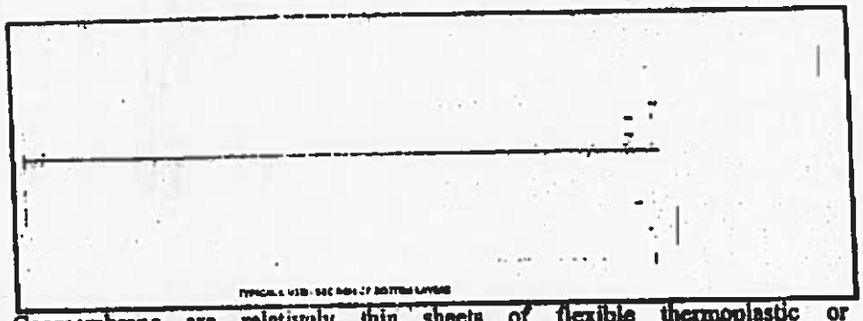
10.6 LINER SYSTEM DESIGN

The liner system for landfill site at Guwahati is designed based on MoEF recommendations. As per MoEF "*Construction of a non-permeable lining system at the base and wall of waste disposal site area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous material (such as aerosol, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specification shall be a composite barrier having 1.5mm High Density Polyethylene (HDPE) geomembrane or equivalent overlying 90cm of soil (clay/amended soil) having permeability coefficient not greater than $1X10^{-7}$ cm/sec.*"

Therefore for the landfill site composite liner of following specifications has been recommended complying Municipal Solid Waste (Management and Handling) Rules 2000.

- A 90cm thick compacted clay or amended soil (amended with bentonite) of permeability not greater than 1×10^{-7} cm/sec
- A HDPE geomembrane liner of thickness 1.5mm
- A drainage layer of 300 mm thick granular material of permeability not greater than 10^{-2} cm/sec.

Main components of co nposite liner are clay/amended soil layer and geomembrane liner and performance of landfill largely depends on this liner system. Thus it is incumbent to have the liner system very accurately and perfectly.



Geomembrane are relatively thin sheets of flexible thermoplastic or thermopolymeric materials. Because of their inherent impermeability, geomembranes are proposed as barrier layer in landfill site. Even though geomembranes are highly impermeable, their safety against manufacturing, installation, handling and other defects is essential criteria in designing liner system.

Table 10.3 Typical Values for Geomembrane Measure in Performance Tests

		Property	Typical Value
1		Thickness	1.5mm (60mil)
2		Density	0.94gm/cc
3		Roll Width X Length	6.5m X 150m
4		Tensile Strength	
	a	Tensile Strength at Yield	24kN/m
	b	Tensile Strength at Break	42kN/m
	c	Elongation at Yield	15%
	d	Elongation at Break	700%
	e	Secant Modulus (1%)	500MPa
5		Toughness	
	a	Tear Resistance (initiation)	200N
	b	Puncture Resistance	480N
	c	Low Temperature Brittleness	-94°F
6		Durability	
	a	Carbon Black	±2%
	b	Carbon Black Dispersion	A-1
	c	Accelerated Heat Ageing	Negligible Strength Changes after 1 month at 110°C
7		Chemical Resistance	
	a	Resistance to Chemical Waste Mixture	10% Strength Change Over 120 days
	b	Resistance to Chemical Reagents	10% Strength Change Over 7

8	Environmental Stress Crack Resistance	days
9	Dimensional Stability	1500 hrs
10	Seam Strength	2%
		80% or more (of Tensile Strength)

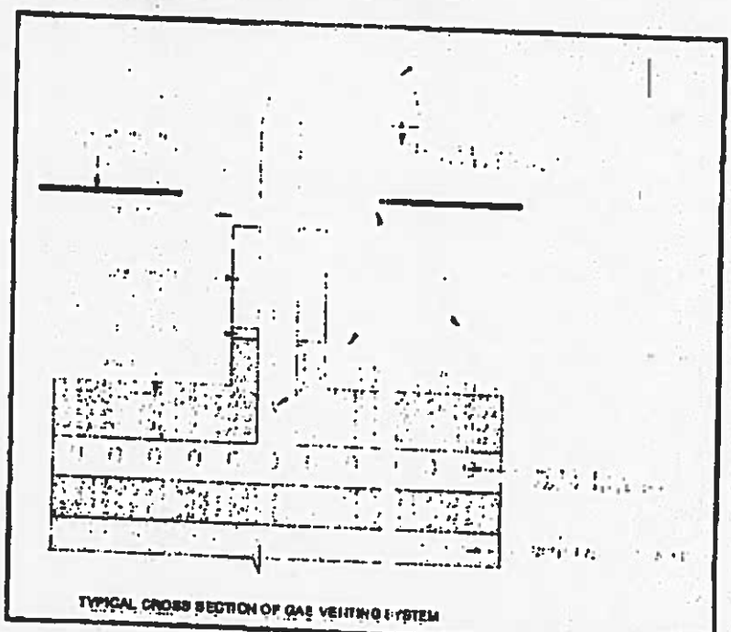
Source CPHEEO Manual

10.7 LANDFILL GAS MANAGEMENT SYSTEM

Landfill gas is a bi-product of biodegradation process that takes place in landfills. Since landfill site at Guwahati is supported by compost plant, gas generation is anticipated to be very less. The principal components of landfill gas are Methane (CH_4) and Carbon dioxide (CO_2) and USEPA has identified another 47 type of toxicants and carcinogens liberate from the landfill. For landfill site at Guwahati a gas venting system with flaring arrangement is proposed.

An active gas venting system is proposed for landfill site at Guwahati. A gas-venting layer of 20 cm thick granular soil should be provided on the top of solid waste and the gas collected in this layer shall be collected and vented through gas vent pipes of 150 mm diameter perforated HDPE pipes. It is assumed that 5 vents are required for 2 Ha of landfill and thus estimated 38 vents for the landfill site.

With the help of blower gas through the pipes shall be collected and taken to flaring unit. The collection system is a network of 150 mm HDPE perforated pipes connected to flaring unit. The flaring unit consists of collection chamber, blower, ignition mechanism, control valves and sensors.



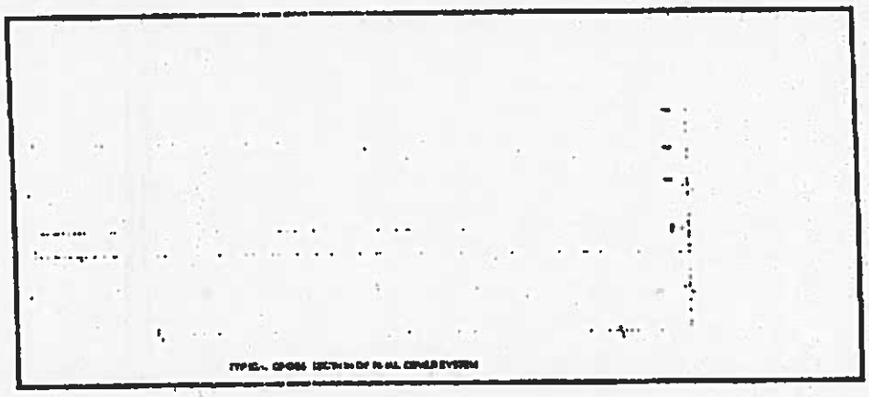
TYPICAL CROSS SECTION OF GAS VENTING SYSTEM

TRUE COPY

10.8 FINAL COVER SYSTEM

The final cover system proposed for landfill site at Guwahati is based on the recommendations of MoEF and CPHEEO Manual. The final cover consists of the following components,

- Vegetative layer of 450 mm thick with good vegetation supporting soil
- Drainage layer of 150 mm thick granular material with permeability $1x10^{-2}$ cm/sec
- Barrier layer of 600 mm thick clay/amended soil with permeability $1 X 10^{-7}$ cm/sec
- Gas venting layer of 200mm thick granular material with permeability $1 X 10^{-2}$ cm/sec



10.9 EQUIPMENT

For the daily cell formation, cutting, compaction and transportation landfill vehicles are required and the details of the same are presented in table 4.4, as recommended by CPHEEO Manual

Table 10.4 Details of Landfill Equipment

S. No	Type of Vehicle	Number
1	Dozer	1
2	Backhoe and Loader	1
3	Excavator	1
4	Vibro Compactor	1
5	Water Tanker	1
6	Tipper Truck	2

10.10 SUMMARY OF DESIGN

This section of the chapter presents the summary of the design as worked out in the earlier sections. The details of design summary are presented in table 10.5.

Table 10.5 Summary of Landfill Design

Landfill Component	Design Specifications
Design Life	20 years
Area	15.12 Ha
Leachate Collection Sump	13.5m X 13.5m X 9m and 12m X 12m X 9m
Feeder Pipes Spacing Size	 10 m 200 mm diameter
Header Pipe Size	 260 mm diameter
Feeder and Header Pipe Material	HDPF perforated pipes with sufficient strength
Liner System	A 90cm thick compacted clay or amended soil (amended with bentonite) of permeability not greater than $1X10^{-7}$ cm/sec A HDPE geomembrane liner of thickness 1.5mm A drainage layer of 300 mm thick granular material of permeability not greater than $1X10^{-2}$ cm/sec.
Number of Gas Vents Required	38
Final Cover System	Vegetative layer of 450 mm thick with good vegetation supporting soil Drainage layer of 150 mm thick granular material with permeability $1 X 10^{-2}$cm/sec Barrier layer of 600 mm thick clay/amended soil with permeability $1 X 10^{-7}$cm/sec Gas venting layer of 200 mm thick granular material with permeability $1 X 10^{-2}$cm/sec

TRUE COPY

194
2916

CHAPTER – 11
COST ESTIMATES

11.1 OVERVIEW OF GMC FINANCIALS

The major sources of income for GMC are property tax of Rs. 9.5 Crores. The revenue income is to the tune of Rs. 35 Crore where as capital is Rs. 2.2 Crore only. It appears that currently GMC is not financially in a very sound position. The income & expenditure of GMC is shown in Table 11.1.

Table 11.1: Income & Expenditure of GMC (2002-05)

(Rs. Crores)

Year	Revenue Income	Capital income	Total	Revenue expenditure	Capital Expenditure	Total
2002-03	33.25	4.65	37.9	27.35	3.53	30.89
2003-04	30.49	0.2	30.69	29.99	4.47	34.46
2004-05	35.13	2.2	37.33	33.87	6.36	40.23

Source: GMC

11.1.1 Current SWM Expenditure

In the year 2004-05, GMC has incurred expenditure to the tune of Rs. 1487 Lakhs on SWM. The expenditure, as provided by GMC, shows annual increase of about 6%-7%. Annual expenditure incurred by GMC on SWM services for last three years are given in Table 11.2 below:

Table 11.2: Annual Expenditure incurred by GMC on SWM services

Designation	Nos/qty	Annual salary/costs		
		2004-2005	2003-2004	2002-2003
Supervisory Staff				
Chief Engineer				
Superintendent-Engineer	1	2,84,408.00	2,32,000.00	2,07,650.00
Executive Engineer	5	11,28,487.50	10,41,666.66	9,99,720.00
Zonal Engineers	23	32,98,320.00	30,90,000.00	29,15,000.00
Supervisors & Inspectors (GMC does not have inspectors for SWM activity)Inspectors work in sanitation activity.	60	55,54,800.00	53,02,800.00	50,76,000.00
Workers				
Sweepers & Waste Collectors	800	4,31,05,054.00	4,25,20,500.00	4,13,85,000.00
Drain Cleaning labour	270	2,87,36,702.00	2,58,80,650.00	2,39,83,000.00

Garage Staff	x			
Salaries (There is no as such staff in the garage directly involved in Drain cleaning activity other than above mentioned labours)				
Other Expenditure on establishment				
Pension of workers				
P F- (CPF)		2,60,00,000.00	2,50,00,000.00	2,34,75,550.00
Other benefits (Gratuity)		50,00,000.00	40,000.00.00	35,500,00.00
Contract & hire				
Transportation contract		2,57,57,400.00	2,26,20,120.00	2,02,28,460.00
Other contract labour				
Hire of Bull dozer	1 No.	16,42,857.00	16,39,754.00	15,31,560.00
Other equipment hire				
Annual procurements				
Brooms		67,500.00	65,000.00	61,500.00
baskets		82,000.00	37,460.00	54,750.00
Shovel		50,500.00	47,540.00	19,200.00
Landfill sanitizer (including the medicine).		6,07,773.00	.....	.....
Others		2,00,000.00	1,50,000.00	1,47,000.00
Fuel & Vehicle Maintenance				
Vehicles used by Staff engaged in SWM.	5 Nos.	19,20,000.00	19,12,750.00	18,45,400.00
Vehicles used for drain cleaning.				
Excavator	5 Nos.	21,36,700.00	21,36,650.00	20,05,472.00
Tipper	12 Nos.	26,00,300.00	17,09,085.00	16,11,222.00
Other vehicles & Infrastructure				
Maintenance of carts / wheel barrows	104 nos of handcarts	5,38,792.00	5,38,335.00	5,11,350.00
Total Expenditure		14,87,11,593.00	137924310.6	12,60,93,334.00

Source : GMC

It appears that GMC has no separate accounts on SWM expenditure because many of the activities are not related to SWM alone but also relate to other activities. However the expenditure details provided by GMC indicate that almost 45% of the revenue is spent on SWM operations which are very high compared to expenditures incurred by other cities in India. The expenditure on the SWM is depicted below:

Table 11.3: Annual Expenditure

Year	2004-2005	2003-2004	2002-2003
SWM Expenditure	14,87,11,593.00	137924310.60	12,60,93,334.00
% to total Revenue expenditure	43.90	45.98	46.10

TRUE COPY

GMC could consider the following:

- To introduce separate accounting for SWM, maintain separate budget, income/expenditure details to monitor per ton cost.
- To levy user charges for direct collection from hotels, hospitals and bulk generators
- To modify the contract for transportation with clearly set performance indicators making payments based on weight/volume of waste transported

11.2 COST OF INTEGRATED SOLID WASTE MANAGEMENT SYSTEM

The cost estimates for integrated solid waste management facility for GMC is worked out based on the detailed study done by IL&FS Ecosmart Limited and its assessment of the SWM operations in Guwahati. The existing infrastructure available with the municipality has been taken into account and costing for up-gradation of the system is worked out. The additional investments thus required to increase the efficiency of the system and to meet the norms prescribed by the MSW (Management and Handling) Rules, 2000.

In the proposed system, it has been suggested that the complete collection, transportation, treatment and disposal may be handled through a single entity of a Special Purpose Vehicle (SPV) on Public Private Partnership basis. The SPV may appoint an operator or may undertake responsibility of the total operation on its own.

It is desirable to have a single operator for the comprehensive SWM system. The collection, transportation, treatment and disposal system will be entrusted to a single operator. The GMC will procure all the equipments required for the collection, transportation and a part of the disposal system. The operator will recover the O&M cost partially from the waste generators and GMC.

11.3 CAPITAL / PROJECT COST

The project cost has been divided in to two parts:

a) Investment required for Collection and Transportation;

b) Investment required for Integrated Processing and Disposal facility

11.3.1 Investment requirement for proposed, Collection and Transportation of MSW

Various components of collection and transportation of MSW for the city of Guwahati are as follows:

- Door to door collection of MSW from houses, slums

- Collection of the MSW from the secondary collections points and transfer the same to the integrated facility
- Drain cleaning, collection of the sludge and transport the sludge to the integrated facility
- Street sweeping and transport of the material to the integrated facility
- Collection and transportation of the wastes from Hotels, Markets, Hospitals etc. and transportation to the integrated facility

The major components of the capital investment for improving collection and transportation of waste are:

- Bins, containers
- Transportation vehicles
- Tools and equipment for collection of waste, street sweeping etc.

In the proposed system, JNNURM may be approached for capital investment of collection and transportation system. The capital investment for collection and transportation of the waste, as shown in Table 11.4 below:

Table 11.4: Investment for collection & transportation of waste

S No	Item of expenditure	Quantity required (numbers)	Cost per unit (Rs)	Total expenditure (in Rs lakhs)
1.	Containerized tricycles (Door to Door Collection)	262	15,000	39,30,000
2.	Containerized tricycles (Collection from Slums)	10	15,000	1,50,000
3.	Containerised Carts (Street Sweeping)	365	12,000	43,80,000
4.	Wheel barrows for drain cleaning	150	8,000	12,00,000
5.	Litter bins	200	2,000	4,00,000
6.	Dumper placer containers of 3.5 cu m	347	45,000	1,56,15,000
7.	Concrete flooring under the bins	215	5,376	1,15,58,40
8.	Dumper placer vehicles (twin container lifting device)	26	12,50,000	3,25,00,000
	Total Capital Cost			593,30,840

All the capital cost will be borne by GMC which is further proposed to be arranged through Grant funding..

TRUE COPY

11.3.2 Operation & Maintenance Costs for Segregation, Collection and Transportation of MSW

The entire primary collection operation would be contracted to an Operator by the SPV. The Operator will recover the collection cost partially from the generators and partially from GMC. The collection cost shown in the Table 11.5 has been estimated based on the expenditure on O&M and manpower per annum. This cost does not include any profit margin of the Operator.

Table 11.5: O&M Cost for Collection and Transportation of MSW

S.No.	Component	Collection cost per annum (Rs. in Lakhs)	To be recovered from
1	Door to Door from houses and Colonies	284.93	Households as user fee
2	Door-to Door from Slums	7.28	GMC
3	Major Markets	6.28	Generators as user fee
4	Street Sweeping	266.50	GMC
5	Drain Cleaning	8.95	GMC
6	Direct Collection from Hotel Restaurants, Marriage hall, Institutions etc.	25.00	Generators as User fee
	Collection Cost borne by Generator	316.21	
	Collection cost borne by GMC	282.73	
	Secondary Collection and Transportation	199.17	

11.3.3 Cost of Disposal & Processing Facility

As discussed in Chapter–7, the proposed integrated facility for disposal & Processing of MSW of Guwahati at "Badagaon" site will mainly comprise of composting plant and Sanitary landfill site. The land allocated for this purpose is 24.12 Ha and would be sufficient for 20 years operations.

Site Development

The proposed site for sanitary landfill development is located at Badagaon. Initially, there were two isolated pieces of land. One was 9.38 ha piece of land and the other was 2.8 ha land at a distance of 200-300 m from each other. However, in the draft report the consultants had suggested for requisition of only one piece of land with additional area to increase the life of landfill. Subsequently, GOA has agreed and additional land of 110 bighas (14.74 Ha) has been provided for development of integrated facility for solid waste management. Now, the total area of land available for sanitary landfill development is 15.12 Ha This site is a low lying area which is required to be raised by minimum 8 m from existing ground level to avoid flooding. Construction of an access road of 1.3 km length and 8 m width is proposed from NH-37 to the waste disposal & processing facility. The cost of construction of the access road has been considered as part of site development.

The detail of the cost for site development for integrated facility is presented in the table below:

Table 11.6: Summary of Cost for Site Development

S. No.	Description	Quantity	Unit Rate, Rs	Total Cost (Rs Lakh)
(A) Sanitary Landfill site Development				
1	Retaining Wall (8 m high)	2182 m	36,000	785.52
2	Bottom filling of (2m) (Soil filling)	302400 cum	262	791.98
(B) Composting (Filling of land with soil upto 8 m)				
	Ph I for 200 TPD	301346 cum	262	789.23
(C) Common Facilities				
	Access Road (8 m wide	1300m	40,466	452.73
	Grand Total (A) +(B) + (C)			2819.46
(D)	Ph-II for 300 TPD Compost plant	362592	262	949.63

The above mentioned expenditure on Site Development for Phase-1 is proposed to be met through Grant funding in the first year of the project. The site development of Phase II, will be carried out in the eleventh year of the project.

11.3.4 Composting Facility

It is recommended that a composting facility for treating 200 tons of waste per day be set up at the site in the initial phase. The total cost of setting up the facility is worked out to be Rs 854.88 lakhs as detailed in table below:

Table 11.7: Cost for Setting up the compost facility

S No.	Particulars	For 200 TPD (Rs. Lakhs)	For 300 TPD (Rs. Lakhs
1	Civil Works (including windrows yard, storage, office, drainage etc.)	600.08	747.96
2	Plant Machinery & Equipment	254.80	269.03
	Total	854.88	1016.98