

# Landfill design – General principles

- Average height of a landfill should be **at least 15 m**
- Each section (**cell**) should accommodate waste to be landfilled during **5 years period**
- Sections/cells should be hydraulically separate from each other
- Leachate should **ideally** flow from the landfill to the leachate pond(s) only by gravity
- Minimum 2 leachate ponds (so one can be cleaned or repaired if necessary)
- Enough space between landfill border and ring road (for drainage trenches and future capping system)

# Landfill design - Surface water management systems

## Surface water drainage is required to ensure that:

- Rainwater runoff does not drain into the waste from surrounding area.
- Rainfall does not generate excessive leachate.
- Contaminated surface runoff from the operational landfill area does not enter water courses.
- Slopes on the landfill are protected from infiltration and erosion.
- Final cover soils are not subject to ponding.

These requirements can be achieved through the provision of surface water drainage systems

# Landfill design - Surface water management systems

## Design considerations

- The surface water drainage system performs the function of collecting and transporting run off from the landfill and surrounding area to drains at the periphery of the landfill
- The design of surface water drains is usually based on storm events with specified return period and duration of rainfall (longer return periods will lead to systems with greater capacities → at a higher Cost)
- The peak discharge rate and run off volume during peak discharge should be determined
- Surface water drains can take the form of piped systems or open channels:

# Landfill design - Surface water management systems

**Piped Systems** : Groundwater/surface water drains are typically 300-400 mm, precast concrete. The pipe bedding and surround material is critical.

**Open Channels** diversion ditches are usually sized based on the Manning's Formula



Flow rate design is usually based on rational formula for basins up to 81 ha:

*In Metric units:*

$$Q = CiA / 360$$

- Q = peak rate of runoff (m<sup>3</sup>/sec)
- C = runoff coefficient
- i = rainfall intensity (mm) during time of concentration of drainage area (mm/hr)
- A is basin area (ha)

# Landfill design - Leachate management systems

## Leachate

It consists of all water which comes in contact with waste, generated by precipitation water on the landfill body, water content of waste stored or infiltration of groundwater, requires **collection, removal** and **treatment**.

## Goals of leachate collection systems

The primary criterion for design of the leachate system is that all leachate be collected and removed from the landfill at a rate sufficient to prevent an unacceptable hydraulic head occurring at any point over the lining system.

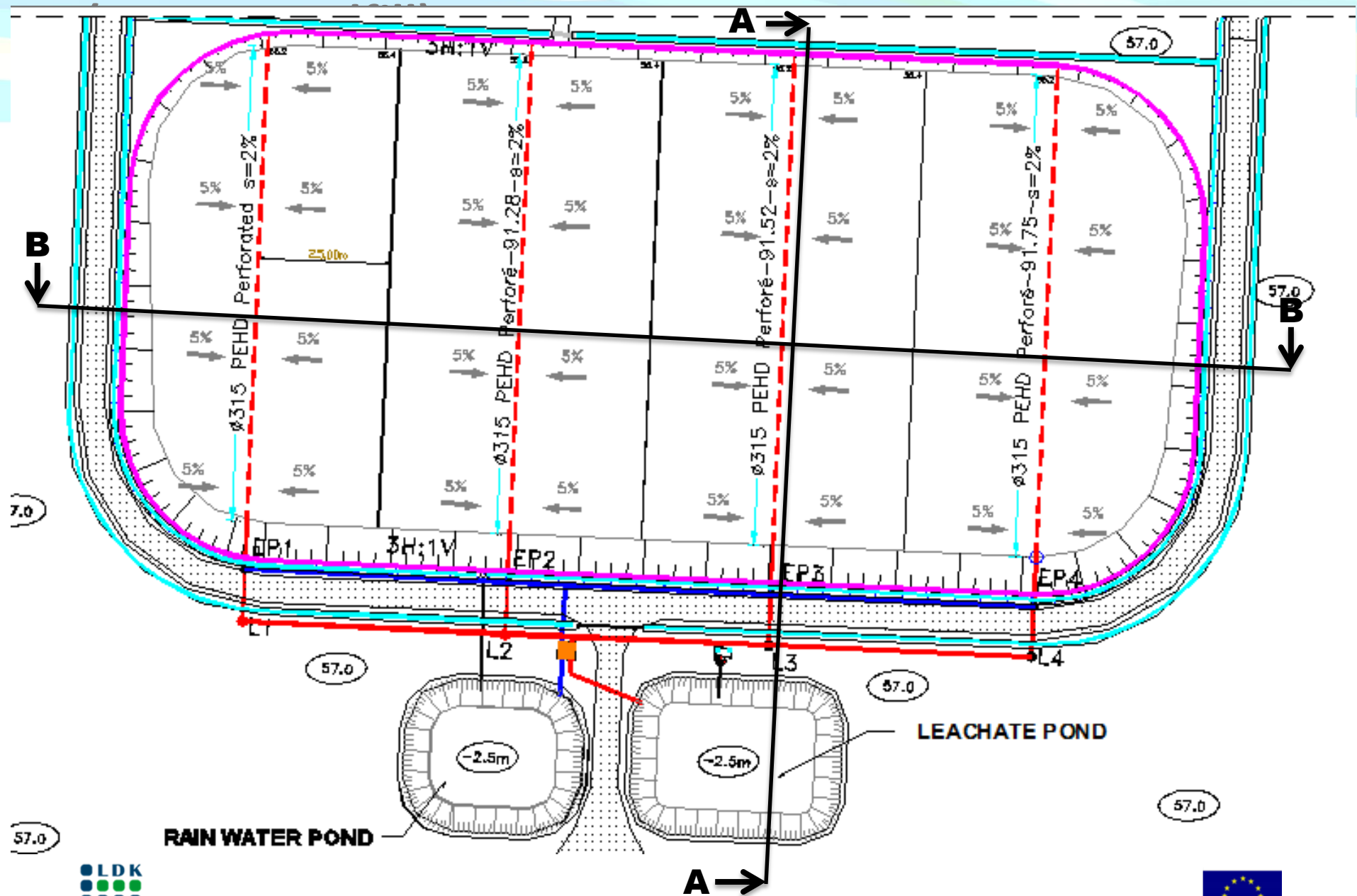
## Components of leachate collection systems

There are many components to a collection system including **pumps, manholes, discharge lines** and liquid level monitors. However, there are four main components which govern the overall efficiency of the system. These four elements are **liners, filters, pumps** and **manholes**.

# Landfill design - Leachate management systems

Factors that influence leachate generation	Estimating leachate generation in active landfill
<ul style="list-style-type: none"><li>• Precipitation</li><li>• Ground-water intrusion</li><li>• Moisture content of waste (Particularly if sludge or liquids are disposed)</li><li>• Daily cover during filling period</li><li>• Final cover design</li></ul>	$L_A = P + S - E - W_A$ <p><math>L_A</math> = leachate from active area <math>P</math> = precipitation <math>S</math> = pore squeeze liquid from waste <math>E</math> = evaporation <math>W_A</math> = waste moisture adsorption</p> <p>(all in units in L<sup>3</sup>/T)</p>

# Landfill design - Leachate management systems

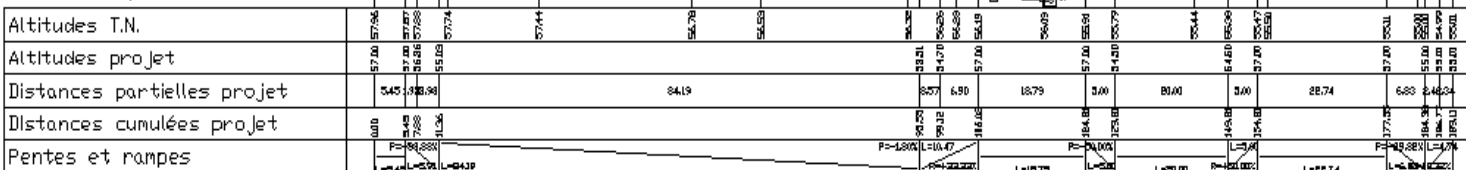


# Landfill design - Leachate management systems

## Cross-section A-A

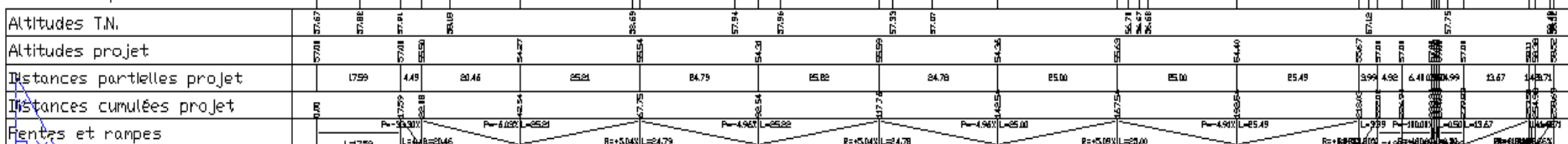
Profil en long n°1

Echelle horizontale :500  
Echelle verticale : 100  
Plan de comparaison :53



Profil en long n°2

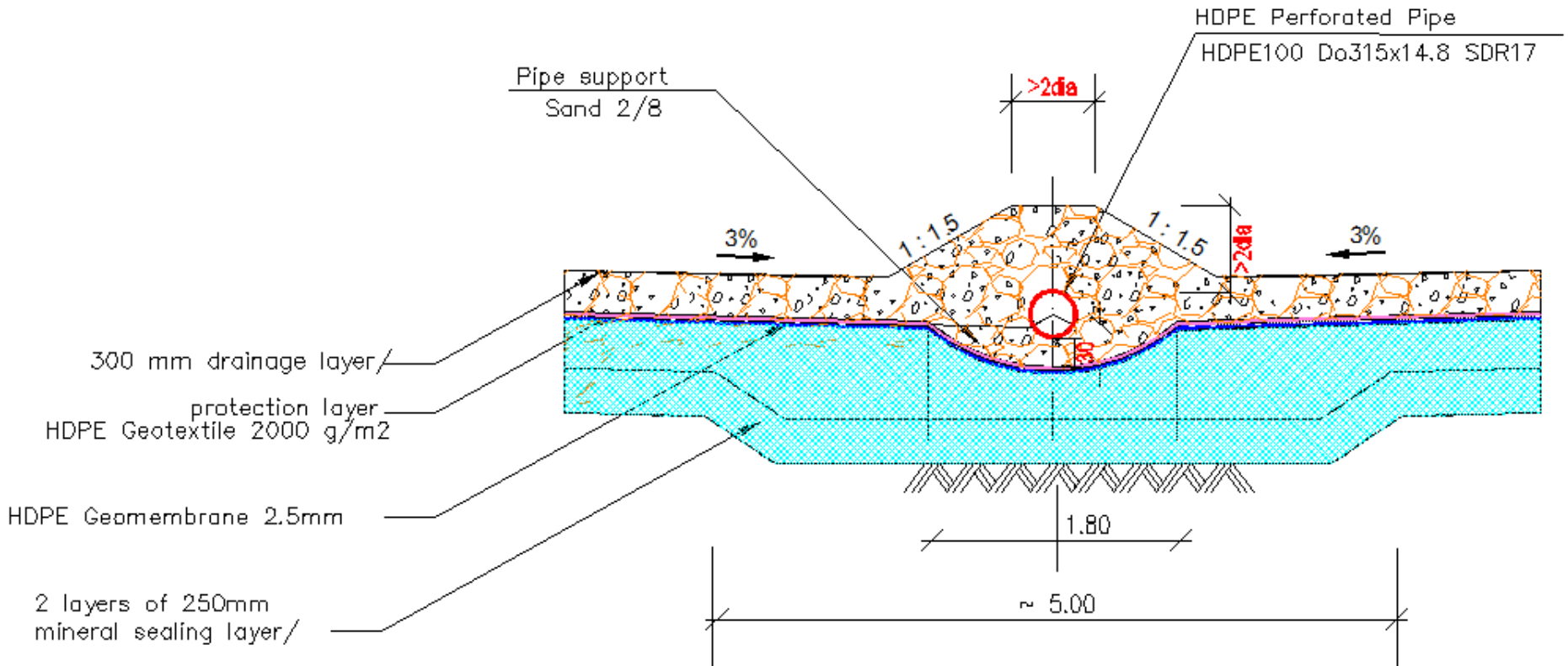
Echelle horizontale :500  
Echelle verticale : 100  
Plan de comparaison :53



## Cross-section B-B



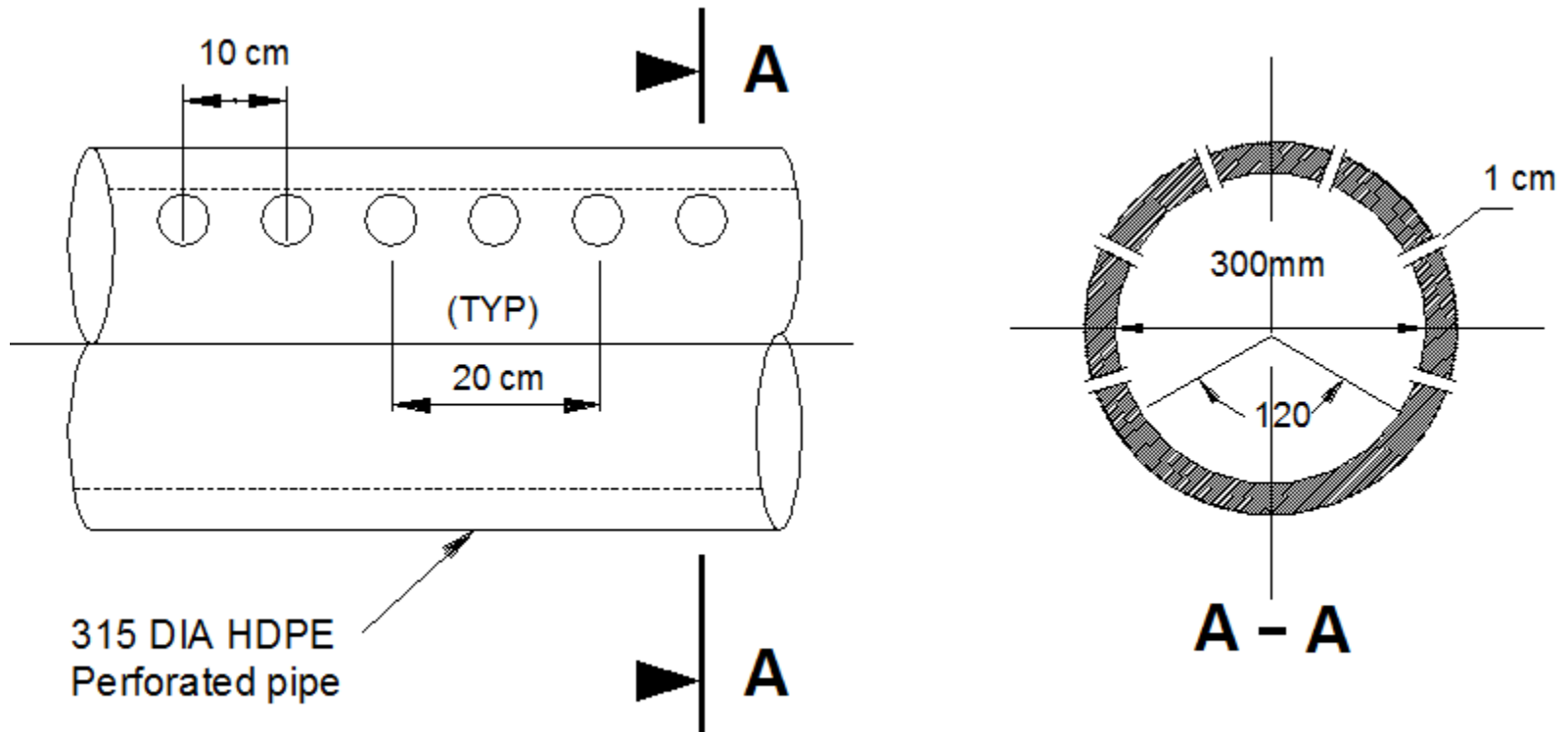
# Landfill design - Leachate management systems – Collection systems



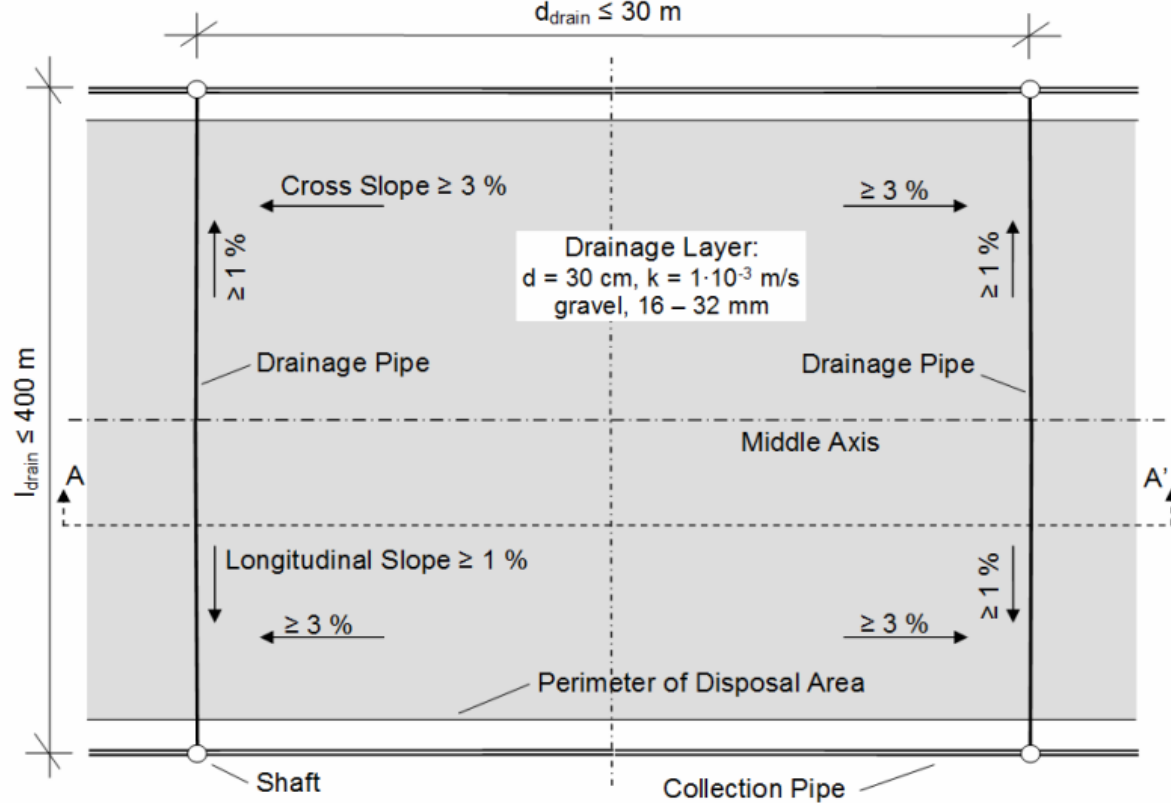
Support of leachate pipes

# Landfill design - Leachate management systems

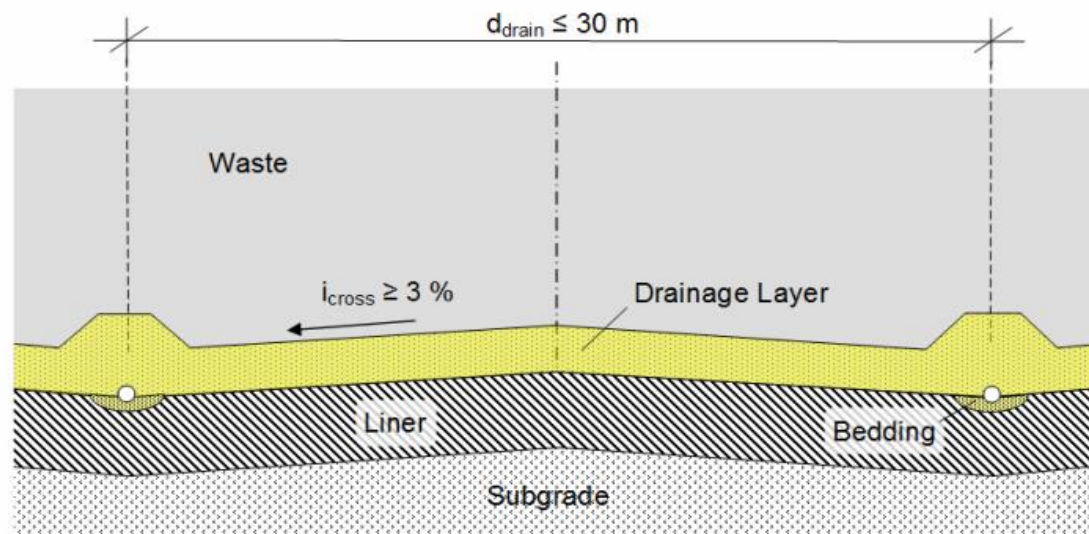
## Collection drain



# Leachate management systems



Part 2: Cross Section A – A'



# Landfill design - Leachate management systems

## Drains spacing

Giroud's equation is used to derive the required spacing between subsurface drainage pipes given the maximum permissible head over the pipes and a number of physical parameters.

The equation is:

$$L = \frac{T_{\max} (2 \cos^2 \beta)}{\sqrt{\tan^2 \beta + 4 \frac{q}{k} - \tan \beta}}$$

Where:

- $L$  = spacing between drainage pipes (m)
- $T_{\max}$  = maximum leachate head over liner (m)
- $k$  = permeability of drainage layer (m/sec)
- $\beta$  = slope of the liner (radians)
- $q$  = leachate seepage rate into drainage layer (m/sec)

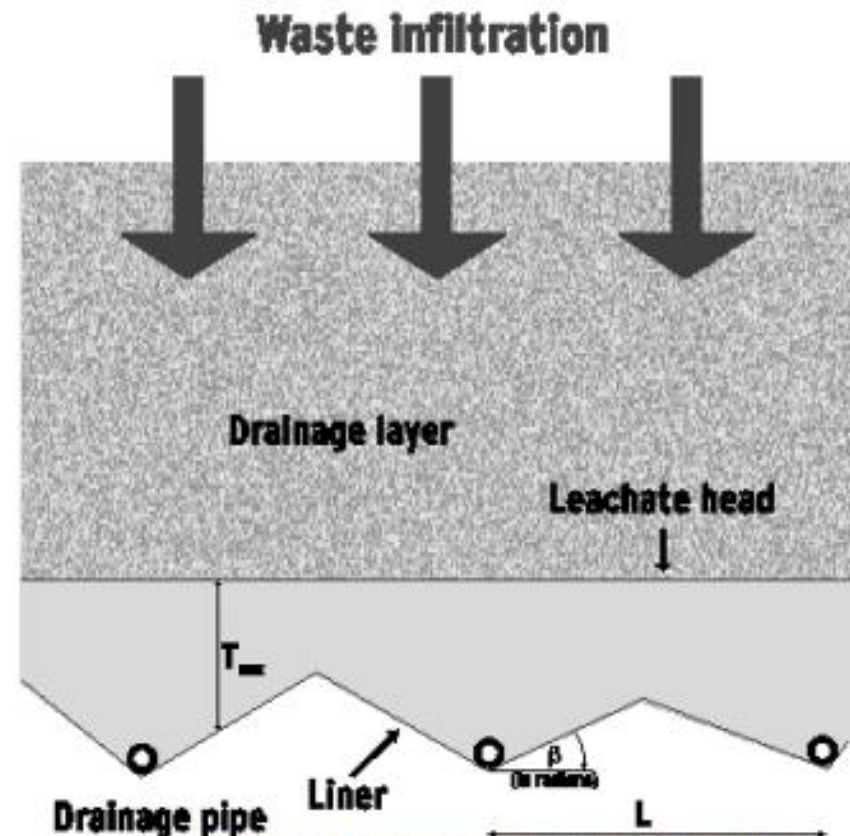


Figure B.2: Parameters for Giroud's equation

# Landfill design - Leachate management systems

## Requirements on the drainage system

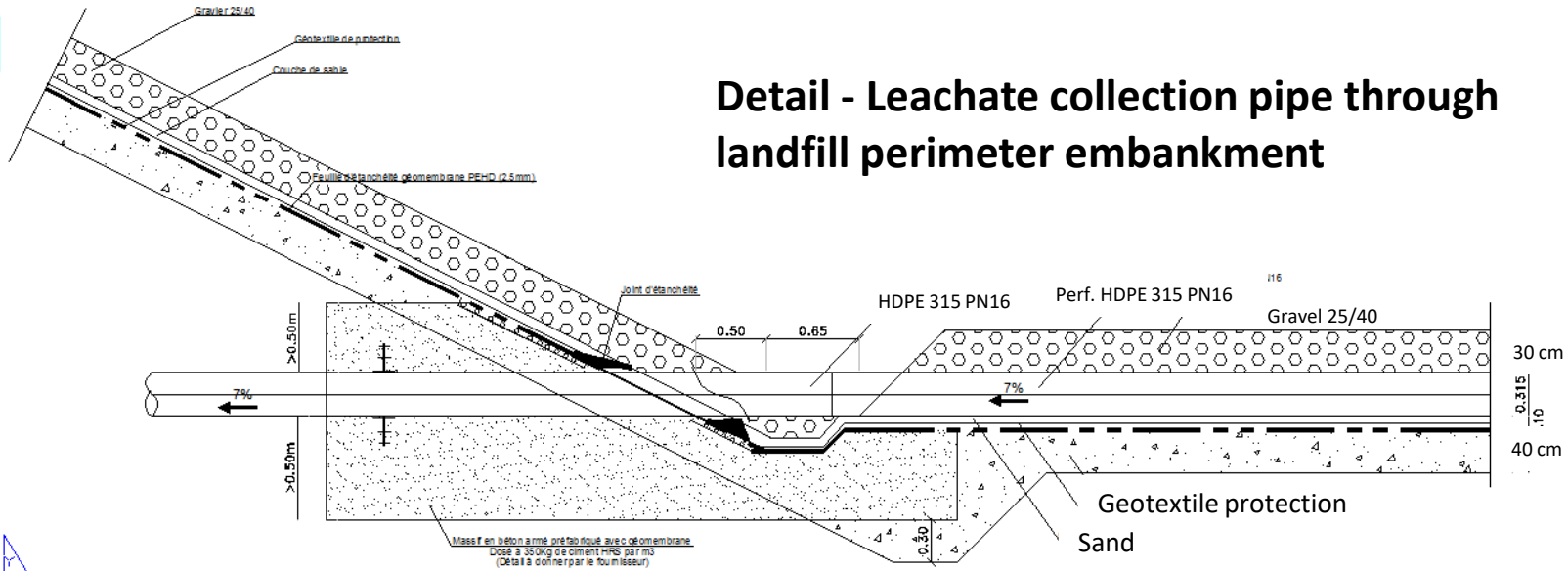
- Slope of the landfill bottom
  - Lateral slope minimum 3 %
  - Longitudinal slope minimum 1.5 %
- Drainage pipes
  - Installed without any deflection
  - Materials: HDPE or PP
  - Minimum (inner) diameter 250 mm
  - Perforation about 100 cm<sup>2</sup> per m pipe

# Landfill design - Leachate management systems

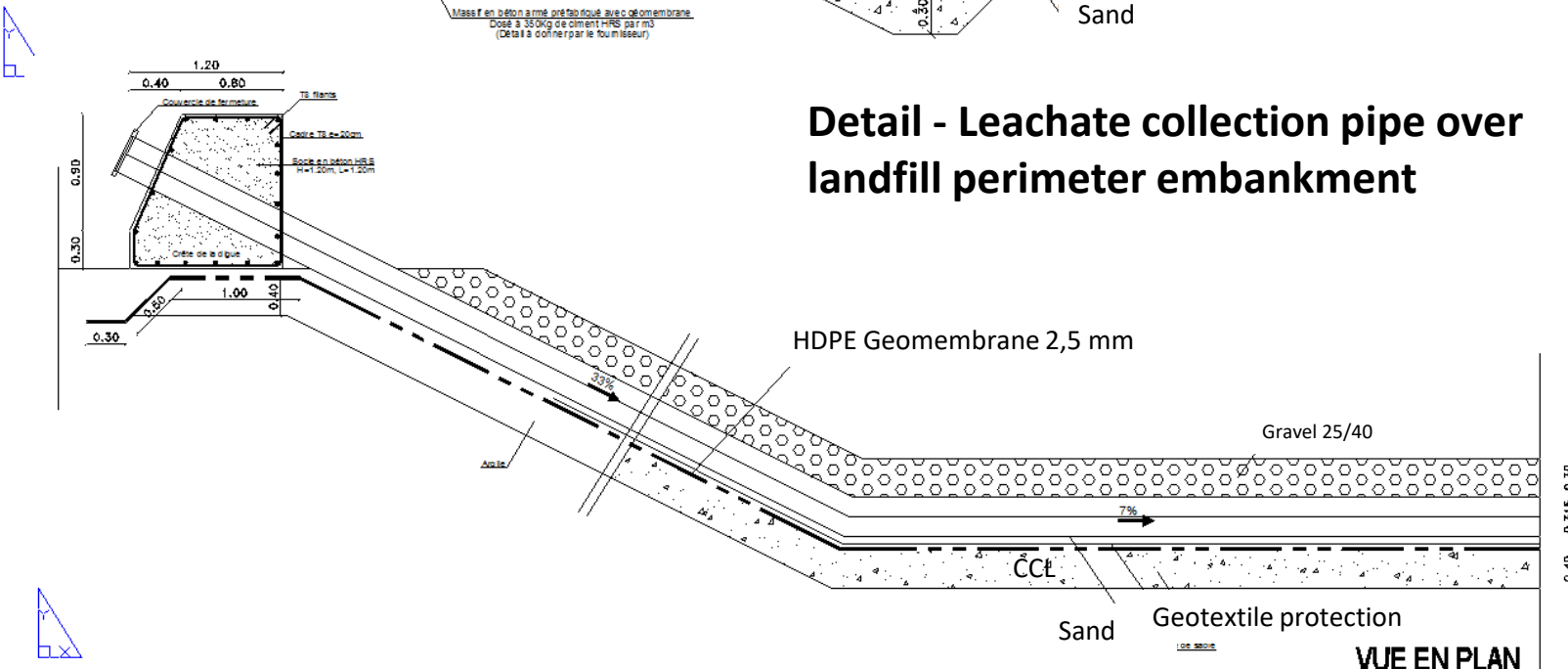
## Requirements on the drainage layer

- Natural gravel or crushed stones with a grain size of minimum about 10 mm to maximum about 40 mm, generally gravel with a grain size of 8/16 mm and 16/32 mm
- Lime content should be minimized but this depends on the availability of gravel with a low lime content, generally lime content must be less than 20 % by weight
- Fine grains less than 5 % by weight
- Coarse grains (>40 mm) less than 5 % by weight
- No grains > 50 mm

# Landfill design - Leachate management systems



**Detail - Leachate collection pipe through landfill perimeter embankment**



**Detail - Leachate collection pipe over landfill perimeter embankment**

