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Guidelines and Check-list for evaluation of MSW Landfills proposals with Information on existing landfills

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CENTRAL POLLUTION CONTROL BOARD

(Ministry of Environment & Forests)

Parivesh Bhawan, East Arjun Nagar,

Delhi-110032

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e-mail: cpcb@nic.in Website: www.cpcb.nic.in

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GUIDELINES AND CHECK-LIST FOR EVALUATION OF MSW LANDFILLS PROPOSALS WITH INFORMATION ON EXISTING LANDFILLS

1.0 INTRODUCTION:

Landfilling is the ultimate disposal process for Municipal Solid Wastes (MSW) management. The quantity of MSW for land disposal can be substantially reduced by setting up of waste processing facilities and recycling the waste materials as much as possible. A few Urban Local Bodies (ULBs) have attempted to demonstrate "Zero garbage" on Municipal Solid Wastes Management (MSWM) by adopting method of recycling/reusing and processing of wastes. Still, some inert wastes are left out for disposal. It is estimated that the inert wastes for landfilling occupies 40-55% of the total wastes depending upon type of city.

The landfill is an unavoidable component in MSW Management and its planning and design, construction, operation & maintenance involves technical skills and safety measures in terms of health and environmental protection. The Municipal Solid wastes (Management & Handling) Rules, 2000 specify relevant points with regard to site selection for proposed landfill site, facilities requires at landfill site, specification for landfilling, pollution prevention, water quality monitoring, ambient air quality monitoring, plantation at landfill site, closure of landfill site/ post closure, etc. These specific provisions are to be implemented as per rules and need to be ensured during the planning and design stage. The adequacy and performance of these provisions are to be monitored by the regulating authorities (SPCBs/PCCs) during issue of consent/authorization. Central Pollution Control Board (CPCB) has made an effort to bring out the present document incorporating the check-list for quick review during monitoring of the landfill facilities all stages right from planning to commission of landfill facilities. Information on a few existing/operating landfill facilities set up by the local bodies is also presented in this document for reference purpose.

2.0 REGULATORY ASPECTS/PROVISION OF MSW LANDFILLS:

Under section 6 (3) of the MSW (M&H) Rules, 2000 State Pollution Control Board (SPCBs) or Pollution Control Committee (PCCs), shall issue authorization 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 Schedule II, III and IV including such other conditions, as may be necessary. SPCBs/PCCs, after the receipt of application from the municipal authority or the operator of a 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 authorization.

3.0 LANDFILLS AS PER MSW RULES

3.1 Requisites of Landfills:

The Sl. No.6.under Schedule-II of MSW Rules, 2000 prescribes that landfilling shall be permitted to non-biodegradable, inert waste and other wastes that are not suitable either for recycling or for biological process. Landfilling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Landfilling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule-III.

3.2 Specifications for landfill Sites:

(a) Site selection:

Landfill identification shall be done by 'Development Authorities' for the area falling under 'Development Authority', otherwise it shall be done by the concerned Municipal authority. The site selection shall be done based on examination of environmental issues. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan. The landfill facility shall be nearby waste processing plant or an integral part of it. The landfill site shall be designed for 20-25 years. The proposed landfill site should be away from habitation clusters, forest areas, water bodies, monuments, national Parks, Wetlands and places of important cultural, historical or religious interest. Also, approval shall be taken from the concerned authorities in case the landfill site is located within 20 km from the airport/airbase.

(b) Facilities at Site:

The landfill shall be fenced with proper gate at entrance for monitoring incoming wastes/vehicles, to prevent entry of cattle, to keep record movement of vehicles and wastes, etc. Also, provision of weigh-bridge may be made for assessing quantum of wastes. Drinking water and other sanitary facilities and other safety measures including health check up shall be provided to workers.

(c) Specification for land filling:

Waste subjected to landfilling shall be compacted in thin layers to achieve maximum capacity of landfill. The disposed wastes shall be covered immediately/at the end of working day with 10 cm of soil. Prior to commencing monsoon period, an immediate soil cover of 40-65 cm thickness shall be placed on the landfill with compaction to prevent rainwater infiltration. Proper drainage to be provided to divert run-off water from the active landfill cell.

After completion of landfill, a final capping shall be provided with (i) a barrier of soil cover of 60 cm of clay or amended soil with permeability of $1X10^{-7}$ cm/sec, (ii) on top of the barrier soil layer, there shall be a drainage layer of 15 cm and (iii) on top of the drainage layer, there shall be vegetation layer of 45 cm to support natural plant growth to minimize soil erosion.

(d) Pollution Prevention:

In order to prevent pollution problems from landfill operation the necessary steps should be taken viz. (i) Diversion of storm water to minimize leachate generation and to avoid flooding/water logging, (ii) Construction of non-permeable linings system at the base and walls of waste disposal area against contamination from domestic hazardous wastes. The liner shall be a composite barrier having 1.5 mm HDPE or equivalent having permeability least than $1X10^{-7}$ cm/sec. The water table should be at least 2 m below the base clay or amended soil barrier layer. (iii) Provision of leachate collection and treatment shall be made as per standards specified in Schedule-IV,

(e) Water quality monitoring:

Ground water quality to be monitored within 50 m periphery of landfill site. Also, ground water quality data to be generated before construction of landfill site for future reference.

(f) Ambient air quality monitoring:

Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odor generation, prevent off-site migration of gases and to protect vegetation planted on rehabilitated landfill surface. The concentration of methane gas at the landfill site shall not exceed 25 LEL. The landfill gas collected from the facility shall be utilized either direct thermal application or power generation, otherwise, landfill gas shall be flared to prevent direct escape. Passive venting will be allowed if flaring is not possible.

(g) Plantation at Landfill site:

A vegetative cover shall be provided over completed site as follows; (i) Selected species of locally adopted non-edible perennial plants that resistance to drought and extreme temperature shall be allowed to grow, (ii) The roots of the plants grown should not penetrate more than 30 cm, (iii) The plant species shall have ability to thrive on low-nutrient soil and (iv) the density of plantation shall be sufficient to minimize soil erosion.

(h) Closure of landfill site and post- care:

The post-closure care of landfill site shall be conducted after fifteen years and long term monitoring to assess; (i) maintaining integrity and effectiveness of final cover and repair required, (ii) efficiency of leachate collection system, (iii) ground water quality and action required to improve, (iv) maintenance and operation of gas collection system to meet the standards. The closed landfill may be used for human settlement after 15 years of post-closure care by ensuring gaseous emission and leachate compliance.

(i) Special provisions for hilly areas:

Cities/ towns located in hilly areas shall adopt location specific methods of disposal with permission of concerned SPCB/PCCs.

4.0 A CHECK LIST FOR MSW LANDFILLS

The municipal authority or an operator of a facility is required to make an application in Form-I, for seeking authorization for setting up waste processing and disposal facility including landfills from the State Board or the Committee in order to comply with the implementation of Rules/Schedules. The state Boards or Committee, after the receipt of application from the municipal authority or the operator of a facility in Form-I, for grant of authorization for setting up waste processing and disposal facility including landfills will examine the proposal taking into consideration the views of the other agencies like the State Urban Department, Air Port or Air Base Authority, the Ground water Board or any such other agency prior to issuing the authorization. In order to facilitate SPCBs/PCCs to examine the received proposals a check-list is necessary to enable an officer of a regulatory Authority (SPCBs/PCCs) to undertake the following:

(a) Assess a report submitted for starting a new landfill,

(b) Assess a report submitted for closure of an existing waste dump or an existing landfill without liner,
(c) Assess a report for expansion of an existing waste dump or an existing landfill without liner,
(d) Record- keeping and inspection of a landfill.

In making the assessment of a report, the concerned Officer will be checking the same for its comprehensiveness. The assessment will not be a technical proof-check and the responsibility of the design of each component given in a report will lie with the Organization which has submitted the report (Operator of the landfill or his Design Consultant). Should the Officer assessing the report find the need for an independent technical proof-check, he shall have the authority to refer parts of the report to an Expert.

(In this checklist some typical diagrams are shown; these are only conceptual in nature. The actual diagrams in the Report to be submitted by an Operator would be full scale diagrams with complete details)

A. Assessment of a Report for a New Landfill

The Officer of the Regulatory Authority shall examine each of the aspects described in the Sections listed below from A.1 to A.16 for their completeness.

A.1 Contents of the Report

The Report should contain the following Sections:
(a) Description of Landfill Site
(b) Infrastructural Facilities
(c) Plan and Section of the Landfill
(d) Landfill Capacity and Life
(e) Operation in Yearly Phases
(f) Liner System
(g) Cover System
(h) Leachate Collection and Management
(i) Gas Collection and Management
(j) Surface Water Drainage
(k) Slope Stability
(l) Closure Plan
(m) Environmental Monitoring
(n) Post Closure Maintenance
(o) Construction Quality Control
If any of the above-listed sections or their subsections (listed hereafter) are missing, the Officer may request for a re-submission of the report after their incorporation and suitable alterations.

A.2 Description of Landfill Site

This Section should contain the sub-sections described below :

(a) Location: The report should include (i) a diagram depicting the location of the landfill on a road map of the entire urban area from which it is receiving waste; (ii) a diagram showing all features (eg. roads, parks, habitation, water bodies etc.) within a range of 500m outside the boundary of the landfill and (iii) any other information.

(b) Site Characteristics: The report should provide a summary (including diagrams wherever necessary (eg. Fig 1 and 2)) of (i) site topography including permanent features such as roads, transmission lines, pipelines, drains etc. present at the site; (ii) subsurface soil profile; (iii) depth to ground water table and its quality; (iii) depth to bedrock; (iv) annual rainfall and (v) any other relevant information.

(c) Site Selection Aspects: The report should provide a summary of the following aspects relating to site selection: (i) a expected life of the landfill; (ii) buffer zone around landfill; (iii) distances form habitation clusters, water bodies, forest areas, National Parks, monuments, wetlands etc.; (iv) distance from airport; (v) record of the highest flood level in the past and (vi) any other relevant information.

A.3 Location and Size of Infrastructural Facilities:

Plan View of Infrastructural Facilities: The report should include one plan view (eg. Fig 3) of the complete site depicting the size and location of the following facilities: (i) boundary fencing; (ii) green belt; (iii) entrance and gate; (iv) weighbridge; (v) parking area; (vi)

inspection and sampling facility; (vii) administrative building and laboratory; (viii) road; (ix) equipment workshop and garage; (x) vehicle tyre wash facility; (xi) leachate treatment plant; (xii) gas flaring /processing facility (optional); (xii) surface water drains and sedimentation tank; (xiii) environmental monitoring facilities; (xiv) waste processing facilities; (xv) temporary holding areas; (xvi) special phases / cells; (xvii) completed landfill and (xviii) others (see Fig 3).

The plan view of infrastructural facilities would be displayed at the entrance gate of the site.

A.4 Plan and Section of Landfill

This section should contain subsections listed and described below.

(a) Plan and Section of Original Ground (without landfill): The report should include description and diagrams showing the following: (i) plan view of the ground surface on which the landfill is to be located (eg. Fig 1) with contours of ground elevation (typical increment 1.0m or less; lower for steeply sloping ground); (ii) sectional view of original ground along one or two sets of orthogonal directions and (iii) any other relevant information.

(b) Plan and Section of Landfill Site after Excavation: If the landfill is partly (or wholly) below the ground, the plan view of excavated ground should be included in the report along with the sectional view along one (eg. Fig 4) or two sets of orthogonal directions. All dimensions and elevations will be marked in the plan and section.

(c) Plan and Section of Completed Landfill: The report should include diagrams (eg. Fig 5) showing the following: (i) plan view of the completed landfill; (ii) sectional view of completed landfill along one or two orthogonal directions; and (iii) any other relevant information. All dimensions and elevations will be marked in the plan and section.

A.5 Landfill Capacity and Life

The report should contain a separate section showing computation of landfill volume, annual waste quantities, waste density and estimated life of the landfill.

A.6 Operation in Yearly Phases

The report should include diagrams depicting how the landfill will progress in yearly phases. The plan view of the landfill should be divided into approximate phases and numbered sequentially, with each number corresponding to each year in the life of the landfill (eg. Fig 6). Diagrams should also be made showing sectional views of method of closing the previous phase before starting a new active phase. Keeping the fact in view that that waste quantities are often approximate to start with and vary annually, the size and shape of the phases can be modified as the landfill operation proceeds. In such cases, a report of all modifications and revised plans will be submitted annually to the regulatory authority for information and record.

A.7 Liner System

The report should include (i) a diagram showing the components of the liner along the base of the landfill (eg. Fig 7); (ii) a diagram of the components of the liner along the side slope of the landfill; (iii) a diagram showing the junction of the liner along side slope and the horizontal base; (iv) a diagram of the junction of the liner with the cover at the ground level; (v) the design of the run out length / anchor trench of the liner geomembrane; (vi) check for filters or separators or protectors at the interfaces between different materials of the liner and (vii) check for stability of liner components against slippage along interfaces on the side slope of the liner.

A.8 Cover System

The report should include (i) a diagram showing the components of the cover system at the top of the landfill (eg. Fig 8); (ii) a diagram of the components of the cover system along the side slopes, including the berm with surface water drains (if any); (iii) a diagram of the junction of the cover system with the liner system at the ground level; (iv) check for requirement of filters or separators or protectors at the interfaces of different materials of the cover; (v) check for stability of cover system components against slippage along interfaces on the side slope of the cover.

A.9 Leachate Collection and Management

The report should include (i) choice of leachate management strategy including details of the chosen treatment methodology (onsite / offsite treatment or evaporation or recirculation or any other), (ii) computation of the total estimated leachate quantity per annum; (iii) landfill base slopes for flow of the leachate in the longitudinal and transverse directions; (iv) location and components of leachate drainage system including sand-gravel drains and pipes, wherever required; (eg. Fig 9) (v) location and components of leachate collection wells or side risers including sumps and pumps; (vi) location and size of leachate header pipe for leachate removal, if required; (vii) the methodology of handling waste and leachate during high rainfall periods; and (iv) any other information.

A.10 Gas Collection and Management

If biodegradable material is expected to reach the landfill, the report should include (i) choice of gas management strategy including details of the chosen methodology (passive venting, flaring, gas-to-heating, gas-to-energy, or any other); (ii) estimation of gas quantity (wherever significant quantity is anticipated); (iii) location and components of landfill gas collection layers, pipes and vents (eg. Fig 10), wherever required; (iv) location of gas collection wells, risers, header pipes and other components wherever active systems are used.

If a gas collection system is not being provided, the Designer should demonstrate that no biodegradables or VoCs will be present in the rejects from waste processing plants and other miscellaneous waste which reach the landfill.

A.11 Surface Water Drainage

The report should depict how the rain water falling on the site as well as that entering the site from neighboring areas will be handled during operation and after closure. It should contain (i) an estimate of the quantity of surface water to be handled every year; (ii) the scheme of drains for handling surface water during monsoons in the operating phase; (iii) the location of the storm water drains on the original ground, on top of the completed landfill (eg. Fig 11) and any interceptor / diversion hydraulic structures after closure of the landfill; (iv) the size and location of the sedimentation chamber; and (v) any other information.

A.12 Slope Stability

The report should contain the stability computations for the following cases: (i) stability of soil slope after excavation; (ii) stability of liner components against slippage along side slope of excavation; (iii) stability of waste slope during filling operations; (iv) stability of cover components against slippage along side slope of waste filled above the ground level. It will be the responsibility of the Operator/Designer to demonstrate the stability against worst anticipated conditions with adequate factor of safety.

A.13 Closure

The report should indicate the following with respect to closure of the landfill: (i) intended use after closure; (ii) establishment of self sustaining vegetation on the cover; (iii) final slopes of the cover system; (iv) berms, roads and drains on the cover system and along its perimeter; (iv) wells and pipes / vents of gas, leachate, and monitoring instrumentation on the cover system and along its perimeter; and (v) any other facilities set up on the cover.

A.14 Environmental Monitoring

The report should (i) depict the location and depth of environmental monitoring facilities comprising of ground water wells (atleast 4: one upstream, three downstream), air samplers and surface water sampling points; (ii) state the method and frequency of environmental monitoring; and (iii) list the background values of various parameters observed prior to the setting up of the landfill.

A.15 Post Closure Maintenance

The report should list the periodic inspection and maintenance activities to be undertaken with respect to the (i) landfill cover, (ii) surface water drainage system, (iii) leachate management facilities; (iv) gas management facilities; (v) environmental monitoring systems and (vi) other infrastructure facilities.

A.16 Construction Quality Control

The construction procedures for landfill liners and covers as well as the quality control methodology will be specified in the report. Independent agencies proposed to be used for quality control will be listed in the report.

A.17 Operation and Safety

The procedures for waste filling and compaction as well as the safety measures for the site workers will be listed.

B. Assessment of a Report for Closure of an Existing Waste Dump or an Existing Landfill Without Liner

In making an assessment of a Report, the Officer of the Regulatory Authority shall examine each of the aspects described below.

B.1 Contents of the Report: The Report shall contain the following sections:

(a) Condition and Impact of the Existing Waste Dump or Landfill (without liner)
(b) Selection of Methodology for Closure
(c) Details of Closure Methodology
(d) Stability Aspects
(e) Cover System
(f) Cut-off Walls
(g) Leachate Collection and Management
(h) Gas Collection and Management
(i) Surface Water Drainage System
(j) Environmental Monitoring
(k) Post Closure Maintenance
(l) Construction Quality Control

If any of the above-listed sections or their sub-sections (listed hereafter) are missing, the Officer may request for a re-submission of the Report after their incorporation and necessary corrections.

B.2 Condition and Impact of Existing Waste Dump or Landfill (without liner)

This section should contain information on the following:

(i) A topographic map and section (estimated) (eg. Fig 12) of the waste dump,
(ii) Area and depth of the waste,
(iii) Condition of the waste (as determined from samples obtained by drilling),
(iv) Quality of leachate,

(v) Quality of ground water just beneath the dump,
(vi) Quality of surface water in the immediate vicinity of the dump,
(vii) Quality of air (including odour), above and adjacent to the dump,
(viii) Subsoil conditions beneath the waste including type of soil, its permeability, compressibility and strength, depth of water table, depth of bedrock etc upto 10 – 15m below the base of the dump.

B.3 Selection of Methodology for Closure

In this section the following alternatives should be compared and justification provided for selection of a particular method:

(i) Placing the waste in a new landfill with liner and cover as per MSW Rules (eg. Fig 13),
(ii) Closure by means of re-grading and then providing cover system and cut-off walls (eg. Fig 14),
(iii) Closure by means of re-grading and providing cover system (eg. Fig 15),
(iv) Closure by other means.

B.4 Details of Closure Methodology

This section should describe the components of the closure methodology as well as the process of construction in phases. Diagrams showing all the components in an over-all plan and in section should be provided. The components discussed hereafter shall also be included.

B.5 Stability Aspects

The Report should include computations for the stability of the slopes of the existing waste dump. It should also indicate the stability of the slopes after provision of the cover system. If a geomembrane is included in the cover, the stability of the components of the cover against slippage should be reported.

B.6 Cover System

The report should include (i) a diagram depicting the cover slopes, (ii) a diagram showing the components of the cover system at the top, (iii) a diagram showing the cover system along the side slopes, including the berm with surface water drains, and (iv) a diagram showing the junction of the cover with the ground surface / base of the landfill.

B.7 Cut-off Walls

The report should include details of the type of cut-off wall (if adopted), its dimensions and components and the method of construction / installation.

B.8 Leachate Collection and Management

The strategy for leachate collection and management should be described. The following diagrams should be included: (a) leachate collection trench along the perimeter, (b)leachate collection drain along existing preferential drainage paths, (c) leachate collection wells (if provided) and (iv) leachate storage tank.

B.9 Gas Collection and Management

The report should include the selection and description of the gas management strategy being adopted from amongst passive venting, flaring, active collection, gas-to-heating, gas-to-energy or any other. The components of gas collection system and their location should be depicted.

B.10 Surface water Drainage

The report should depict how precipitation on the site as well as that entering from neighboring areas would be handled. It should contain (i) an estimate of the quantity of surface water to be handled every year, (ii) the location of storm water drains on the cover and on the ground surface, (iii) location of interceptor / diversion hydraulic structures, and (iv) size and location of the sedimentation chamber.

B.11 Environmental Monitoring

The report should (i) depict the location and depth of environmental monitoring facilities comprising of ground water wells (atleast 4: one upstream, three downstream), air samplers and surface water sampling points; (ii) state the method and frequency of environmental monitoring; and (iii) list the background values of various parameters observed prior to the setting up of the landfill

B.12 Post Closure Maintenance

The report should list the periodic inspection and maintenance activities to be undertaken with respect to the (i) landfill cover, (ii) surface water drainage system, (iii) leachate management facilities; (iv) gas management facilities; (v) environmental monitoring systems and (vi) other infrastructure facilities.

B.13 Construction Quality Control

The construction procedures for landfill covers and cut-off walls (wherever adopted) as well as the quality control methodology will be specified in the report.

C. Assessment of a Report for Expansion of an Existing Waste Dump or an Existing Landfill Without Liner

In making an assessment of a Report, the Officer of the Regulatory Authority shall examine each of the aspects described below.

C.1 Contents of the Report

The report shall have the following sections:

(a) Closure of the existing waste dump or landfill without liner
(b) Expansion of the waste dump or landfill

For section (a) above, all the aspects covered under Part B of this report shall be addressed. In section (b), the following will be checked.

C.2 Expansion of the Waste Dump or Landfill

Expansion of landfilling operations at an existing site should only be undertaken after closure of the existing waste dump or existing landfill without liner. The expansion can take place in the form of (i) a new landfill adjacent to the existing dump which has been closed (eg. Fig 16); or (ii) a new landfill constructed adjacent to the existing dump by making space for it by re-locating existing waste from the sides of the waste dump to its top and then closing the waste dump (eg. Figs 17, 18, 19). In both such cases, the new landfill should conform to the check-list described in Part A of this report and the closure of the waste dump should conform to the checklist prescribed in Part B of this report. For option (ii), the operator shall list the steps for odor control during re-location of the waste.
Vertical expansion of an existing waste dump or existing landfill should not be undertaken by placing a cover on the waste dump and filling on top of the cover (eg. Fig 20). This is so because the cover between the old waste and the new waste would be subjected to large settlements and may not perform satisfactorily. Wherever it is stated that large settlements will not occur or that these can be withstood effectively, the proposed design should be got checked by an expert.

D. Records and Inspection

The Regulatory Authority will receive the overall proposal for a new landfill or an expansion in the form of a report at the start of a project with complete details and drawings. In addition, the following records should be received by the Regulatory Authority at regular intervals:

(a) Drawings (plan view, sectional view, major component details) of the Phase of Landfill proposed to be constructed in the coming year (annual).
(b) Drawings (plan view, sectional view, major component details) of the Phase of Landfill completed in the previous year after filling with waste. These should include indication of deviations made from the previously submitted drawings.
(c) Photographic record of important construction details with dates.
(d) Leachate quantity and quality (3-monthly).
(e) Environmental monitoring data (3-monthly) relating to ground water, surface water air quality etc.

The following should be checked by visual inspection during site visits by Officers of the Regulatory Authority. The basic intent is to confirm that the operator is adhering to the design, construction and operating procedures specified in their report approved by the Regulatory Authority (such a Report should be available during the site visit):

(a) During construction: (i) procedures of quality control adopted for welding of geomembrane in the liner as well as for compaction of the clay which is a part of the liner; (ii) verification of the components of the liner and cover (wherever visible).
(b) During operation: (i) procedures for weighing of waste; (ii) procedures for sampling and testing of waste; (ii) record keeping at site; (iii) height of waste lift and slopes; (iii) adequate thickness of daily cover on waste; and (iv) leachate management during operation as well as leachate level / depth in wells.
(c) After closure: (i) cleanliness and maintenance of the surface water drains; (ii) adequacy of vegetative growth on cover; (iii) signs of erosion due to rain water; (iv) presence of depressions on the cover due to large settlement which have not been repaired; (v) proper operation and maintenance of leachate management and gas management systems; and (vi) proper maintenance and operation of environmental monitoring systems.

Random sampling: The Regulatory Authority can request the Operator to provide samples of ground water, surface water or air during their visit for independent testing and verification.

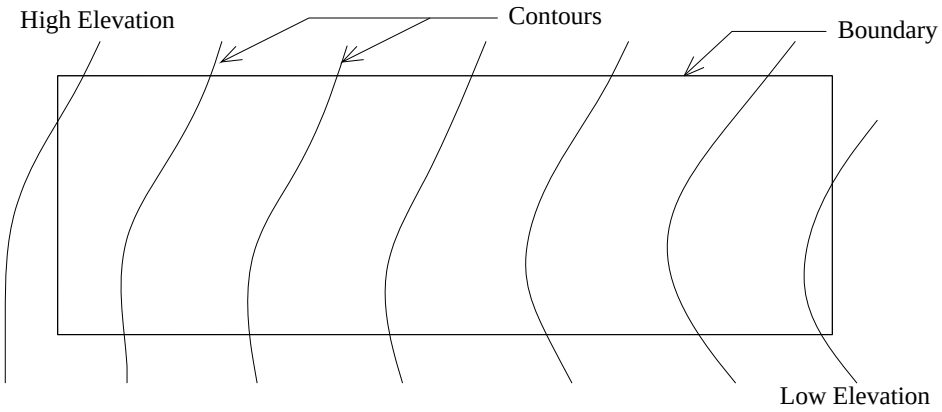


Figure 1: Site Boundary with Contours

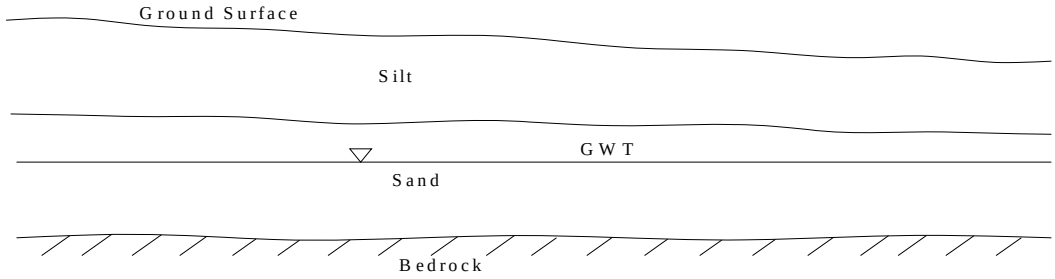
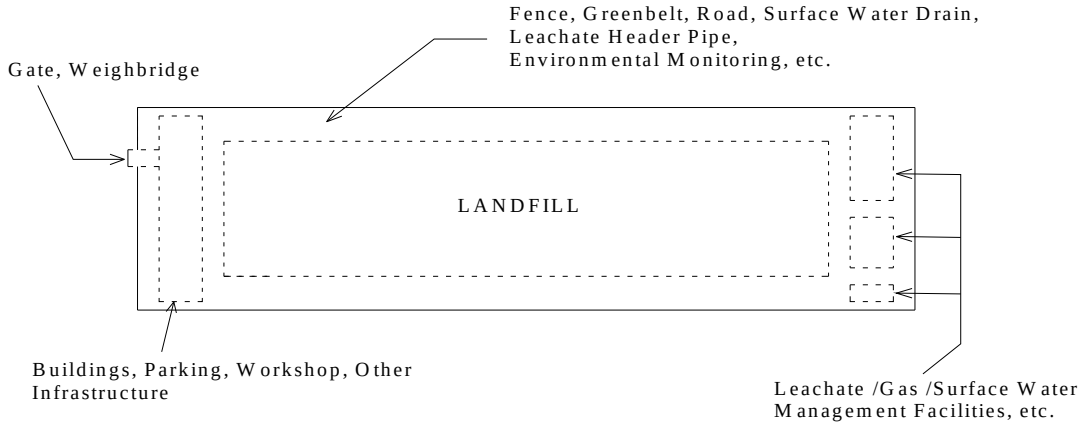
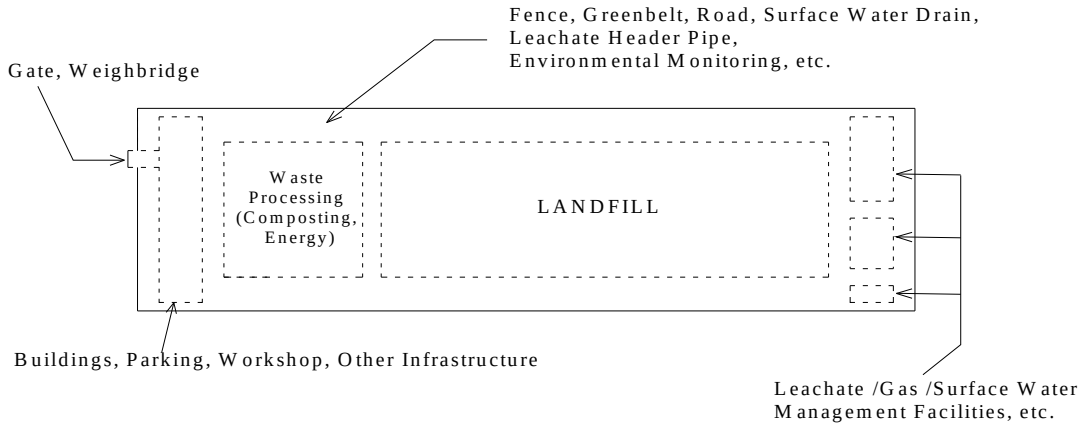


Figure 2: Subsurface Profile

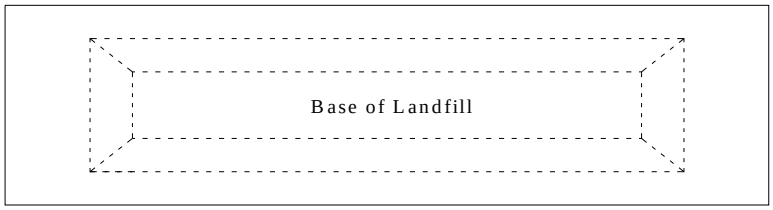


(a) Without Waste Processing

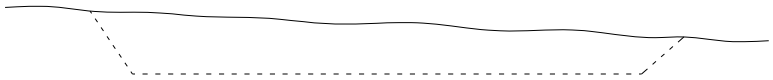


(b) With Waste Processing

Figure 3: Site Infrastructure

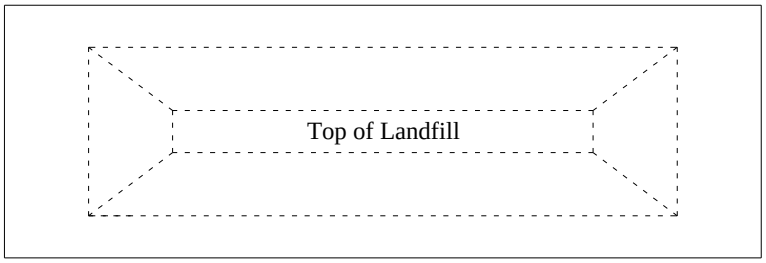


(a) Plan



(b) Section

Figure 4: Landfill After Excavation



(a) Plan

(b) Section

Figure 5: Completed Landfill

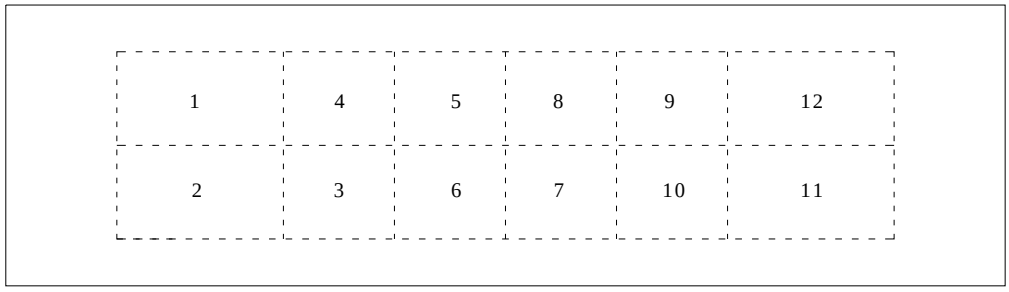


Figure 6: Footprint of Yearly Phases at Ground Level

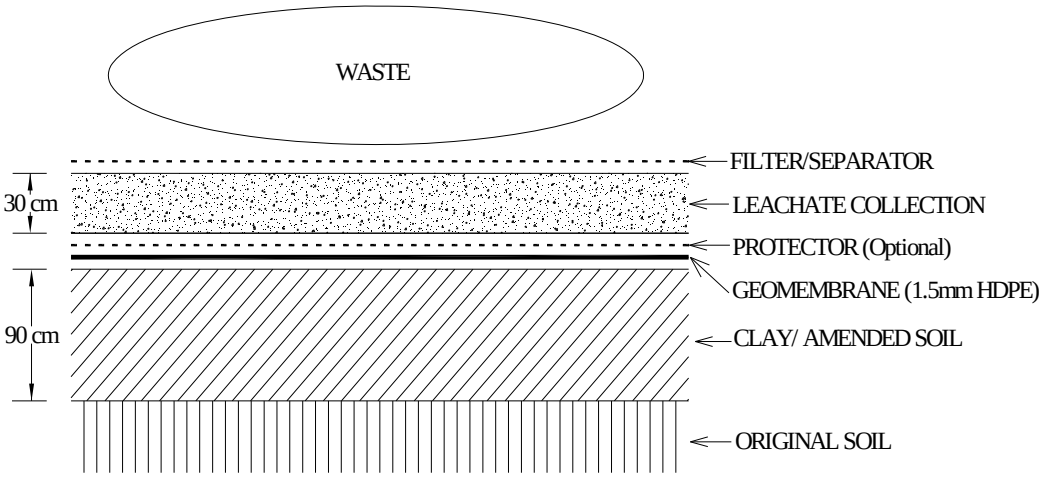


Figure 7: Landfill Liner

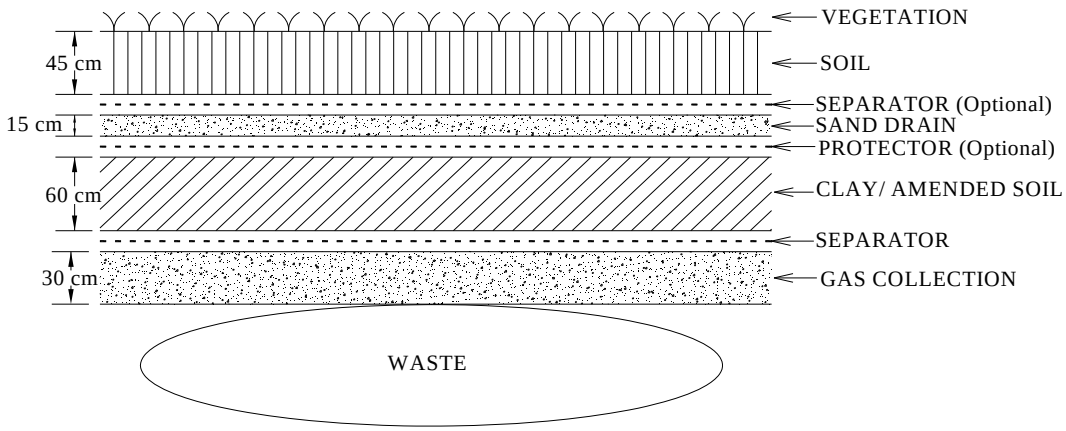


Figure 8: Landfill Cover

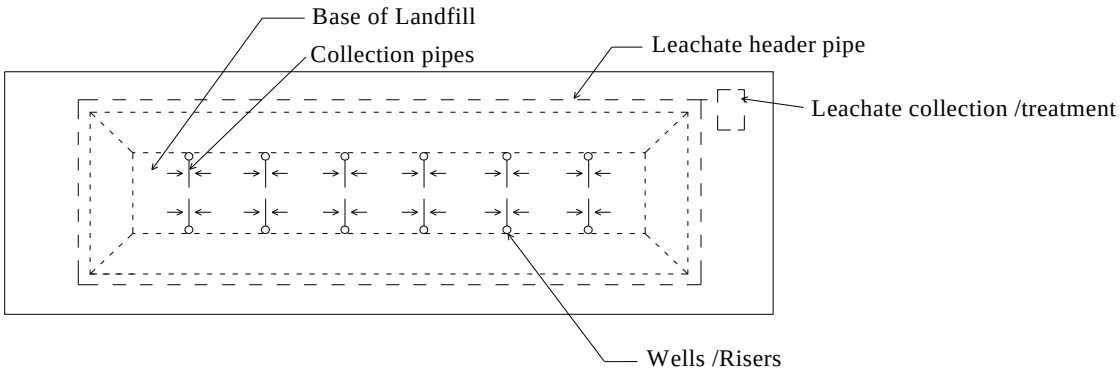


Figure 9: Leachate Collection

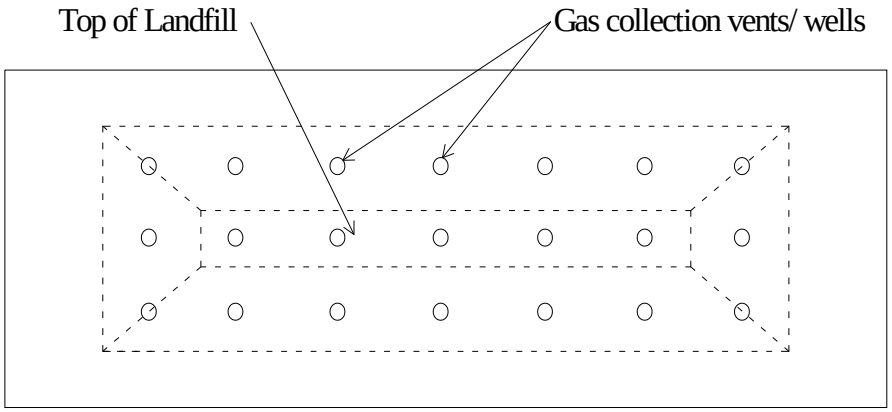


Figure 10: Gas Collection

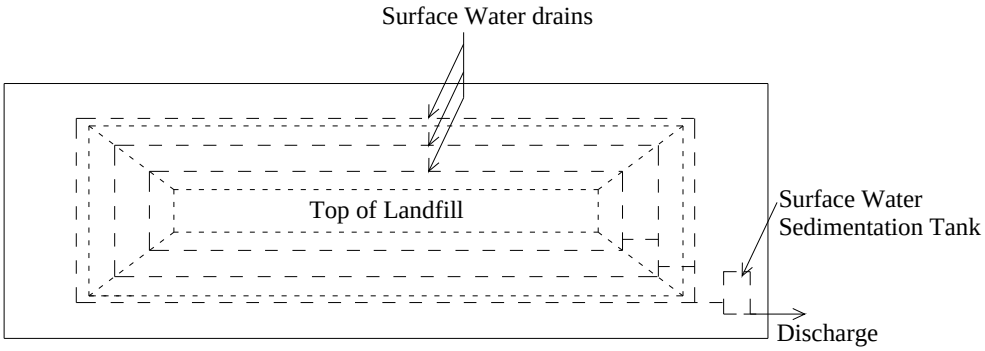


Figure 11: Surface Water drain

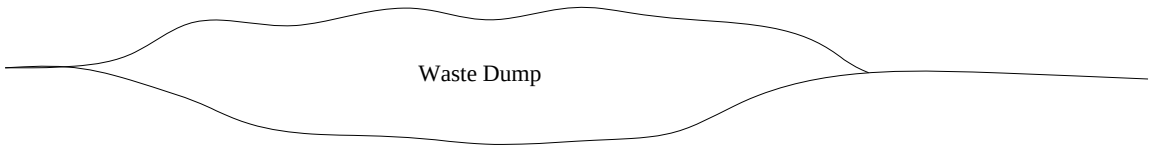
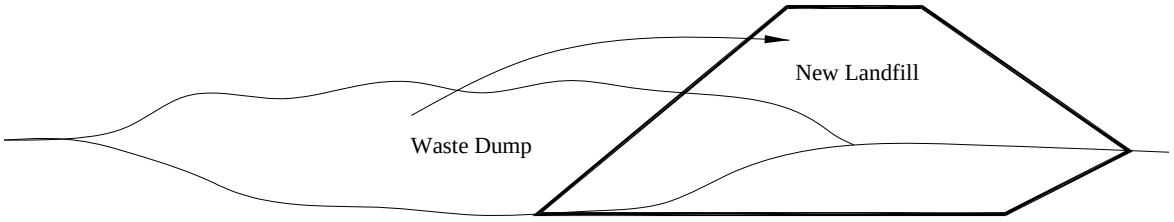
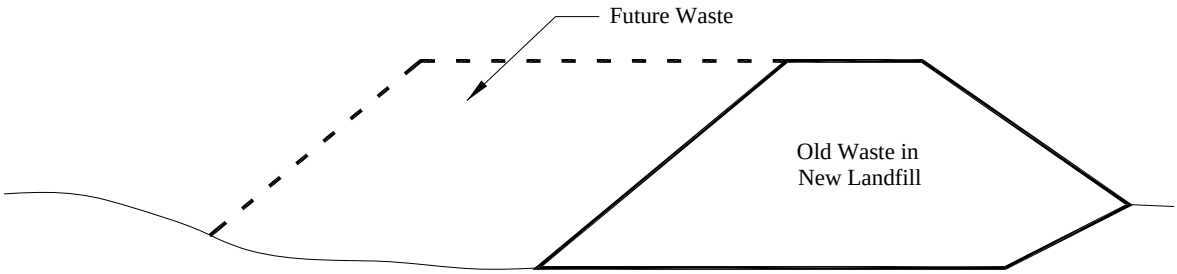


Figure 12: Old Waste Dump



(a) Relocation of Waste



(b) Waste Placement in Future

Figure 13: Old Waste in New Landfill

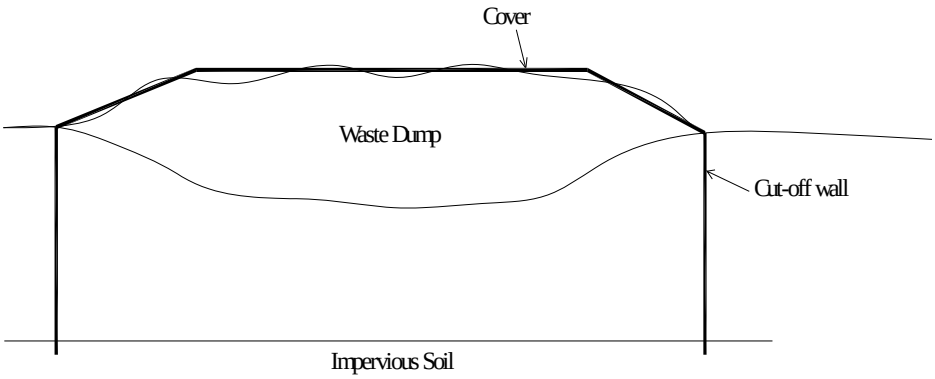


Figure 14: Closure of Old Waste Dump with Cover and Cut-off Wall

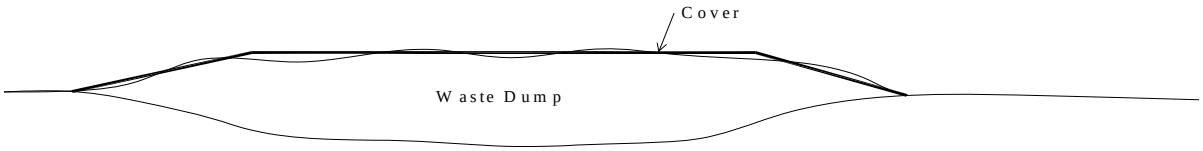


Figure 15: Closure of Old Waste Dump with Cover

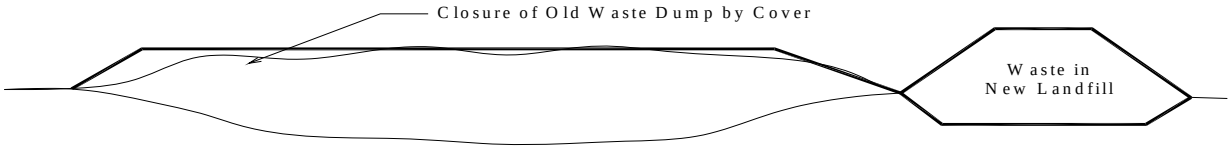


Figure 16: Expansion of Waste Dump

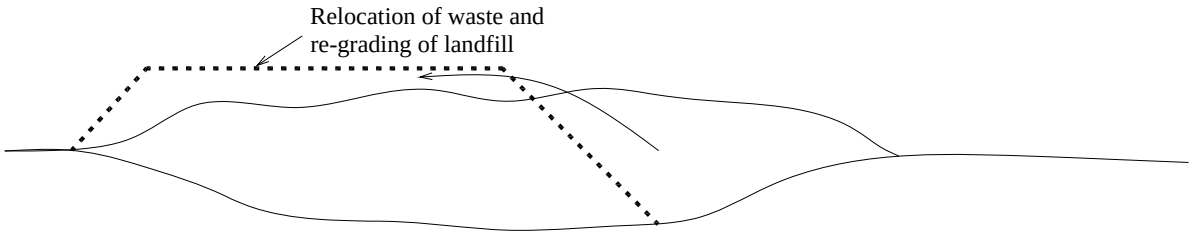


Figure 17: Relocation of Waste

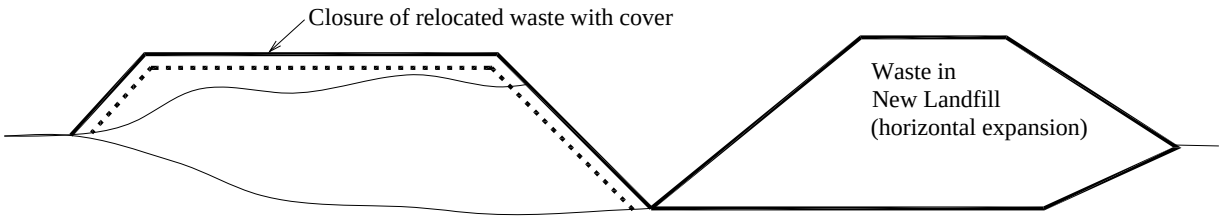


Figure 18: Horizontal Expansion (option A (preferred))

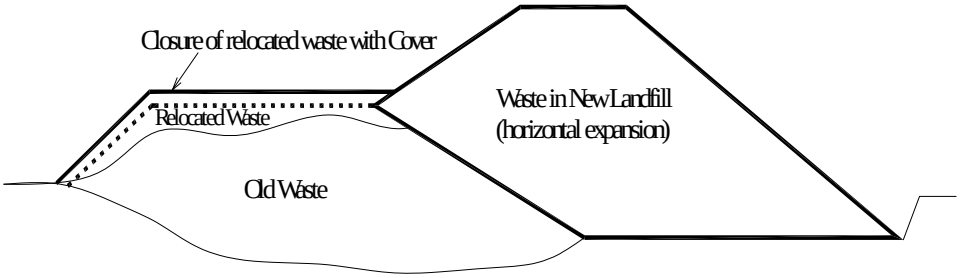


Figure 19: Horizontal Expansion (option B)

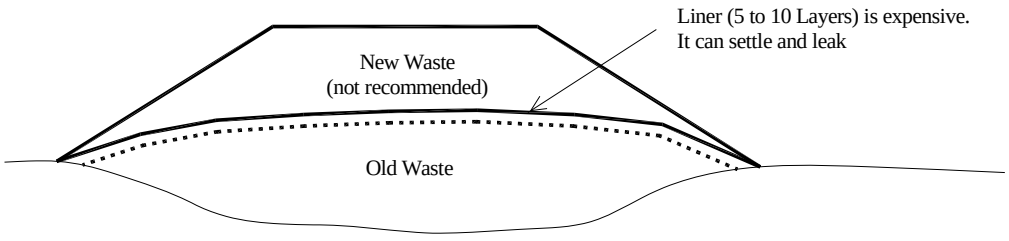


Figure 20: Vertical Expansion (should be avoided)

5.0 LANDFILLS IN INDIA

Based on the Annual Report filed by the State Pollution Control Boards, it is learnt that many ULBs have taken initiatives to set up landfill facilities. Information relating to landfills received from SPCBs is presented in a table given below:

Table-1

Landfills Constructed	Landfills under construction	Landfills Under Planning
Bangalore	Chandigarh	Mandi
Mangalore	North Dum Dum and New Barrackpore	Jalna
Karwar		Suryapet
Puttur		Udumalpet
Ankola		Kohima
Surat		Agartala
Alang		Sipchu (Sikkim)
Nashik		Itanagar
Ambad		
Sonpeth		
Vizianagaram		
Jodhpur		
Sirsa		
Ambala		
Admpur		
Pune		
Dindigal		
Ahmdabad		

Further, collated information on a few landfill facilities is summarized below (table-2) for reference. The summary of each existing landfill site is provided at Annexure-I

Table -2 : Information about existing landfill sites in the country

S. No.	Towns/cities	City profile			Landfill sites				
		Present Population	Municipal Area (Sq.km)	Waste generation (TPD)	Waste processing	Name of Landfill site	Area of Landfill site	Landfilling Area (Sq.m.)	Design aspects
1	Ahmedabad-12 towns (Gurajat)	664865 (Cen:2001)	75.51	200	Compost Plant (200TPD)	Sarkhej-Vasna Road	3800 Acres	36000	78000cum
2	Puttur (Karnataka)	52000	34	16	Compost Plant in 3100 Sq.m.	Banner Nekkila	7.15 Acres	17500 (5100-12000)	61800 cum for 20 yrs. HDPE liner, storm drains and leachate treatment facility.
3	Karwar (Karnataka)	67411	27.15	23	Nil	Shirwad Village	6 Acres	6600	89770 Tonnes for 25yrs. 1.5mm HDPE liner, leachate collection & treatment facility, storm drains.
4	Ankola (Karnataka)	14309	7.42	6.2	Nil	Bogribail Village	4.9 Acres	5150 (4200-950)	26000 cum for 10 yrs., 30 cm thick compacted soil, open lined drains for leachate collection & storm drains.

S. No.	Towns/cities	City profile			Landfill sites				
		Present Population	Municipal Area (Sq.km)	Waste generation (TPD)	Waste processing	Name of Landfill site	Area of Landfill site	Landfilling Area (Sq.m.)	Design Aspects
5	Ambad (Maharashtra)	28000	70.87	5.0	In-vessel composting	Sr. No. 407, Pachod Road	0.62 Acres (2500Sq.m.)	2500	456.25 cum for 10 yrs., HDPE lining, leachate collection & treatment, storm drains provisions.
6	Nasik (Maharashtra)	1077236	259.13	230	---	Pathrdi Shivar & bank of river Godavari	68853 sq.m.	57.378	223240 Tonnes with 6 cells, waste thickness 12m, 1.5 mm HDPE liner, provision of leachate collection & treatment, gas collection, storm ware drains, etc.
7	Surat (Gurajat)	2.43million	112.27	850	---	Khajod	478.6 Acres	---	389781 cum with 7 cells for 30 yrs. 45 cm clay layer & 1.5mm HDPE, commissioned in June 200

S. No.	Towns/cities	City profile			Landfill sites				
		Present Population	**Municipal Area (Sq.km)**	**Waste generation (TPD)**	**Waste processing**	**Name of Landfill site**	**Area of Landfill site**	**Landfilling Area (Sq.m.)**	**Design Aspects**
8	Sonpet (Maharashtra)	13022	1305	5.0	Aerobic In-vessel composting	Post Dighol, Purbani	0.62 Acres (2500 sq.m.)	2281	Sigle-celled 10375 Tonnes capacity for 10 yrs. 250 microne size HDPE liner. Leachate collection & treatment facility with storm drains.
9	Vizaianagaram (Andhara Pradesh)	174324	---	---	---	---	30 Acres	3025	Lined pit (55mX55mX2m) for landfilling with separate pit for leachate collection and treatment.
10	Jodhpur (Rajasthan)	1306035	108.26	250	Vermin & Mechanical Composting	Keru	---	---	No clay or membrane, only drainage layer due to rocky bed

S. No.	Towns/cities	City profile			Landfill sites				
		Present Population	Municipal Area (Sq.km)	Waste generation (TPD)	Waste processing	Name of Landfill site	Area of Landfill site	Landfilling Area (Sq.m.)	Design Aspects
11	Sirsa (Haryana)	160129	---	50	Vermin Composting	---	---	---	Deep landfill with less area, provided clay (300mm bentonite), membrane, silty sand protective layer & coarse sand for drainage.
12	Gwalior (Madhya Pradesh)	826919	289.85	250	Mechanical composting	---	---	---	Clay, membrane, silty sand protection layer & coarse sand drainage layer of 600m with 20% bentonite.
13	Ambala (Haryana)	139279	---	150	---	---	---	---	Brick bat consolidation, before clay liner, other systems same as Sirsa. Special drainage system & geo-fabric reinforcement of embankment to deal with River erosion.

S. No.	Towns/cities	City profile			Landfill sites				
		Present Population	**Municipal Area (Sq.km)**	**Waste generation (TPD)**	**Waste processing**	**Name of Landfill site**	**Area of Landfill site**	**Landfilling Area (Sq.m.)**	**Design aspects**
14	Pune (Maharashtra)	3760636	430	1000	Mechanical	Uruli Dewachi	34600 sq.m. Closure area	18500sq.m	Sandwiched geo-synthetic bentonite clay liners, geo-textile as protective layer & fabric drainage layer to reduce overall thickness of liner system.

Annexure-I

5.1 Landfill Site of Ahmedabad :

Ahmedabad Urban Development Authority (AUDA) has constructed a common landfill site at Fatehwadi (Ahmedabad) for sharing this facility by 12 Nagar Palikas of West AUDA area. The landfill area of 1178 sq. km. will take care of 200 TPD MSW generated by 12 Nagar Palikas viz.Chandkheda, Kali, Ranip, Ghatlodia, Chandlodia, Memnagar, Thaltej, Bodakdev, Vastrapur, Vejalpur, Jodhpur and Sarkhej Nagar Palika.

Total population is estimated to be 10 lacs and waste generation of 200TPD. The average annual rainfall is 300mm, the depth of groundwater table is 6 meters and the soil is sandy.

AUDA has constructed a common landfill site at Fatehwadi village with a disposal capacity of 1,45,534 cum and designed for 50TPD (8 years). The size of the landfill is 151m X 122m X 7.9m. The detail of liners provided is as under;

Amended clay liner	900mm thick using 10% bentonite clay and mixing with the soil at the site upto the permeability of $1X10^{-7}$cm/sec.
HDPE liner	1.5mm thick Followed by 300mm thick protective soil cover over HDPE line.
Drainage layer	300mm thick with 100mm thick protective soil cover over drainage layer.

Leachate collection and treatment facility:

150mm diameter HDPE perforated pipe having holes of 10mm@ centre to centre at 150 mm distance are laid in drainage layer. Leachate will be collected in leachate collection tank having size of 2m X 2m X 3m height. The collected leachate will be pumped out in tanker and discharges in to nearby trunk sewer line.

Gas collection:

Gas collection vent pipe having 230mm diameter size HDPE pipe having holes of 10mm @ c/c 150mm distance has been provided.

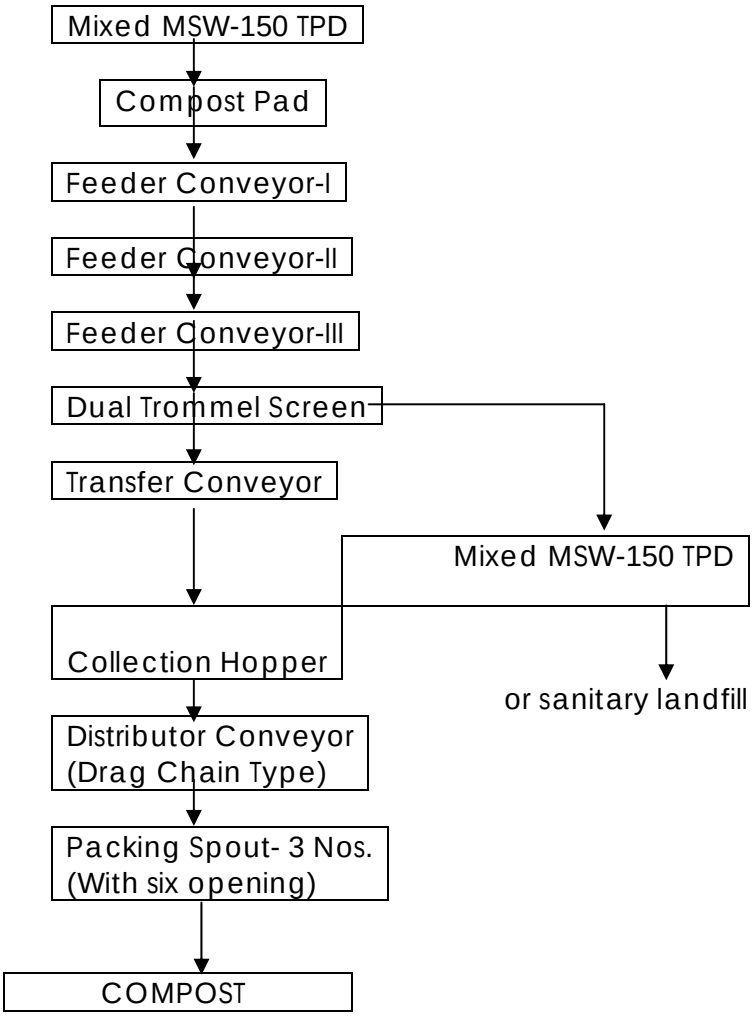
Stormwater drainage:

stormwater drainage system has been provided on outer side of top service road and at the bottom of edge of the cell to drain out storm water.

Other information:

the waste processing (aerobic compost) plant of capacity 150 TPD is under execution. It is planned to fix up operation and maintenance agency for landfill cell and compost plant.

Flow chart of MSW Processing Plant:



5.2 Landfill site of Puttur (Karnataka):

Puttur is the second biggest town in the district, located on the Mangalore-Mysore Highway and 52 Km away from Mangalore.

Puttur is also considered one of the 10 projects towns of coastal belt taken up for infrastructure development by Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC). Municipal Solid Wastes Management (MSWM) is the one of the subjects under this programme and implemented as per State Policy and as per guidelines laid down under MSW Rules, 2000. The salient feature of the town is as under;

Present Populataion	52,000
Municipal Area	34 Sq. Km.
waste Generation	16TPD
Rainfall	3400 mm – 4400mm (June-September)
Temperature	Min^{m} :$22^{0}C$-$25^{0}C$ Max^{m} :$31^{0}C$- $33^{0}C$
Climate	Heavy rainfall during monsoon and characterized by high humidity and temperature.
Soil	Laterite

About Landfill Site:

MSW landfill facility has been prepared at Bannur village in Nekkila, 5 Km away from Puttur. The total area of landfill site is 7.15 Acres.
Design Aspect: The landfill has been designed for 20 years of life with total capacity of landfill 61800 cum. The Phase-I of the landfill is designed for 8 years. The final landfill area is planned for a mini forest or park.

The design parameters considered are;

(i) The required volume of landfill
(ii) Provision of liner of life 5 years.
(iii) The use of 1:3 slope for the fill.
(iv) Provision of fencing
(v) Provision of rainwater drains, leachate collection system and drain out of the site.
(vi) Provision of leachate treatment system.

Site- specific Importance:

The Nekkila site at Puttur is on the steep face of a cliff. The filling of the solid waste is planned from bottom to the top and not tipped from the cliff surface. There is an existing road, which leads to the bottom of the cliff. This road originates on the Puttur-Uppinagangady road. The initial part of this road is tarred, the balance of the portion of 1500m would be made 4m wide tarred road. The landfill has two valleys- the valley adjacent to the road would be taken initially under Phase-I and followed by the valley away from the road as Phase-II.
The Phase-I will be designed for 8 years life. The initial construction would provide for the entire basic infrastructure for the landfill and the construction of fill area and liner for a 5 years life. The valley would be filled in 2- meter lifts. To enable this, the valley has to be leveled and to provide benches.

Landfill Layout:

The total area of landfill is 7 acres. The proposed landfill area is divided into four parts- (1) Area for compost plant (3100 sq.m), (2) Area for Phase-I (5100 sq.m.) (3) Area for Phase-II (12000 sq. m.) and (4) Area for storing cover materials (7700 sq. m).
Compound wall for the whole area is proposed excluding the fence of adjoining the estate. A drain is proposed to collect and drain the rainwater. The contour drain would transfer the water to the drain on the road, which in turn transfer the water at the foot- hills of landfill to connect with external drain. Plantation will be made at the down side of landfill. A gate with cattle bridge and building for office room will be provided. There will be a leachate treatment plant at the lowest level of the landfill of Phase-I and Phase-II. The Phase-I would be constructed as a part of the KUDCEM project. The construction of landfill site, Phase-II will be taken up by TMC.

Landfill Process:

The landfill operation would be from bottom to top. The landfill process would take place 2m lifts starting from the RL of 85m. At each lift, 1.3m liner and drainage layer will be provided. The second lift start at 88m RL and the Top level RL will be ended at 103m. For the first 5 years, the lift RL 94 would be used. At each of the levels, ground cutting will be done up to the next base along the contour line of the next base. After laying the liner layer the waste is filled up. The final slope is maintained at 1 vertical to 3 horizontal.

Volume of Landfill:

The total estimated landfill volume of phase-I & Phase-II is 43900 cum. The life of landfill is expected to last for 20 years.

The detailed specifications of landfill components are;

a) Provision of approach road to landfill: 4 meter width WBM from the end of the existing WBM road up to the inside of landfill. Total length will be 1000m.
b) Provision of drains: Size Stone Masonry drains with caping concrete on top and pointing shall be provided for the locations- (i) at foot hills of the landfill a length of 217m (0.5m X 0.5m), (ii) across the plantation for a distance of 100m of (0.5m X 1.0m.) and (iii) for drains along contour No. 103 and along the road a BS slab drain is proposed for 835m.
c) Provision of building, sump, septic tank: The proposed building and parking facility will be constructed. A septic tank with dispersion trench and staffs requirement facilities will be provided.
d) Provision of Compound wall:

KARWAR SANITARY LANDFILL

5.3 Landfill site of Karwar (Karnataka):

Karwar is the Head Quarter of Uttar Kannada Dsitrict and is one of the famous tourist places in Karnataka along the Arabian Sea-shore. The famous sea-bird project is located here. Karwar town is considered under KUDCEMP, which is bestowed with gentle wave, miles of golden sand, tranquil ambience and acres of emerald foliage. Karwar town is situated just 100 Km away from Goa that makes good starting point for voyage of discovering the thrills of sea, sand and the Sun.

Population	: 67,411 (2005)
Municipal Area	: 27.15 Sq. Km.
Solid Waste Generation	: 23 TPD
Number of wards	: 31
Average Annual Rainfall	: 3800 mm
Temperature	: Min^{m}: 20^{0}C and Max^{m}: 39^{0}C
Climate	: Heavy rainfall in Monsoon and Characterized by high humidity and temperature.

Details of Landfill Site:

The landfill site is located at Shirwad Village around 4 km away from Karwar. The total landfill site area is 6 Acres, approval of an additional area of 5 Acre is pending with DOEE. The construction is done through contract tendering by KUIDFC. The landfill was commissioned in August 2005.

Design Aspect: The landfill area is designed for 25 years of life with total capacity for landfilling 89,770 Tonnes of MSW.

- Landfill: 6600 Sq.meter area designated for dumping. The inner bottom dimension of the landfill cell is 140m X 42m. There is a 2m height of earthen -embankment with 3:1 slope, bottom 90cm thick soil liner having coefficient of permeability less than 1 X 10^{-7} cm/sec, overlaid by 1.5 mm thick high Density Poly Ethylene (HDPE) liner of 11 years life.
- Leachate Collection and treatment: Quantity of leachate generation is 540 cum per day by considering peak rainfall, collection of leachate through a perforated HDPE pipe (48 slots per meter, 60mm X 3 mm size) network above the HDPE liner. Pipes are laid over 10cm thick sand layer. To avoid choking a 20cm thick graded pebble (40mm down size) layer over the HDPE pipes has been provided. Leachate will be in an anaerobic pond (5 days detention time, having dimension 81m X 23.5m at top with liquid depth of 4m) followed by stabilization pond (1 day detention time, having dimension 27.5m X 25.5m at top with liquid depth of 1.5 m) before final disposal.
- Catch Drains & Roads: 725m length of laterite stone masonry drain (0.5m X 0.5m) is constructed to safely divert all storm water around the site. 350m long asphalted approach road, 3m wide WBM road for internal use.
- Administrative Block: Inclined RCC roof structure of 82 sq.m to accommodate an office room for a sanitary supervisor to facilitate maintenance of records, monitor

routine activities, Change room of staffs, store room for keeping equipments/instruments, etc. and toilets.

- Area designated for storage of domestic hazardous waste, stacking of debris, silt and cover materials, etc.
- 2.4 m high chain link fencing, entry gate with cattle trap.
- Plantation in the front side for aesthetic appeal
- Vehicle and equipment: 1 front loader with backhoe, 1 auto tipper, 2 dumper placer, 1 tractor with attachment, 12 nos. of metallic container of 4.5 cum of metallic container of 3 cum capacity.
- Being a small landfill, the gas collection and flaring provisions are not envisaged.

About Waste Processing:

In accordance with the Karnataka State Policy on ISWM, initially all Class-I cities in the state would have both compost plant and landfill (sanitary). Other cities/towns less than 1 lakh population would have only suitable engineered landfill site with control tipping to begin with, and would be progressively upgraded to sanitary landfill with treatment facility. In case of Karwar, the landfill is an Engineered landfill.

5.4 Landfill site of Ankola (Karnataka):

Ankola is considered as one of the developing towns in Uttar Kannada District. It is a historic and coastal town located on the Western coast. It is a Taluka head Quarter, endowed with excellent environment within the coastal belt. Ankola town is characterized by small hillocks in eastern and western sides, paddy fields, coconut trees, mangoes and casuarinas trees spread over the town. Agriculture is the main economic activity of this

town. Ankola is one of the towns under ADB assisted KUDCEM Project. The salient features of the towns are as under;

Population (Census: 2001)	14,309
Area	7.42 Sq. Km.
Number of Wards	14
Quantity of waste generation	6.2 TPD
Average Annual Rainfall	3700 mm
Temperature	Min^{m}: $20^{0}C$ Max^{m}: $39^{0}C$
Climate	Heavy rainfall during Monsoon and characterized by high humidity and temperature.

About Landfill Site:

The landfill site of Town Panchayat, Ankola is located at Bogribail village, 5 km away from the centre of the town. The total area of the landfill site is 4.9 Acres. The construction works carried out by parties through tendering by KUIDFC. The landfill is designed for 10 years with capacity of 26,000 cum. There are two quarry pits measuring total area 5150 Sq. m (Pit A: 4200 sq.m and Pit B: 950 sq. m.), which are used as cell for landfilling. The base of the landfill has been constructed with 30 cm thick compacted layer of locally available soil. Open lined drains of suitable size (0.5m X 0.5m) have been constructed with laterite stone masonry for collection of leachate. Provision of lined storm water drainage system is provided. However, gas collection and flaring arrangement is not envisaged owing to its small size.

About Waste Processing Plant:

In accordance with the Karnataka State Policy on ISWM, initially all Class-I cities in the state would have both compost plant and landfill (sanitary). Other cities/towns less than 1 lakh population would have only suitable engineered landfill site with control tipping to begin with, and would be progressively upgraded to sanitary landfill with treatment facility. In case of Ankola, the landfill is an Engineered landfill.

Other facilities provided in landfill site:

- Hired drains all along the edge of the quarry provided to prevent flow of surface water into the landfill area.
- Green belt
- Compound wall with gate and cattle- bridge.
- Office building with store, workers room, toilet facility.
- Parking shed for vehicles
- WBM access and internal roads.

5.5 Landfill site of Ambad (Maharshtra):

Ambad Muncipal Council falls under 'C' grade local body, which population is 28,000 (census: 2004) within the municipal area of 70.87 sq. km. The total waste generation is estimated to be 5.0 TPD. The landfill facility has been constructed at Sr. No. 407, Pachod Road, Ambad. The landfill was commissioned on 17.07.2006.

Design Aspects: The total area of the landfill site is 2500 Sq. m (50m X50m) and the capacity of the Single-Celled landfill is 456.25 cum. The landfill is designed for 10 years of life. The proposed thickness of waste disposal is ½ meter. There is a bottom layer of 250 micron HDPE lining for checking leachate infiltration. Provisions have been made for leachate collection & treatment and storm water diversion, but gas collection is found irrelevant owing to its small size.
Waste processing: Aerobic In-vessel Composting system has been provided for waste process. However, the compostable matter is very low in the waste. Proper segregation is done to sort out recyclable matters and bio-degradable wastes.

5.6 Landfill site of Nashik (Maharashtra):

Nashik is a district head quarter located on the bank of Godavari River having population of 10, 77,236 within 36 municipal wards. The total Municipal area is 259.13 sq. km and waste generation is estimated at 230 TPD. Nashik Municipal Corporation has a landfill facility at Pathrdi Shivar, Nashik and the landfill site is being operated by the corporation itself.
The total capacity of the landfill facility is 2,23,240 Tonnes having 6 cells, one completed and 5 others in operation. The total landfill area is 68853 sq.mt. and effective area of landfill is 57,378 sq. mt. The proposed waste thickness of disposal is 12 meters. 1500 micron HDPE liner is provided at the bottom. Provision is made for leachate collection, landfill gas collection and storm water diversion. The landfill site was commissioned in August, 2001. There is also a compost plant of 300 TPD.

5.7 Landfill site of Surat (Gujarat):

Surat Municipal Corporation (SMC) has constructed a landfill site at Khajod, Surat. Total population of Surat city is 33 lacs within municipal area of 335 sq. km. with 74 sanitation wards. Total waste generation is estimated to be 1250 TPD. The average annual rainfall is 45cm. The soil is black silty and sandy, groundwater table depth is located at 2.4 meter. The landfill is located at Khajod (at revenue survey No.111/A), Taluka Choryasi within an area of 200 heactares. The SLF area is 12 Hectares. It is proposed to establish 7 cells for 30 years life. At present one cell has been constructed having capacity of 3,89,781 cum (200m X 180m) and proposed 400m X 300m. The construction cost of Rs. 131 Lacs was entirely borne by SMC and the construction works were assigned to M/s En-Vision. The site was commissioned in June 2005.

Design Aspect: The Cell-1 is trapezoidal in shape with side slope 1:2. The bottom of the cell has a slope (1:40) for leachate collection on the both sides. Perforated HDPE pipes are laid for leachate collection. Two leachate collection wells have been constructed at

the end of each leachate collection system. Different impervious layers have been provided at the bottom of the cell Viz. from bottom 450 mm thick clay layer having permeability $1X10^{-7}$ cm/sec and 1.5 mm HDPE Geaneous brave lining followed by 300 mm thick sand layer; and 450 mm thick clay layer. Life of each Cell is designed for five and half year @215 TPD.
Installation of Storm water drainage system is proposed.

5.8 Landfill site of Sonpeth (Maharashtra):

Sonpeth Municipal Council falls under 'C' class Local Body having population of 13, 022. The total municipal area is 1305 sq. km. The waste generation is estimated to be 5.0 TPD. The landfill site is located at Post. Dighol, in Prbani District. The landfill is being operated by the Municipal council w.e.f. 04.07.2006.

Design Aspect: The total capacity of the landfill site is 10375 Tonnes and designed for 10 years. The area of landfill site is 2500 sq. m. and there is only one cell, which effective area is 2281 sq. m. The proposed thickness of the landfilling will be half meter. 250 microne size HDPE lining is provided at the bottom. There is a pit (size: 4.5m X 4.5 m X 1.5 m) for leachate collection and treatment.

Waste Processing facility: Aerobic in-vessel composting is adopted. The compostable matter is very low. However, proper segregation of recyclable and inert materials are done.

LANDFILL AT VIZIANAGARAM

5.9 Landfill site of Vizianagaram (AP):

Vizianagaram municipality has population of 1,74,651 (Census: 2001) within municipal area of 29.7 Sq.Km. which comprises 36 Wards. The total waste generation is estimated to be 120 TPD. The average annual rainfall recoreded is 1000-1032 mm. The soil may be classified as clayey (30% clay and 35% silt). Vizianagaram municipality has acquired 30 acres of land for establishing landfill facility of capacity 5000 with a lined pit of dimension 55m x 55m X 2m. The landfill site is about 10 km away from Vizianagaram town and existing dump site yard (Dasanapara) is within the municipal premises. No waste processing plant has been established, segregation is being done at Dasanapara dumpsite as transit point. Presently, only one landfill site has been constructed and was commissioned in 2003. The cost incurred for HDPE sheet is Rs.22.0 Lacs, for HDPE pipe Rs. 3.0 Lacs, for filter media Rs.5.0 Lacs and for civil construction Rs. 10.0 Lcas. The total expenditure for landfill construction is Rs 40.0 Lacs. The details of liners provided are as under;

Clay lining	Andhra University has certified that the existing soil in the pit is having characteristics is similar to Clay. As per the municipality, external clay lining is not required.
HDPE sheet lining	Thickness of the sheet : 1.5 mm Width of each sheet : 7.0 meters Length of each sheet : 140 meters No. of role : 6 Nos. Area of each role : 980 sq. meters
Details of filter media above the HDPE sheets	Thickness of the filter media : 0.3 m 20mm chips thickness : 0.2 m 12 mm chips thickness : 0.1 m
Details of HDPE pipe lines	Diameter : 160mm Total length : 200m Pressure : 10 kg/sq. cm. Nos. of pipe line in the pit : 5 Nos. Lenth of each pipe line: 40 m

Leachate Collection and Treatment: A separate pit also has been constructed for leachate collection and treatment. The top dimension of the pit is 7.5m X 7.5 m and the bottom dimension is 2.5m X 2.5m. with 2 meter depth.

Other provisions: provided chimney of 30ft. height for landfill gas escaping. No provision is made for storm water drain.

5.10 Landfill site at Alang:

A MSW landfill has been constructed at Along, Sosiya ship breaking yard in Bhavnagar district of Gujarat. The total population involved in ship breaking area is 25000 within a area of 10 sq. km. and the total waste generation is estimated to be 5-8 TPD. The waste generated is mainly the inorganic waste (95%). The soil is black and grey color at the site with groundwater table depth 8-9m. Total capacity of the landfill is 8723 cum, designed for 20 years. It was commissioned in October, 2005. The total area of the landfill site is 6650 sq. m. and the size of the effective landfill is 95m X 70m. Proposed thickness of waste to be disposed is 10m. The detail of liners provided is as under;

From bottom, 1st layer-Metal soiling	300mm
2nd layer- Hard murrum	200mm
3rd layer- Blended clay	450mm
4th layer- Geo-membrane	1.5mm
5th layer- Drainage detection	300mm
6th layer- Geo-textile	1.5mm
7th layer- Blended clay	450mm
8th layer- Geo-membrane	1.5mm
9th layer- Drainage detection	300mm

Leachate collection and treatment: A leachate collection sump has been provided, any leachate generation will be sent to TSDF of Surat for further treatment.

5.11 Landfill sites of Airfield Towns (Jodhpur, Sirsa, Gwalior, Ambala & Pune):

National Building Construction Corporation (NBCC) has undertaken 8 (eight) Airfield Towns viz-Gwalior, (MP), Ambala & Sirsa (Haryana), Jodhpur (Rajasthan), Tezpur (Assam), Dundigal (AP), Adampur (Punjab) and Pune (Maharashtra), for Municipal Solid waste Management. The Ministry of Urban Development (MoUD) has financed Rs100 Crores for the projects.

The Status of Projects including landfill facility:

Sl No.	Towns	Designed Capacity (TPD)	Waste Processing	Type of Landfill facility	Type of Liner system
1	Jodhpur (Rajasthan)	250	Vermin-Composting & Mechanical Composting	More Area with minimum depth	No clay or Membrane, only Drainage layer due to Rocky strata. Special drainage system to deal with flash floods.
2	Sirsa (Haryana)	50	Vermin-composting	Deep landfill with less Area	Clay, membrane, silty sand protection layer & Coarse sand drainage layer. Clay liner of 300mm without bentonite
3	Gwalior (MP)	250	Mechanical Composting	Depth created with part excavation & part embankment.	Clay, membrane, silty sand protection layer & Coarse sand drainage layer of 600mm with 20% bentonite..
4	Ambala (Punjab)	150	-	Zero excavation and depth created with only embankment.	Brick bat consolidation before Clay Liner, Other systems same as Sirsa. Special drainage system & geo fabric reinforcement of embankments to deal with River Floods.
5	Pune (Maharshtra)	1000	Mechanical Composting		Sandwitched geo-synthetic Bentonite Clay liners, geotextile as protection layer & Febrick Drainage layer to reduce overall thickness of liner system.

Other salient features of landfills:

- Minimized the cost of sanitary landfill by

- Carrying out intensive geotechnical & Hydrological investigation and the results are analyzed.

- Appropriate liner systems and construction systems are designed as per CPHEEO manual.

- Cost -benefit analysis for depth & area of landfill.

- Use of natural ground profile to discharge & collect leachate & minimizing HDPE pipe networking.

-Use of naturally available local materials like silty sand etc. as protective materials.

- Cell- wise Construction of Landfills: Not Envisaged
    - Permanent Protection system of Brick Lining provided to side slopes of Landfills forlongivity.
    - Leachate Pipe networking system is provided to include surface ruoff of entire landfills footprint including unutilized area of landfill.
    - Suitable Ramps are provided for movement of compaction equipment to bottom of landfills.
- Specially designed vermin-Composting Units with Temperate control.

NBCC Contract Management/ Implementation Methodology

- The entire MSW processing & disposal facilities are designed by NBCC and bid out for construction as per NBCC design, specifications and Terms & Conditions.

- The Terms & conditions are kept as agreed by the Municipal Body. Basically Two-system are followed;

System1: No Long term O&M by except Commissioning & Trial run.

System2: Contract includes long term as per a Concession Agreement between the ULB & Contractor. This system may have short Term O&M for 5 years like in Jodhpur and Ambala or long term O&M for 30 years like in Pune, Gwalior, etc.

- As envisaged by the Govt. of India under the Airfield scheme and similarly under JNNURM & UIDSSMT schemes , the capital cost of SWM schemes are incurred from the project cost while the O&M cost is being taken care of through sale of products like compost, RDF, etc by the operators on PPP basis.

- NBCC deploys a team of Engineers at the project sites and all construction works are executed under strict supervision and quality control norms as per design & drawing.
- NBCC also assists the ULBs in generating Carbon Credits from the SWM schemes under the CDM Mechanism of the Kyoto Protocol.

6.0 Landfills Under Construction:

6.1 Landfill site of Chandigarh:

Municipal Corporation of Chandigarh (MCC) has taken up the project at a cost of Rs.9.55 Crores, which includes closing and capping the existing dumping site measuring an area of 25.12 acres and for construction of a new sanitary landfill over it, in an area of 8.28 acres. The general profile of Chandigarh is as under;

Population (Census: 2001)	9,00,014
Total Municipal Area	114 Sq. Km.
Sectors	61
Waste generation	300TPD
Landfill site	Dadu Majra Colony (West of Sector 38)
Average Annual rainfall	1059.3 mm
Water bodies	River patali- Ki-Rao flows along the North.

Design Aspects of Cell -1: The Cell-1 is designed for @ 400TPD for 2 years of life. The foot print size of landfill is 245m X 245 m (14.85 acres). Slope of landfill is kept at 1:4. Maximum height of cover is 10 m at the centre.
Design Aspects of (Cell-2): The Cell-2 is designed for 4 years in an area of 9.73 Acres.

6.2 Landfill site of N. Dum Dum:

The Municipalities of North Dum Dum and New Barrackpore are jointly implementing the MSW Rules, 2000 under the supervision of Kolkata Municipal Development Authority (KMDA). The common site for waste processing (vermin-composting) and waste Disposal (landfill) has been undertaken at Fatullapur (JL No.3) PS: Nimta, Dist: 24 Parganas (N) within municipal area of N. Dum Dum. There will be two landfill facilities (cells-1 & Cell-2) under this project. The construction work of cell-1 is already started and likely to be completed by June 2008.

Waste Processing facility: The vermin- compost beds are ready for operation at Fatullapur. There are 75 nos. vermin-pits, each of size 15m X 1.5m with depth 0.9m, which will take care of 106.5 TPD of MSW.

6.3 Landfill site at South Sikkim District (Sipchu):

A common landfill site is under construction at Sipchu for South and West districts towns of Sikkim. The estimated waste generation in the area is 45 TPD. The terrain is hilly, therefore, an area has been selected on the river bank of Rangeet. The approach road has been cleared and the proposed site has been leveled and earmarked 160m X 40m size plot for proposed landfill.

Landfill at Mangalore (Karnataka) during construction

Landfill at Dindigal (Andhra Pradesh)

7.0 REFERENCES:

7.1.1 Letter from Maharashtra Pollution Control Board, vide No. MPCB/RO(HQ)/MSW/B-1609 dated 11/03/2008

7.1.2 Letter from CPCB, Zonal Office –Bangalore, vide No. Tech/30/MSW/ZOB/2007-08/7804 dated 19/03/2008

7.1.3 Report forwarded by Indian Institute of technology-Delhi, vide letter No. IITD/CE/MD/07 dated 12th March, 2008

7.1.4 Letter from Karnataka State Pollution Control Board, vide No. KSPCB/RO (KWR)/ Landfill-site / 2007-08/1262 dated 19.9.2007

7.1.5 Letter from Karnataka State Pollution Control Board, vide No. KSPCB/EO(MNG)/ DEO/ TMC Puttur /2007-08/2628 dated 5.10,2007

7.1.6 Pollution Control Acts, Rules and Notifications Issued thereunder, SERIES:PCLS/02/ 2006.