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Leachate Collection and Treatment

***Seventh interregional exchange of
experience meeting of COCOON***

Part A

Leachate Collection

Content

- 1. Leachate collection – design principles**
- 2. Drainage layer**
- 3. Leachate collection pipes**
- 4. Dam penetration**
- 5. Leachate control shafts (manholes)**

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1. Design principles

A leachate collection system consists of:

- *Drainage layer above base sealing system*
- *Leachate collection pipes (drainage pipes)*
- *Manholes (outside of dumping area!)*
- *Leachate transport pipes (from manholes to storage pond or basin)*
- *Leachate storage ponds, basins or tanks*

Sometimes it includes (should be avoided):

- *Manholes within the dumping area*
- *Tunnels beneath or on landfill bottom*

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Leachate Collection and Storage

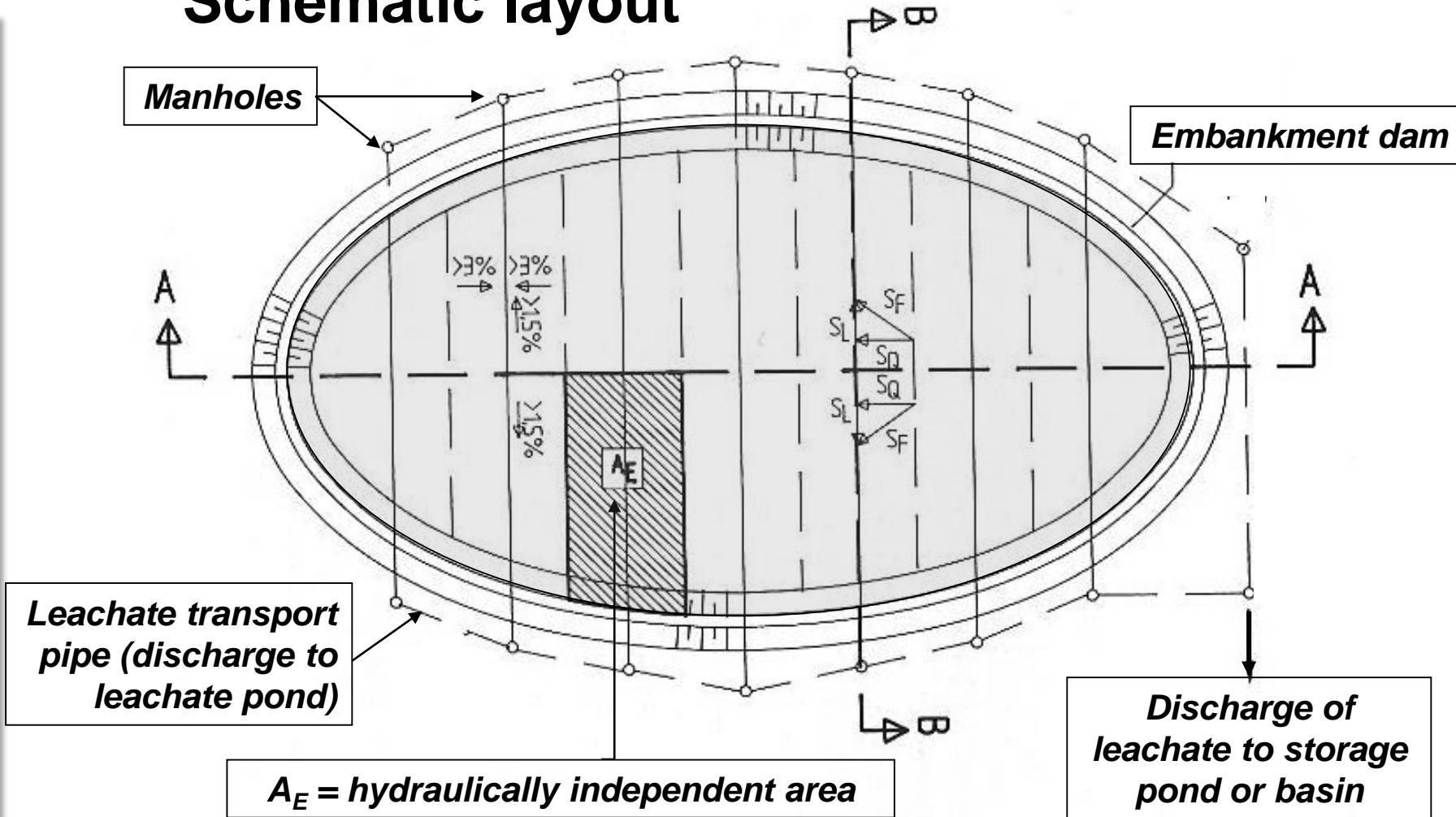
Most important design principles -1:

- Try to design cells and/or sub-cells which are hydraulically independent from each other.
- Leachate shall be discharged to the storage pond or basin whenever possible by gravity flow. This means the leachate pond or basin must be located at the deepest point of the landfill site.
- Please allow space for minimum 2 leachate storage ponds or basins, so that one of them may be closed, emptied and cleaned or repaired without problem.

Most important design principles - 2:

- **Leachate collection pipes (drainage pipes) should have a minimum incline of 1.5 % (considering settlement of landfill bottom)**
- **The minimum incline towards the leachate collection pipes (transverse gradient) should be 3 % minimum**
- **Leachate collection pipes shall be designed without any curve or off-axis angle**
- **Leachate collection pipes shall end in a manhole (outside of sealed landfill area)**
- **The distance between leachate collection pipes should be maximum about 50 m**

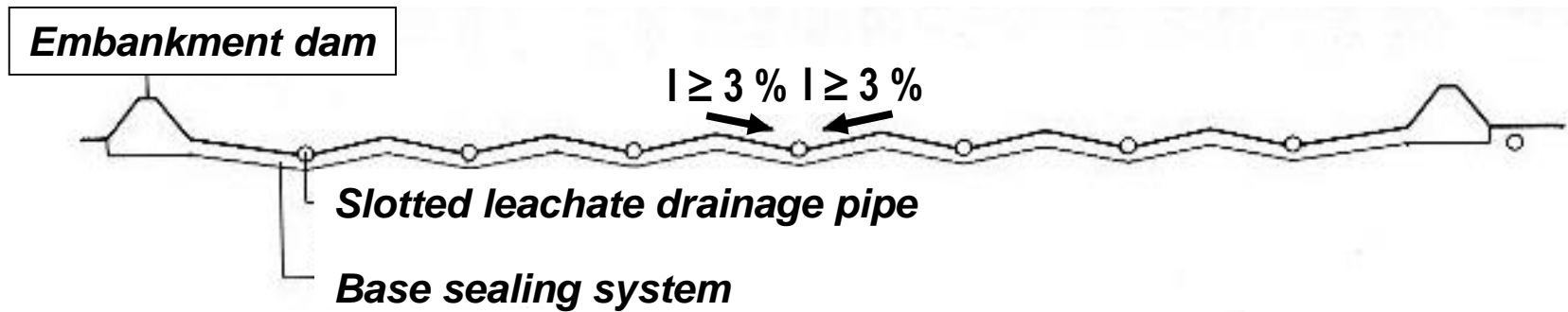
Schematic layout



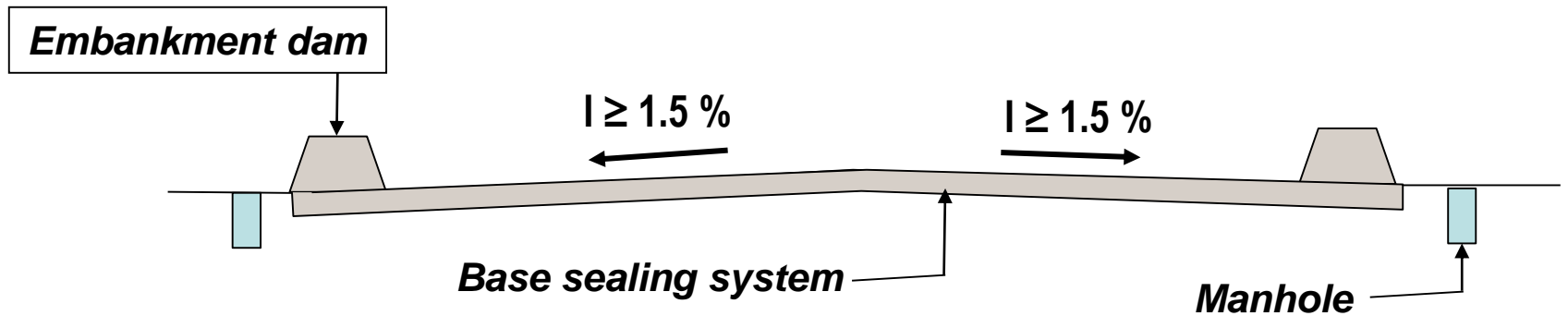
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Cross section A - A



Cross section B - B



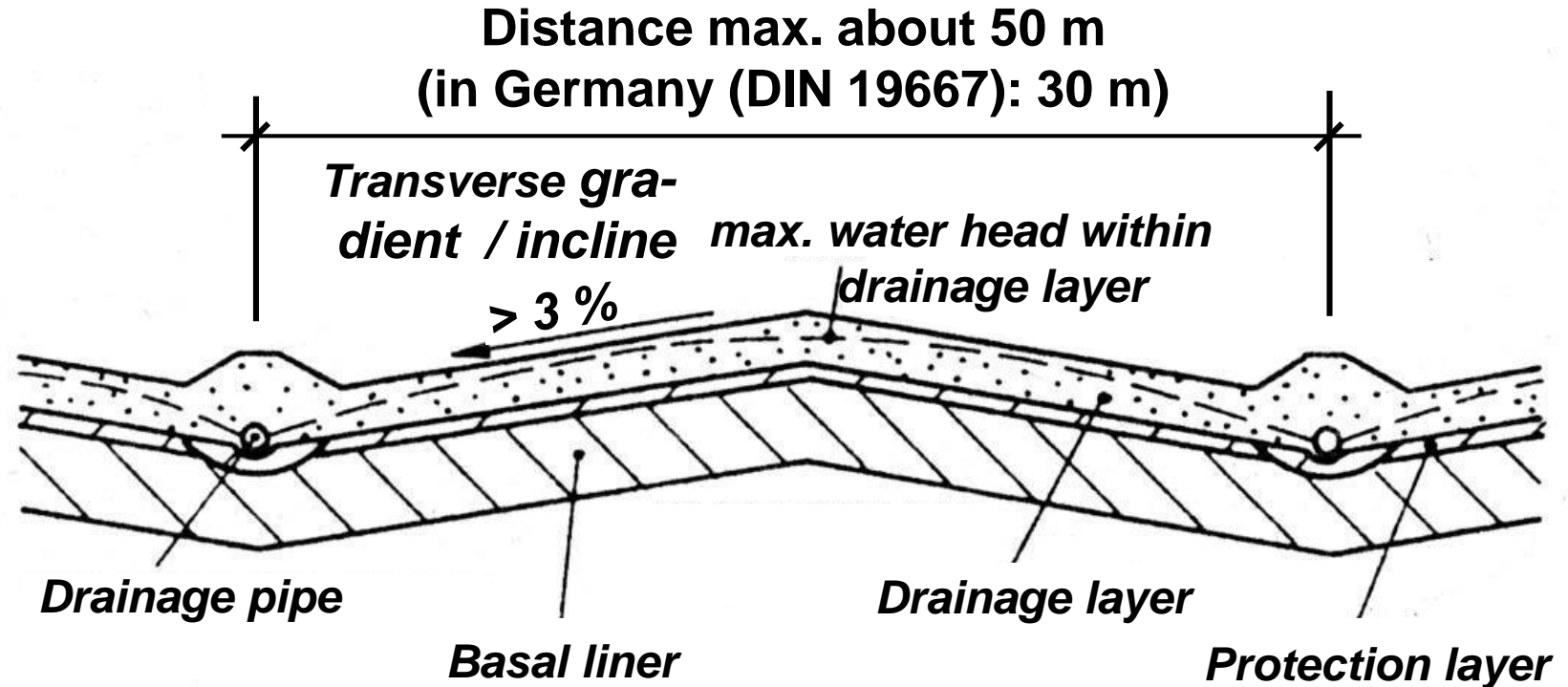
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Schematic section of a base sealing system

Source: GDA (German Society of Geotechnic)

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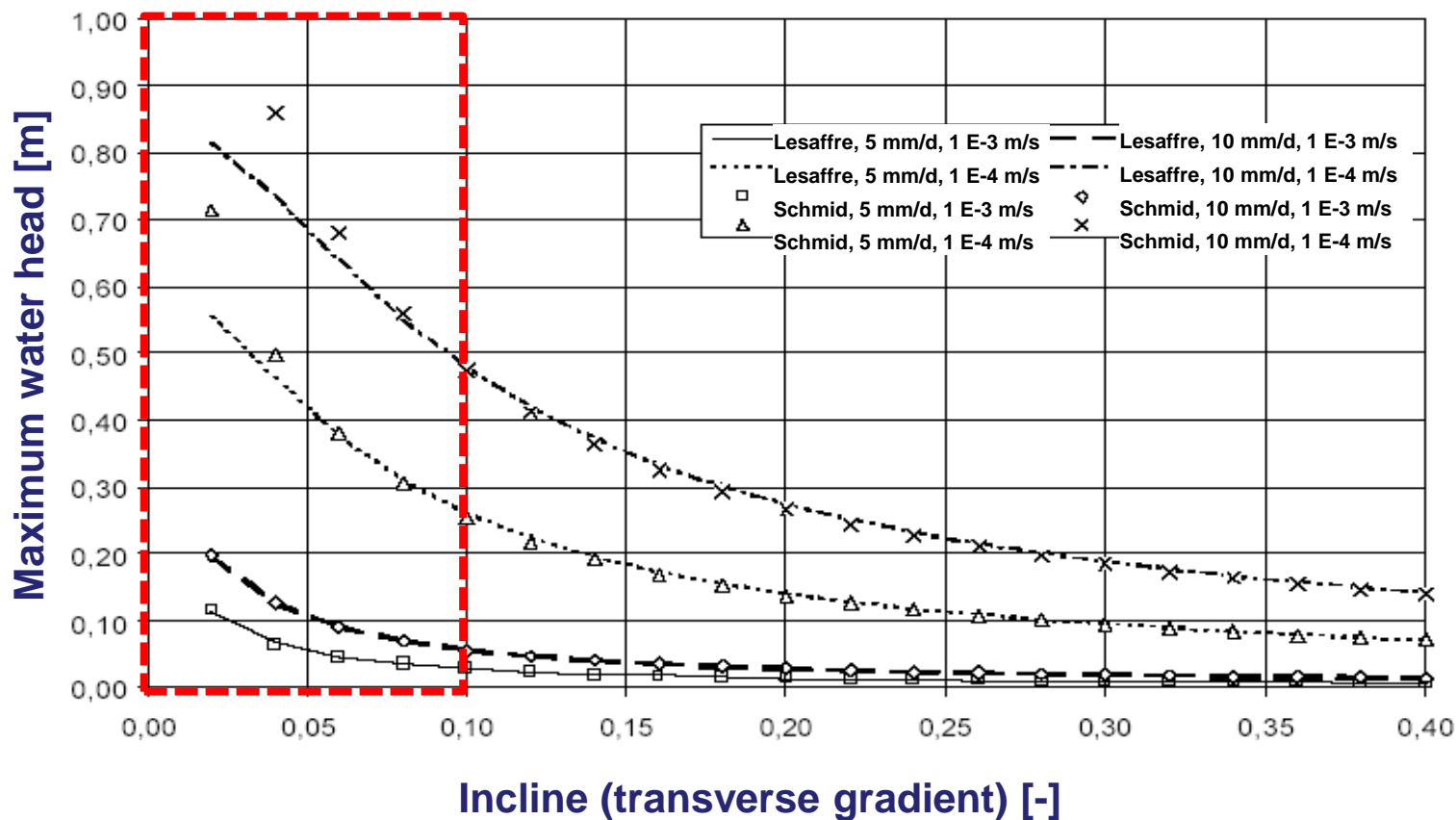
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Examples of computations:
 Incline of bottom sealing and maximum water head, $k = 1 \times 10^{-3}$ m/s or $k = 1 \times 10^{-4}$ m/s, length of slope = 50 m

Source: GDA (German Society of Geotechnic)

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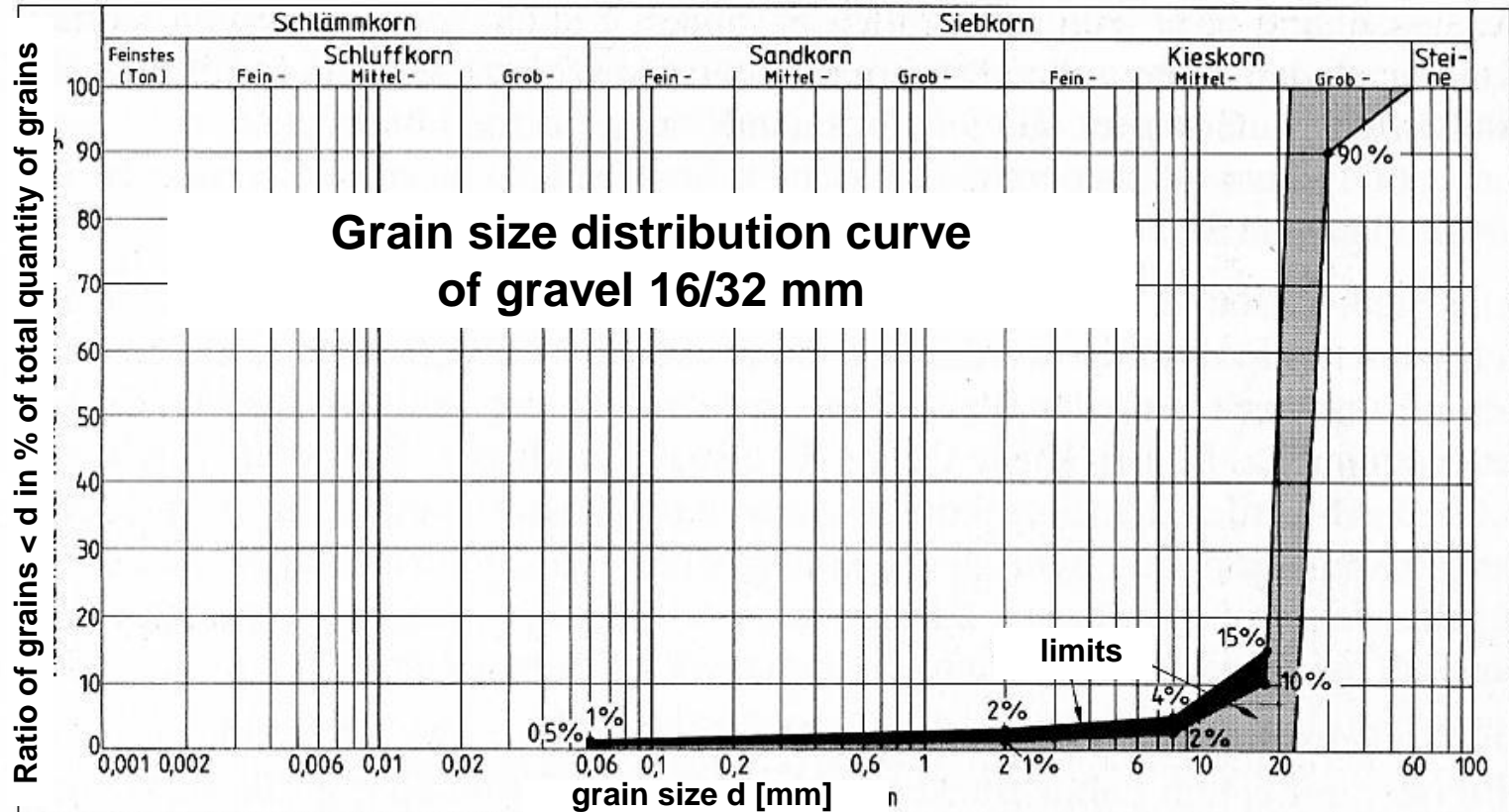
2. Drainage layer

Drainage layer

- Spread over the whole area of the landfill (sections)
- Thickness according to EU Landfill Directive (1999/31/EC) minimum 50 cm (but 30 cm is sufficient in most cases)

Requirements on the material for drainage layer

- Gravel (river gravel or crushed stones)
- Minimum grain size about 6 to 8 mm
- Maximum grain size about 32 to 40 mm
- High void ratio
- High hydraulic conductivity ($k \geq 1 \times 10^{-2}$ m/s)
- If possible: low lime / carbonate content - Calcite CaCO_3 and Dolomite $\text{Mg}(\text{CO}_3)_2$



Linie	Nr.		Bemerkung
Labor	Nr.		
Entnahmestelle	-	Limit after construction	
Probe	Nr.		
Entnahmetiefe	[m]	Limit for material tests in laboratory	
Tongehalt < 0,002 mm	[%]		
Ungleichförmigkeitszahl U	$[d_{60}/d_{10}]$		
Kornkennziffern	-		
Bodenart	-		
Arbeitsweise	-		

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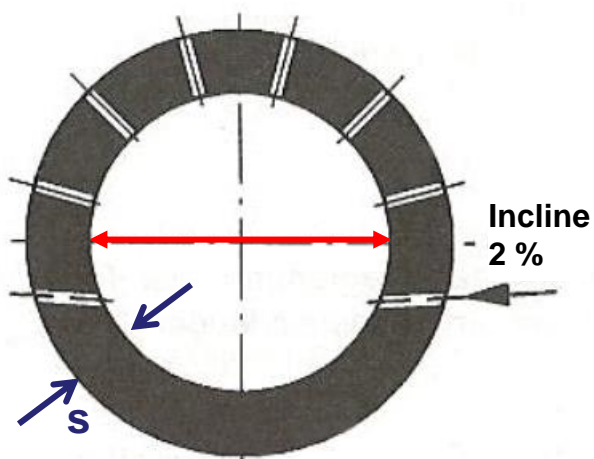
3. Drainage pipes

Requirements on slotted / punched drainage pipes (DIN 19667):

- Inner diameter minimum 250 mm
- 240 ° slotted / punched (120° without slots or borings)
- Borings or slots: 100 cm²/m pipe length
- Boring \geq 12 mm diameter (pay attention to grain size of gravel)
Slot minimum 5 mm x 25 mm (inside pipe)
- Material resistant against leachate components
- Stability calculation is necessary
- Drainage pipes accessible from both ends, but minimum from deeper end
- Length of pipes: Pipe must be inspected with cameras and flushed (max. length about 300 m, in D up to 800 m)

Requirements on leachate collection pipes

Outer diameter e.g.
355 mm

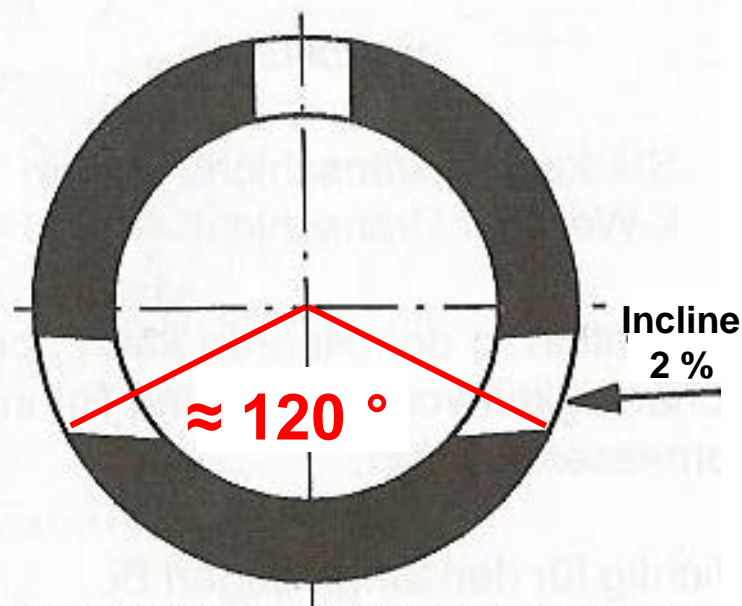
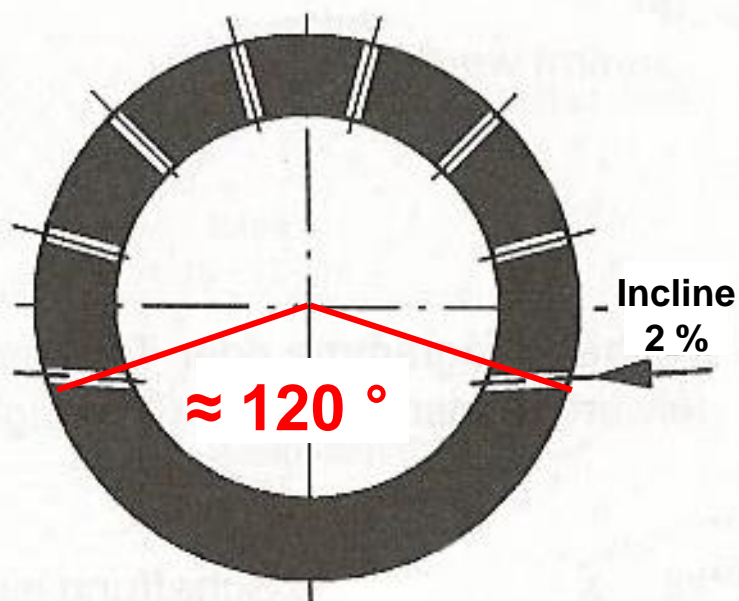


Inner diameter
≥ 250 mm

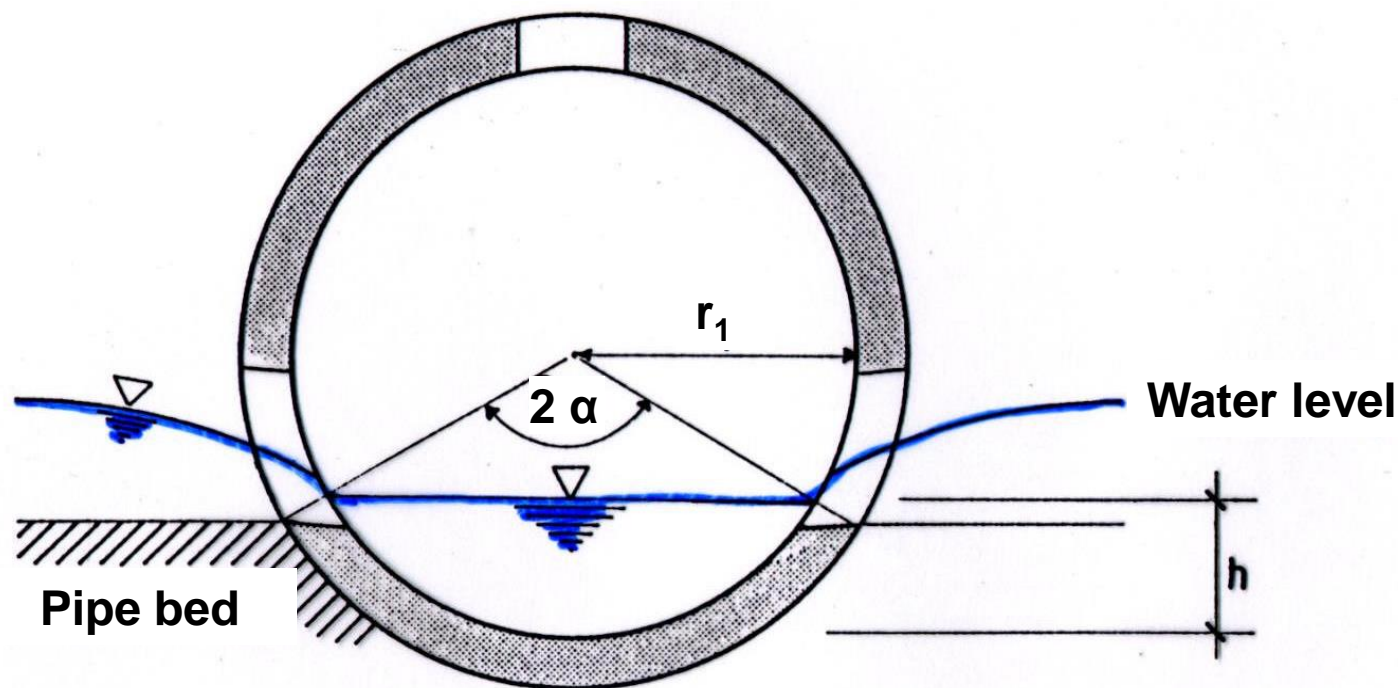
Wall thickness “s”
according to
structural analyses

Parameter	/	Material	PE-100
Density [g/m ³] ISO 118			0.958
Creep strength [MPa] DIN EN ISO 527			22
Creep elongation [%] DIN EN ISO 527			9
Breaking elongation [%] DIN EN ISO 527			300
E-Modulus [MPa] DIN EN ISO 527			> 900
Shore hardness			61
Coefficient of thermal expansion DIN 53752			1.8 · 10 ⁻⁴ m/s
OIT value at 210° C			> 30 minutes
FNCT value at 80° C			> 1000 hours
Color			black
Wall thickness – dimensioning necessary			SDR ?

Very important parameters for long term behavior



Leachate collection (drainage) pipes with borings (punch holes – left) and slots (right) and a non slotted part of 120°



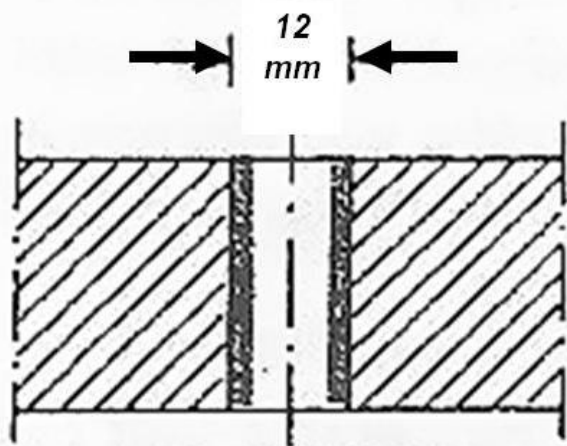
- 2α = about 120° (depending on pipe diameter and punch holes or slots)**
- h = height of water level at maximum filling**
- r_1 = radius of pipe (inner radius)**

$$h = r_1 \cdot (1 - \cos \alpha)$$

$$h = r_1 \cdot (1 - \cos 60^\circ)$$

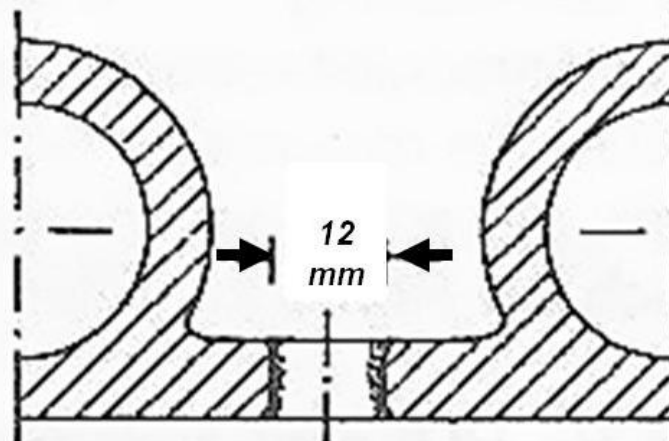
$$h = 0.5 r_1$$

**HDPE pipe
manufactured by
extrusion**



HDPE pipe / DIN 8074/75

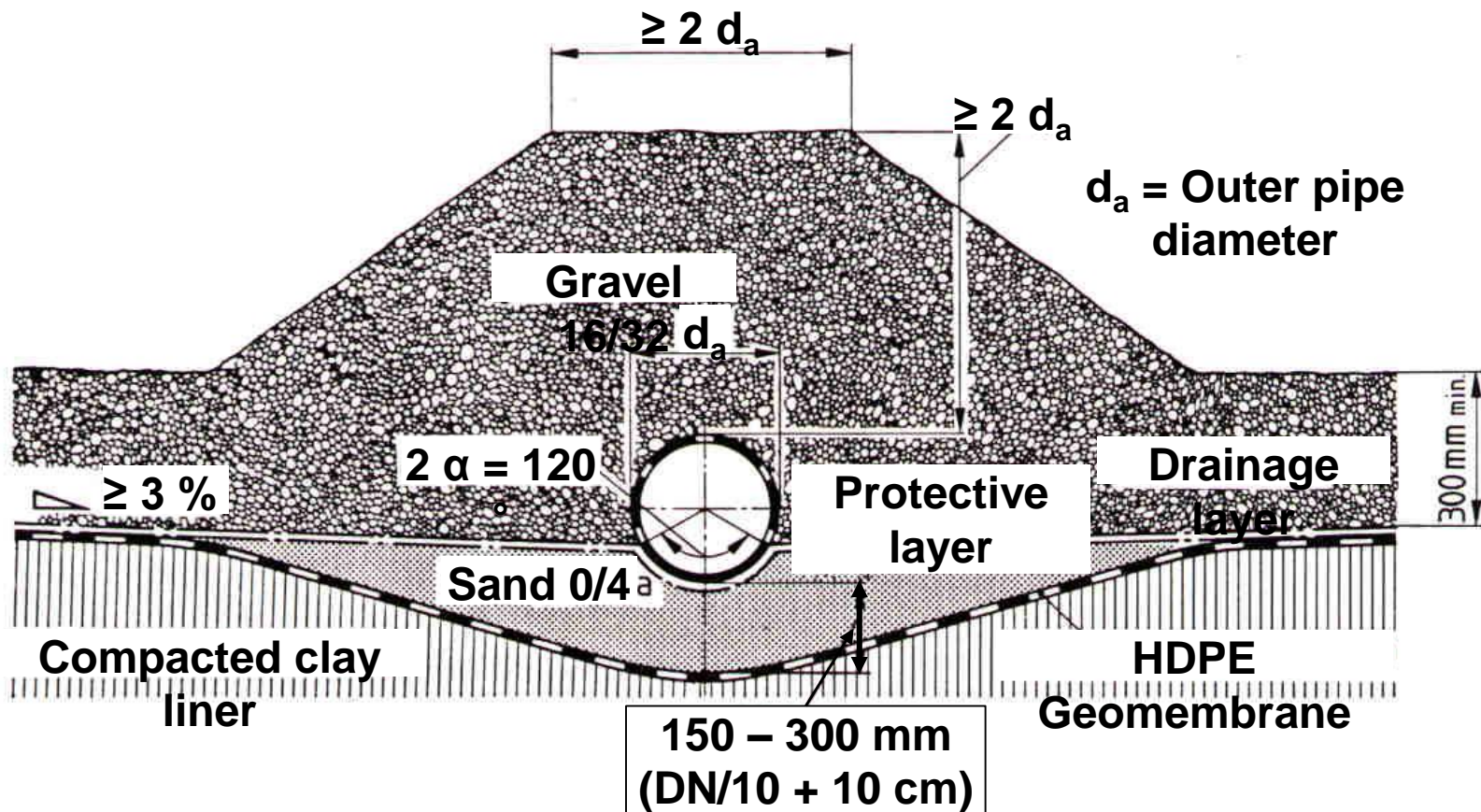
HDPE spiral pipe



HDPE pipe / DIN 16961

**Different types of HDPE pipes, depending on
manufacturing process**

Pipe bedding (DIN 19667)

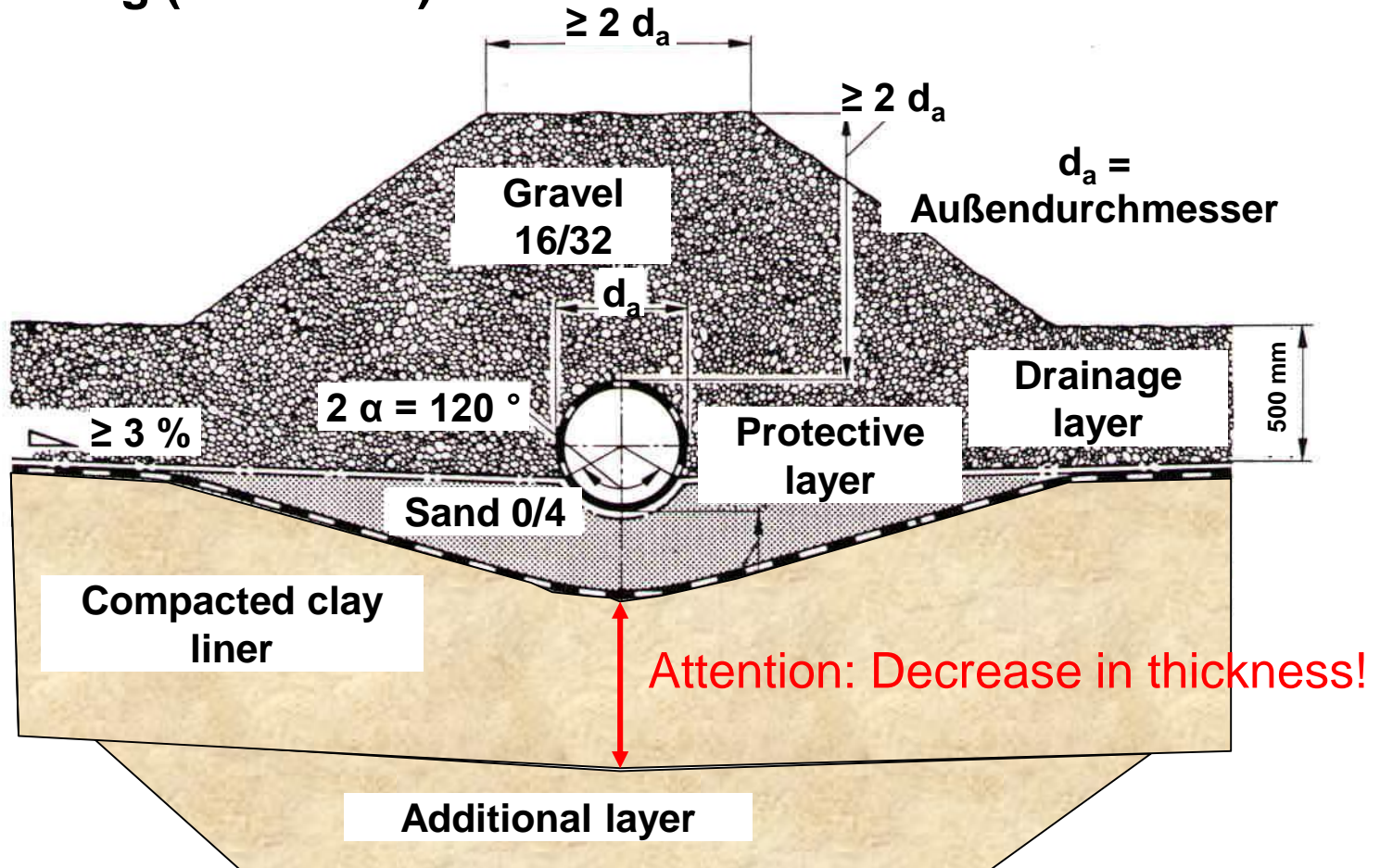


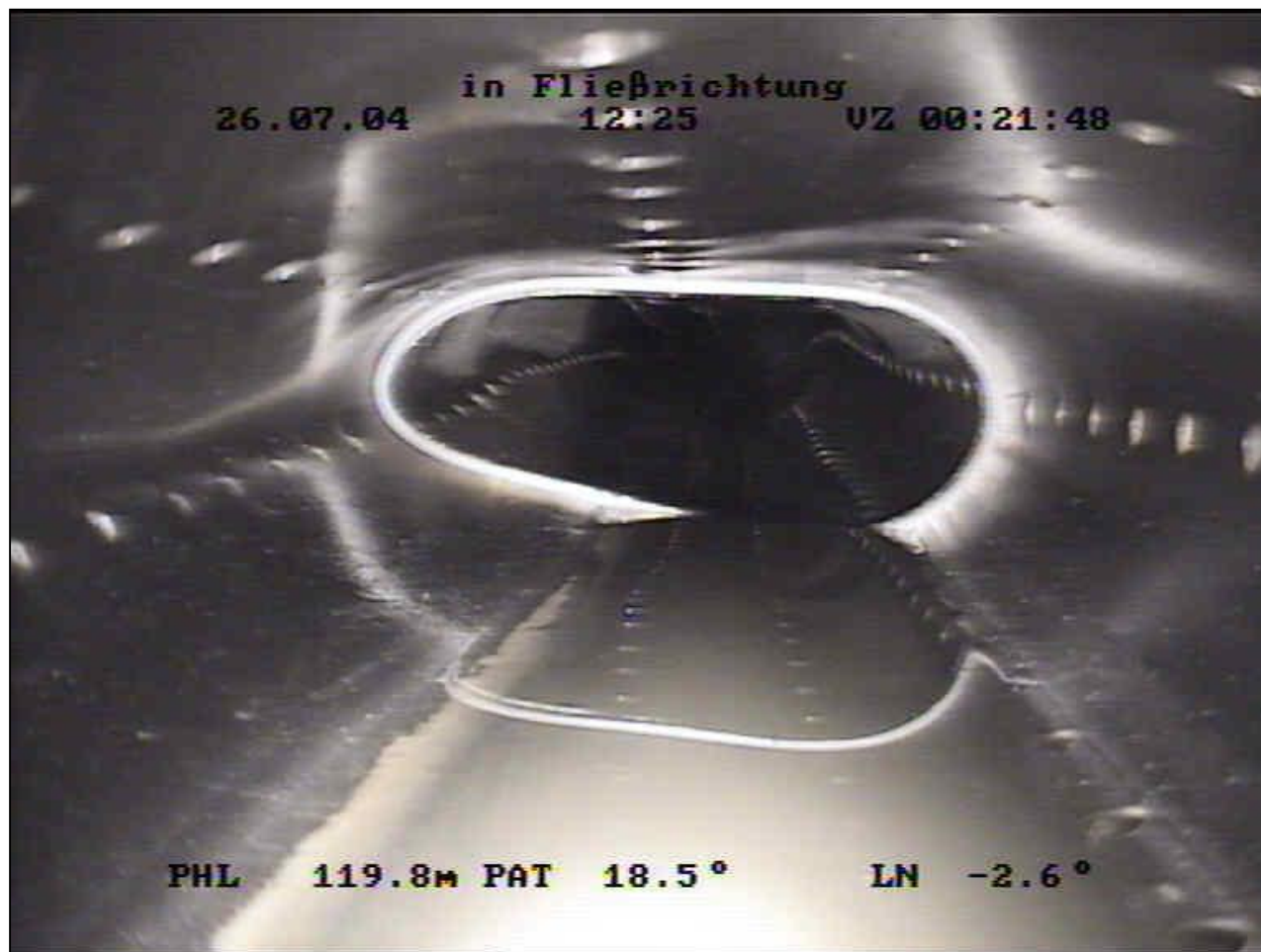
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Bedding in Sand 0 – 4 mm or, if a low permeability is necessary, a mixture out of sand, cement and bentonite)

Pipe bedding (DIN 19667)





Damages of leachate collection pipes Distortion because of high load and/or high temperatures

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Damages of leachate collection pipes Cracks in a punched HDPE pipe

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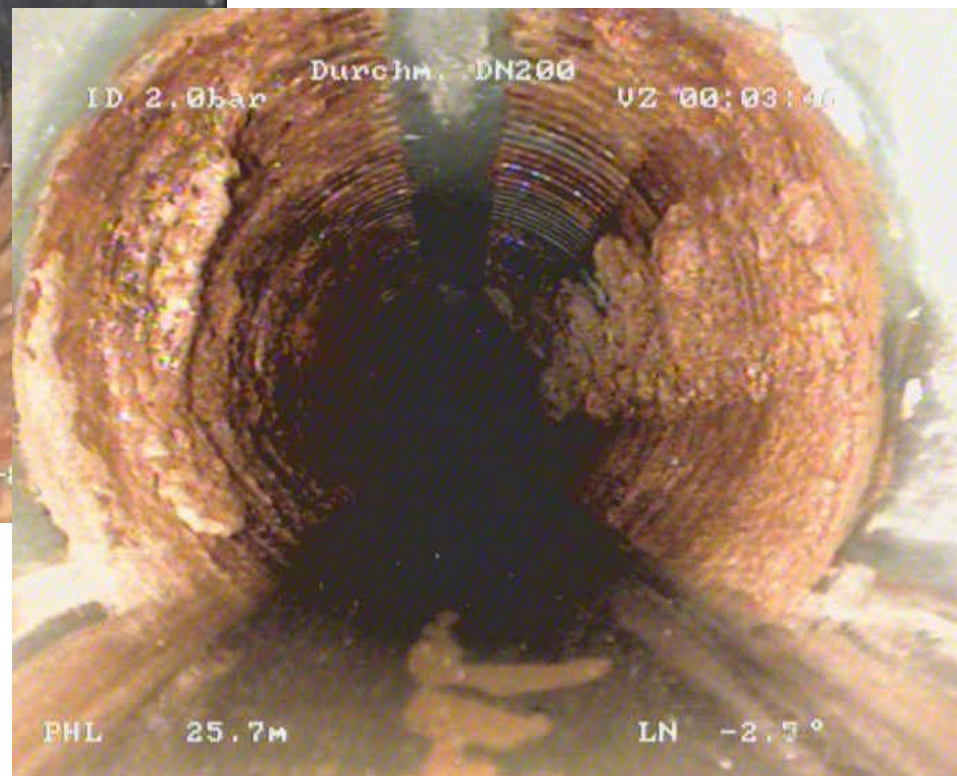
Collapse of leachate collection pipes
Material of drainage pipes is HDPE!
Long term behavior must be considered!

Incrustation in leachate drainage pipes - 1

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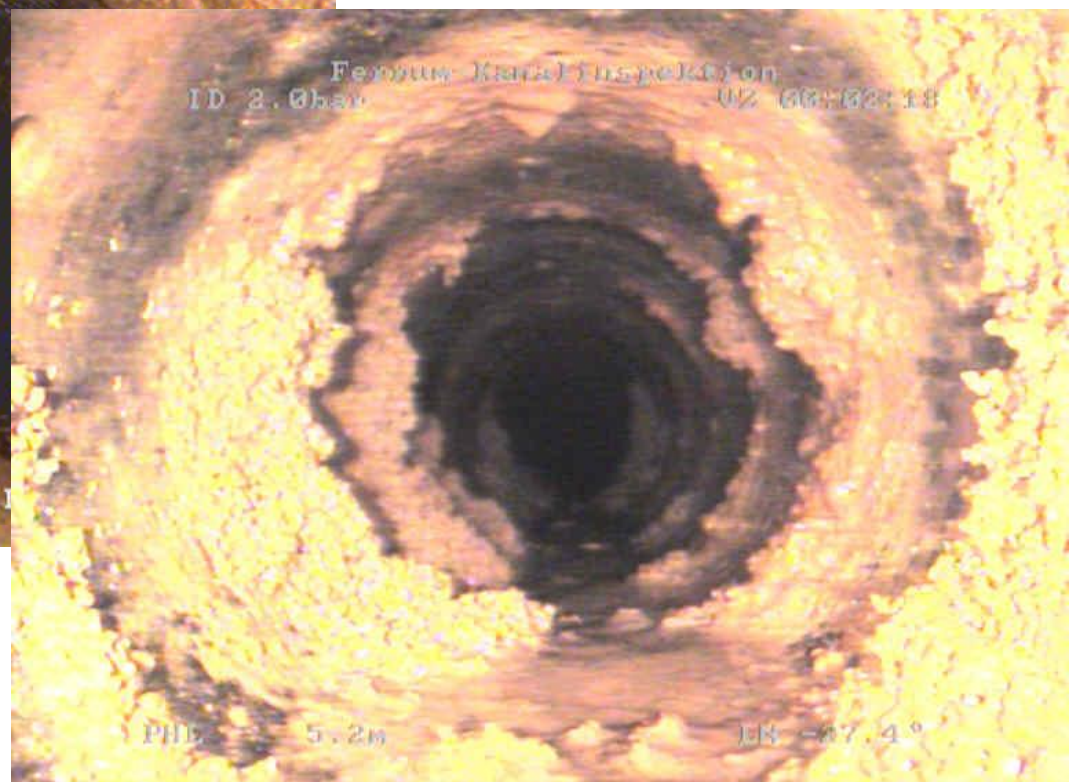
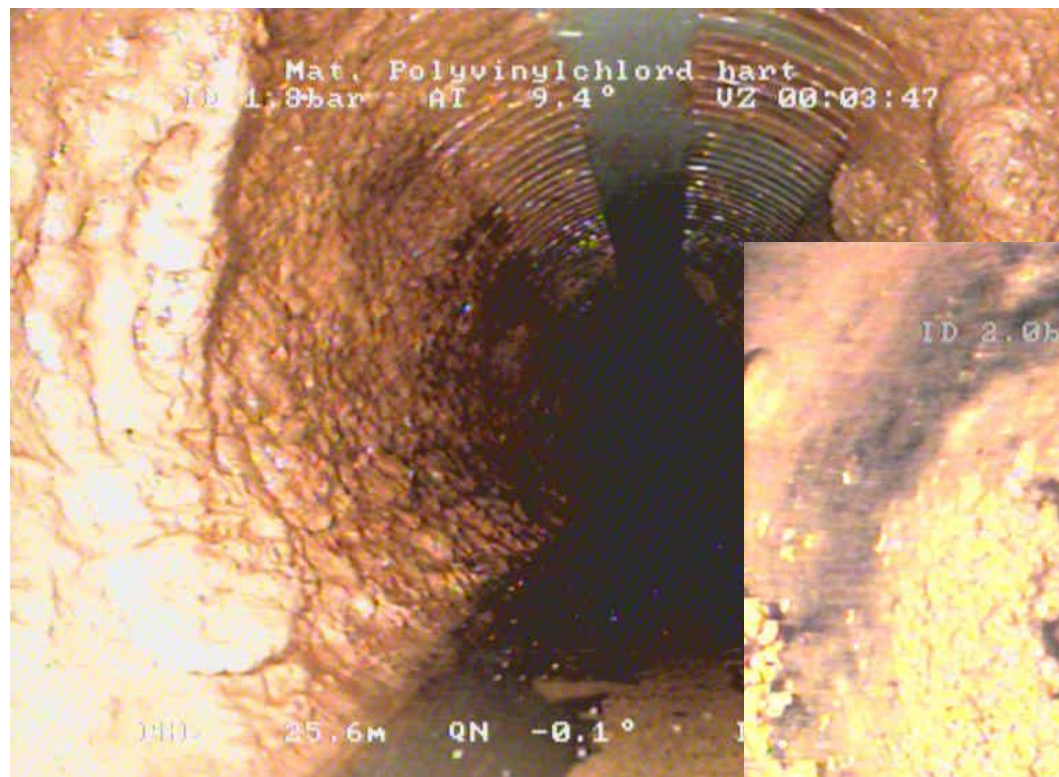
**Incrustation of pipes
begins slowly...**



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Incrustation in leachate drainage pipes - 2

... but it never stops...

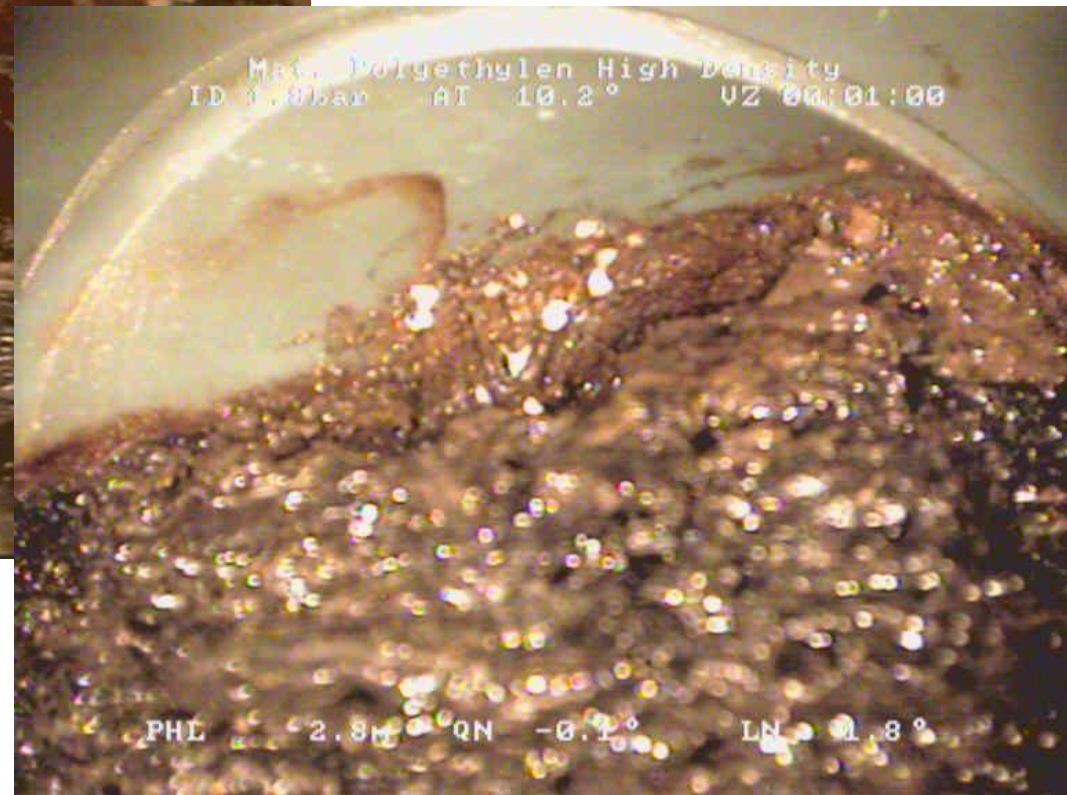


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Incrustation in leachate drainage pipes - 3

... until the pipes are
blocked totally.

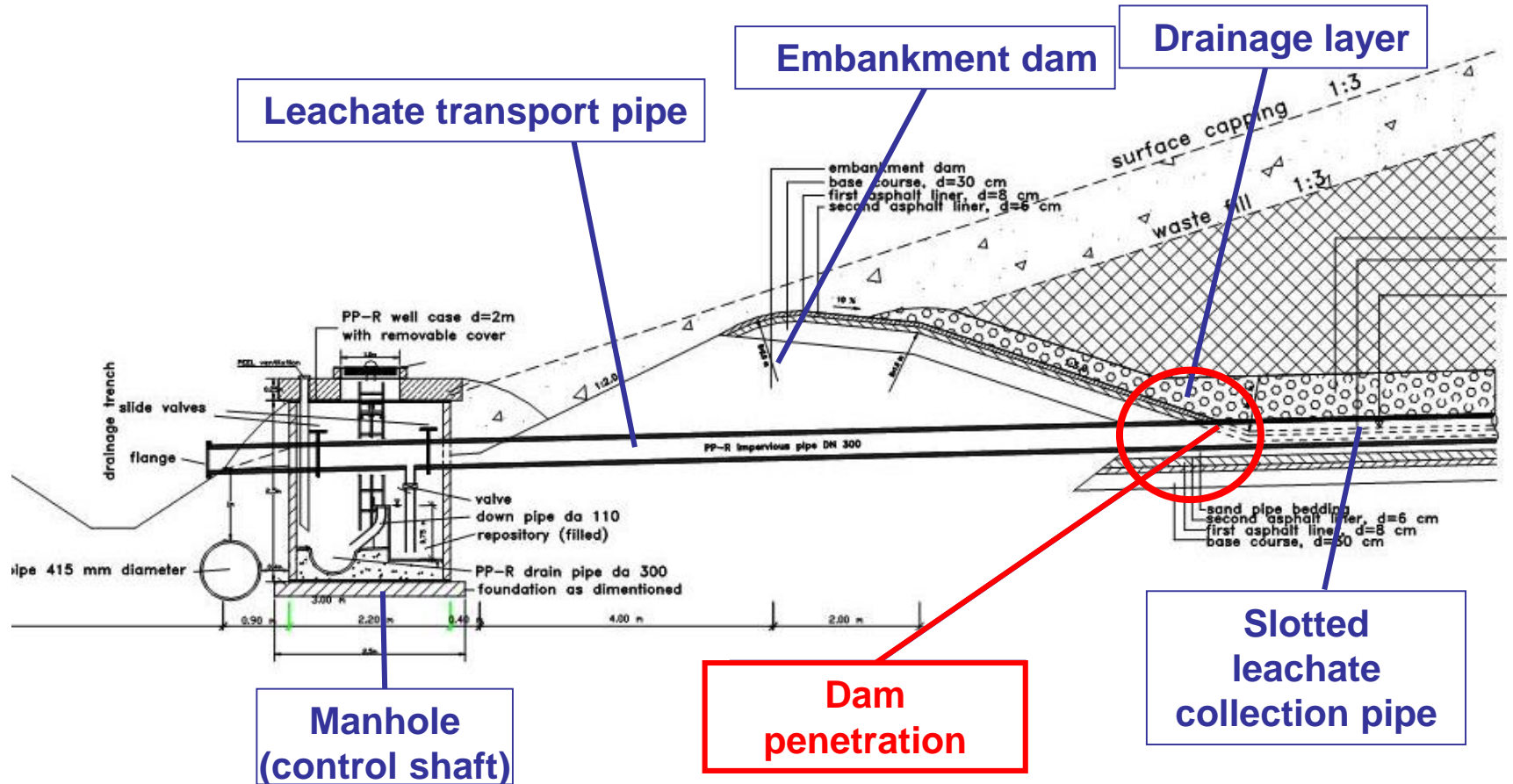


**Regular flushing of
pipes is essential**

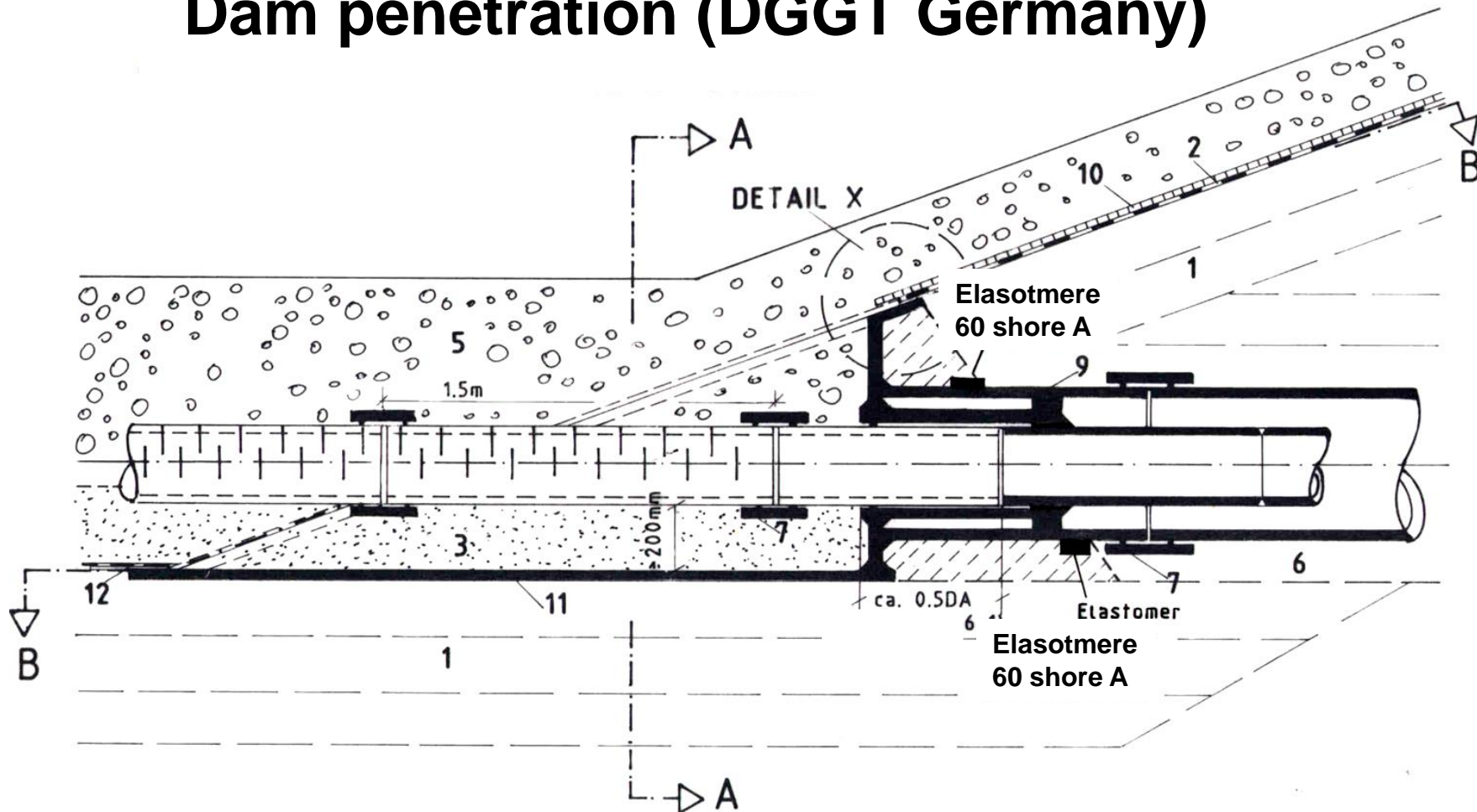
4. Dam penetration

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Dam penetration (DGGT Germany)



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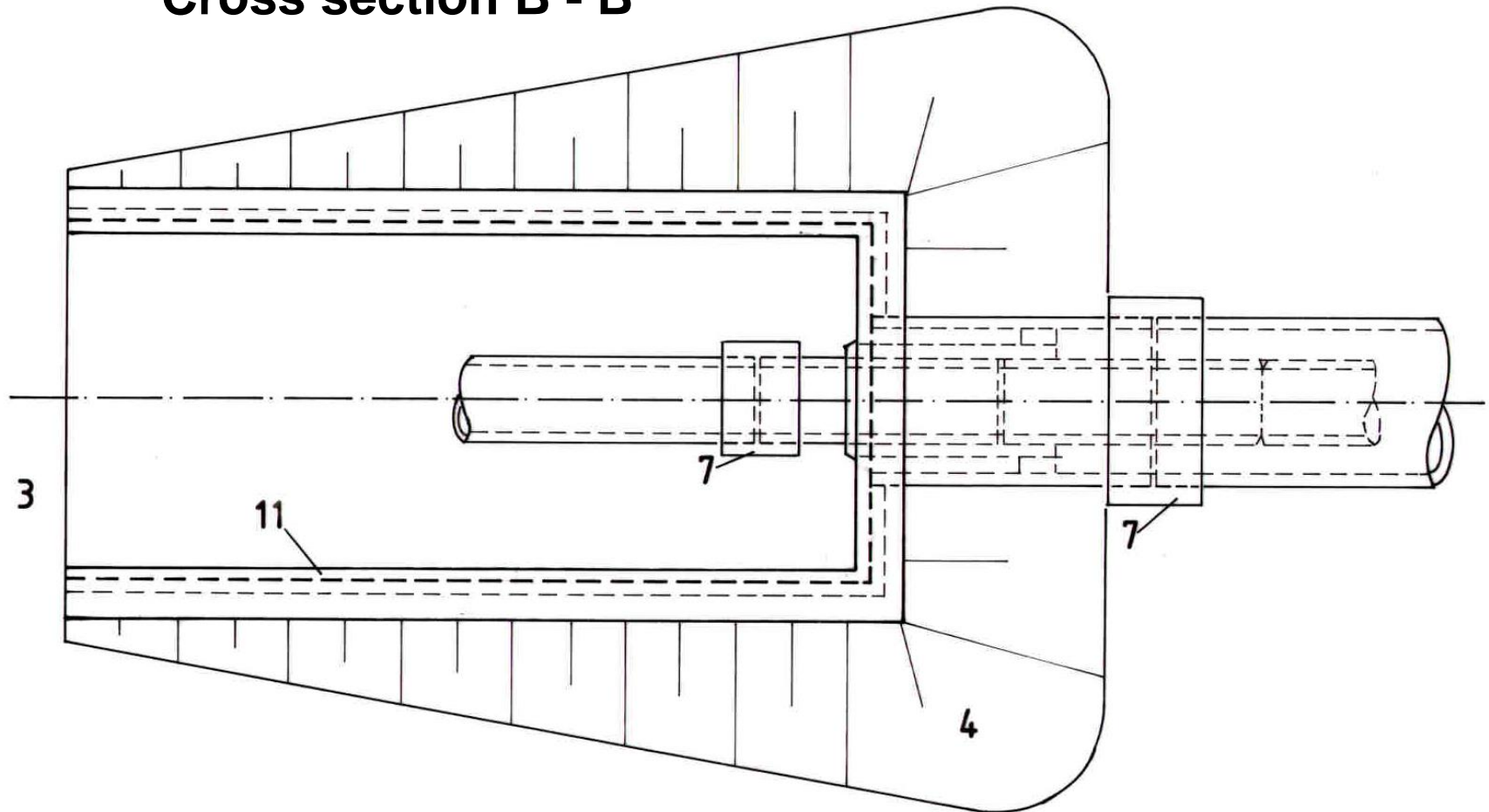
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Dam penetration (DGGT Germany)

Cross section B - B



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Dam penetration (example for CCL)



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Dam penetration (example)

HDPE Drainage pipe

HDPE sheet

Compacted clay liner

Concrete structure

HDPE leachate transport
pipe

5. Leachate control shafts (manholes)

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Manholes (leachate control shafts)

Why are manholes needed?

- They give access to the leachate drainage pipes for TV inspection and flushing

Where should manholes be placed ?

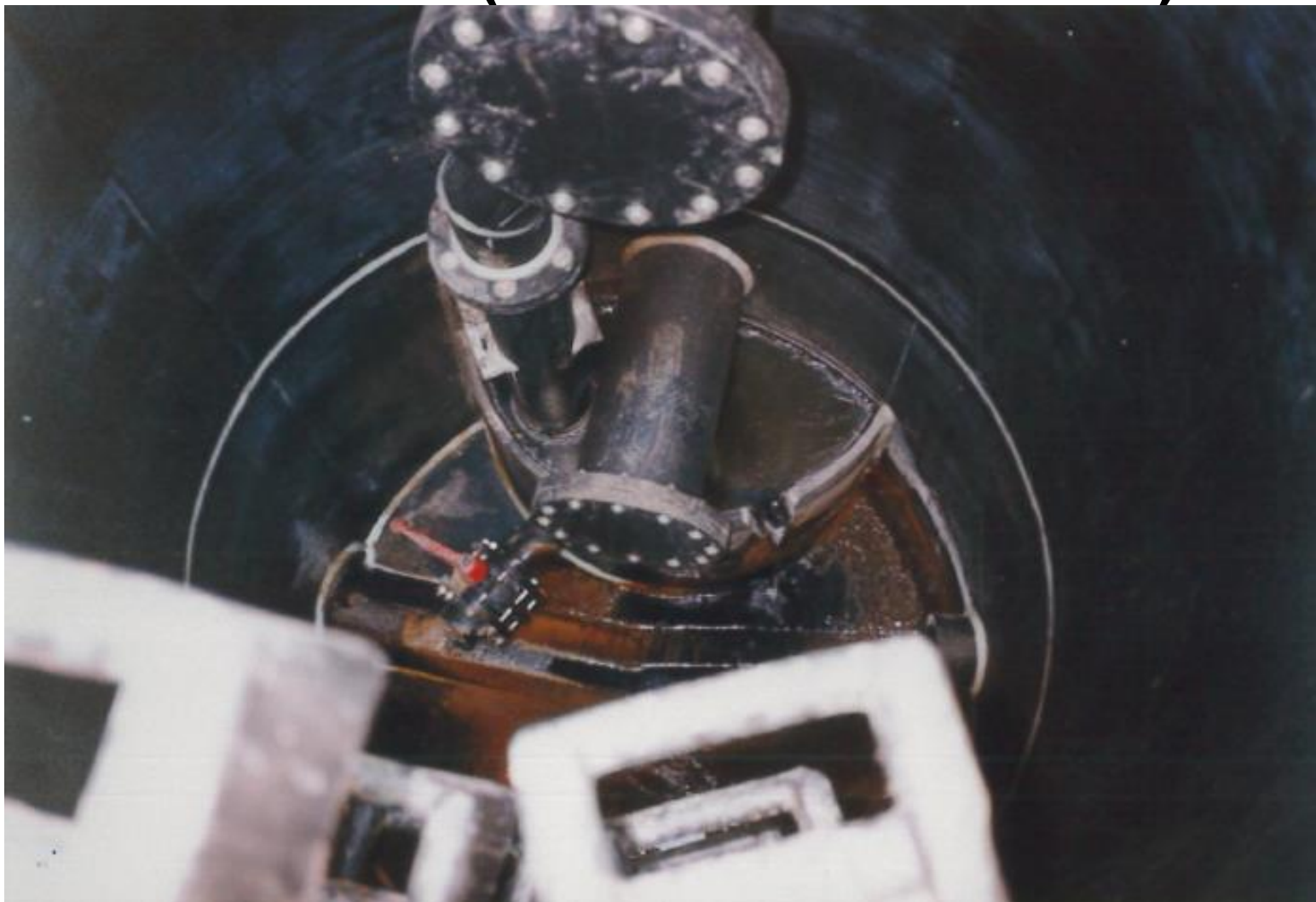
- Outside of landfill area (dumping area)
- At least at the deeper end of the leachate drainage pipe
- Close to a road (access to manhole)

HDPE manhole (leachate control shaft)



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HDPE manhole (leachate control shaft)



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*Thank you very much
for your attention*



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