Contents

1. INTRODUCTION

Shimla district is a part of the northwestern Himalayan agro climatic region and is located within the state of Himachal Pradesh. It is located in the south of Himachal Pradesh at 31^{o}04' North to 31^{o}10' North latitude and 77^{o} 05' East to 77^{o}15' East longitude, at an altitude of 2,130 m above mean sea level. The terrain is very complex and undulating with steep slopes and valleys.

To the north and east, a network of mountain ranges which are crossed at a distance by a magnificent crescent of new peaks, the mountains of Kullu & Spiti in the North. The central range of the eastern Himalayas stretching East and South-east. The East-West axis have emerged major axis of development for the city. The total area of the district, as given in the Shimla Development Plan 2021 is 9,950 ha with radius of approximately 15 km.

The city is connected by rail, road and air link. It is 88 km from Kalka and 115 km from Chandigarh. The temperature varies from 15ºC to 20ºC in summer and 0ºC to 13ºC in winter. The average annual rainfall in the region is 1,089 mm. Shimla is a Zone IV (High Damage Risk Zone) per the Earthquake hazard zoning of India.

The main tourist spots of the city are Vicereal Lodge (Indian Institute of Advanced Studies), Glenn Falls, Jakhoo Temple, Kali Bari Temple, Kamna Devi Temple, Mall Road & Ridge. The hill town suffers from rampant commercialization and various other ecological and infrastructural issues in addition to the tourist load which is maximum in the months of May, June and July.

The economy of Shimla mainly depends on tourism. Large influx of floating population, (tourists), Shimla has to house during the tourist season. By the year 2031, this influx is likely to be about 35.86% of the total population of Shimla. Shimla is also an area for service industry and most of the inhabitants are either employed in white-collar jobs or have some commercial establishments.

The main forests in the area are that of Pine, Deodar, Oak and Rhododendron. Most of the hillsides are covered with pine and the ground underfoot is thickly carpeted with resin rich needles.

This tourist town is rapidly developing due to its tourism potentials and thus seasonal increase of population due to inflow of tourists. As a result, the municipality is facing a challenge in proper disposal of solid waste management. To overcome this disposal problem, landfill site has been identified at Bharial, in approx 9.77 Ha of land which is a natural valley of depth approx. 80 m below the bypass road.

Figure 1.1: Jakhoo Temple View

However, in the present conditions, in the absence of the well defined landfill site, the waste is being dumped down the valley, thus creating unhygienic and unsustainable practice.

Urban solid waste management with special emphasis on proper disposal of waste is one of the basic essential services catered by the municipality. In order to manage urban waste scientifically, Ministry of Environment & Forests, Govt. of India has promulgated Municipal Solid Waste (Management & Handling) Rules, 2000. The honorable Supreme Court has set certain timeframe to comply with these rules. However, due to lack of infrastructure, technical manpower etc. these deadlines have not been fulfilled.

In order to fructify investments for urban development, a national level initiative Jawaharlal Nehru National Urban Renewal Mission (JNNuRM) has been set up to bring together the State Governments and enable ULB's to catalyze investment flows in the urban infrastructure sector.

Shimla is one of the cities planned under JNNuRM for urban development. Solid Waste management including proper disposal of inerts and rejects from processing plants at sanitary landfill site is part of sustainable waste management practices.

In this regard, Municipal Corporation (MC) of Shimla released a notice inviting EOI for preparation of DPR of Sanitary Landfill and Voyants Solutions Pvt. Ltd. (VSPL), Gurgaon was awarded the work of DPR preparation of Landfill Site located at Bharial, Distt. Shimla.

For this purpose, a landfill site has been identified at Bharial, in approx. 9.77 Ha of land. The landfill is a natural valley of a depth of approx. 80 m below the bypass road.

Legal Framework Governing Municipal Solid Waste Management

The Municipal Solid Wastes (Management and Handling) Rules, 2000 were published under the notification of the Government of India in the Ministry of Environment and Forests. In exercise of the powers conferred by section 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby made the rules to regulate the management and handling of the municipal solid wastes. The design of sanitary landfill will be based on these rules.

Thus, in accordance with ***MSW Rules, 2000*** landfilling of the below mentioned waste will be practiced at the identified site:

Land filling shall be restricted to non-biodegradable, inert wastes and other wastes which are suitable neither for recycling nor for biological processing.

Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities.

Objective and Scope of Work

To design Sanitary Landfill for Shimla Municipal Corporation ***while reassessing the waste quantity by carrying out waste quantification and waste characterization studies***. The detailed project report will be prepared in accordance with Supreme Court Committee's recommendations as well as Municipal Solid Waste (Management & Handling) Rules, 2000 and will include all necessary data to evaluate the feasibility of the project in terms of technical, financial and environmental criteria.

Our Detailed Scope of Work is as follows:

Compilation of the necessary design criteria (on the basis of detailed physical surveys and tests for waste composition and characteristics, waste quantities, climatic data, soil characteristics etc.)

Technical implementation planning of the new sanitary landfill (disposal section and related infrastructure) at the site of Bhariyal, including design of connections to water supply, electricity and telephone network as well as layouts of access road, reception area with all facilities etc.

Bills of quantities for the investment cost as well as operation and maintenance cost estimates

Approval of DPR from MoUD GoI, as per the JNNURM Guidelines

An assessment of the environmental impacts of the landfill at the chosen site

All data was elaborated and collaborated with due consideration of the MSW (Management and Handling) Rules, 2000 and a list of basic requirements for construction and management of sanitary landfills. This comprised essentially of the following services:

Compilation of design criteria such as population data, waste quantities, both over the planning horizon of at least 20-25 years and including the above mentioned waste reduction targets, waste composition, topographical data, climatic data, design principles and other information as deemed necessary

A site survey was undertaken assessing at least the following issues:

Geological investigation of soil and subsoil conditions, analysis of physical, chemical and geotechnical properties of the subsoil

Soil stability tests for the slopes and the base of the landfill area, especially the slopes and base for the retaining wall

Determination of the precise dimensioning of the various structures and detailed description of all individual components of the engineering measures and technical equipment, giving due consideration to the national construction codes, especially the labor safety and security regulations

Preparation of plans (plan views, cross sections and elevations) with specification of all dimensions of the structures and itemization of the tables of bill of quantities. The landfill design has to meet the Indian MSW Rules 2000. Due to the steep slopes, the design should be carried out under consideration of the **"Valley method":**

The construction works for the valley landfill will start from the lowest point with the construction of a retaining wall so as to contain the waste in the designed cell

The base will be constructed in form of steps depending on the natural slope of the valley. Cover material for the deposited waste can be obtained from the excavation works from the slopes of the valley itself

The length of the initial section will be determined in a way that settlements can take place over one year before the next section is placed

Succeeding sections have to be constructed by hauling solid waste over the first section to the head of the valley

When the final grade has been reached (with allowance for settlement), the upper lift can be extended and the process is repeated

General requirements on the design are the following:

Division of filling area in 3-4 filling sections each with a lifetime of 5-7 years

Calculation of the landfill volume taking into consideration the possible slopes

Planning of access roads for the respective filling sections

Design of the sealing system and description of the construction methods

Design of a retaining wall at the base of the landfill and related slope stability calculations for the retaining wall

Design of the waste body under consideration of the stability calculations for the waste body

Calculation of leachate generation during the filling period and during the after care period

Design of leachate collection system (perforated and header leachate collection pipes, drainage layer etc.)

Design of leachate treatment under consideration of the local situation. All stability calculations have to be approved by an independent expert for soil stability calculations.

Precise determination of construction methods, operating principles, structural conditions and the necessary substructure and superstructure works with indication of the anticipated design, thereof in consideration of the geotechnical and topographical conditions as may be revealed from detailed surveys on site.

Specification of services to be performed by the Municipality (own contribution which is a prerequisite for handing over to the Operator).

Preparation of a final assessment in the form of itemized tables of bill of quantities and provisional schedule of works (subdivided into reasonable lots in consideration of the results of the project review). Cost estimate for the works and services for each individual lot.

Potential environmental impacts of the new landfill at the chosen site shall be presented according to the requirements to be issued by the HP Pollution Control Board against the environmental situation before the implementation of the project.

Need For Study

One of the most pressing problems facing the municipalities is the efficient and long-term disposal of urban solid waste. There are deficiencies in the present system, waste segregation is taking place to a small extent only and uncontrolled dumping down the valley is being carried out at Darni Ka Bagicha. With the concepts of engineered landfill becoming mandatory, it is evident that Municipalities need to go for efficient waste disposal practices which will form a pathway for resource conservation and environment protection.

The proper disposal of municipal solid waste is not only absolutely necessary for the preservation and improvement of public health but it has an immense potential for resource recovery. Scientific disposal of waste is lacking in the existing system. To overcome this problem, design of sanitary landfill is required.

Existing scenario

Projected Population

According to DPR prepared for of MCS Waste Management, the population of Shimla has increased from 1,29,827 persons in 1991 to 1,74,789 in 2001, recording a decadal growth rate of 34.63 percent (***Source:*** Census report obtained through Shimla Municipal Corporation office). Based on the census data for the years 1971, 1981, 1991, 2001, populations for the next 20 years have been projected using the incremental increase method.

The floating population of Shimla for the year 2001 is 56,000 (***Source:*** Census report obtained through Municipal Corporation, Shimla). Based on the census data for previous years, floating population for next 7 years has been projected using incremental increase method.

Total Population of Shimla

The total population including fixed and floating population for Shimla projected for the year 2001, and 2018 is given below:

Table 1.1: DESIGN POPULATION FOR DPR

Year	Permanent Population	Floating Population	Total Population
Year 2001	174789	56000	230789
Year 2011	229452	71577	301029
Year 2018	286443	28644	315087

The arithmetic and geometric progression method for population projection can't be adopted in case of Shimla city as it is neither near the saturation limit nor is it growing very fast with vast scope for expansion. Thus, observing the above trends, for projecting the future Shimla population **Incremental Increase Method** has been followed

For the design of landfill, Population of year 2018 will be taken as the design population.

Waste Quantification

This landfill is designed for inert waste received from Shimla Planning Area. Shimla Planning Area includes Municipal Corporation Area and special areas of Kufri, Shoghi and Ghanahatti, **figure 2 and figure 3** depicts location map showing outline of Shimla Planning Area and its detailed map respectively.

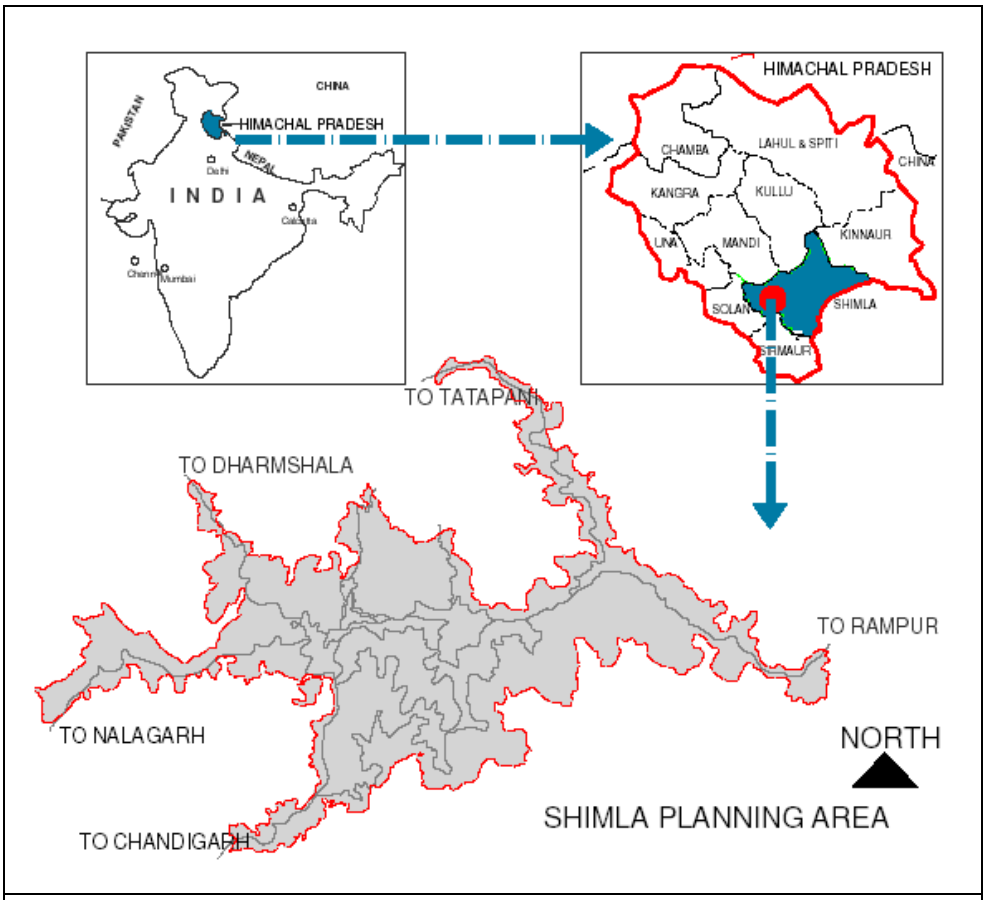


Figure 1.2: Location Map of Shimla Planning Area

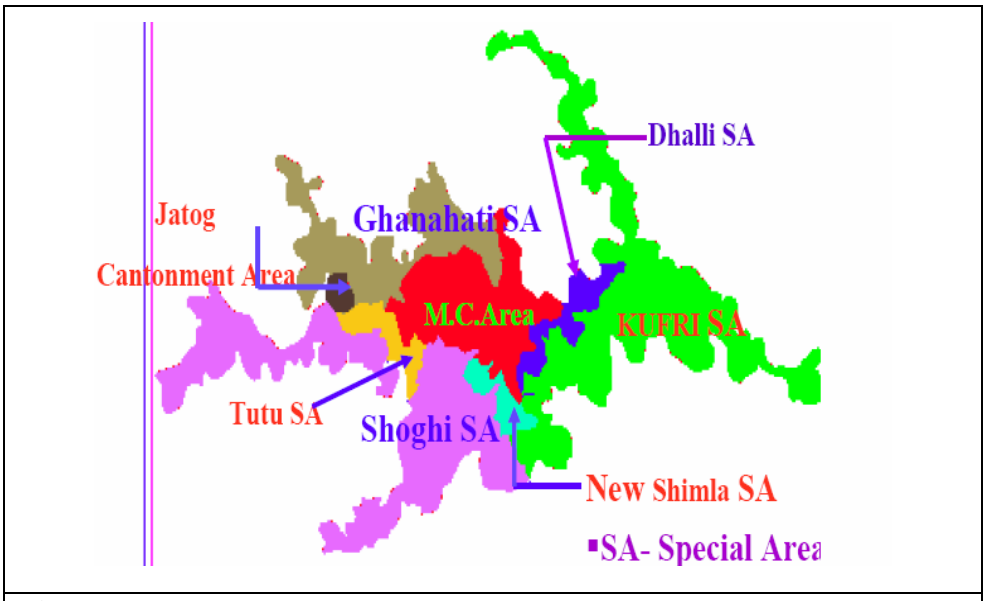


Figure 1.3: Municipal Council area and other special areas of Shimla
Source: Town & Country Planning Department, Govt. of Himachal Pradesh

Thus, the average waste generation in Shimla Planning area as of 2011 is estimated to be 87 tonnes per day at an average waste generation of 0.46 to 0.50 kg per capita per day. The waste generation is characterized by high seasonal variations with a 30% increase in MSW due to tourist significance of the town.

According to the DPR prepared for improvement of MCS Waste Management, the population will grow from 174789 in 2001 to 286443 in 2018. Waste generation has been calculated applying a daily per-capita generation of 0.462 kg per capita per day and an annual increase at the rate of 1.5% due to the socio-economic development of the society. This is in line with other Indian municipalities and international standards.

The waste generation projection covers a planning horizon of 5 years, starting 2011. This leads to around 132 MTPD of municipal waste generated. In accordance with the MSW Rules, 2000 and JNNuRM requirements, only inert waste and rejects from processing facility can be diverted to landfill. Thus, Landfill will be designed only for inert waste & processing rejects waste.

In accordance with the population projection using incremental increase as elaborated in Table 1 above, the waste which will be generated in year 2018 is as follows:

Year	Total waste Generation in (MTPD)
2011	87.47
2018	**132**

Table 1.2: Quantity of Waste Generated

Thus, out of anticipated 132 MTPD only inert waste fraction and pre & post processing rejects will be diverted to proposed landfill. As per the agreement signed between M/s Hanjer Biotech Energies Pvt. Ltd. and Shimla Municipal Corporation only 20% of the total waste generated will be sent to proposed sanitary landfill. However, as discussed during the meeting, keeping safety margin of 5% landfill will be designed for 25% of the waste i.e. 30 MT/day

However, in order to assess the quantity and quality of waste generated in present conditions accurately, the waste quantification and characterization exercise was carried out in accordance with methodology of CPHEEO Manual. Attached is the report as Annexure 6 – Waste Characterization Report

Treatment & Disposal in Existing Conditions

Existing waste processing site is located on the valley side of by pass, at Darni-ka- Bagicha, Lalpani, Shimla. This site is about 5 km from Central Shimla and has an area of around 1200 sq.m. The dead animal is also brought to this site.

Bioconversion Process followed at Darni-ka-Bagicha

The solid waste is unloaded in the premises of the plant, and then stacked as heaps. Unauthorized rag pickers at the site also do primary segregation of recyclable materials. A specific chemical, manufactured by the Excel Industries is sprayed on the heaps to accelerate the bacteriological decomposition to reduce the volume and to control odour nuisance. The processed heap is sorted manually for removal of glasses, stones and then allowed on to the sieves for separation of sand, dust and other inorganic substances. These screened materials are allowed on to the magnetic separators for segregation of iron pieces and the finely screened waste is loaded on the grinders for generation of organic manure. The rejects from the bioconversion plant and other non-biodegradable waste along with construction waste is directly dumped on nearby valley as shown in the picture below:

Figure 1.4: Rejects of Compost Plant thrown on the Adjacent Valley

Description of the Proposed New Landfill Site

The proposed sanitary landfill area is located at Bhariyal, along Taradevi-Totu bypass road, Maujja. Shimla having coordinates of 31° 05'06" N and 77°7'44" E. The site has an area of 9.77 Ha. The annual average rain is 1,089 mm and average daily evaporation is approximately 4 mm.

The landfill site is a natural valley of a depth of approx. 80 m below the bypass road. The nearest residential area is more than 500 m away from the downstream end of the site. It is a rocky terrain with no access road for vehicle traffic. Pedestrian tracks are visible at the site as can be seen in pictures below. There is a need to notify the buffer zone on the periphery as a 'No Development Zone' under the H.P. Town & Country Planning Act, 1977.

Site Visit:

A **visit to Shimla was made on 19th July, 2010 and in October, 2010** and detailed field investigation/study was conducted including interaction with the concerned agencies for formulation of this report. Field observation/investigation/study including review of existing conditions, assessing the quantity and quality of waste, their composition and status of waste processing and disposal were studied. Our team was mobilized for waste sample collection and for situation analysis.

To initiate the process, visit to the landfill site was conducted and during the site visit, site was assessed in terms of its accessibility and to study the topography and extent of the site.

In addition to this, detailed discussion with the concerned officers in the department was undertaken to become acquainted with matters like:

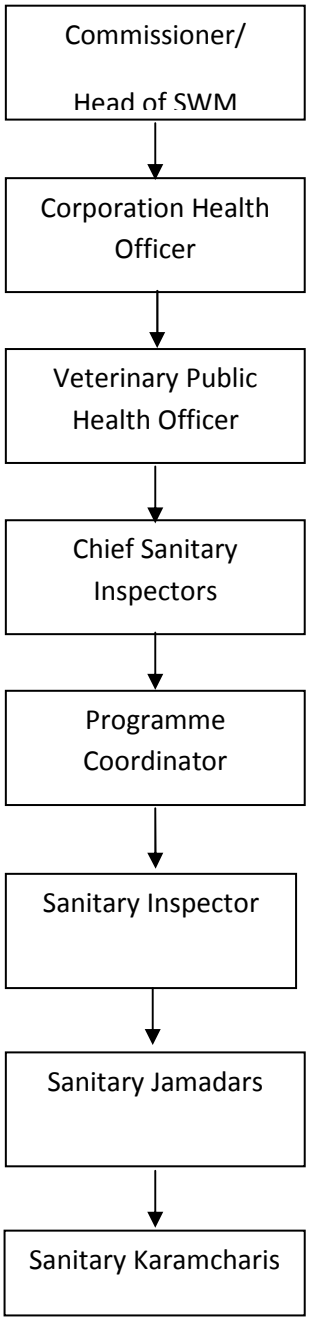
Organizational setup
Financial Issues
Existing Waste Management Practices
Constraints etc.

Few pictures of the proposed landfill site clicked during our visit are:


Pedestrian Tracks

Organizational Structure for Handling MSW

The existing organizational structure of SWM department of Municipal Corporation, Shimla is given below:



2. APPROACH & METHODOLGY

The methodology broadly given in subsequent paragraphs of this heading describes our strategy and approach for carrying out the various major activities keeping in view the guidelines/directions contained in our scope of work.

Field Survey

Waste Characterization

Information on the nature of wastes, its composition, physical and chemical characteristics and the quantities generated are basic requirements for devising solid waste management plans.

Quantity and characteristics of solid waste generated varies with income, socio-economic conditions, social developments and cultural practices. It is observed that the quantity of waste generated has been increasing with improvement in life style. The characteristics of solid wastes too have been very inconsistent with time. There have been tremendous changes with time, and these changes are expected to continue.

Thus, information on the nature of wastes, its composition, physical and chemical characteristics and quantities generated are basic needs for the planning of a solid waste management and disposal system of project area.

Therefore, in order to assess the type and quantity of waste that will be diverted to the solid waste landfill located at Bhariyal, the exercise of waste quantification and characterization studies of representative samples has been carried out.

Detailed Survey of municipal area was carried out in 1st week of August to define the sampling points, waste was collected from:

Residential (targeting higher income group, lower income group and middle income group),
Commercial
Slums,
Hotel,
Tourists spots
Dumping site

In order to get representative analytical results and as required by Ministry of Urban Development, minimum one week sampling was carried out in the study area.

Waste was quantified at representative locations for the Residential Area, Slum Area, the Market Area, Subzi Mandi Area and the Commercial Area to assess the waste quantities with respect to their physical composition.

In addition to this, Shimla being a preferred tourist destination, waste generated by tourists also has been taken into account.

Methodology of Waste Characterization

The methodology adopted for sample collection to assess the physical and chemical composition of the waste is as described below:

Studying the area map of the study region:

Classification of the areas into Residential (High Income, Middle Income and Low Income Groups), Commercial and Market Yards

Location of the Garbage/Dust Bins

Analysis of present condition at the dumpsite

Reconnaissance survey of the municipal area was conducted to assess the overall situation and to identify representative locations for sample collection and composition analysis. The process of sample collection was carried out in the first week of August, 2010, for which analysis is being done.

Sample Collection: When collecting samples of municipal solid waste, major collection sites were identified covering a larger size of population. Based on the type of area such as residential, commercial, and industrial, market, slum etc. sampling points were distributed uniformly all over the study area. Municipal solid waste was collected from 10 points from outside and inside of the solid waste heap. The total quantity of waste so collected, was thoroughly mixed and reduced by method of **quartering** till a sample of such a size is obtained, which can be handled in a laboratory. The quartering method is as explained below-

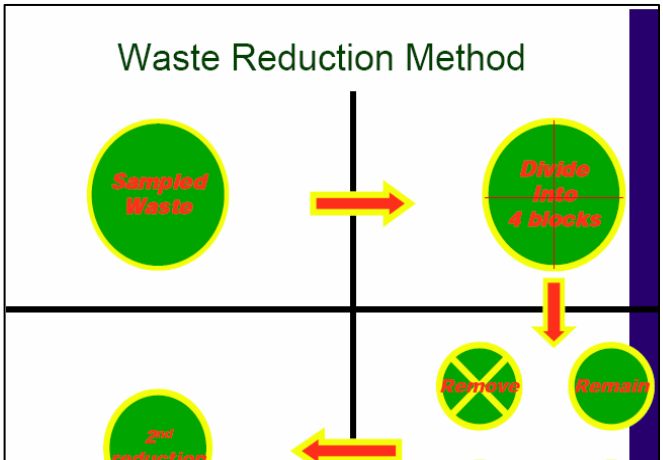
Prepare 50 kg of waste sample from waste pit/collection point

Mix and flatten the waste

Divide the waste into 4 blocks

Remove 2 blocks of diagonally opposite waste

Remaining diagonally opposite waste is again mixed and flattened and then the reduction process is repeated 3-4 times. Big sized waste should be crushed into small pieces and cans and bottles should be picked up to reduce equally instead of crushing. Thus, following the above method, mixed waste was divided to formulate 4 blocks to reduce and then further reducing by discarding diagonally opposite waste as shown in the figure below and in subsequent pictures.



The sample so obtained is subjected to physical analysis, determination of moisture and then the sample is processed for further chemical analysis. Samples collected for physical and chemical analysis are double bagged in plastic bags, sealed and sent to the laboratory for analysis.
The various physical and chemical parameters which were analyzed are:

Physical - Composition (% by weight)

Metal, Glass, ceramics, Food & garden waste, Paper & Cardboard, Textiles, Plastic/rubber, Misc. combustible, Misc. Incombustible, Inert, Density (kg/m^3) and Moisture content (% by weight), Particle size distribution

Chemical:-

pH**,** Nitrogen**,** Phosphorous**,** Potassium**,** Total Carbon**,** C/N Ratio**,** Calorific value**,** Organic Matter

Performing composition analysis and collection of samples at the identified locations by segregating wastes into paper, plastic, metal, glass, textiles, organic fraction and others. The segregated materials are then separately weighed and represented as percentage of total weight (wet stage).
For carrying out physical and chemical characterization, methodology as described in the CPHEEO Manual was adopted.

The analytical results of physical and chemical characterization of wastes were carried out in the first week of August. Attached Annexure 6 – Waste Characterization Report

Waste Quantification

The most important aspect of solid waste management is the quantity of waste to be managed. The quantity determines the size and number of functional units and equipments required for managing the waste. The quantities are measured in terms of weight and volume. The weight is fairly constant for a given set of discarded objects whereas volume is highly variable.

Methodology for Waste Quantification

The weighing of loaded and unloaded vehicles is accomplished with a weigh bridge. The loaded vehicles were weighed when they entered the disposal site at Darni Ka Bagicha and empty vehicles were weighed when they leave the site after unloading. The no. of trips made by each

vehicle will be counted and then the total municipal solid waste generated from Shimla Municipal area will be quantified.

Geotechnical Investigation

The geotechnical investigation was carried out for designing landfill

For which SPT tests will be performed to obtain undisturbed samples and laboratory tests will be conducted on undisturbed samples to determine permeability, strength, compressibility and classification tests.

Approach road to landfill will be designed as per the IRC Codes.

Geological investigation of soil and subsoil conditions, analysis of physical, chemical and geotechnical properties of the subsoil

Soil stability tests will be conducted for the slopes and the base of the landfill area, especially the slopes and base for the retaining wall.

Topograhical Investigation

In order to determine the topography of the site, surveying of the Landfill area is required and preparation of topographical map with 0.3 m contour interval is required.

However, contour map at 1m interval will be considered for the design which has already been provided by Shimla Municipal Corporation.

The aerial view of the proposed site has been generated using software **MXV8i.**

The aerial view represents the ridge line and two valleys like depressions, the designing of landfill will be started from the base. The aerial view obtained from the Landfill Area is as follows:

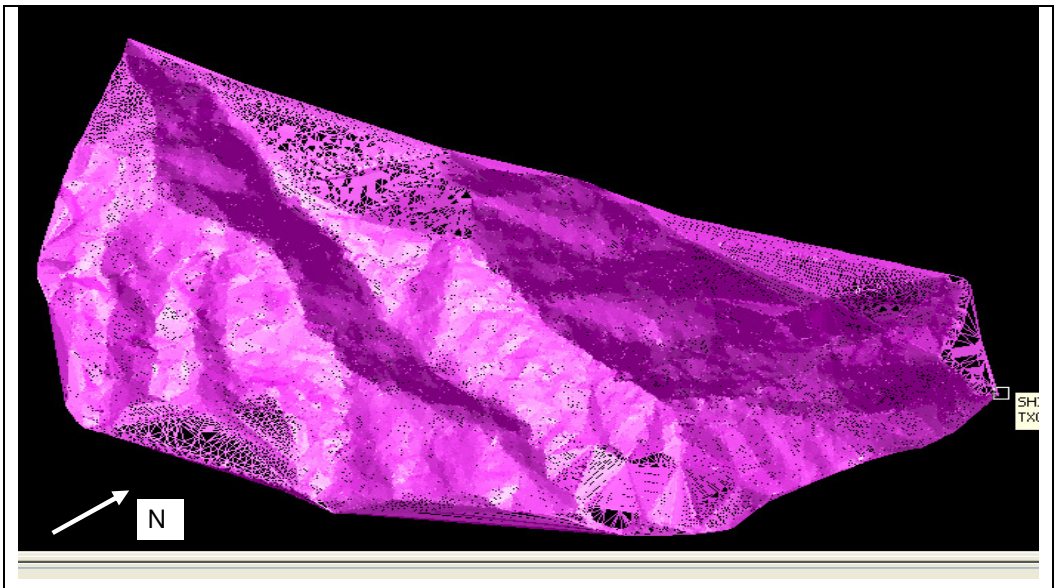


Figure2.1: Aerial View of Landfill Site (showing depressions and ridge line)

The topography is such that there is ridge line which will divide the site into various parts, hence landfill will be developed in phases on both the sides of the ridge and each will have nearly 5 years of life span.

Concepts Followed for Landfill Design

The Landfill design covers in detail the following:

Waste volume to be landfilled

The solid waste generated from the Shimla Municipal area which has to be sent for land filling will be based on the following method:

Quantity of solid waste generated in present conditions
Rate of Increment
Life of the Landfill Facility
Area Requirement for the development of infrastructure (Road, Green Belt, leachate treatment facility, gas flaring facility etc)
Based on the present quantity of waste generation and applying annual increment, the land area required for the development of the Landfill Facility (for 21 years) has been calculated.

The area calculation included the buffer zone, no development area and the other infrastructure facilities.

Landfill Capacity, Sections, Elevations and Plans

The required landfill capacity is significantly greater than the waste volume it accommodates. The actual capacity will depend upon the volume occupied by the liner system and the cover material (daily, intermediate and final cover) as well as compacted density of waste. In addition, the amount of settlement a waste will undergo due to overburden stress and due to bio degradation too will be taken into account.

Thus, landfill facility design calculations cover estimation of the area, height and capacity required for land fill site.

Estimation of Landfill Capacity

The capacity of landfill has been worked out using ACAD and the volume of IV phases of landfill (each phase for approx. 5 years) has been calculated (Details in Landfill Design section later in this report). For one of our other project, which too was for landfill facility design of hilly area, the drawing which gives details of Plan and Longitudinal section of Landfill Area is attached for reference; for Shimla facility too such plans and sections have been generated.
The sketch showing a section of the landfill is given below for the estimation of valley type landfill capacity -

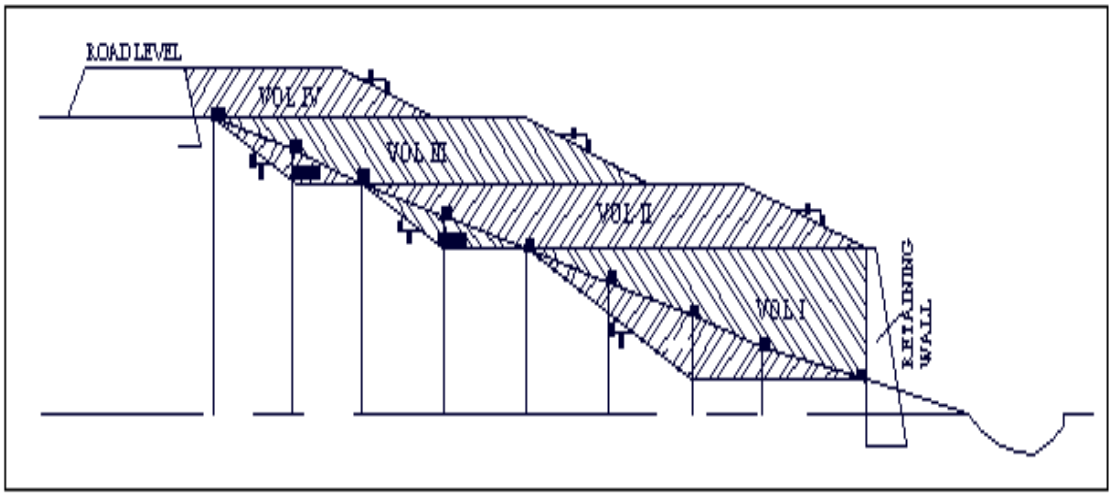


Figure 2.2: Section of a landfill for estimation of Valley type landfill capacity

Plans and Sections

The landfill facility as shown above shall have retaining wall of varying heights. A complete list of the utilities and building and the layout plan of the treatment, processing and disposal facility which was prepared is attached as **Annexure 1**.

Landfill Design

Concept of waste containment has been followed while designing the landfill which is as illustrated below, thus averting air pollution, surface water and ground water pollution and soil contamination.

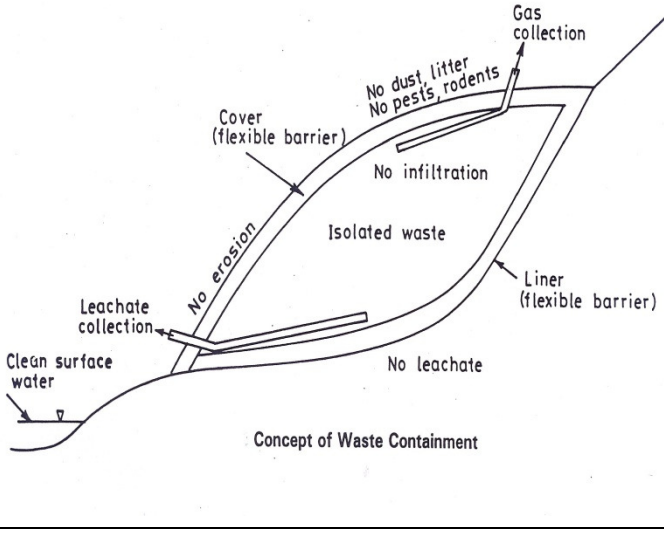


Figure 2.3: Concept of Waste Containment

Components of landfill Design

The components of landfill which will be taken care of while designing the landfill are:
Liner system at base and sides of landfill
Leachate collection and control facility
Final cover system at top of landfill
Surface water drainage system
Environmental Monitoring system
Closure and Post Closure Plan

Valley Landfill

Since the proposed landfill site is a natural valley of a depth of approx. 80 m below the ground, "**valley landfill**" has been designed. The techniques to place and compact solid wastes in such landfills vary with the geometry of the site, the characteristics of the available cover material, the hydrology and geology of the site, the type of leachate and access to the site. **Control of surface drainage is often a critical factor in the development of canyon/depression sites.**

Thus, the landfill section has been arrived at keeping in view the topography, depth to water table and availability of daily cover material.

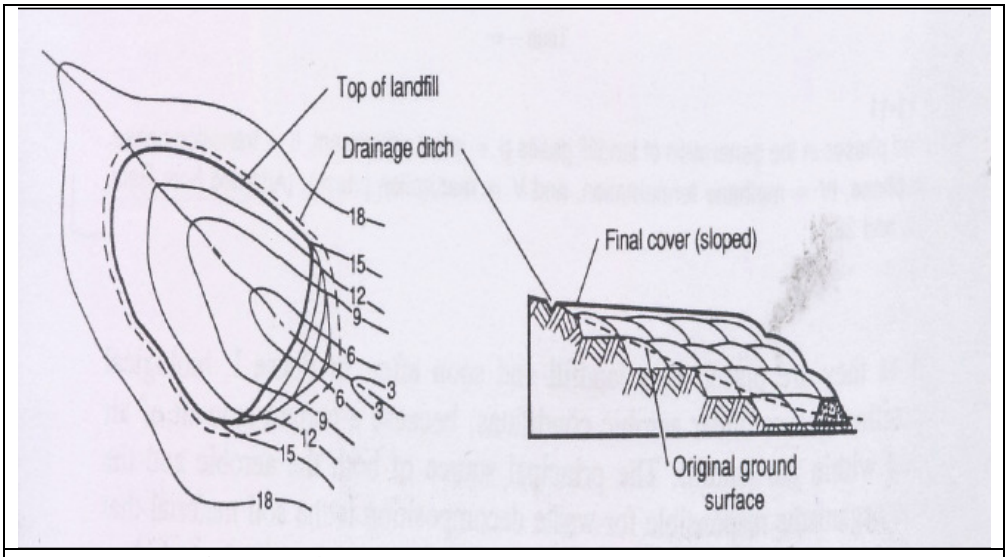


Figure 2.4: Canyon/Depression Landfill Sections

The construction works for the valley landfill will start from the lowest point with the construction of a retaining wall so as to contain the waste in the designed cell.

The base will be constructed in the form of steps depending on the natural slope of the valley. Cover material for the deposited waste is obtained from the excavation works from the slopes of the valley itself. The length of the initial section has been determined in a way that settlements can take place over one year before the next section is placed.

It may be desirable to construct the first layer for a relatively short distance from the head of the ravine across its width. The length of this initial lift has been determined so that a one year settlement can take place before the next lift is placed, although this is not essential if operation can be controlled carefully. Succeeding sections have to be constructed by hauling solid waste over the first section to the head of the valley. When the final grade has been reached (with allowance for settlement), the upper lift can be extended and the process is repeated.

The bottom landfill liner and leachate collection and removal system has been designed carefully to ensure that slope stability of the liner system and the waste placed is adequately maintained.

The design is based on the following steps:

Division of filling area in 3-4 filling sections each with a lifetime of 5-7 years

Calculation of the landfill volume taking into consideration the possible slopes

Planning of access roads for the respective filling sections

Design of the sealing system and description of the construction methods

Design of a retaining wall at the base of the landfill and related slope stability calculations for the retaining wall

Design of the waste body under consideration of the stability calculations for the waste body

Calculation of leachate generation during the filling period and during the after care period

Design of leachate collection system (perforated and header leachate collection pipes, drainage layer etc.)

Design of leachate treatment under consideration of the local situation.

Liner System Design

Base Liners

The bottom portion of the landfill directly rests on stable compacted specially prepared soil bed. The various layers of liners from bottom to top which are required as per the SWM CPHEEO Manual are:

300 mm thick crushed material blended with bentonite ($k \leq 10^{-7}$ cm/sec.)
8 mm GCL Layer
1.5 mm thick high density polyethylene (HDPE) Geomembrane
200 mm Geotextile Layer
300 mm thick granular soil drainage layer (Leachate Collection Layer)

Top Cover Design

The top cover of the landfill directly rests on compacted specially shaped waste surface. The bed shall be laid to 3 to 5 % slope (after allowing for pre-grade settlements of the waste) for providing good natural drainage. The various layers of liners from bottom to top are:

Top Cover:

Vegetation Soil	150 mm
Top Soil	450 mm
HDPE Layer	1.5 mm
GCL	8 mm
Soil Cover	150 mm
Total	**910 mm**

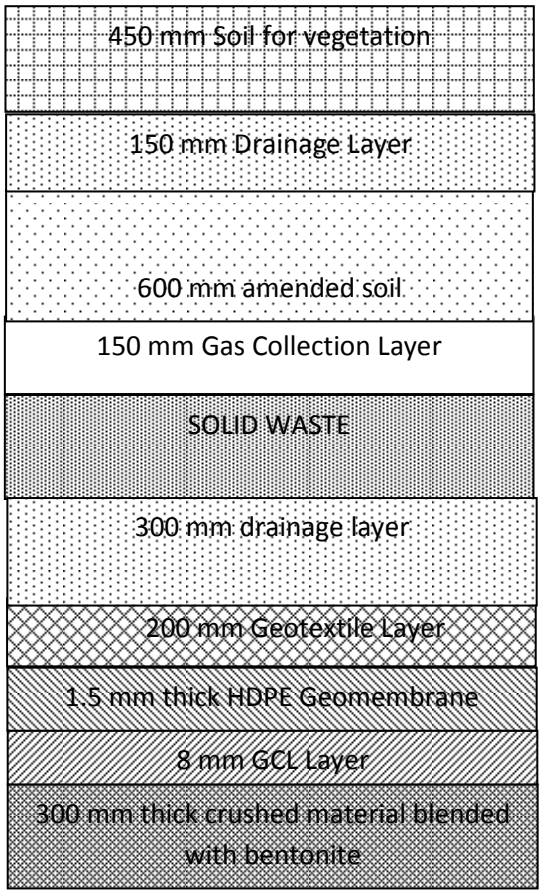


Figure 2.5: Sections of Top Cover and Bottom Liner System of landfill

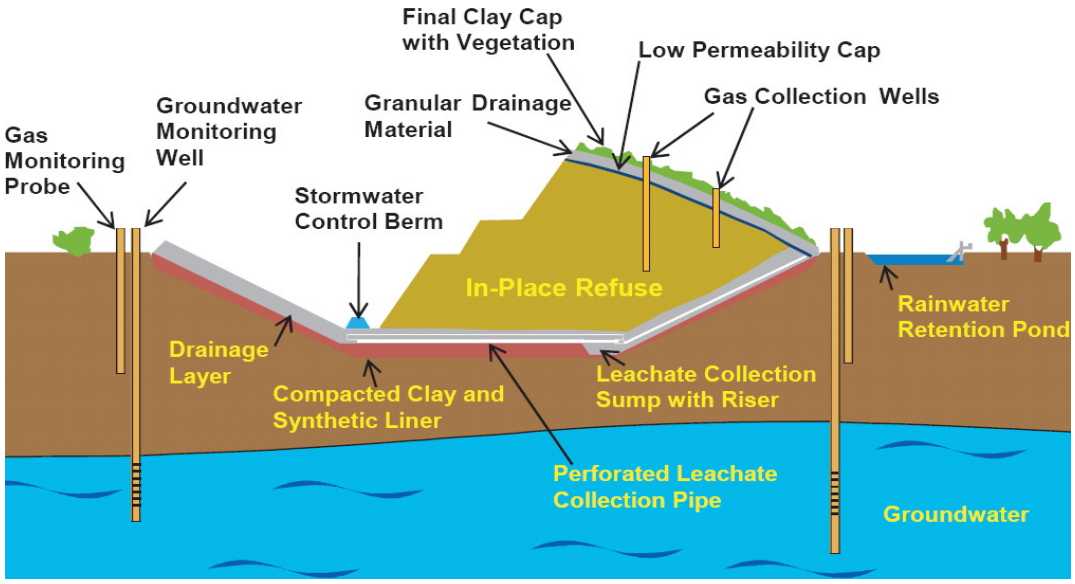


Figure 2.6: Typical Sanitary Landfill Section

Leachate Collection and Treatment Facility

A leachate collection system is designed at the base of landfill. It comprises of a drainage layer, perforated pipe collection system, sump collection area, and a removal system. A system of perforated pipes and sumps is provided within the drainage layer. The pipe spacing will be governed by the requirement that the leachate head shall not be greater than the drainage layer thickness. In order to collect and convey the leachate to the collection sump, the leachate collection channel will be designed. The generated leachate will be collected in the channel due to bottom transverse slope of 2% or less as required and conveyed to sump by gravity.

For collection and conveyance of leachate to sump, a perforated HDPE pipe has to be installed in the channel. At the end of the channel the perforated HDPE pipe has to be connected with non-perforated HDPE pipe, which will subsequently be connected to RCC sump.

Treatment of Leachate

There are two options for treating the leachate. One is to provide a solar pond with a liner at the base so that the leachate does not penetrate into the earth and may pollute the ground water. The other is to precipitate the heavy metals present in the inert waste by Physiochemical Processes. The second method is not very cost-effective and it works only under certain temperature ranges which are non existing in the present case. Therefore the first method i.e. solar pond is proposed so that leachate is prevented from getting released in the environment directly.

Surface Water Drainage

To minimise the generation of Leachate and the prevent pollution of surface water sources at the site, each phase of the landfill shall be provided with adequate drainage system. The drainage has been designed to the maximum rainfall intensity. Further to avoid the entry of Leachate into the stream flowing across the landfill site, a RCC box culvert of adequate size is provided for the entire length of stream stretch that is passing through the site. At the upstream end of the stream, a silt trap and a bar screen is provided to the culvert, so that the silt deposition in the stream is minimised.

Landfill Design Requirements as per MSW Rules, 2000

The primary objective of land filling is the safe long-term disposal of wastes, both from a health and environmental view point; hence the term sanitary landfill will be required for environmentally sustainable design. The proposed landfill will be constructed in accordance with Municipal Solid Waste (Mgmt & Handling) Rules'2000 which are as stated below:

The landfill site shall be so designed that it lasts for at least 20-25 years

A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the Town Planning Department's land-use plans

Facilities at the Site

Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation

The landfill site shall be well protected to prevent entry of unauthorized persons and stray animals

Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site

The landfill site shall have wastes inspection facility to monitor wastes brought in for landfill, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments

Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided

Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided

Safety provisions including health inspections of workers at landfill site shall be periodically made

Specifications for Land Filling

Wastes subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the wastes. In high rainfall areas where heavy compactors cannot be used, alternative measures shall be adopted

Wastes shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up.

Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be constructed to divert run-off away from the active cell of the landfill

After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications, namely: --

The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1 x 10^{-7} cm/sec

On top of the barrier soil layer there shall be a drainage layer of 15 cm

On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion

Pollution prevention

In order to prevent pollution problems from landfill operations, the following provisions shall be made-

Diversion of storm water drains to minimize leachate generation and to prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;

Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geomembrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1 x 10^{-7} cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;

Provisions for management of leachates collection and treatment shall be made.

Prevention of run-off from landfill area entering any stream, river, lake or pond.

The Operation Procedures to be followed:

Water Quality Monitoring

Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 meters of the periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely :-

S.No.	**Parameters**	**IS 10500: 1991 Desirable limit (mg/l except for pH)**
1.	Arsenic	0.05
2.	Cadmium	0.01
3	Chromium	0.05
4.	Copper	0.05
5.	Cyanide	0.05
6.	Lead	0.05
7.	Mercury	0.001
8.	Nickel	-

9.	Nitrate as NO_3	45.0
10	PH	6.5-8.5
11.	Iron	0.3
12.	Total hardness (as $CaCO_3$)	300.0
13.	Chlorides	250
14.	Dissolved solids	500
15.	Phenolic compounds (as C_6H_5OH)	0.001
16.	Zinc	5.0
17.	Sulphate (as SO_4)	200

Table 1.1: Drinking water quality parameters

Plantation at Landfill Site

A vegetative cover shall be provided over the completed site in accordance with the following specifications -

(a) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow

(b) The plants grown are such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilized

(c) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition

(d) Plantation to be made in sufficient density to minimize soil erosion

Closure of Landfill Site and Post-care

The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following-

(a) Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover

(b) Monitoring leachate collection system in accordance with the requirement

(c) Monitoring of ground water in accordance with requirements and maintaining ground water quality

Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement.

View of Section

The landfill has been designed as an engineered liner constructed prior to the placement of waste and also an engineered capping over the surface after completion of filling to minimize the infiltration of rainfall. A leachate collection and removal system has been placed to collect and remove any leachate generated by infiltration of precipitation or by the moisture entrapped in the waste. The DPR covers complete landfill design covering details of its capacity, lining, slope, leachate collection and treatment system, drainage system etc. along with the landfill and equipment costing, design of environment monitoring system and Quality Assurance Plan, Closure and Post Closure Plan.

Design Criteria considered for DPR preparation of Sanitary Landfill:

Population Projection has been done using incremental increase method for calculating the design year population (2018), the results for which are:

Year	Permanent	Total Population

	Population	
Year 2001	174789	230789
Year 2011	229452	301029
Year 2018	286443	390840

Table 2.2: Design population for DPR

The Waste generated for design year 2018 is 132 MTPD. Out of which as per the characterization study was done only for the inert waste and pre and post processing rejects from waste processing facilities. Actually, this quantification is based on some assumption, but to find total waste generated and collected, survey was conducted, the results of which are incorporated as Annexure 6 – Waste Characterization Report and those figures were finally adopted for design purpose.

Year	Total waste Generation in (MTPD)
2011	87.47
2018	**132**

Table 2.3: Waste quantification for DPR

For the landfill design purpose, 4 cells will be constructed which will accumulate waste for approx. 5 years each. Thus, the landfill design will be such that it can accumulate all the waste generated till year 2018.

In accordance with the MSW Rules, 2000 and JNNuRM requirements, only inert waste and rejects from processing facility can be diverted to landfill. Thus, Landfill has been designed only for inert waste & processing rejects waste.

Landfill will have single composite liner system with 1000 mm thick compacted clay/amended soil and 1.5mm thick high density polyethylene (HDPE) Geomembrane and 200 mm thick silty sand protective layer and 300 mm thick granular soil drainage layer (Leachate Collection Layer)

Out of anticipated 132 MTPD only inert waste fraction and pre & post processing rejects will be diverted to proposed landfill.

3. DETAILED LANDFILL 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.

3.1 Assessment of Waste Volume

Based on the detailed field investigations, it is estimated that Shimla generates about 87.47 tonnes of solid waste every day and is projected to generate about 132 tonnes of solid waste every day by the year 2018.

The quantum of bio-degradable MSW, to be processed at the bio-conversion facility before Landfilling in 2011, has been estimated at approximately 87.47 MT/day. The quantum of non-biodegradable MSW and the inert rejects of the bio-conversion facility for Landfilling has been estimated at 21.9 MT per day.

Only 20% of the total waste generated will be sent to proposed sanitary landfill. However, keeping safety margin of 5% landfill will be designed for 25% of the waste i.e. 30 MT/day (25% of 132 MT/day).

3.2 Landfill Design Calculations

Sl. No.	Particulars	Unit	Quantity	Horizon Years		
				2011	**2013**	**2018**
A.	**Solid Waste Generation**					
1	Solid Waste Generation for Inert and Pre & Post Processing Rejects	MT/Day		87.47	93	132
2	Quantity of Waste to Disposal	MT/ Day	25%	21.8675	23.25	30
B.	**Landfill Phases**					
	Phase I - 5 years					
1	Total Landfill Capacity	Cum		60000		
2	Density	MT/Cum		0.9		
3	Weight	MT		54000		
4	Height of Retaining Wall	M		15		
5	Slope below ground	V:H		1:3		
6	Slope above ground	V:H		1:3		
C.	**Liner System**					
(i)	**Base Liner**					
1	Geotextile	200 cm GSM				
2	Leachate Drainage Layer (K > 1x 10^{-2} cm/sec)	30 cm				
3	Geotextile	200 cm GSM				
4	Thick HDPE Liner	1.5 mm				
5	Thick Clay Liner (with K < 1 x 10^{-7} cm/sec)	90 cm				
(ii)	**Top Liners**					
1	Native Soil Layer for Vegetation	45 cm				
2	Drainage Layer (K > 1x 10^{-2} cm/sec)	15 cm				
3	Clay or Amended Soil (with K < 1 x 10^{-7} cm/sec)	60 cm				
4	Gas Collection Layer	15 cm				
5	**Total**	**135 cm**				

3.3 Plan and Cross-Section of Sanitary Landfill

The plan and cross-section of the landfill and its phases have been presented in Annexure 1 and Annexure 4.

Landfill Section and Plan

(a) Landfill Section and Plan is evaluated on the basis of

General 3:1 side slope for the above –ground portion of the landfill

General 3:1 side slope for the below –ground portion of the landfill

Material balance for daily cover, liner and final cover material through excavation at site.

Extra space around the waste filling area for infrastructural facilities.

(b) The final plan and section adopted is shown in Annexure 1.

Landfill Infrastructure & Layout

(a) Site Fencing : All around the landfill

(b) Weighbridge Operator`s Room : 5 X 3.5

(c) Administrative Office : 450 sqm building

(d) Security Room : 3 m x 5m (portable cabin)

Workshop : 220 sqm

Overhead Tank : 50, 000 Ltrs

Access Roads : As depicted in Annexure 1

Other Facilities

Surface water drain: Adjacent to arterial road along periphery

Leachate collection pipe

Leachate holding tank

Leachate treatment facility: The Leachate is sent to Solar Pond

Phase Development

Development of each phase will be done in following stages:

Clearing the area of all shrubs and vegetation
Excavation upto 2m.
Levelling of base and side slopes of landfill and achieving desirable grades at the base of the landfill.
Construction of embankment and temporary terms along the perimeter of the phase
Construction of temporary surface water drains
Installation of monitoring instruments
Liner construction
Leachate collection and removal system

For Phase 1 in particular, when the waste volume reaches the base of Retaining wall 2 location, the construction of Retaining wall 2 should start. After that the rest of the Phase 1 will be filled as per the profile sections.

Phase Operation

Operation of a phase requires planning and execution of daily activities which are given below:

Daily waste filling plan and demarcation at the site
Waste discharge and inspection
Waste placement
Waste compaction
Daily cover
Pollution prevention during operation
Landfill Safety aspects

Phase closure

After the last set of cells of a phase is placed, an intermediate or final cover is constructed.

ANNEXURES

Annexure 1: Phase Profiles, Layout Plan with Access Roads

Name of the Work : DETAILED PROJECT REPORTOF SANITARY LANDFILLSITEFOR SOLID WASTE MANAGEMENT PROJECT AT VILLAGE BHARIYAL, TEHSIL & DISTRICT SHIMLA.

FINANCIAL PATTERN					
S No	Project Name	Project Cost in Lacs	Central Govt Share	State Govt Share	ULB Share
1	Sanitary landfill site for Solid waste Management Project at Village Bhariyal, Tehsil & Dist Shimla	939.32	751.45	93.931	93,931
2	Add for preparation of CDP@ 5%of Project Cost	46.965	37.573	4.696	4.696
3	Add for Administration & other Expenses@5 %of Project Cost	46.965	37.573	4.696	4.696
4	**Grand Total**	**1033.25**	**826.596**	**103.323**	**103.323**

ABSTRACT OF BOQ FOR SHIMLA LANDFILL PROJECT

Sl.No.	Description of Work	Amount(Rs.)
1	DevelopmentofLandFill	18339644
2	TopCoverforLandfill	2424450
3	Retaining Wall	6942500
4	StormWaterDrains	10730490
5	Leachate Sump	836696
6	Solar Ponds	210700
7	Approach Roads	33995080
8	Fencing &Greenbelt	5,792 115
9	AdminBuilding	7,650,000
10	Workshop (Vehicle)	3,960,000
11	SubStation	2,000,000
12	Weigh Bridge	1,000,000
13	WaterSupply	500,000
14	**TOTAL:**	**93931675**

S No	Description	Unit	Quantity	Rate	Amount
1	Excavation in Hard rock (requiring blasting),over (exceeding 30m in depth 1.5m in width as10 sqm on plan) including disposal of earth, dressing of execaved area, lead and lift up to	Cum	1474	450	636300

	1.5m;disposed earth to beand neatly dressed.				
2	Mixing bentonite in proportion specified or directed by the project engineer with crushed material including placing the amended material in position as per drawing to proper levels, slopes, grades and thickness including spreading in layers, watering and permeability of less than 1x10-7 cm/sec including providing and operating charges of necessary sheep foot roller and other equipment to give optimum moisture density as directed by the project engineer for all lead and lift.	Cum	3289	120	394680
3	Supply of Bentonite at site including cost of transportation loading, unloading and other charges complete.	Tones	1264	3000	3792000
4	Supply of crushed material at site including cost of transportation loading unloading and other charges complete.	Tones	1871	1200	2245200
5	Providing, supplying, laying and testing of GCL, including handling, storage and laying of liners to proper levels, grades and slopes as directed by the project engineer, anchoringthe layer suitably as per directions, developing panel layout, carrying out seaming/welding of the liner, testing of joints through the entire length as per the quality control procedure and as per the drawings, specifications and instructions of project engineer.	sqm	5848	220	1286560
6	Providing, supplying laying and testing of 200 GSM Geo Textile including handling storage, certifying the sub grad and laying of liners to proper level, grades and slopes as directed by the project engineer, anchoring the layer suitably as per directions, developing panel layout, carrying out seaming, weldingof the liner, testing of	Sq m	5847	220	1286340

	joints through out the entire length as per the quality assurance and quality control procedureand as per the drawing specifications and instruction of project enginer.				
7	Providing, supplying laying and testing of minimum 1.5 mm thick HDPE Geomembrane at the base and side slopes of the landfill including handling storage, certifying the sub grad and laying of liners to proper level, grades and slopes as directed by the project engineer, anchoring the layer suitably as per directions, developing panel layout, carrying out seaming, welding of the liner, testing of joints through out the entire length as per the quality assurance and quality control procedure and as per the drawing specifications and instruction of project engineer	sqm	5847	280	1637160
8	Supplying and laying of high permeability Leachete Collection Layer consisting og graded gravel approved by project engineer , the maximum size of which not exceeding 32 mm and permeability not less than 0.01cm/sec, as directed to proper levels, grades and slopes at the base of the landfill including dressing and leveling complete as per drawing specifications of project engineer.	Cum	324	585	189540
9	Providing at the site of work and lowering, laying and jointing perforated HOPE pipe of 6kg/sq.cm and confirming IS 14333 (HOPE pipe for sewerage application) to required grade and level including cost of jointing, all fitting materials, chemicals, labour required for handling and making joints etc.				
	(a)63mm dia HOPE	Rmt	125	70	8750

	(b)100mmdiaHOPE	Rmt	253	210	53130
	(c)150mmdiaHOPE	Rmt	73	575	41975
	(d)300mmdiaHOPE	Rmt	207	2207	456849
10	Carriage of Land fill and banking it for liner in layers not exceeding 20cm in depth, breaking clods, watering, rolling each layer with \12 tone roller of wooden or steel rammers and rolling every third and top most layer with power roller of minimum 8 tones and dressing up (including all leads and lifts).	Cum	70124	90	6311160
Sub Total of cost of Land Fill					**18339644**
TOP COVER FOR LAND FILL					
11	Supplying laying amended soil in proportion as specified or directed by the project engineer including breaking clodes and spreading In layers, watering and compacting with sheep foot roller as directed by the project engineer for all lead and lift.	Cum	3500	250	875000
12	Supplying and laying of high permeability drainage layer consisting of graded gravel approved by project engineer, the maximum size of which not exceeding 32mm and permeability not lessthan0.01cm/sec,as directed to proper levels, grades and slopes all the top of the land fill including dressing and leveling complete as per drawing specifications of project engineer.	Cum	834	585	487890
13	Supplying and Laying of good earth as specified or directed by the project engineer including breaking clodes and spreading in layers,walering and Compacting.	Cum	2533	160	405280
14	Grassing with fine grassing/doob including complete loosening of slope surface, dressing evenly, breaking of	Sq m	5469	120	656280

	clods, removal of rubbish, supply& spreading 12.5 mm manure over the surface, watering and supplying & grassing doobs grass roots at the distance of 5 cm apart in either direction, all to the satisfaction of Engineer incharge in all respect. Payment shall be released once the grass covers the whole area.				
Sub Total of Cost of Top Cover					**2424450**
	RETAINING WALL				
15	Earth work in excavation (in Hard Rock required Blasting) of foundation of structures as per drawing and technicalspecification,including setting out construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom.	Cum	170	450	76500
16	Providing and Laying in position reinforce cement concrete of M-25 grade including centering shuttering/deshuttering staging/destaging,but excluding the cost of reinforcement, complete as per drawing and technical specification and instruction of Project Engineer.	Cu m	378	5800	2192400
17	Providing & fixing HYSD bar reinforcement in Structure Work including straightening, cutting, bending, placing & binding with wire and applying cement coating and cover block making and placing complete in all respect as per Technical Specification Section & Instruction of Project Engineer. Necessary chairs, spacebars, welding supports wherever necessary shall also be made and fixed as per direction of the engineer -in-	Tonnes	30.2	48000	1449600

	charge and the same shall also be measured for payment.				
18	Providing & fixing ISMB 600 reinforcement in Structure Work complete in all respect as per Technical Specification Section & Instruction of Project Engineer.	Tonnes	30	52000	1560000
19	Providing & fixing ISMC 400reinforcement in structure work complete in all respect as per Technical Specification Section & Instruction of Project Engineer.	Tonnes	32	52000	1664000
	Sub Total Cost of RW				**6942500**
STORM WATER DRAIN					
25	Excavation in Hard rock (requiring blasting) by mechanical means (Hydraulic excavator)manual8 means in foundation trenches or drains not exceeding 1.5 m in width or 10 sqm on plan including dressing of sides and ramming of bottoms lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soils as directed, within a lead of 50m.	Cum	7585	450	3413250
26	Providing coursed stone masonry in plinth aboveground level with finely chisel dressed stone face and rough hammer dressed stone back bonded with cement mortar of proportion 1:6 (H:ement: 6-sand) including curing complete. (Average size is not less than 20cm x 20cm x 25cml				
	b) Cement procured by contractor	Cum	1404	3000	4212000
27	Providing and laying in position cement concrete of specified grade excluding the cost of centering and	Cum	285	4000	1140000

	shuttering - all work up to plinth level 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)				
28	Providing 12mm thick cement plaster including the surface and curing complete.				
	(c) Proportion 1:4	M^2	16377	120	1965240
Sub Total of Cost of Storm Water Drain					10730490
Lechate Sump					
29	Excavation in Hard rock (requiring blasting) by mechanical means (Hydraulic excavator)/manual means in foundation trenches or drains not exceeding 1.5 m in width or 10 sqm on plan including dressing of sides and ramming of bottoms lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soils as directed, within a lead of 50m.	Cum	444	450	199800
30	Providing and laying in positioncement concrete ofspecified grade excluding the cost of centering and shuttering- ail work up to plinth ievel1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate40 mm nominal size).	Cum	10	4000	40000
31	Providing and laying in position machine batched, Machine mixed and machine vibrated design mix cement concrete of M-25 grade for reinforced cement concrete structural elements, including the cost of centering, shuttering, finishing and excluding the cost of reinforcement including Admixtures in recommended proportions. (as per IS 9103) to accelerate, retard setting of ·concrete	Cum	18	5800	104400

	improve workability without impairing strength and durability as per direction of Engineer-in-Charge- M-20 grade reinforced cement concrete.				
32	Providing &fixing HSYD bar reinforcement in RCC work including straightening, cutting bending placing & binding with wire and applying cement coating and cover block making and placing complete in all respects as per Technical Specification Section & instruction of Project Engineer. Necessary chairs, spacebars, welding supports wherever necessary shall also be made and fixing as per direction of the engineer-in-charge and the same shall be also be measured for payment.	Kg	1927	48	92496
33	Pumps	Nos	2	200000	400000
Sub Total Cost of Leachate Sump					836696
	SOLARPOND				
34	Excavation in Hard rock (requiring blasting) by mechanical means (Hydraulic excavator) /manual means in foundation trenches or drains not exceeding 1.5 m in width or 10 sqm on plan including dressing of sides and ramming of bottoms lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soils as directed, within a lead of 50m.	Cum	350	450	157500
35	Providing,Supplying,layingand testing of minimum 1.5mm thick HDPE Geomembrane at the base and side slopes of the landfill including handling, storage, certifying the sub grade and laying of liners to proper levels, grades and slopes as directed by the project Engineer, anchoring the layer suitably as per directions,	Sq m	190	280	53200

	developing panel layout, carrying out seaming/welding of the liner ,testing of joints throughout the entire length as per the quality assurance and quality control procedure as per the drawing specifications and instructions of project engineer.				
	Sub Total Cost of Solar Pond				210700
ACCESS ROADS					
36	Clearing and Grubbing Road Land (Clearing and grubbing road land including uprooting rank vegetation, grass, bushes,shrubs,saplings and trees girth up to 300 mm, removal of stumps of tr materials and stacking of serviceable material to be used or auctioned up to a lead of 1000 meters including removal and disposal of top organic soil not exceeding 150 mm in thickness). By Manual Means in area of thorny jungle.	hectare	2	15000	30000
37	Excavation for roadway in hard rock (requiring blasting)by drilling, blasting and breaking, trimming of bottom and side slopes in accordance with requirements of lines, grades and crosssections, loading and disposal of cut road with In all lifts and leads up to 1000 meters.	Cum	55076	450	24784200
38	Construction of embankment with approved materials deposited at site from roadway cuttingand excavation from drain andfoundation of other structures graded and compacted to meet requirement of table 300-2.	Cum	55076	80	406080

39	Construction of Embankment with approved material obtained from borrow pits with all lifts &leads, transporting to site, spreading, grading to required slope and compacted to meet requirementof table No. 300-2	Cum	34524	200	6904800
40	Construction of granular sub-base by providingcoarse graded material spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC and compacting with vibratory roller to achieve the desired, complete as per clause 401. (MoRT&H Specification section 401				
	For grading II Material	m3	2200	850	1870000
	Sub Total of Cost of Acess Road				33995080
FENCING/GREEN BELT					
41	Turfing in Green Belt with fine grassing/doob including complete loosening of slope surface, dressing evenly, breaking of clods, removal of rubbish, supply & spreading 12.5 mm manure over the surface, watering and supplying & grassing doobs grass roots at the distance of 5 cm apart in either direction, all to the satisfaction of Engineer incharge in all respect. Payment shall be released once the grass covers the whole area.	sqm	8645	35	302575
42	Supply and planting of trees (Maximum Height 1.5 ft to 2.0 ft)in Green Belt, including dugging holes (0.60 mt.dia and 0.60 mt. depth), mixing the soil with manure in ratio of 2:1(2 part of earth & 1part of manure),planting the saplings such as Kaneer, Bogenbellia etc, backfilling the	Per Plant	4322	70	302,540

	trenches excavated / imported good earth and watering all to the satisfaction of Project incharge.				
43	Providing 2.00 m high barbed wire fencing fixed topost every 2.50 m apart with 12 horizontals and 2 diagonal lines of barbed wire 3 ply 2pts, 12 BWG complete as directed by Engineer incharge.	LM	3458	1500	5,187,000
	Sub Total Cost of Fencing/Green Belt				**5,792 115**
44	Administration Building	Nos	1	7,650,000	7,650,000
45	Workshop (Vehicle)		1	3960000	3960000
46	Sub Station		1	2000000	2000000
47	Weigh Bridge		1	1000000	1000000
48	Water Supply	Lump sum	1	500000	500000
	Total Project Cost			93931675	