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GUIDELINES FOR CONDUCTING ENVIRONMENTAL IMPACT ASSESSMENT : SITE SELECTION FOR COMMON HAZARDOUS WASTE MANAGEMENT FACILITY

CENTRAL POLLUTION CONTROL BOARD

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FOREWARD

The Ministry of Environment & Forests, under the Environment (Protection) Act, 1986, imposed certain restrictions on the expansion and modernisation of any activity or new projects being undertaken in the country unless environmental clearance is accorded by the Central Government [vide notification No. S.O. 60 (E), January 27, 1994]. For this purpose, the project proponent is required to submit, among other things, statement of environmental impact assessment of the proposed activity.

The Rule 8 of the Hazardous Wastes (Management & Handling) Rules, 1989, as amended in January 2000, provides for preliminary impact assessment studies to identify possible sites for disposal facility of hazardous wastes. Further, there is also requirement to undertake an environmental impact assessment of these sites for selecting an appropriate site for hazardous waste disposal facility.

The High Powered Committee (HPC) on the Management of Hazardous Wastes under the Chairmanship of Prof. M.G.K. Menon, constituted by the Order of the Hon'ble Supreme Court of India (in the matter of CWP 657 of 1995) has also dealt with the issue of environmental impact assessment of the hazardous wastes disposal sites and recommended certain approach for conducting impact assessment studies for site selection.

In order to facilitate the selection of sites for hazardous waste disposal and to bring in certain uniformity in conducting the environmental impact assessment studies, Expert Committee on Management of Hazardous Wastes in Central Pollution Control Board has considered the issue and decided to publish these guidelines.

This report is the outcome of inputs from Dr. A. K. Saxena, Director, National Productivity Council, New Delhi, Dr. D. B. Boralkar, Assistant Secretary & Senior Scientist and Dr. Inamul Haq, Senior Scientist, Central Pollution Control Board, Delhi. Ms. Tanushree Ghosh provided secretarial assistance. I hope this document would be useful to various stake holders in the field.

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1.0 INTRODUCTION

The rapid growth of industries has entirely changed the hazardous waste generation scenario in the country. The quantity of hazardous wastes generated has increased appreciably and the nature of the waste generated has become complex. In order to manage these waste scientifically, Ministry of Environment and Forest has promulgated Hazardous Waste (Management & Handling) Rules, 1989 and amended them in year 2000. According to the rules, hazardous wastes have to be managed scientifically. Environmentally sound management of hazardous wastes would require Common Hazardous Waste Management Facility (CHWMF) for industrial clusters spread all over the country, as it is not possible to have hazardous waste management facility for each unit. Such CHWMFs becomes more necessary in the wake of large number of SMEs in our country, which neither have funds nor space for development of hazardous waste management facilities.

CHWMF would facilitate operations like waste pre-treatment, storage of various hazardous wastes, stabilization, leachate treatment, incineration and final disposal. All these operations would release various pollutants into the environment, which in turn may cause low to severe damages to the ecosystem, if not handled properly. In view of this, it is very important to site such facilities in systematic way through evaluating the environmental adequacy. Amended rules state that after preliminary impact assessment studies, for identification of possible sites for disposal facility, EIA study should be undertaken to select appropriate site.

The objective of this approach paper is to provide the procedural guidelines for carrying out EIA for site selection for development of Common Hazardous Waste Management Facility (CHWMF).

2.0 DEFINITION & NEED

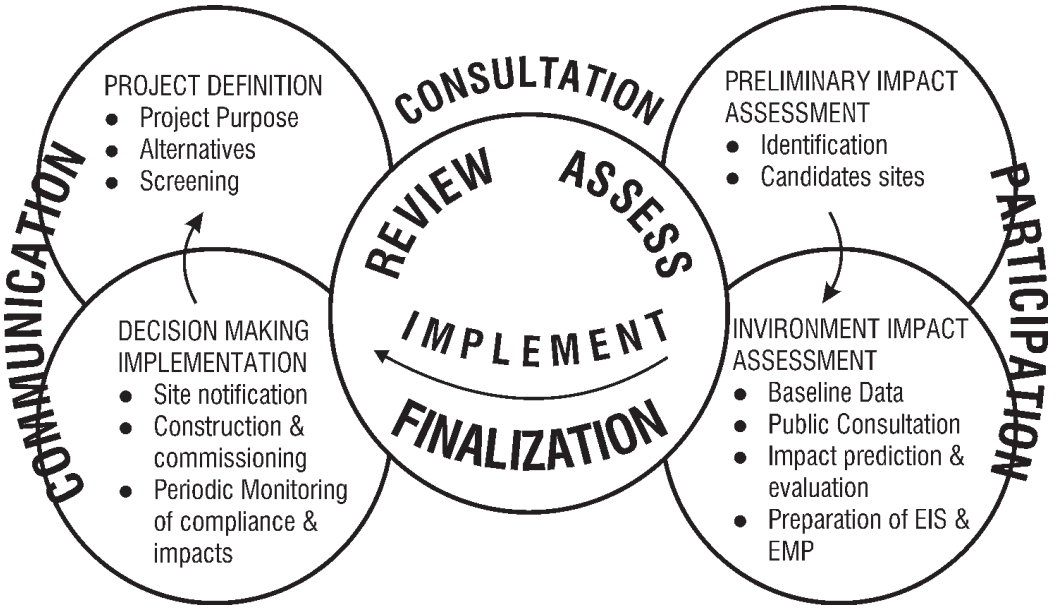
Environmental Impact Assessment (EIA) is the process of identifying and evaluating the effects on the environment of impact factors arising from a proposed change in environmental quality. In other words, we can say that the purpose of an EIA is to determine the potential environmental, social and health effects of a proposed development. It is a systematic examination of the environmental consequences of projects, policies, plans and programs. Its main aim is to provide decision-makers with an account of the implications of alternative courses of action before a decision is made.

During the process of EIA, various project alternatives are studied and potential adverse and beneficial environmental impacts of the project activities are singled out. Based on this, the project alternative is selected and mitigation measures are identified for the adverse impacts arising out of the activities of the project in order to mitigate the adverse impacts on air, water, soil, flora and fauna. Thus through Environment Impact Assessment studies, environment issues can be identified in advance and addressed at a fundamental level eliminating delays in the planning process or during implementation due to unforseen environmental problems. The negative decisions that may arise from the process are of greatest benefit in terms of pollution control and environmental management.

3.0 OVERVIEW OF EIA FOR CHWMF

Overview Environmental Impact Assessment Projects for Development of Hazardous Waste Disposal Facility - Overview.

General stages of Environment Impact Assessment are as depicted in following figure :



In broad terms, Environmental Impact Assessment Process for CHWMF undergoes four stages :

(i) Project Definition; Project definition includes basic designing of the project and identification of project alternatives, screening and scoping of the project.

(ii) Preliminary Impact Assessment : Based on the project activities and project type, candidate sites would be identified and subject to preliminary assessment keeping in view the present usage of site and it's surroundings and prominent features in order to single out potential sites for development of CHWMF.

(iii) Environment Impact Assessment : All Potential sites would be subjected to detailed environmental assessment which would consist of baseline data collection, prediction of environmental impacts and their evaluation, identification of mitigation measures and finally preparation of Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).

(iv) Decision Making & Implementation : Based on the findings of EIA, final site would be recommended with appropriate Environment Management Plan comprising of different technical measures to mitigate the adverse environmental impacts. This site would be notified by the state government and construction of CHWMF would be taken up.

All the stages are connected to each other in a cyclic form and the whole process is of iterative nature as indicated in above figure. The two main components, which interlink with the main stages are: (i) consideration of the need to mitigate the impacts by changes to the proposal and (ii) consultation, both informal and formal, with interested parties. These two components provide a common thread throughout the process, allowing at any time for the assessor to revise previous judgements, measurements and decisions.

4.0 Project Definition

The first step in Project Definition is defining the objective or purpose of the project. Once the purpose of the project is understood, the various alternatives to achieve the objective have to be listed out. These alternatives are then compared with respect to their techno-economic feasibility. This helps in screening of the best fitting alternative. Once the alternative is decided, scoping of the project is to be finalised. Scoping helps in minimising the potential for disputes over the adequacy of the Environmental assessment statements later in the Environment assessment process.

Scoping is done by identifying the key issues of concern. It is finalised after consultations and discussions between the project team and the relevant experts, and with external interested parties such as the planning authority, other statutory authorities, conservation groups, etc.

The first requirement of scoping is a familiarity with the project and the study area. This can be achieved by site visits, exploratory site survey, gathering of map, report and remote-sensing information, and collecting local information so as to understand the character of a locality and to identify potentially sensitive land-uses and locally important issues.

5.0 PRELIMINARY IMPACT ASSESSMENT FOR SELECTION OF CANDIDATE SITES

5.1 Objective

The primary objective of the candidate site selection process should be

- To identify prima-facie suitable candidate sites

5.2 Preliminary Impact Assessment

About eight to ten candidate sites would be identified based on the satellite imageries and topographical sheets of the area. Preliminary studies with respect to their prominent features, surrounding establishments and their proximity to drinking water sources, habitation and usage etc. would be done. These sites then would be subjected to knock out criteria in order to single out potential sites for carrying out Environmental Impact Assessment Studies.

5.3 Rejection or Knock Out Criteria

These criteria have been developed to reject the sites based on certain parameters such as characteristics of land, geology, hydro-geology, ground water conditions and ecological considerations etc. These criteria have been adapted from Guidelines developed for Management of Domestic Sanitary Landfill Sites in Germany and modified to suit Indian conditions.

Under this Criteria, following areas have to be excluded or rejected:

- areas with unstable geological features like;
- Unstable or weak soils: organic soil, soft clay or clay-sand mixtures, soils that lose strength with compaction or with wetting, clays with a shrink-swell character, sand subject to subsidence and hydraulic influence.
- Subsidence : e.g. owing to subsurface mines; water, oil or gas withdrawal; or solution-prone subsurface
- Wet lands;
- historical migration zones;
- flood prone areas;
- areas within 500 meter from water supply zone and within 200 meter from property line;
- natural depression and valleys where water contamination is likely;
- areas of ground water recharge and extremely high water table zone;
- unique habitation areas, close to national parks with scenic beauty and formerly used landfills.
- aeras with high population, unique archaeological, historical, paleontogical and religious interests;
- agricultural and forest lands and existing dump sites.
- Atmospheric conditions that would prevent safe dispersal of an accidental release
- Major natural hazards : e.g. volcanic activity, seismic disturbance and landsites
- Sensitive locations : e.g. storing flammable or explosive materials; airports.

The identified site are excluded (preferably) if the following conditions are existing :-

- An unfavourable local hydro-geological situation, e.g. springs or drinking water well within very close proximity to the chosen area;
- extremely bad access, i.e. no existing access roads to the selected area which may involve
- long distance more than 5 km from main roads;
- access roads passing densely populated areas;
- great differences in altitude between the area of waste collection and the selected site;
- very intense agricultural use:
- inadequate available area;
- difficult geological situation, danger of mass movements, too steep slopes, strata-bound groundwater etc.

The above mentioned criteria and conditions are evaluated and presented in the Table 1.

TABLE - 1 : REJECTION OR KNOCK-OUT CRITERIA

IDENTIFICATION LOCATION OF SITE VILLAGE / CITY			
SL. NO.	**CRITERIA**	**ANSWER (Y/N)**	**REMARKS**
1.	Existing or planned drinking water protection and catchment areas		
2.	High flood prone areas		
3.	Areas with unstable ground		
4.	Closer than 200 meters to populated areas		
5.	Closer than 200 meters to river boundaries		
6.	Close to National Parks, Monuments, Forests with large no. of flora and faunda, historical, religious and other important cultural places.		
7.	Existing use of site (Agricultural / Forest / Old dump site)		
REMARKS :		COMMENTS:	
Site is suitable for detailed EIA study (Y/N)			

6.0 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Detailed Site Investigation and Evalution:

Only those sites, which pass the examination for the knock-out criteria, would undergo detail investigation and are further evaluated as per “Site Evaluation Criteria” given in Table 2. The main objective of the detailed evaluation is to assign the relative rank to the potential sites among themselves.

Before taking up detail evaluation, base line data regarding the site and it's surroundings have to be collected and site specific studies with respect to geology, hydro-geology, flood proneness, accessibility. The sites have to be investigated for

- Site Specific Information; proximity to the waste source, slope at site, topography, accessibility, meteorology etc.
- Hydro-geology/Geology; Ground water table fluctuation, ground water direction, ground water quality, depth to bed rock, soil type, geo-technical features etc.
- Socio-economic Features; land use, demography, transportation impact etc.

In order to carry out detailed evaluation, criteria have been developed. These criteria have been adapted and modified to suit the Indian Environmental conditions, from the criteria developed by UNEP.

TABLE - 2 : SITE EVALUATION

Sl. No.	Criteria	Relative value 5 Excel	4 Ideal	3 Good	2 Poor	1 Bad	Weightage (C)
1.0	General Information						
1.1	Transportation economy						
1.2	Slope percent - I						
	- do -						
1.3	Topography						
1.4	Flood proness						
1.5	Optimum wind direction (down stream village in Km)						
1.6	Infrastructure :						
1.6.1	Accessibility						
1.6.2	Power supply						
2.0	**Hydrology / Hydrogeology / Geology / Geotechnology**						
2.1	Hydrological features						
2.1.1	Distance from surface water body (m)						
2.1.2	Annual Rainfall (cm/yr)						
2.2	**Hydrogeological features:**						
2.2.1	Groundwater depth (m)						
2.2.2	Groundwater flow direction (distance to D/S Village)						
2.2.3	Groundwater quality						
2.2.4	Groundwater gradient (m/km)						
2.3	**Geological features:**						
2.3.1	Subsidence						
2.3.2	Depth to bed rock (m)						
2.3.3	Seismic conditions (Intensity)						
2.4	Geotechnical features :						
2.4.1	Permeability (1×10^{-6} cm/s)						
2.4.2	Engineering property (MA, PI, Shear)						
3.0	Socio-Economic / Ecological						
3.1	Demography						
3.2	Landuse pattern						
3.2.1	Existing						
3.2.2	Future						
3.3	Transportation Impact						
3.4	Special ecological features						
Total							

6.2 Assigning Weightages And Scaling

The key factors involved for the assessment and selection of site for the disposal of hazardous waste (as given in table 2.0) are divided into three groups. Each group is further subdivided into relevant parameters. The reasons for assigning the due weightages to different factors are given below.

6.2.1. General Information :

25% weightage have been given to “General Information” as this pertains to the key features of sites. The factors like “Transportation Economy”, “Land Slope”, “Flood Proneness” and “Wind Direction” have been assigned weightages as per their relative importance. The following reasons were considered for assigning the weightage :-

- *Transportation Economy*

  The transportation of waste from the souce of waste generation to the disposal site is one of the important factor in order to decide the economic location of site. So the sites for this evaluation have to be given relative value from 5 to 2 corresponding to excellent to poor as per their distance from the source of generation

Distance km	**Evaluation (Relative Value)**
0 - 5.00	Excellent (5)
5.00 - 10.00	Ideal (4)
10.00 - 20.00	Good (3)
20.00 - 40.00	Poor (2)
> 40.00	Bad (1)

- *Slope Percent :*

  Natural slope of a site is important from the drainage consideration. But, land with higher slopes may pose difficulty in the construction and may need leveling up. To prevent water logging, the site should not be concave i.e. there should not be any depression. Therefore, following scales have been developed for evaluating the slope percent of the sites :

First Scale (Slope %)	**Second Scale (Slope %)**	**Evaluation (Relative Value)**
1.5	1.5	Excellent (5)
1.5 - 1.2	1.5 - 2.5	Ideal (4)
1.2 - 0.75	2.5 - 7.0	Good (3)
0.75 - 0.50	7.0 - 15	Poor (2)
< 0.5	> 15	Bad (1)

- *Topography :*

  In general the site topography is to be convex in relation to the surrounding so that the rain-water is drained away from the site naturally. So, a site with convex topography can be regarded as excellent and that with concave is regarded as bad.

- *Flood Proneness :*

  In general, the flood prone areas are rejected. But the site can get flooded incase of very high rainfall and without proper drainage. There is a possiblity of water contamination if the site gets flooded. So due weightage is given depending upon extent of flood proneness in a scale of 5 to 1 corresponding to excellent to bad.

- *Wind Direction*

  Though, generation of toxic fumes is not expected due to very nature of the waste to be disposed off, handling of waste in the disposal facility may create air pollution in form of dust formation. Prominent wind direction may affect the population on the downstream side of the facility. So any village within a distance of one km downstream of the sites can be vulnerable to any air pollution due to the operation of the landfill. The sites have to be ranked as per the degree of impact on the downstream. The location of the facility should be in such a manner that there is no or minimum effect at the downstream habitation.

Following relative value scale is developed for ranking the sites:

Downstream distance (km)	**Evaluation (Relative Value)**
> 1	Excellent (5)
1 - 0.5	Ideal (4)
0.5 - 0.2	Good (3)
0.2 - 0.1	Poor (2)
< 0.1 (adjacent to site)	Bad (1)

- *Infrastucture :*

  Out of all the infrastuctures required at a landfill site, the approach road and the power supply are the most important. All the sites have been therefore, evaluated relatively from excellent to bad in a scale of 5 to 1 as per the availability of road and power supply.

6.2.2. Hydrology / Hydrogeology / Geology / Geotechnology :

50% weightage is given to Hydrological, Hydro-geological, Geological and Geo-technical situation of the site as these are the environmental conditions which will affect the design of the landfill.

- **Hydrological Conditions :**
  - Distance from Surface Water Body

    Surface water bodies & drinking water sources should be protected and site should not be close to these sources. Following scale have been therefore, developed for ranking the sites:

Distance Km	**Evaluation (Relative Value)**
> 5	Excellent (5)
5 - 3	Ideal (4)
3 - 2	Good (3)
2 - 1	Poor (2)
< 1	Bad (1)

- *Rainfall*

  Higher annual precipitation will not only lead to higher leachable generation and therefore more changes of ground water contamination, but also will create problems in controlling surface / contact water at dumpsite. Following scale for annual rainfall have been therefore, developed for ranking the sites :

Annual Rainfall (cm / Yr)	**Evaluation (Relative Value)**
< 25	Excellent (5)
25 - 80	Ideal (4)
80 - 150	Good (3)
150 - 250	Poor (2)
> 250	Bad (1)

- **Hydro-geology :**
- Groundwater Table Depth :

  Groundwater table should be as low as possible because of its possible contamination. The level of groundwater should be more than 1 meter below the bearing surface of the landfill. More the clearance between the ground level and the post-monsoon groundwater table depth, more depth is available for excavation of the landfill. If the groundwater is high, the facility has to be designed as a stock-pile. Following scale for groundwater table have been therefore developed for ranking the sites :

Post-monsoon GW table (m)	**Evaluation (Relative Value)**
> 15	Excellent (5)
15 - 10	Ideal (4)
10 - 5	Good (3)
5 - 1	Poor (2)
< 1	Bad (1)

- Groundwater Flow Direction

  As the wastes will be disposed in the landfill permanently, they can pose a threat to the groundwater in case of failure of the liner system. So it is necessary to locate the site in such a way that in case of such eventuality, the impact is the least. The sites have to be evaluated as per the distance of downstream villages.

  Following relative value scale have been developed for ranking the sites :

Distance in downstream (Km)	**Evaluation (Relative Value)**
> 5	Excellent (5)
5.0 - 3.0	Ideal (4)
3.0 - 1.0	Good (3)
1.0 - 0.5	Poor (2)
< 0.5 (Adjacent to Site)	Bad (1)

- Groundwater Flow Gradient :

  The groundwater gradient gives the idea of the rate of flow of the groundwater. Greater the gradient, the greater is the flow rate. For a suitable site, the hydraulic gradient should be as low as possible. If there is any contamination due to the failure of the liner system, the impact at the downstream is minimal. The following scale has been developed for evaluating the sites form the groundwater gradient consideration.

GW Gradient (m / Km)	**Evaluation (Relative Value)**
< 5	Excellent (5)
5 - 10	Ideal (4)
10 - 20	Good (3)
20 - 50	Poor (2)
> 50	Bad (1)

- Groundwater Quality :

  Groundwater quality may not directly influence the evaluation of the waste disposal site. But if the groundwater is non-potable or can not be used for any useful purpose, then the site has the advantage over the others. If the ground water quality does not conform to the drinking water

quality standards, the site is to be considered as excellent with a relative value 5 otherwise can be considered as bad with a value of 1.

- **Geological Features :**
  - *Subsidence :*

    Area with unstable soil such as filled up area still under the process of consolidation may not be suitable for construction of the landfill due to chances of uneven settlement, which may rupture the liner system. A fairly settled soil can be considered as an excellent site whereas a site filled up with borrowed soil can be considered as a bad or poor site from the subsidence point of view.

  - *Depth to bedrock :*

    Higher the depth to bedrock, better will be the site from construction of landfill point of view. Following scale have been developed for ranking the sites from depth to bed rock consideration.

Depth to bed rock (m)	**Evaluation (Relative Value)**
> 15	Excellent (5)
15 - 10	Ideal (4)
10 - 5	Good (3)
5 - 1	Poor (2)
< 1	Bad (1)

  - *Seismic Condition :*

    Seismic conditions, should be considered in the site evaluation to know the seismic intensity at various identified sites. The seismic intensity should be as low as possible so that there is no danger involved due to any earthquake. Following scale have been therefore, developed for ranking the sites from seismic intensity considerations :

Seismic Intensity	**Evaluation (Relative Value)**
V	Excellent (5)
VI	Ideal (4)
VII	Good (3)
VIII	Poor (2)
IX	Bad (1)

  - *Permeability :*

    The permeability of the subsoil of a landfill site has an important role to play in the development of landfill as it acts like a barrier to leachate. In an ideal condition, the permeability of the soil should be about 1 x 10-7 cm/sec. Following scale have been developed for ranking the sites from permeability of the subsoil consideration :

Permeability (1 x 10-6 cm / sec)	**Evaluation (Relative Value)**
< 0.1	Excellent (5)
0.1 - 1	Ideal (4)
1 - 10	Good (3)
10 - 100	Poor (2)
> 100	Bad (1)

- *Engineering Properties :*

  The grain size distribution, c-i analysis and the plasticity index of the soil give the idea about the engineering properties of the soil. Depending upon the soil analysis for these parameters, the sites have to be relatively classified from excellent to bad with value of 5 to 1.

6.2.3. Socio-Economic / Ecological Features :

25% weightage is given to "Socio-economic/ecological features" as this pertains to the surrounding features of the sites. The factors like "Demography", "land-use", "Distance from airport" and "Special Ecological Features" are assigned due weightages as per their relative importance.

- Demography :

  Demography is important factor in choosing the landfill sites. The population and the distance of the populated areas from the sites should be considered for evaluating the sites. For this reason, the population of villages within 5 km radius and their distances from the site have to be considered.

Distance from site (Km)	**Evaluation (Relative Value)**
> 5	Excellent (5)
5 - 2.5	Ideal (4)
1.0 - 2.5	Good (3)
0.2 - 1.0	Poor (2)
> 0.2	Bad (1)

- Land-use :
  - *Existing Land-use :*

    The existing land cover depicts the economic importance of the site. Less the economic importance of the site more suitability of the site for landfill development. Following scale have been developed for ranking the sites from existing land-use consideration :

Existing Land use	**Evaluation (Relative Value)**
Wasteland / Saline	Excellent (5)
Grazing / Fallow	Ideal (4)
Single Corp / non-irrigated	Good (3)
Double Corp / irrigated	Poor (2)
Plantation	Bad (1)

  - *Proposed Land-use*

    The proposed land-use around the sites by the local development authority is another major consideration for evaluation of the sites. If the development authority near the site envisages any sort of development, the site should not be preferred. If the area around the site has the potentiality for development, the relative value of 1 i.e. bad has to given otherwise a relative value of 5 i.e. excellent has to be assigned.

  - *Impact of Waste Transportation :*

    The transportation of waste poses threat to the areas through it passes. A site, which poses minimum threat to the health by virtue of its traffic linkage, should be considered as ideal site. Any site due to which there is possibility of increased exposure of the wastes to the population have to be assigned a relative value of 1 otherwise 5.

- *Special Ecological Features :*

  Areas surrounding the site with special ecological features such as habitation, endangered species etc should be avoided for landfill development. The sites are given a relative value of 1 if close to such areas other wise 5.

6.3 Impact Prediction

6.3.1. General

In order to carry out impact analysis, the whole project has to be broken into major activities and for each activity adverse and/or beneficial environmental impacts have to be identified.

For identification of impacts, following factors and environmental components have to be considered.

(i) **Flora & Fauna :** Exposure to pollutants-via mechanisms such as ingestion, inhalation, skin contact and sorption, direct uptake through gills, membrane uptake processess in micro-organisms, foliar deposition, direct uptake through roots and leaves, etc. - may have lethal and sub-lethal effects on the health of flora and fauna. These effects could include :

- Leaf damage, tissue damage, or reduced productivity in plants and crops.
- Morbidity and mortality in fauna.
- Reproductive effects.
- Skin damage and irritation.
- Carcinogenic effects

(ii) **Geology and soils :** Impacts on geology primarily relate to the loss of, and damage to, geological, palaeontological and physiographic features. Soils can be impacted by :

- Changes in quality of surface water and run-off.
- Leaching of contaminants from sites, in particular landfill leachate.
- Accidental spillages or leaks from tanks.
- Disposal via soakaways
- Direct application of wastes to land, i.e. sewage sludge.
- Aerial deposition
- Landfill gas production and migration leading to changes in soil temperature.
- Contamination of soils by upward movement of leachate by capillary action under certain climatic conditions.

(iii) **Ground and Surface Water :** Protection of groundwater and surface water is of critical importance for three reasons:

- If they becomes polluted it is very difficult to rehabilitate,
- Aquifiers act as natural low-cost storage systems for large volumes of potable water which require relatively little treatment before use,
- Groundwater provides the baseflow of many surface water systems, which may be of amenity value.

  Sources of water impact can be described in terms of (I) direct physical disturbance and change, and (ii) the addition of substances or heat. The result is deterioration of water quality, potential changes in hydrology (flow & Volume).

  The significance of the potential impacts will vary according to the phase of operation, to scale of the facilities, and to proximity and sensitivity of the water resources.

(iv) **Air quality and Climate :** The atmosphere provides an excellent medium through which pollutants can be transported. Releases to atmosphere can occur during the construction, operation and post-closure phases of a facility. The impact of a release to atmosphere can be of two types :

- Direct : i.e. those in which direct contact with the chemical in the air results in an adverse effect. Examples include health effects caused by inhalation (e.g. asthma), nuisance effects from odours, and the effects of acid deposition on vegetation,
- Indirect : i.e. higher-order effects in which the receptor is in contact with environmental media (e.g. soil or water) or materials, which have been contaminated by chemicals in the air. An example is the ingestion of foods affected by atmospheric deposition.

  Unlike pollution in other environmental media, air pollution cannot be remediated by containment or cleaning of the affected area. Hence, the potential impact to air quality and climate has to be studied in detail.

(v) **Public Health :** Potential risks to the public arise not through direct contact with the waste, but off-site, as a result of exposure to :

- Accidental emissions and discharges to air, water and land from events such as a collision involving a waste tanker on the public highway or a fire in a tank farm.
- Low-level, continuous, 'controlled' emissions and discharges during routine operation of the plant.
- Emissions and discharges during routine operation, but associated with poor design or operational practices, for example the discharge of leachate owing to poor landfill containment, or emissions of high levels of hydrocarbons due to poor incinerator combustion conditions.
  The health impact of a chemical is a function of its toxicological properties, duration of exposure and concentration in the body.

(vi) **Landscape and Visual Amenity :** In general, landscape quality is a function of the relative importance and combination of the various physical landscape components, such as topography, trees, hedgegrows, waterbodies and landuse.

Visual Amenity is a function of the visibility of a development in the landscape and of visual sensitivity. The physical components of the landscape, in particular topography, but also vegetation screening, atmospheric conditions and the scale and height of the development itself determine visibility.

Waste activities could particularly impact on landscape quality and visual amenity in terms of, (i) the physical and temporal scale of operations and plant, (ii) the artificiality of many features, e.g. slopes, screening bunds, and (iii) the potential for intrusion, particularly in rural areas.

(vii) **Noise and Vibration :** The primary sources of noise impact on waste disposal and treatment facilities are :

- Mobile plant used in construction, operation and restoration phases.
- Fixed plant, primarily related to the operational period.
- Traffic, particularly heavy good vehicles (HGVs), delivering and unloading waste and removing residues.

Noise impact on environmental receptors will be influenced by a number of site-specific factors relating to site operations and to the location of the site. Operational factors could include size and type of plant. Locational factors could include proximity to sensitive receptors, the existing ambient noise levels and other noise sources in the locality, local meteorological conditions particularly wind direction, etc.

(viii) **Transport :** The transport of waste to a facility provides for the most obvious source of impact. The physical impact of transport relates not only to volume increases upon existing networks, but also to its operational characteristics and composition, most particularly the percentage of heavy good vehicles. There are various components of the sources of traffic,

which will effect its environmental impact. These include the location and spatial extent of traffic movements, the operational hours of the facility, the types of wastes being moved, and the volume of traffic being generated.

In USA accidents arising from hazardous materials transport in general have been seen to represent less than 1% of all fatalities.

(ix) **Social and economic :** Social impacts like property price depreciation represent an external 'cost' of waste disposal and treatment facilities. Property values are also affected by their proximity to a new landfill. The other adverse impact includes stress arising from fear to risk to health, etc. However, as a result of such projects, there would be employment generation, business generation, infrastructure development, etc.

(x) **Land-use and Heritage :** Broad land-use categories would include : industry, agriculture, retail and commercial, residential, recreational, etc. Impacts on land-use would occur directly through the siting of a facility itself and indirectly through its siting in relation to adjacent land-use. The impacts may include;

- Loss of agriculture land
- Change in people's activity due to changed land-use
- Nuisance effect

(xi) **Accidental and Sudden occurrences :** The causes of accidental and sudden releases from CHWMF are similar to those happening in process industries like mechanical failure, improper operation, natural calamities, human error, etc. Such accidents may cause tremendous loss of life, property and natural resources.

The nature and degree of impact depends upon the site location and its characteristics. In order to minimise these impacts, detailed impact analysis is to be carried out and required mitigation measures have to be incorporated in the design of the CHWMF.

6.4 Impact Analysis

A number of techniques are available which provide for an objective and comprehensive identification of environmental factors and impacts, and assist in understanding the interrelation between sources and impacts. These techniques offer means for classifying and presenting material for impact analysis or for aiding their presentation of results. Often they can be modified to assist in the identification of impact magnitude and significance. Following techniques are used :

(i) **Checklists :** A checklist is a list of features, usually accompanied by explanatory notes or guidance. The feature refers either to sources of impact or activities of the project (which give rise to potential impacts) or to receptor or to targets.

(ii) **Matrices :** Matrices combine checklists into a diagrammatic presentation, which allows areas of cause and effect relationships or interactions between the proposed action and the existing situation. The approach to fill matrice is by brainstorming people with the awareness of the proposal, of possible issues of concern, and of environmental effects.

(iii) **Networks :** Networks include the environmental sub-systems or pathways along which the environmental effect can be traced, providing for an understanding of direct and indirect effects and of required linkages in the system.

(iv) **Cause-effect diagrams :** Cause-effect diagrams are a simplified and disaggregated form of network diagrams. Each characteristic of a project is initially though through in terms of environmental impact within its own cause-effect framework.

(v) **Overlay technique :** In the overlay technique, the key restraining factors of development such as engineering factors, existing areas of ecological or landscape sensitivity, population centres, etc. are mapped on transparent overlay sheets. Sites or routes are then identified by placing one map over another, serving to isolate or present clear areas where no sensitive

environments are present and which represent potential alternatives. Advanced mapping tools such as Geographical Information Systems (GIS) can be used for this purpose. Simulation Models and mathematical Models provides predictive framework within which temporal and spatial effects of s releases to the environment can be studied.

6.5 Mitigation Measures

For each adverse environmental impact identified keeping in view the above factors and environmental components, mitigation measures have to be identified to reduce and/or eliminate the adverse impacts and recommended and impact analysis should be done in both cases i.e. if no mitigation measures is adopted by the project proponent and if all the mitigation measure are adopted by the project proponent.

In order to carry out analysis of environmental impacts Checklist Method and Matric Method have been adopted and the impact analysis has been carried out for two alternatives :

(1) Weighted Environmental Impacts without considering any mitigation measures.
(2) Weighted Environmental Impacts considering mitigation measures.

The impact checklist has been prepared based on the activities and impacts mentioned in section 2.0 and is given below in Table 3.

TABLE - 3 : CHECKLIST FOR IMPACT ANALYSIS

POTENTIAL IMPACT AREA	CONSTRUCTION PHASE			OPERATION PHASE		
	Adverse	No	Beneficial	Adverse	No	Beneficial
A. LAND TRANSFORMATION Soil erosion Group Cover Deposition						
B. AIR Suspended Particulate Matter Gaseous Pollution Odour Respirable Particulate Matter						
C. WATER POLLUTION Ground Water Surface Water Storm Water						
D. LAND POLLUTION By Construction Waste By Spillage of Solid Waste						
E. NOISE POLLUTION						
F. VEGETATION & CROP COVER						
G. WILD LIFE						
H. LAND USE						
I. SOCIO - ECONOMIC						
J. AESTHETIC						

Each impact is classified as either short-term or long-term impact in the above table 3.0

Criteria For Rating The Impacts

Following criteria has been considered for rating of the impacts.

* For each impact area, the magnitude of impact has been rated on the scale of 1 to 5

Very High Impact	=	5
High Impact	=	4
Moderate Impact	=	3
Less Impact	=	2
Very Less Impact	=	1

* For each impact area, importance of the impact has been rated on the scale of 1 to 3

Very Important	=	3
Moderately Important	=	2
Less important	=	1

Ranking Criteria

Keeping in view, seven major activities having an impact on the environment and considering eight major impact areas (as shown in Tables 2) the criteria for overall ranking of the secured landfill facility is developed as follows :-

Total Score, if

Above 600	The CWMF is having Very High Adverse Impact
300 - 600	TheCWMF is having Moderate Adverse Impact
100 - 300	The CWMF is having Less Adverse Impact
Below 100	The CWMF is having Very Less Adverse Impact

Based on the criteria for rating the impacts, the weighted impacts are given as shown in. Table 4. In this weighted impact table the entries are presented in the form x(y), where “x” denotes the magnitude of the impact and “y” denotes the importance of the impact while “+” deontes beneficial, “-” denotes adverse impacts and “N” depicts no impact.

TABLE - 4 : WEIGHTED IMPACTS WITHOUT MITIGATION MEASURES (MATRICE METHOD)

No	Potential Impact Area	Construction Phase			Operation Phase				Total
		ACTIVITY							
		A	B	C	D	E	F	G	
1.	Air	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
2.	Water	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
3.	Land	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
4.	Noise	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
5.	Wildlife	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
6.	Vegetation	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
7.	Aesthetic Value	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
8.	Socio-economic	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
	Total								

A, B, C, D, E, F, G are different activities of the development.

In order to reduce all the adverse environmental effects arising out of the various activities pertaining to the development of the CHWMF, mitigation measures have to be recommended. Based on the criteria for rating the impacts, the weighted impacts with mitigation measures are quantified. The weighted impacts of various activities, to be carried out during construction and operation phase of CHWMF with all suggested mitigation measures would be as shown in Table 5.0

TABLE - 5 : WEIGHTED IMPACTS WITH MITIGATION MEASURES (MATRICE METHOD)

No	Potential Impact Area	Construction Phase			Operation Phase				Total
		ACTIVITY							
		A	B	C	D	E	F	G	
1.	Air	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
2.	Water	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
3.	Land	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
4.	Noise	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
5.	Wildlife	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
6.	Vegetation	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
7.	Aesthetic Value	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
8.	Socio-economic	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	x(y)	
	Total								

A, B, C, D, E, F, G are different activities of the development.

After implementation of all the mitigation measures, based on the rating criteria, the project can be considered as Non-Polluting Project.

6.6 Environment Management Plan

The Environment Management Plan would consist of all activity wise mitigation measures to be adopted during the construction, operation, closure and post-closure phase in order to minimise the adverse environmental impacts arising out of the activities of the project.

It would also delineate the environmental monitoring plan for compliance of various environmental regulations.

It would further state the steps to be taken in case of emergency transpiring due to any accident at the site.

6.7 Public Consultation Process (PCP)

During the conduct of EIA, the people, which are likely to be affected directly either during the construction of the CHWMF or operation / closure of CHWMF, have to be taken into confidence. They should be kept continuously informed about the progress of EIA studies and their opinion need to be taken at various stages. This helps in establishing the credibility of the sponsoring agency.

PCP involves the participation of the public in the process of developing the Common Hazardous Waste Management Facility. A effective public involvement would be the one where public concerns and values are given due consideration at every stage of the process.

It is important to establish a one to one relation with them clearing their doubts and forming a unofficial contract with them.

Also it is required to maintain a good relation with the following in order to have smooth conduction of the project:

- **Community Based Organisation :** The village/town societies should be involved in the consultation process. They should be informed of the advantages and disadvantages of the facility in that area for the community and environment as a whole.
- **Environmental NGO :** It is always important to have association with a environmental NGO of that area. NGO's would be of great help in preparing and disseminating information to the public in local languages and also in obtaining public's trust.
- **Local media :** Local media plays a very important role in building up the opinion by publishing the articles in vernacular language regarding landfill project. A public notice has to be published regarding the PCP meeting.
- **Medical Professionals :** It is easier to convince the local people through local doctors about the effect of dumping the waste in haphazard manner on environment.
- **Traditional leaders :** The sarpanch of panchyats of nearby villages should be involved in the PCP. They should be invited to the PCP meeting. These leaders should be informed and explained about the project at an early stage.
- **Waste generators :** Waste generating industries should be taken into confidence before starting the project. It is them who can provide necessary information regarding the quantity and type of waste generated, mode of transport, waste category, etc. so as to enable the smooth conduction of Public Consultation process.

PCP can be carried out in two ways, namely

- Information techniques where public would be given information about the project.
- Participation techniques where public would be involved in discussions in order to extract information from them.

Under information technique, following are the tools :

1. Pamphlets giving details about the project : Pamphlets along with questionnaries can be sent to the residents of the area concerned.
2. Briefings : Important officials or group leaders may be briefed about the project. Their suggestion and advises may be considered.
3. Feature stories : In-depth stories about the siting study can be published in newspaper for information dissemination.
4. News conferences : Brief presentations can made to reporters, followed by question and answer period, often accompanied by handouts of presenter's comments.
5. Brochure : Brief description of what is going on in the siting study, usually issued at key intervals for all people who have shown an interest in the study.
6. Paid advertisements : Advertising space can be purchased in newspapers or on radio or television.
7. Presentations to civic and technical groups : Presentations enhanced with slides or viewgraphs can be delivered to key community members.
8. Press kits : A packet of information can be distributed to reporters.
9. Public service announcement : Short announcement can be provided free of charge by radio and television stations as part of their public obligations.

Under participation technique, following are the tools :

1. Advisory groups task forces : A group of representatives of key or interested parties may be established for policy, technical or citizen advisory group.
2. Focus groups : Small discussion groups may be established to give "typical" reactions of the public. These discussions should be held by professional facilitator. Several sessions of these kinds should be held.
3. Hotline : Special phone numbers should be advertised to handle questions or for providing centralised source of information about the siting.
4. Interviews : Face to face interviews with key officials, interest group leaders, or key individuals should be held.
5. Hearings : Formal meeting informative in nature can be arranged where people present formal speeches and presentations.
6. Meetings : Less formal meetings also can be arranged for people to clear their doubts, ask questions and bring out their suggestions.
7. Workshop : Workshops with the objective of completing a task also can be arranged.

6.8 Environmental Statement

Environmental Statement is prepared following the logical sequence of EIA procedure wherein various project alternatives are delineated and the selected project alternative is defined and described. It also delineates the site details and brief evaluation. Various adverse environmental impacts, impact evaluation and corresponding mitigation measures have to be covered in the statement. Environment Statement would also throw light on Environmental Management Plan developed for the project. In nutshell, EIS is detailed summary of EIA.

7.0 Decision Making & Implementation

At the end of EIA process, if project is found environmentally suitable, the site would be recommended for approval and subsequent notification.

At the notified site, construction of CHWMF would start. The construction of the CHWMF would be monitored by the regulatory agency and project proponent would proceed keeping in view the environmental measures suggested in the EIA report.

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