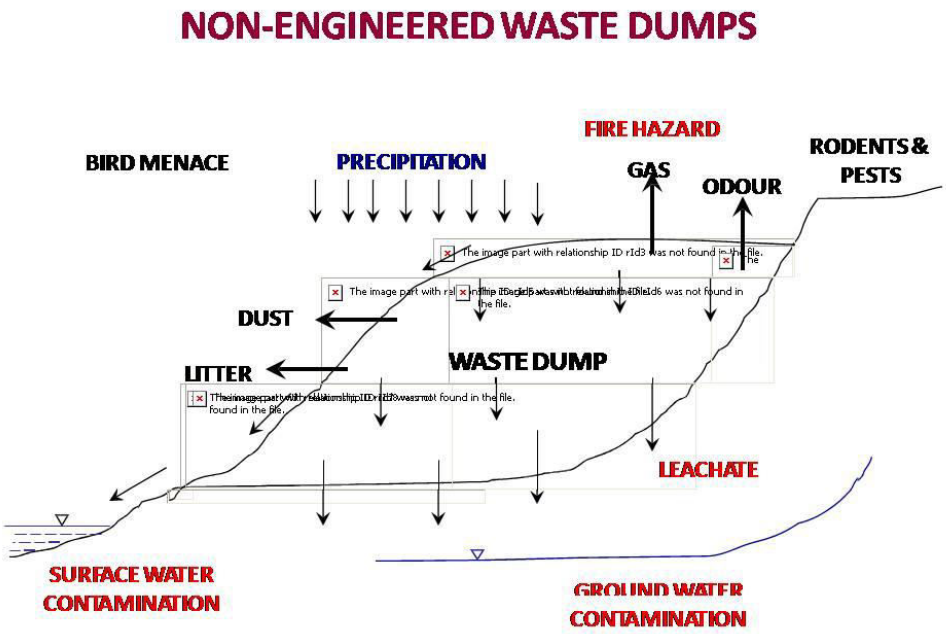
UNIT –I DISPOSAL



LANDFILL ENGINEERING SYSTEMS

- An engineered landfill is a controlled method of waste disposal.
- The objective of a landfill facility is to contain the waste in a manner that is protective to human health and the environment.
- Landfills perform by controlling and managing the movements of fluids.
- Landfills are engineered facilities for the disposal of
  - Municipal Solid Waste
  - Hazardous Waste

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ENGINEERED LANDFILLS - TYPES

Based on Site Topography and Capacity Requirements:

- **Above Ground Landfill (Area Landfill)**
- **Below Ground Landfill (Trench Landfill)**
- **Above and Below Ground Landfill**
- **Slope Landfill**
- **Valley Landfill (Canyon Landfill)**

ENGINEERED LANDFILLS - TYPES

- **Above ground landfill / Area landfill:**
- **Landfill progresses with little or no excavation**
- **Used in areas with high ground water / terrain is unsuitable**

ENGINEERED LANDFILLS - TYPES

- **Below ground landfill / Trench landfill:**
- **Waste is filled in a series of deep and narrow trenches**
- **Used for small waste quantities**

ENGINEERED LANDFILLS - TYPES

- **Above and below ground landfill:**

- **Combination of two previously mentioned landfill types**
- **Excavation area is much larger than in a trench landfill**
- **Depth of excavation normally depends on the depth of ground water table.**

ENGINEERED LANDFILLS - TYPES

- **Valley landfill / Canyon landfill:**
- **Waste is filled between the hills or rolling terrain**
- **Control of surface drainage is often a critical factor**

ENGINEERED LANDFILLS - TYPES

Based on Site Topography and Capacity Requirements:

- **Above Ground Landfill (Area Landfill)**
- **Below Ground Landfill (Trench Landfill)**
- **Above and Below Ground Landfill**
- **Slope Landfill**
- **Valley Landfill (Canyon Landfill)**

ENGINEERED LANDFILLS - TYPES

- **Slope landfill:**

- **In some places, it is not possible to find flat ground for landfills. In such cases slope landfills have to be adopted.**
- **Control of inflowing water from hill slopes is a critical factor in design.**

CRITERIA FOR LANDFILLS

1. Site Selection

- Location criteria
- List of potential sites
- Selection of few best ranked sites
- Environmental impact assessment
- Final site selection

2. Site Investigation

- Subsoil investigation
- Ground water/ Hydrogeological investigation
- Topographical investigation
- Geological and Seismic investigation
- Environmental investigation

CRITERIA FOR LANDFILLS

3. Landfill Planning & Design

- Essential components
- Design life
- Waste volume, waste compatibility and landfill
- Landfill layout and section
- Phased operation
- Estimation of leachate quantity
- Liner system
- Leachate drainage, collection and removal

Contd...

CRITERIA FOR LANDFILLS

3. Landfill Planning & Design

- Leachate management
- Landfill gas management
- Final cover system
- Surface water drainage system
- Base stability, slope stability and seismic aspects
- Site infrastructure
- Environmental monitoring system
- Closure and post-closure maintenance system

CRITERIA FOR LANDFILLS

4. Construction of landfill and operation criteria

- Landfill site construction and development
- Site procedures : Record keeping and waste inspection
- Phase development
- Phase operation
- Pollution prevention and safety during operation
- Phase closure
- Landfill Closure
- Post-closure vegetative stabilization

CRITERIA FOR LANDFILLS

5. Inspection, monitoring and record keeping criteria

- During construction of liners and covers
- During operation
- During closure and post-closure period
- Environmental monitoring systems

6. Post-closure Criteria

LANDFILL COMPONENTS

❖ **Major Components:**

- Bottom and side liner system
- Leachate collection and removal system
- Leak detection system
- Gas collection and removal system
- Top liner system
- Storm water management system
- Environmental monitoring system
- Other infrastructure

LANDFILL COMPONENTS

- **Bottom & Side Liner System:**
  - Single most important element of a landfill
  - Placed at the bottom and sides of a landfill
  - To prevent migration of leachate to the surrounding soil and water
  - Liner consists of multiple barrier and drainage layers
  - May consists of compacted clay liner, geomembrane, geosynthetic clay liner, geotextiles and/or a combination of these.

LANDFILL COMPONENTS

- **Leachate Collection & Removal System:**
  - To collect the leachate produced in a landfill
  - To prevent the buildup of leachate head on the liner and to drain leachate effectively outside the landfill for treatment
- **Leak Detection System:**
  - To drain the leachate if at all present in the secondary liner system

LANDFILL COMPONENTS

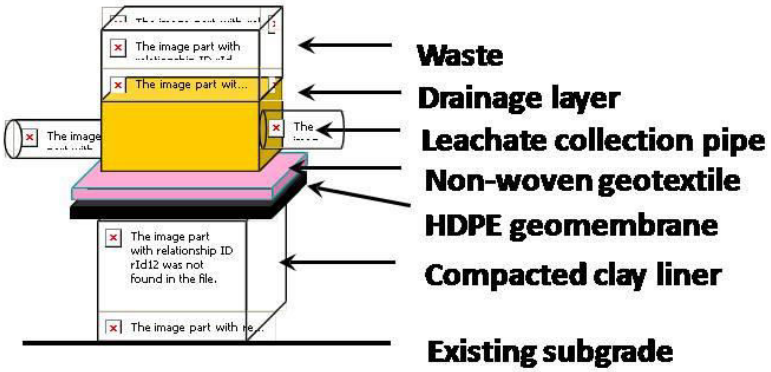
- **Gas Collection & Removal System:**
  - Municipal solid waste can generate large quantities of gas during decomposition.
  - Two primary constituents : Methane and Carbon dioxide
  - System to collect and extract gas from within the landfill
  - Landfill gas can either be used to produce energy or flared under controlled conditions
- **Top Liner System:**
  - Enhances surface drainage, prevents infiltrating water and supports surface vegetation

LANDFILL COMPONENTS

- **Top Liner System:**
  - **Consists of barrier and drainage layers**
  - **Main purpose is to minimize the water infiltration into the landfill to reduce amount of leachate generated after closure**
  - **Soil layer is included at the top to protect the underlying layers against intrusion, damage and to enhance surface drainage & vegetation**

SINGLE COMPOSITE LINER SYSTEM

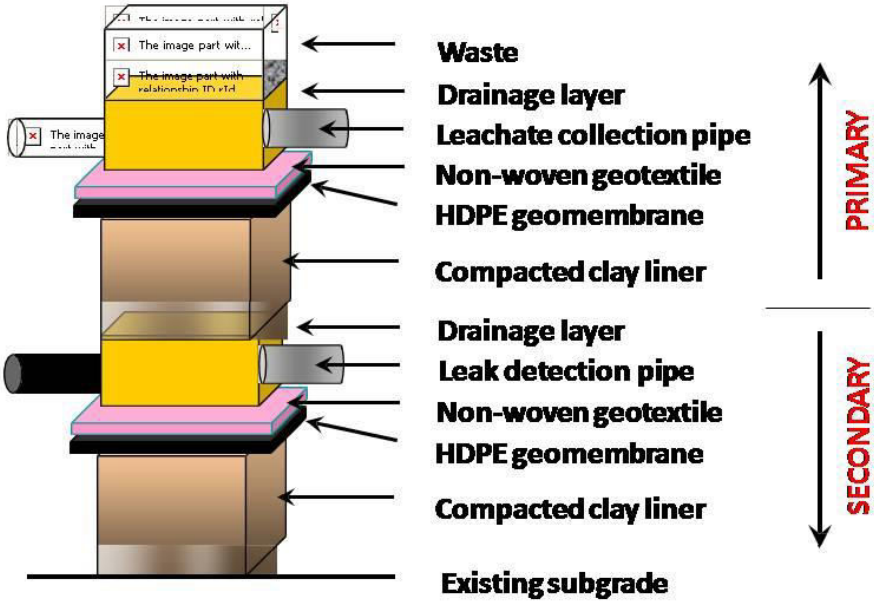
❖Liner system for municipal solid waste & nonhazardous waste landfills



Typical liner system

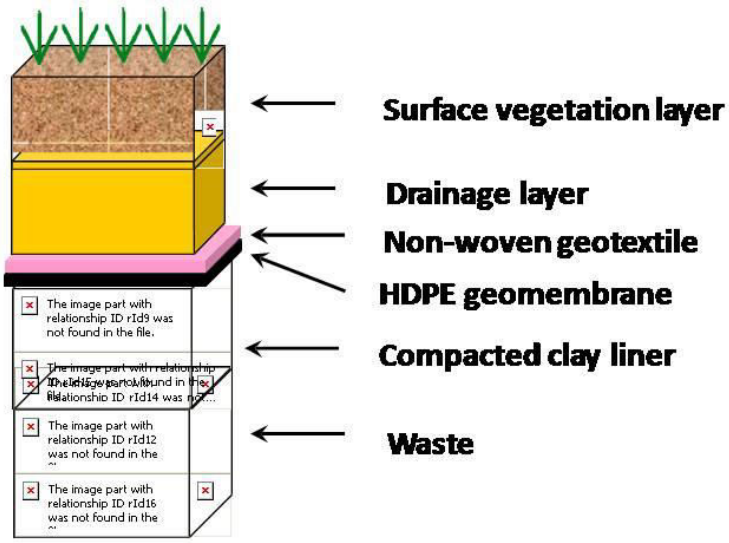
DOUBLE COMPOSITE LINER SYSTEM

❖Liner system for hazardous waste landfills



Typical liner system

TOP LINER SYSTEM



Typical liner system

GEOSYNTHETICS IN LANDFILLS

- **Geosynthetic Products:**
  - **Geosynthetic clay liner**
  - **HDPE geomembrane**
  - **Nonwoven geotextile**
  - **Geonet & geocomposite drain**
  - **Geogrid**
  - **Woven geotextile**
  - **Geomat & Geocell**
  - **Geopipe**

GEOSYNTHETICS IN LANDFILLS

❖ **Alternatives to conventional materials:**

- **Compacted clay liner**

  ⟶ Geosynthetic clay liner (GCL)

- **Drainage layer with sand & aggregates on slopes**

  ⟶ Geonet & geocomposite drain

❖ **Advantages:**

- **Creates extra landfill capacity by replacing conventional clay liner with geosynthetics like GCL**
- **Geosynthetic reinforced embankments can reduce the base width of embankment which result in substantial savings in earthwork for high rise embankments**

INSTALLATION OF GEOSYNTHETIC MATERIALS

INSTALLATION OF HDPE GEOMEMBRANES

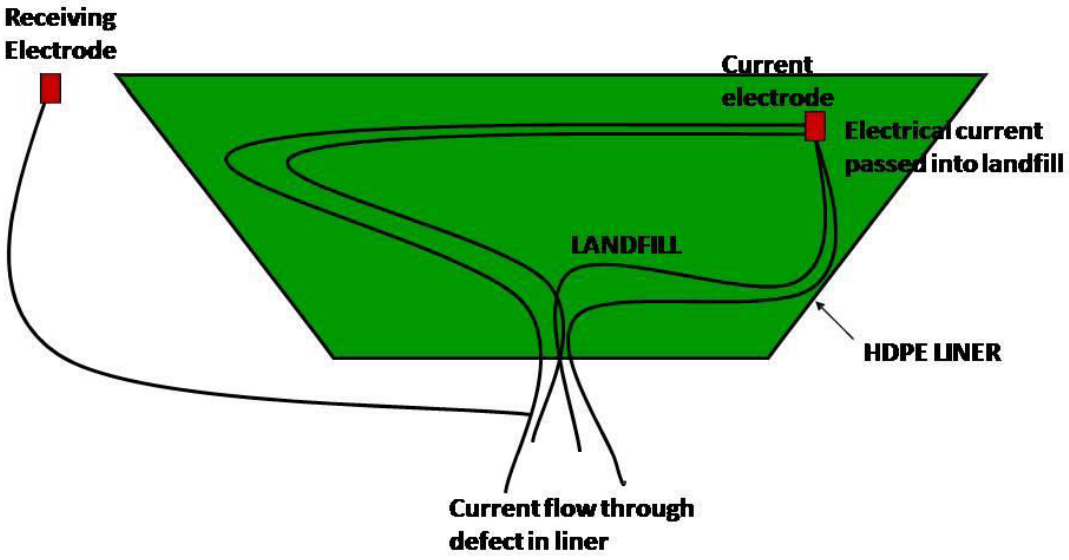
❖**Joining of geomembrane: key aspect in landfill construction**

- **Hot wedge welding (used where machine is feasible to operate)**
- **Extrusion welding (corners, intermediate joints, repairs/patches)**

❖**Testing of Seams:**

- **Non destructive testing**
  - **Air pressure test (seams by hot wedge welding)**
  - **Vacuum Box test (mostly seams by extrusion welding)**
- **Destructing testing (by tensiometer)**
  - **Shear test (seams by hot wedge welding)**
  - **Peel Test (seams by hot wedge welding)**

INSTALLATION OF HDPE GEOMEMBRANES



Leak Detection Test: Two Electrode Method

CASE STUDIES – LANDFILLS :
(executed by Garware-Wall Ropes Ltd.,Pune)

- **Municipal Solid Waste Landfills**
- **Hazardous Waste Landfills**
- **Landfill Capping**

MUNICIPAL SOLID WASTE LANDFILLS

MUNICIPAL SOILD WASTE LANDFILL - INDORE

Liner Installation

Courtesy: Garware-Wall Ropes Ltd., Pune

MUNICIPAL SOILD WASTE LANDFILL - RAMPUR

Liner Installation

Courtesy: Garware-Wall Ropes Ltd., Pune

NONHAZARDOUS LANDFILL – CAIRN ENERGY, BARMER - RAJASTHAN

Courtesy: Garware-Wall Ropes Ltd., Pune

HAZARDOUS WASTE LANDFILLS

HEIGHT RAISING OF JAROSITE POND - DEBARI

Project: Height raising of Jarosite pond by 3 m to create additional capacity, HZL - Debari

❖ Features of the Pond:

- **Area : 18 hectares**
- **Existing embankment height: 3 - 11 m**
- **Length of embankment : 1500 m**