

Prince Mohamed Bin Fahd University
College of Engineering
Civil Engineering Department

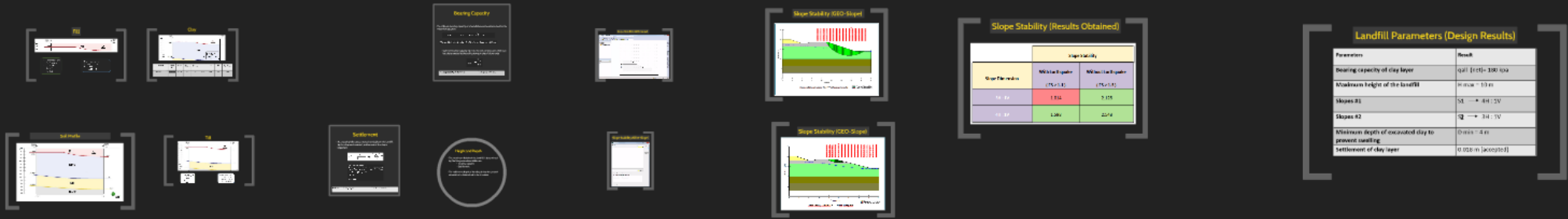


Learning Outcome Assessment III/CIV
Spring 2016/2017

Disposal of Contaminated Construction and Demolition Debris in Clayey Soil

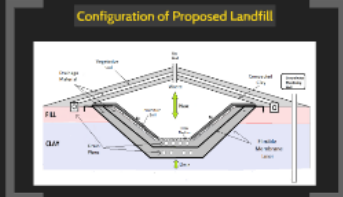
Students Names (ID's #):
 Morther alana (201301454)
 Abdulhman alomair (200900462)
 Mohamed Al Ousman (201200208)
 Abdulrah Al-Charaman (201203235)

Advisers:
 Dr. Tahar Ayadat
 Dr. Omar Ouda



Landfill Parameters (Design Results)

Parameters	Result
Bearing capacity of clay layer	equal 1100-1300 kpa
Maximum height of the landfill	10 m → 13 m
Slopes #1	1V → 4H : 1V
Slopes #2	1V → 3H : 1V
Minimum depth of excavated clay to prevent sliding	0.4 m → 0.4 m
Settlement of clay layer	0.018 m (0.0007 ft)



Integrated Waste Management

Integrated Waste Management (IWM) is a systematic approach to managing waste from its generation to its final disposal. It involves the coordination of various waste management activities, including waste reduction, recycling, energy recovery, and safe disposal, to minimize the environmental and social impacts of waste.

Waste

Waste is any material that is discarded or thrown away. It can be solid, liquid, or gaseous. Waste management involves the collection, transport, treatment, and disposal of waste in a way that minimizes its impact on the environment and human health.

Objectives

The main objectives of waste management are to reduce the amount of waste generated, to recycle and reuse materials, to recover energy from waste, and to dispose of waste safely and responsibly.

Introduction

Construction and demolition (C&D) waste is a significant portion of the total waste stream. It consists of materials such as concrete, brick, wood, and metal that are discarded during the construction or demolition of buildings and infrastructure.

Introduction

- Construction and demolition debris is generated when new structures are built and when existing structures are renovated or demolished.
- In other words, C & D waste consist of materials that are derived from activities such as, construction, demolition, development of structures, buildings, roads, bridges, surface draining, sewage systems and remnants of materials such as glass, slabs wood and Asphalt.
- These materials are estimated to account for about 50% of the disposed waste stream.



Conclusion

The Construction and Demolition waste management system is a complex and multi-faceted system that involves the collection, transport, treatment, and disposal of waste in a way that minimizes its impact on the environment and human health.

Conclusion

- Landfills form one of the major parts of an integrated waste management system.
- If properly designed and managed in the context of available infrastructure and resources, landfills will provide the most efficient and cost-effective way of disposing of waste.
- If not properly designed especially in the disposal of hazardous waste, landfills like any other designed system may fail and lead to dire consequences to the environment.

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Learning Outcome Assessment III/CIV
Spring 2016/2017

**Disposal of Contaminated
Construction and Demolition Debris
and Hazardous Waste in Clayey Soil**

Students Names (ID's #):

Monther alfarra (201301454)
Abdulrhman alomair (200900462)
Mohamed ali Osman (201200208)
Abdullellah Al-Gharamah (201203235)

Advisers:

Dr. Tahar Ayadat
Dr. Omar Ouda

Outline

- Introduction
- Objectives
- Integrated waste management
- Soil Profile
- Parameters
- Slope Stability
- Configuration of Proposed Landfill
- Conclusion

Introduction

- Construction and demolition debris is generated when new structures are built and when existing structures are renovated or demolished.
- In other words, C & D waste consist of materials that are derived from activities such as; construction, demolition, development of structures, buildings, roads, bridges, surface cleaning, sewer systems and remnants of materials such as glass, slabs wood, and Asphalt..
- These materials are estimated to account for about 50% of the disposed waste stream.

Introduction

- Hazardous waste is defined as anything which, because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, an increase in mortality; or cause an increase in serious irreversible, or incapacitating reversible, illness; or pose a substantial present or potential hazard to human health and the environment when improperly treated, stored, transported, or disposed of.
- Primary characteristics : Ignitability, Corrosivity, Reactivity and Toxicity.
- Ground disposal is imperative in this case and could be one of the best solutions.

Objectives

- The main objective of this project is to carry out a geotechnical and geo-environmental design of a landfill destined for the disposal of contaminated construction and demolition debris, and hazardous waste.
- The stratigraphy of the site of the project is composed mainly of clayey soil where the landfill will be founded.
- The design steps include the following:

Objectives

- 1) Analyzing the different components of the site of the project.
- 2) Determining the maximum height of the landfill by verifying the following two principles:
 - Bearing capacity of the soil foundation, and
 - Settlement of the landfill on the clayey soil.
- 3) Assessment of the slope stability of the excavated area which will accommodate the landfill.
- 4) Determining the minimum depth of the clay strata which should be adopted, during the ground excavation, to prevent the swelling of the clay layer caused by the hydrostatic water pressure.

Objectives

- 5) Determining the rate of percolation of contaminated liquids contaminant through the ground layer located beneath the designed landfill.
- 6) Designing a permanent drainage system beneath the base of the landfill to prevent the raise of groundwater table.
- 7) Proposing and analyzing the different landfill accessories that are required for the disposal of hazardous waste such as drainage System, flexible membrane liners, multiple cover layers of different types, etc.).

Integrated Waste Management

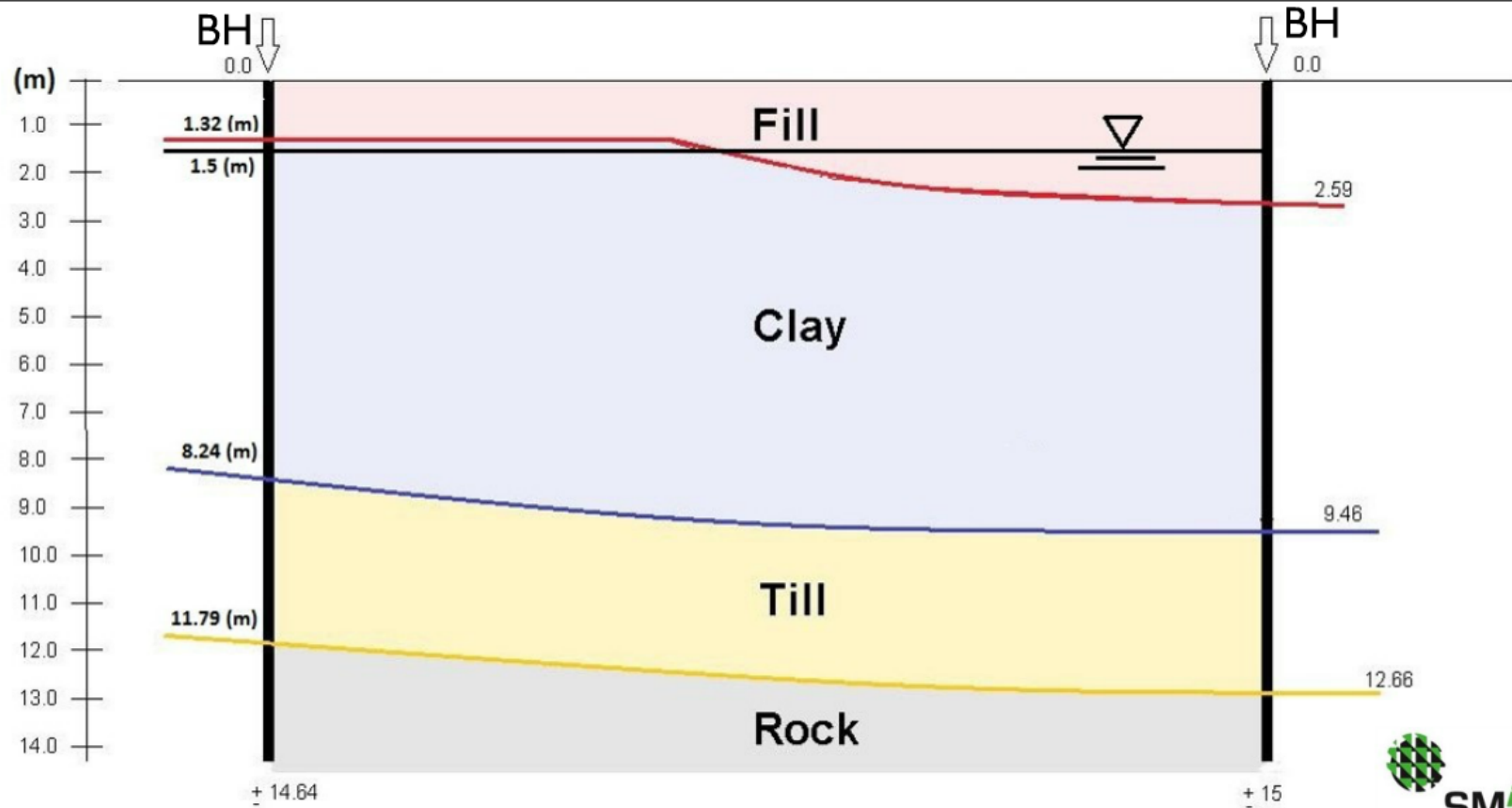
- It is a way of tackling wastes through merging different policies of waste management and waste reduction.
- Waste reduction methods like composting and recycling are also part of integrated waste management systems
- Implementing an integrated system of waste management is quite a complex process.
- To ensure a correct implementation of the system a comprehensive plan consisting of three priorities is required.

Integrated Waste Management

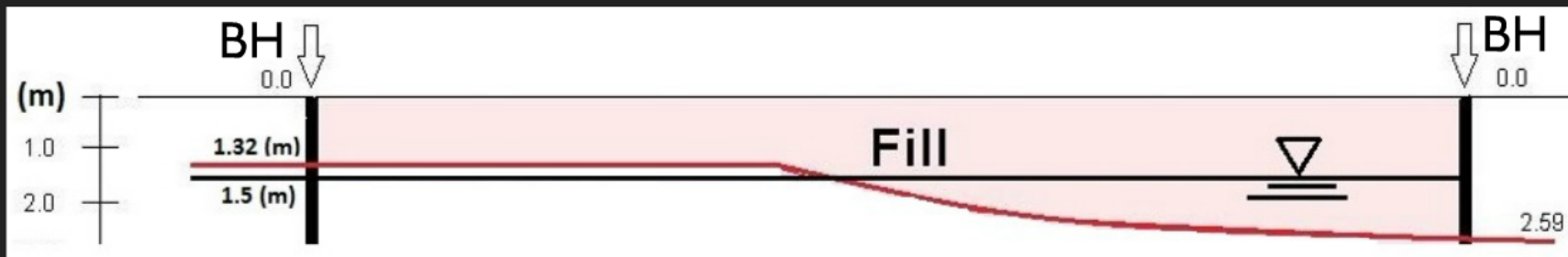
The Three Priorities are :

- **Source Reduction**, also known as waste prevention, aims at reducing unnecessary waste generation. Source reduction strategies may include a variety of approaches.
- **Recycling and Composting**, Recycling is a process that involves collecting, reprocessing and recovering. While, Composting is the conversion of materials that are rich in nutrients to soil additives.
- **Disposal**, in particular through the use of landfills and combustion, are the activities undertaken to manage waste materials that are cannot be prevented or recycled.

Soil Profile



Fill

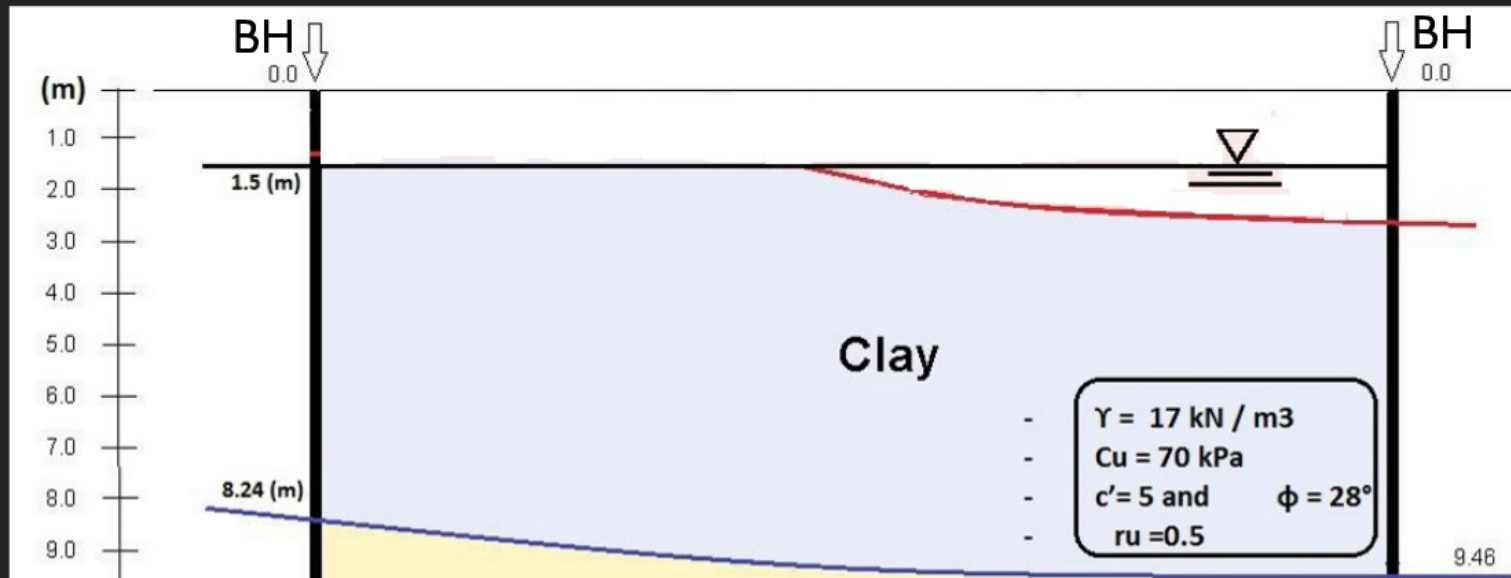


- Thickness = 2m
- $\gamma = 17 \text{ kN/m}^3$
- $\dot{C} = 0 \text{ kPa}$
- $\Phi = 26^\circ$
- $r_u = 0.5$

The fill consists of :

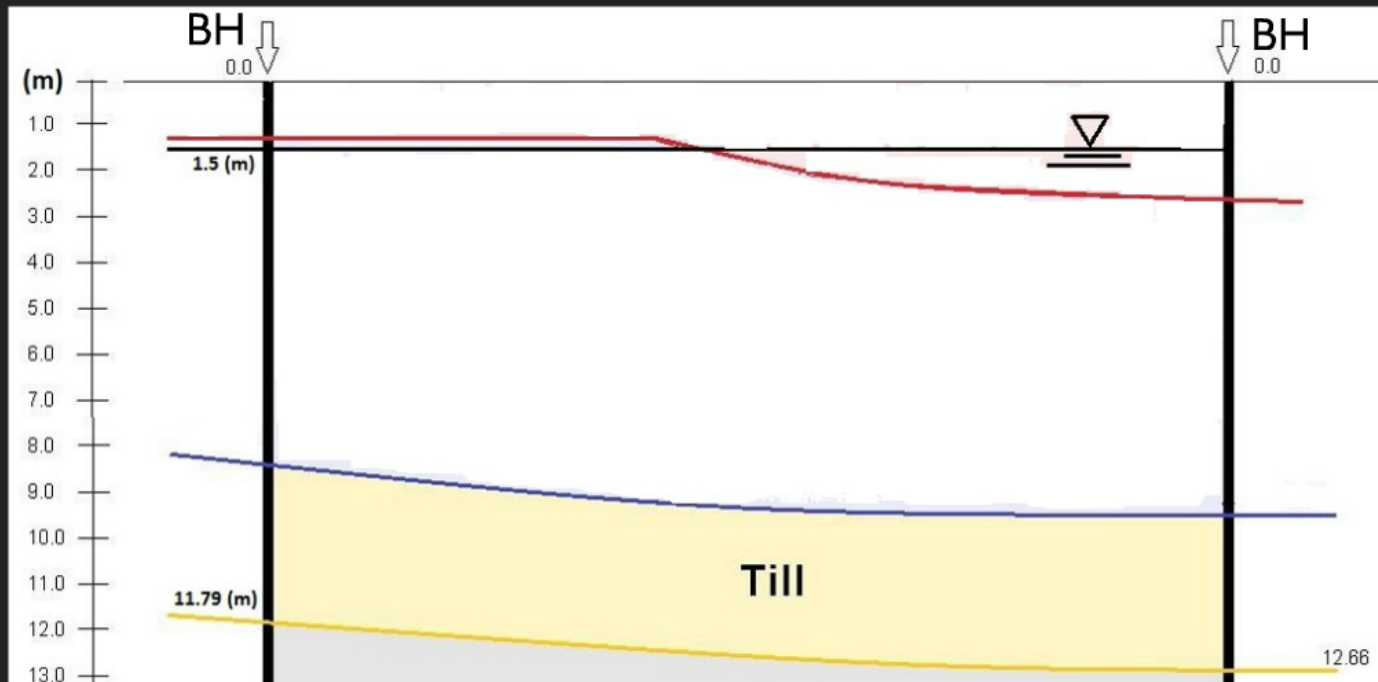
- Sand (93.6 %)
- Gravel
- Silts (6.4 %)

Clay



Sample	Depth (m)	W (%)	σ'_p (kPa)	σ'_{vo} (kPa)	Cr	Cc	e0	$\sigma'_p - \sigma'_{vo}$ (kPa)
BH-01 ;	8.24-9.48	66.14	310	32	0.0702	6.467	1.822	278

Till



- Thickness = 3.3m
- $\gamma = 18 \text{ kN/m}^3$
- $\dot{C} = 0 \text{ kPa}$
- $\Phi = 32^\circ$
- $r_u = 0.5$

- The fill consists of :
- Sand (37.98 %)
 - Gravel (11.64 %)
 - Silts (50.38 %)

Bearing Capacity

- The ultimate bearing capacity of a foundation can be determined by the Meyerhof equation:

$$q_u = c N_c F_{cs} F_{cd} F_{ci} + q N_q F_{qs} F_{qd} F_{qi} + \frac{1}{2} \gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

*By considering for the clay: $C_u = 70$ kPa, $\varphi = 0$ and $\gamma = 18$ kN/m³

- Safe net bearing capacity (q_{ns}) is the net soil pressure which can be safely exerted to the soil factoring in shear failure only.

$$q_{all} = \frac{q_u}{FS}$$

Bearing capacity of clay layer

q_{all} (net) = 180 kpa

Settlement

- As a result of the stress exerted vertically on the landfill by the disposed material, settlement of the clay is expected.

$$\Delta S = \frac{C_c}{1 + e_o} \log \left(\frac{P_2}{P_1} \right) H$$

C_c = Recompression index

P_1 and P_2 are applied pressure on a given point before and after the application of the foundations ($P_2 = P_1 + \Delta P$)

e_o = Void ratio

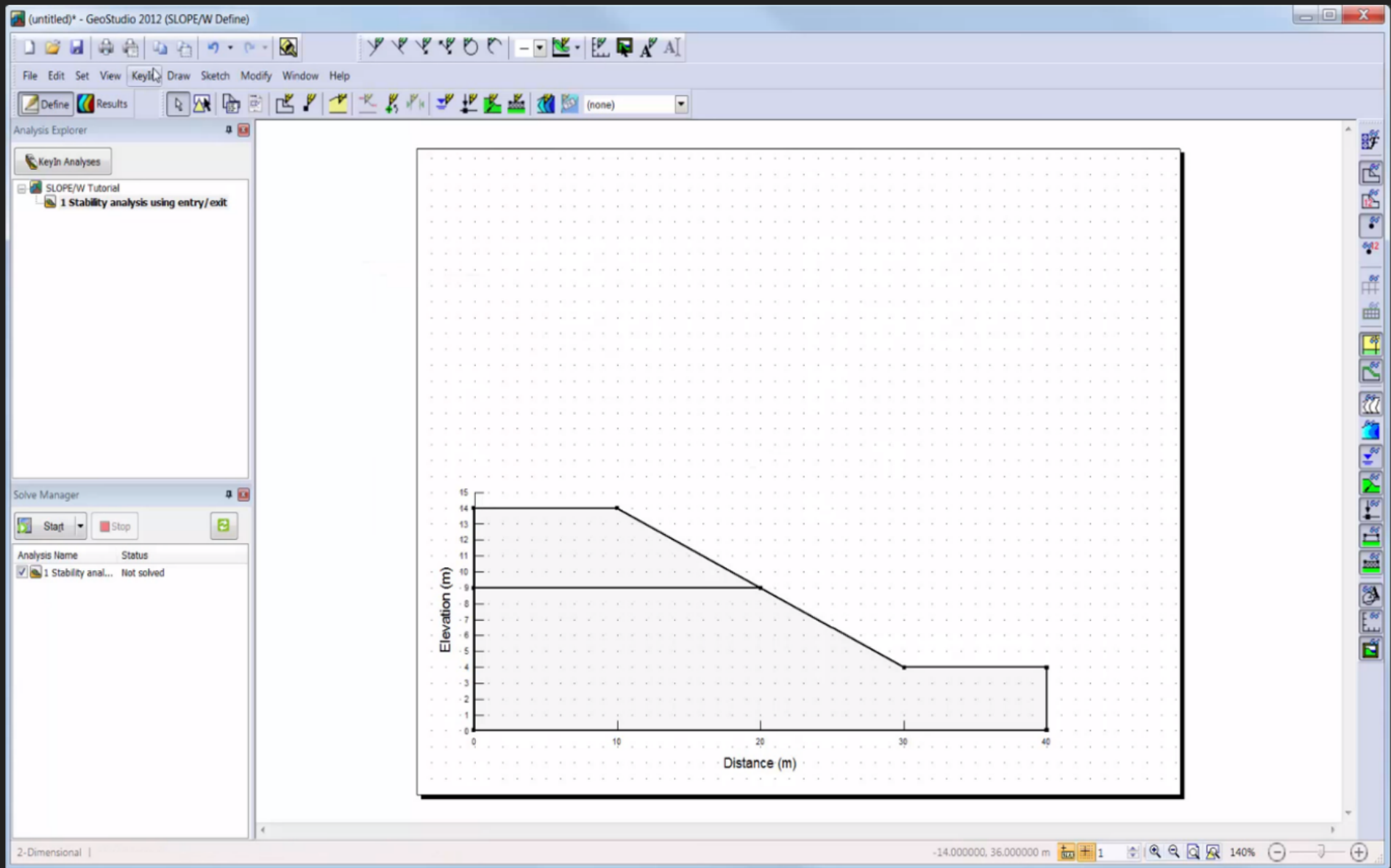
(Das, 1999)

Settlement of clay layer	0.018 m (accepted)
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Height and Depth

- The maximum height of the landfill is determined by the two parameters which are :
 - Bearing capacity
 - Settlement.
- The minimum depth of the clay during the ground excavation is determined to be 4 meters.

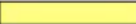
Slope Stability (GEO-Slope)




Slope Stability (GEO-Slope)

KeyIn Materials

Materials

Name	Color
Upper soil layer	

Add ▾
Delete
Assigned...

Name: Upper soil layer Color:  Set...

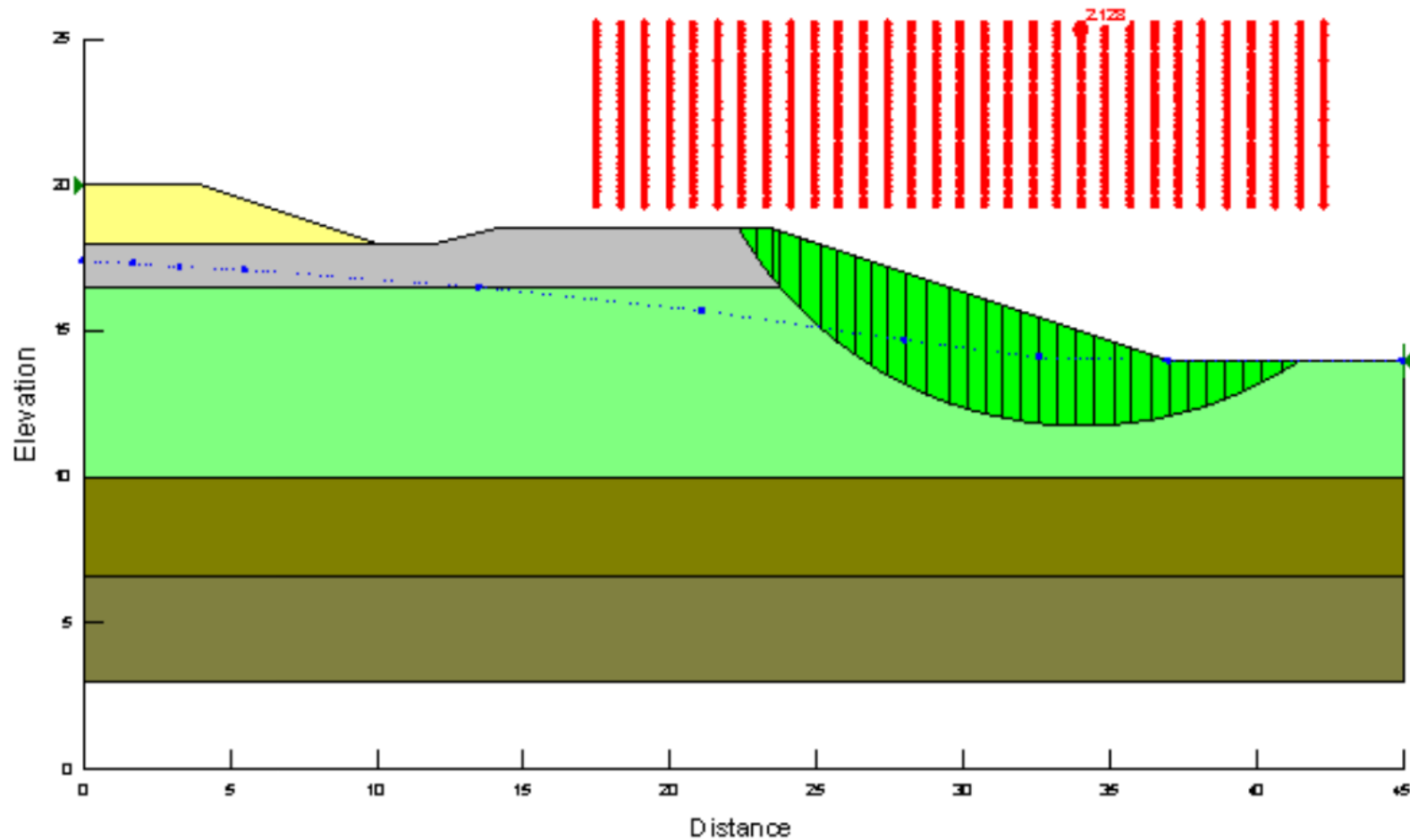
Material Model: Mohr-Coulomb ▾

Basic | Suction | R Envelope | Liquefaction | Advanced

Unit Weight: 0 kN/m³ Cohesion: 0 kPa
Phi: 0°

Undo ▾ Redo ▾ Close

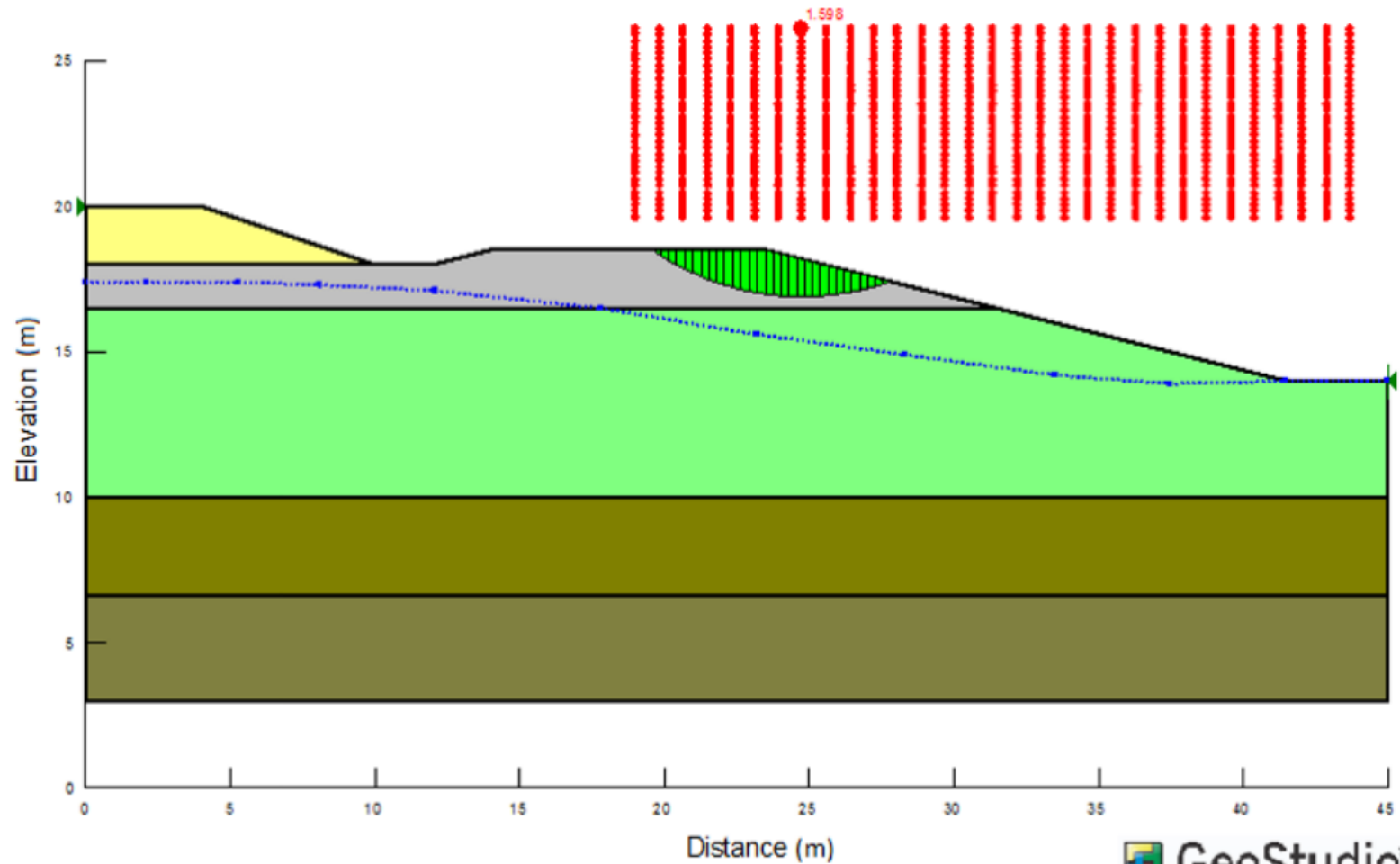
Slope Stability (GEO-Slope)



Slope stability calculation 3H : 1V (without earthquake)

 GeoStudio®

Slope Stability (GEO-Slope)



Slope stability calculation 4H : 1V (With earthquake)

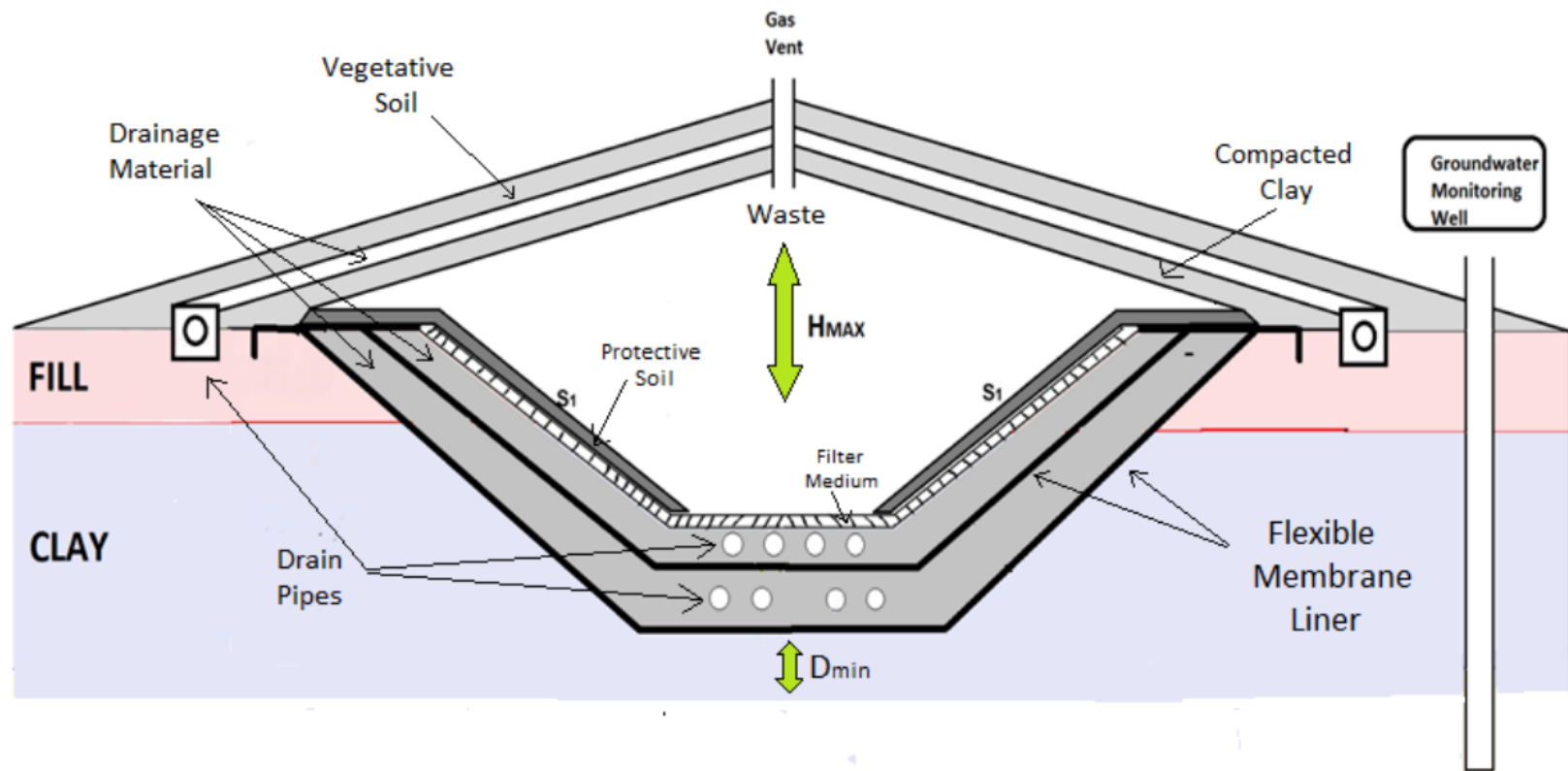
Slope Stability (Results Obtained)

	Slope Stability	
Slope Dimension	With Earthquake (FS > 1.1)	Without Earthquake (FS > 1.3)
3H : 1V	1.014	2.128
4H : 1V	1.598	2.548

Landfill Parameters (Design Results)

Parameters	Result
Bearing capacity of clay layer	$q_{all} \text{ (net)} = 180 \text{ kpa}$
Maximum height of the landfill	$H_{max} = 10 \text{ m}$
Slopes #1	$S1 \rightarrow 4H : 1V$
Slopes #2	$S2 \rightarrow 3H : 1V$
Minimum depth of excavated clay to prevent swelling	$D_{min} = 4 \text{ m}$
Settlement of clay layer	0.018 m (accepted)

Configuration of Proposed Landfill



Flexible Membrane Liner

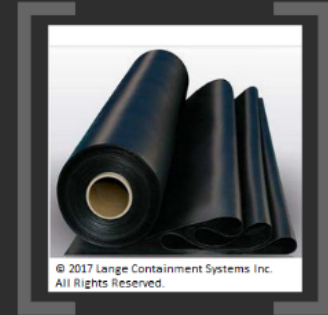
Purposes:

- To prevent leachate from seeping into groundwater.

To prevent landfill gas from migrating out of the landfill below grade.

Proposed Materials:

- High Density Polyethylene (HDPE).



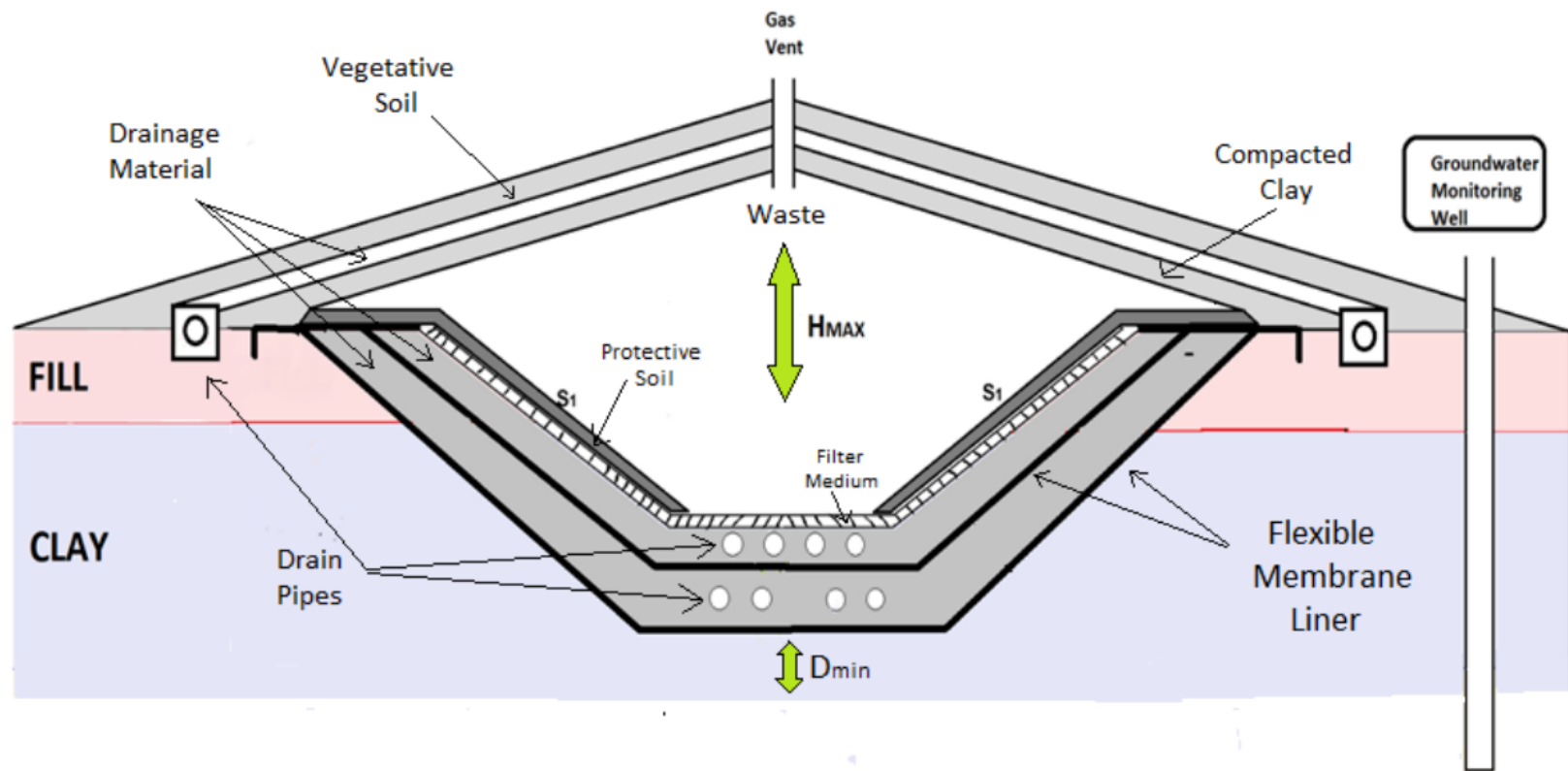


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Configuration of Proposed Landfill

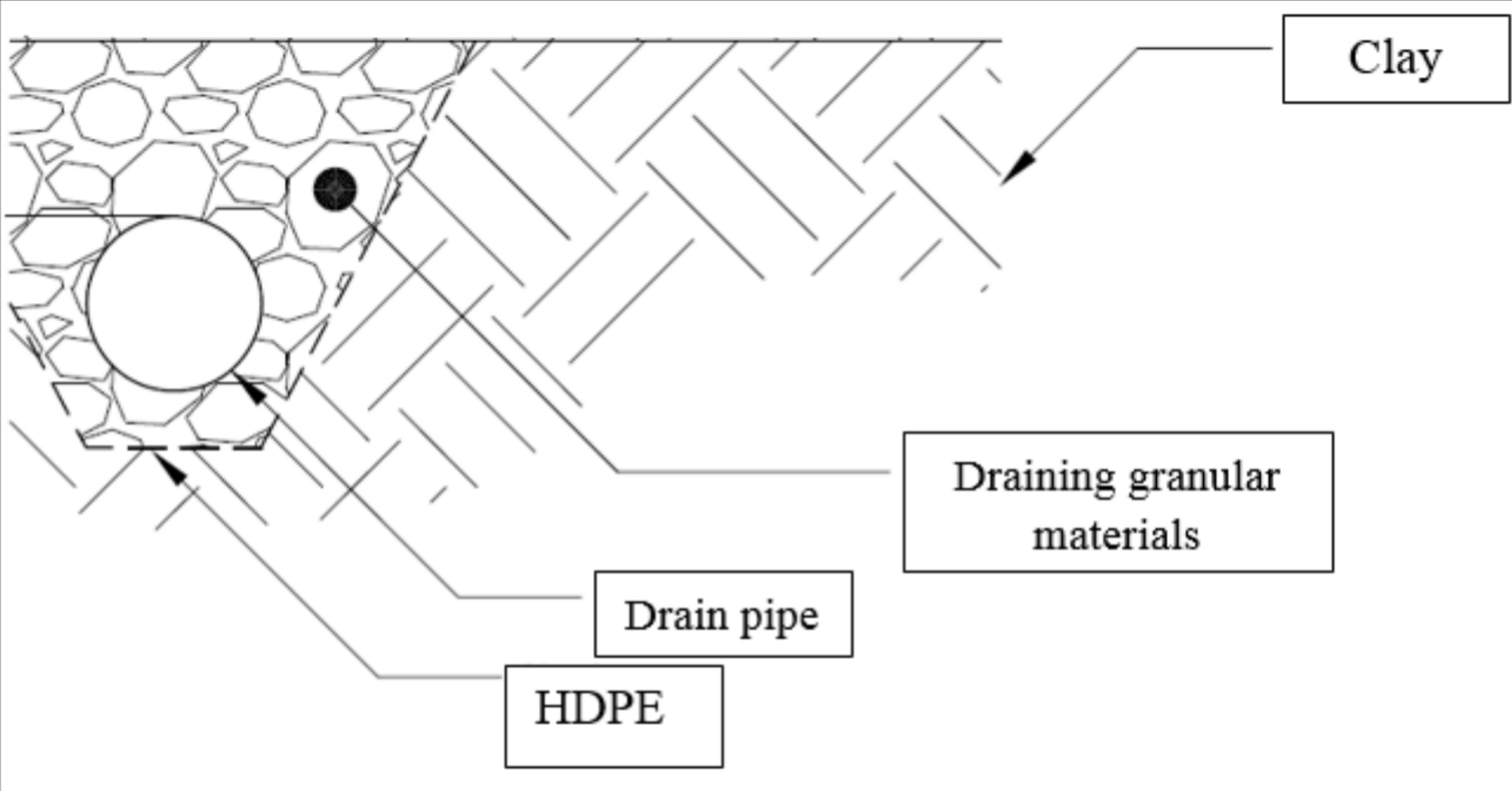


Draining System

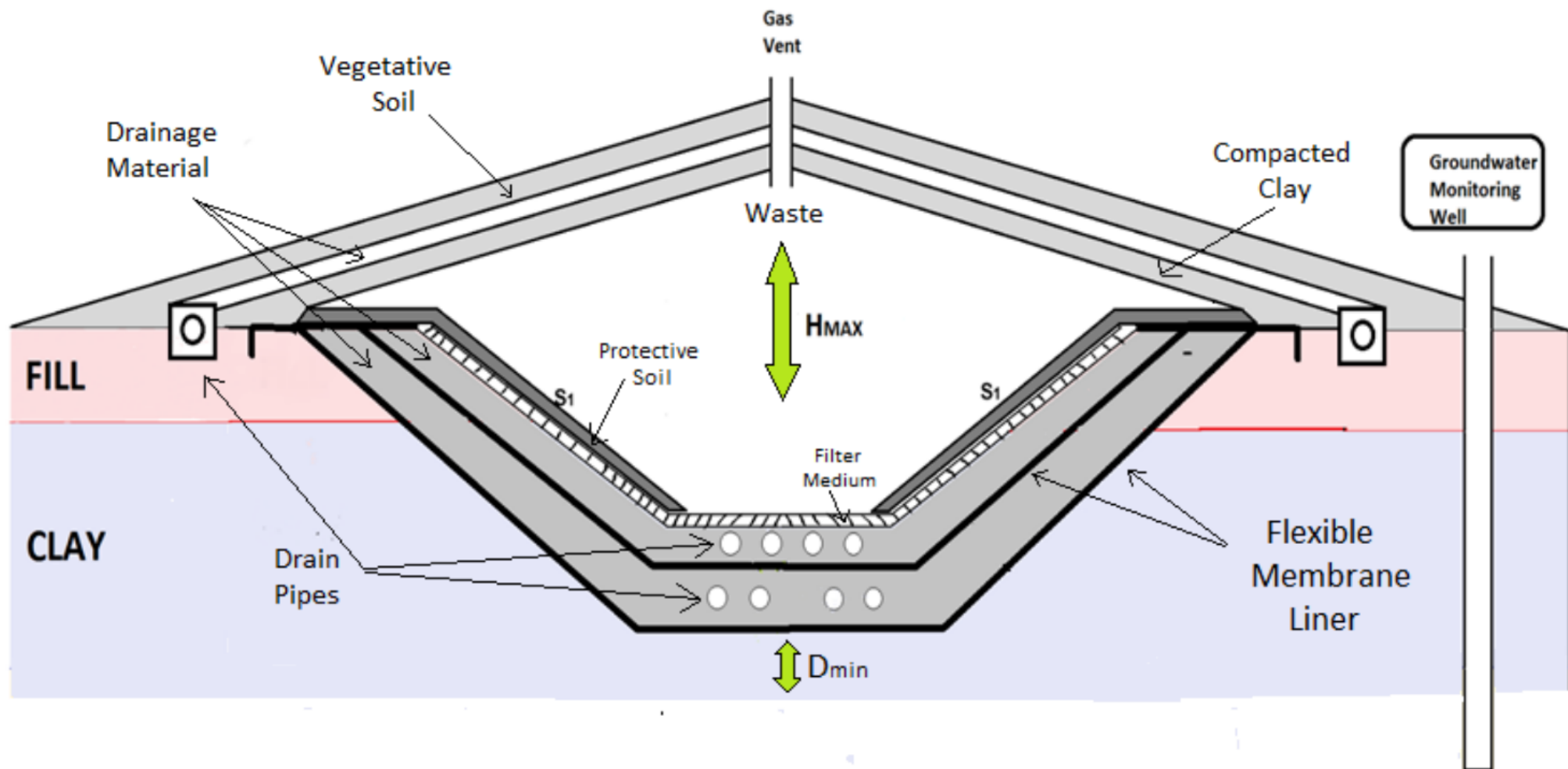
Requirement:

- Installing drainage pipes at the peripheral sides and base of the landfill.
- Protective layer (Compacted Crushed Stone) minimum thickness 30 cm
- Flexible membrane layer for segregation between layers.

Draining System



Configuration of Proposed Landfill



Gas Monitoring System

Purposes:

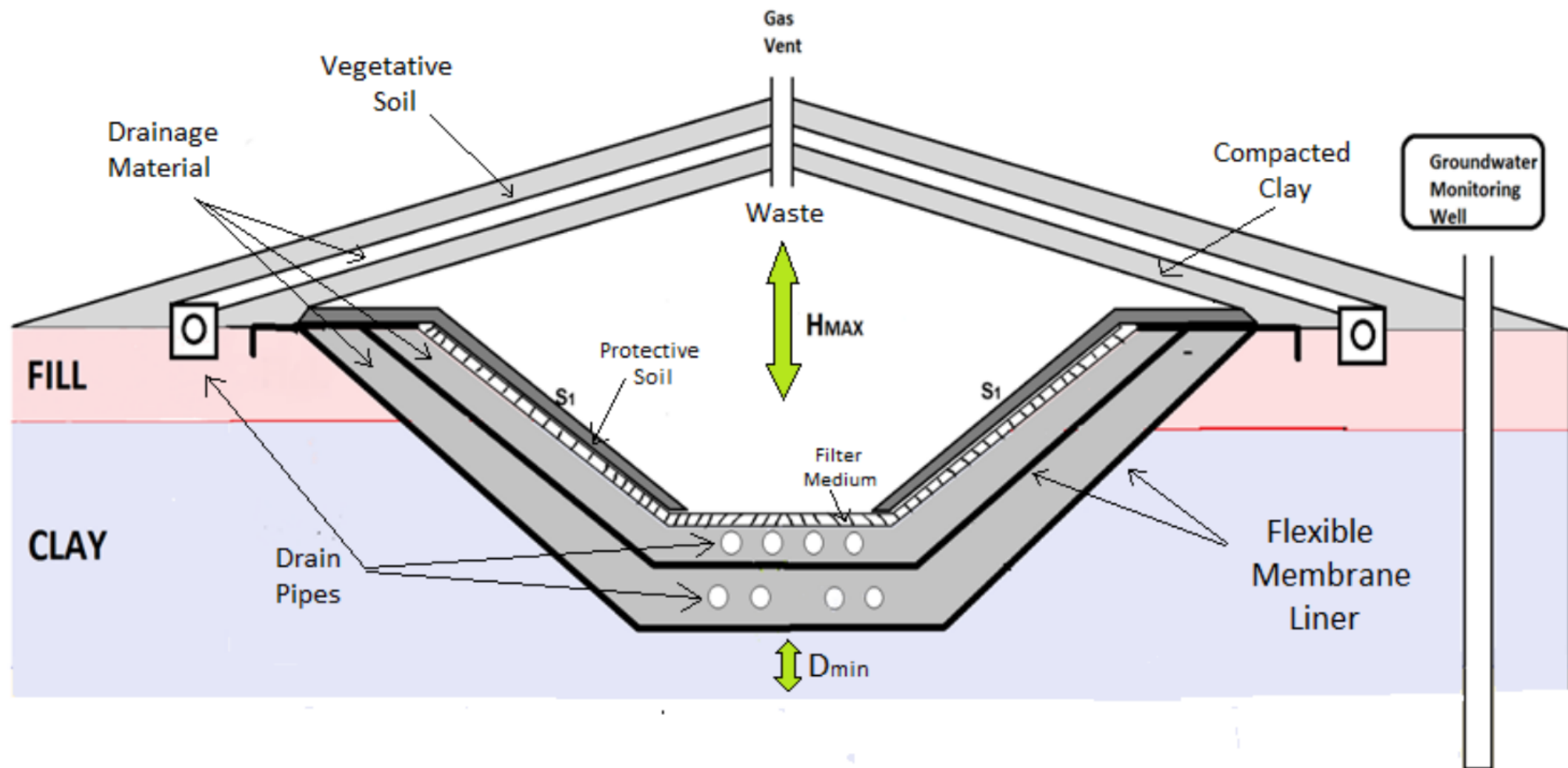
- To characterize gas production within the landfill.
- To detect any methane moving out of the landfill either below grade or through the final cover system.

Groundwater Monitoring System

Purpose

- To detect any groundwater contamination caused by the landfill.

Configuration of Proposed Landfill



Final Cover System

Composed of:

- Low Permeability Layer (Compacted Clay)
- Protective Layer (Compacted Crush Stones)
- Vegetative soil (Fill layer)

Final Cover System

Final Cover System

Composed of:

- Low Permeability Layer (Compacted Clay)
- Protective Layer (Compacted Crush Stones)
- Vegetative soil (Fill layer)

Purposes

- To minimize leachate production by shedding precipitation rather than allowing it to percolate through waste.
- To prevent leachate pop-outs.
- To provide a barrier (along with the protective layer) between the waste and receptors.
- To prevent uncontrolled emission of landfill gas into atmosphere through top of landfill.
- To provide a durable, low maintenance surface.

Conclusion

- Landfills form one of the major parts of an integrated waste management system.
- If properly designed and managed in the context of available infrastructure and resources, landfills will provide the simple and utmost cost-effective way of disposing of wastes.
- If not probably designed especially in the disposal of hazardous waste, landfill like any other designed system may fail and lead to dire consequences to the environment.

Conclusion

- The Geotechnical and geo-environment investigation carried out in this project demonstrated that it is feasible to design a landfill containing heavy materials, in a clayey ground.
- However, landfills should not be considered as the sole means of dealing with waste in the region.

*Thank
you*



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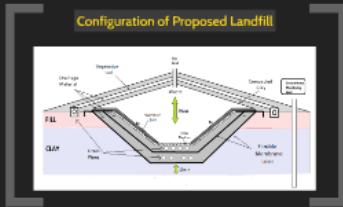
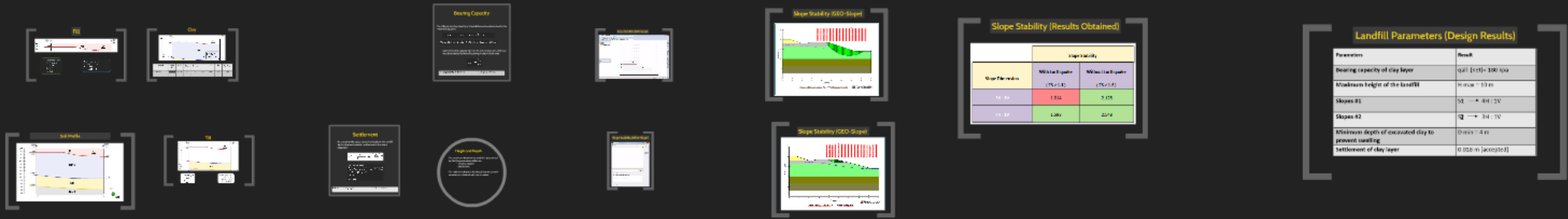


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Possible Hazardous Leaker

Proposed:
 To prevent leachate from seeping into groundwater
 To prevent landfill gas from escaping and to be used for energy
 Proposed Materials:
 High Density Polyethylene (HDPE)

Final Cover System

Proposed:
 To prevent leachate from seeping into groundwater through the landfill
 To prevent landfill gas from escaping and to be used for energy
 To prevent the escape of landfill gas into the atmosphere
 To prevent the escape of landfill gas into the atmosphere
 To prevent the escape of landfill gas into the atmosphere

Integrated Waste Management

The integrated waste management (IWM) approach is a holistic approach to waste management that considers the entire waste management cycle from generation to final disposal. It involves the coordination of various waste management activities such as collection, transport, treatment, and disposal to ensure that waste is managed in a safe, efficient, and environmentally sound manner.

Objectives

The main objective of IWM is to ensure that waste is managed in a safe, efficient, and environmentally sound manner. Other objectives include the following:

- To minimize the environmental impact of waste management activities.
- To protect public health and safety.
- To conserve natural resources.
- To promote economic development.

Introduction

- Construction and demolition debris is generated when new structures are built and when existing structures are renovated or demolished.
- In other words, C & D waste consist of materials that are derived from activities such as, construction, demolition, development of structures, buildings, roads, bridges, surface covering, sewage systems and remnants of materials such as, glass, slabs wood, and Asphalt.
- These materials are estimated to account for about 50% of the disposed waste stream.

Outline

- Introduction
- Objectives
- Scope
- Methodology
- Results and Discussion
- Conclusion



Conclusion

The Contaminated and/or uncontrolled demolition and construction debris is hazardous to the environment and to the health of the community. It is a major source of heavy metals, in a clayey ground.

Hazardous materials should not be discarded in the site without dealing with waste management.

Conclusion

- Landfills form one of the major parts of an integrated waste management system.
- If properly designed and managed in the context of available infrastructure and resources, landfills will provide the most efficient and most cost-effective way of disposing of waste.
- If not properly designed especially in the disposal of hazardous waste, landfills like any other designed system may fail and lead to the consequences to the environment.