CONTROL MEASURES FOR OLD WASTE DUMPS: Two Case Studies

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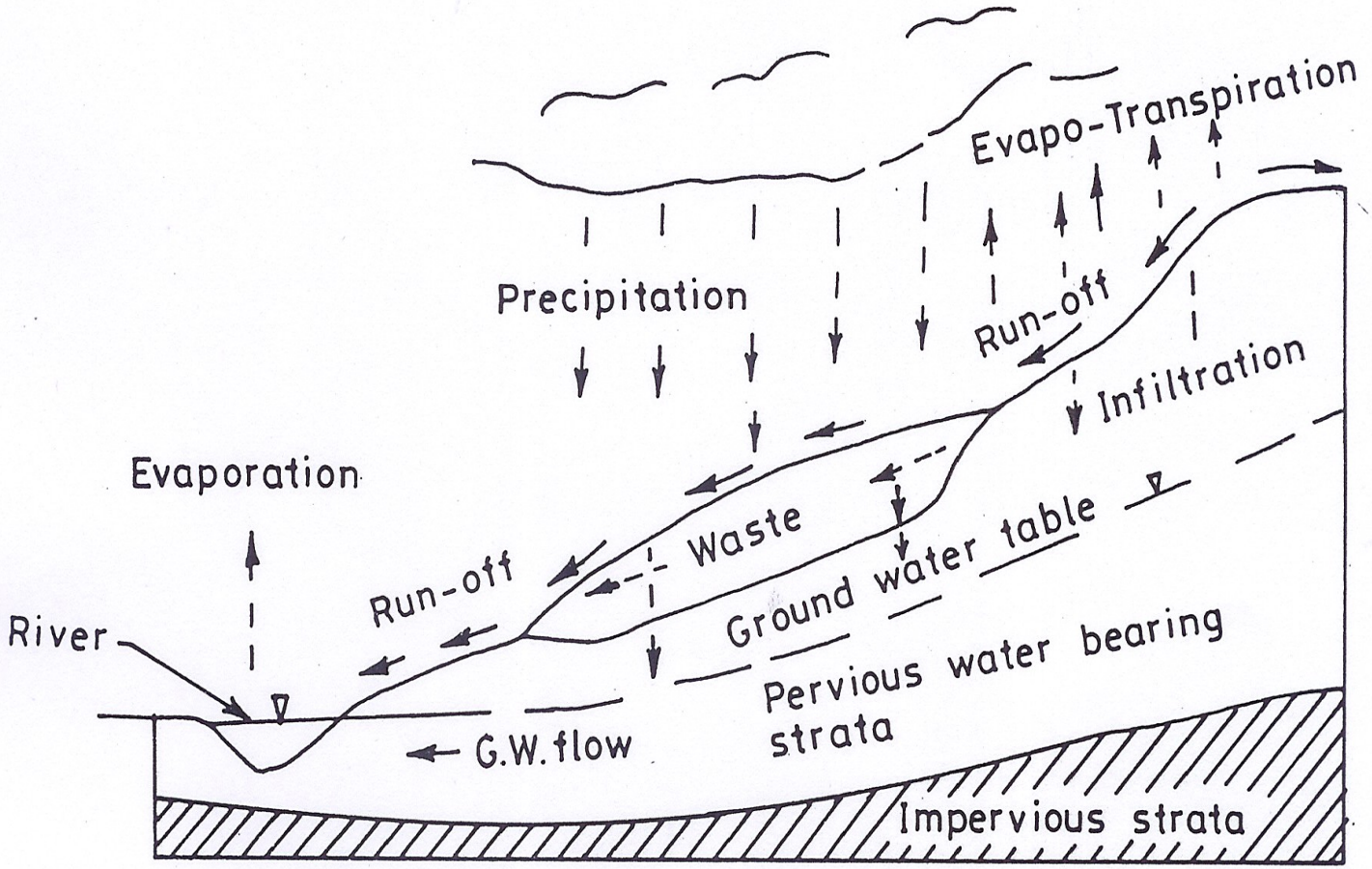
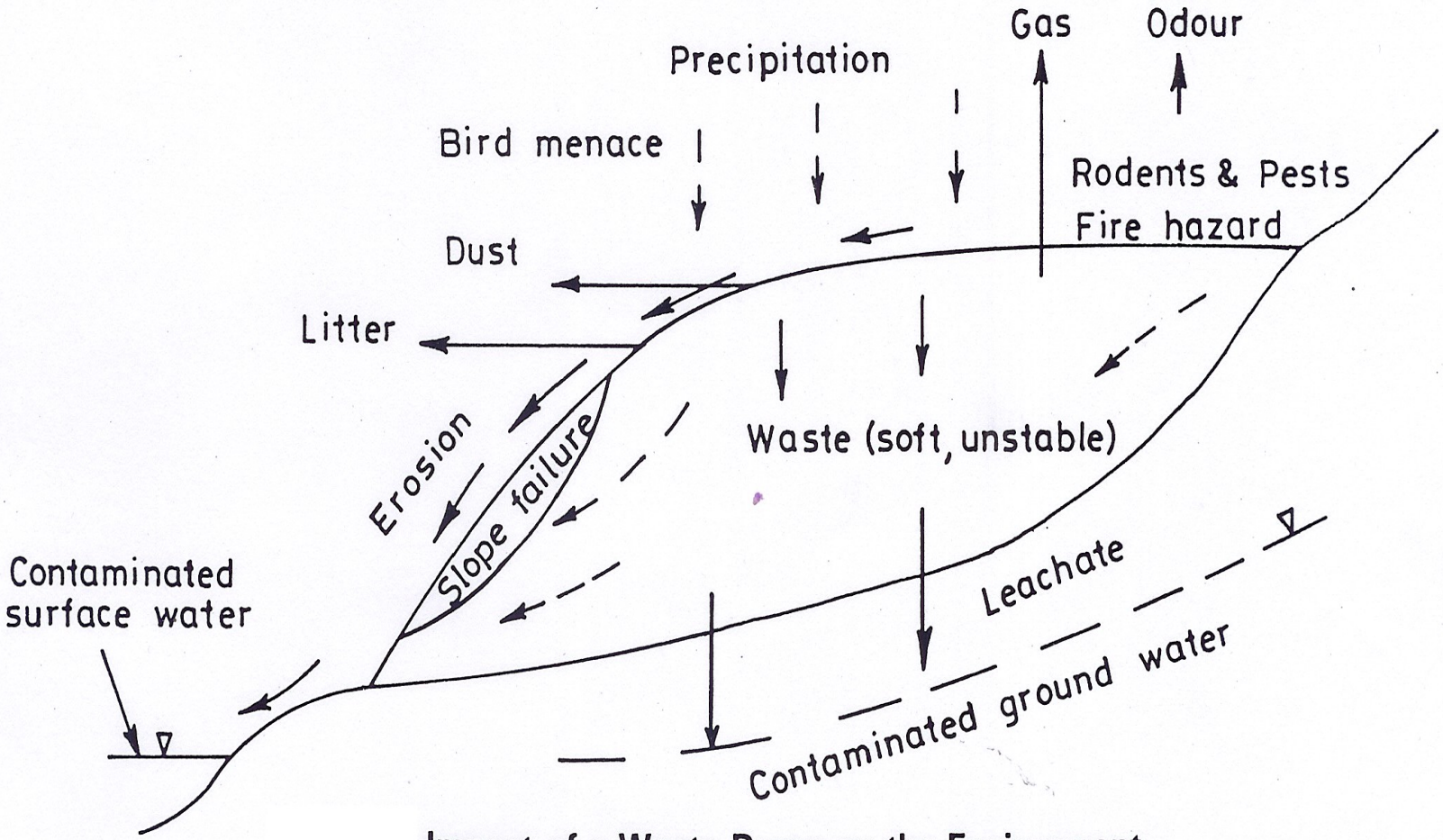
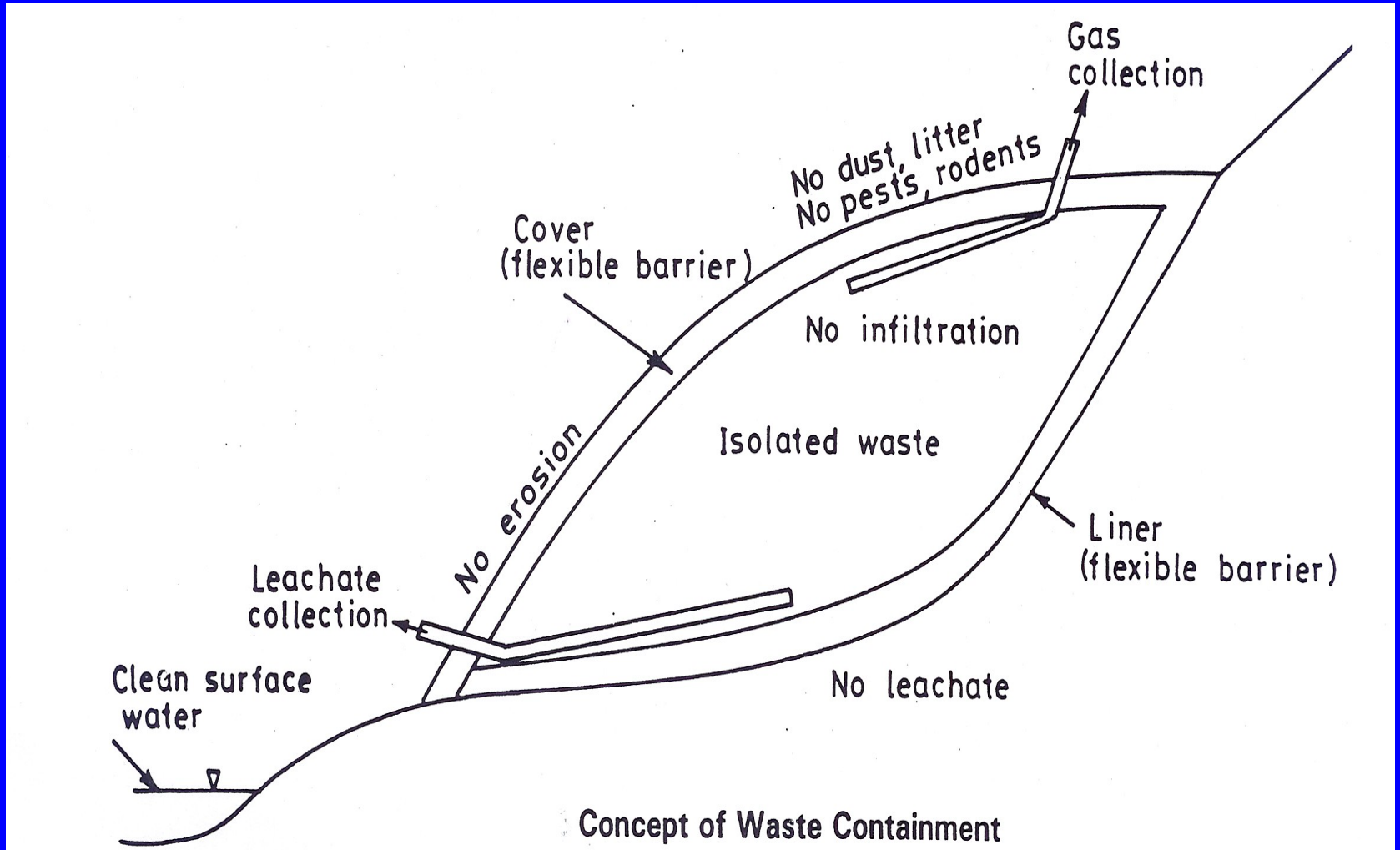


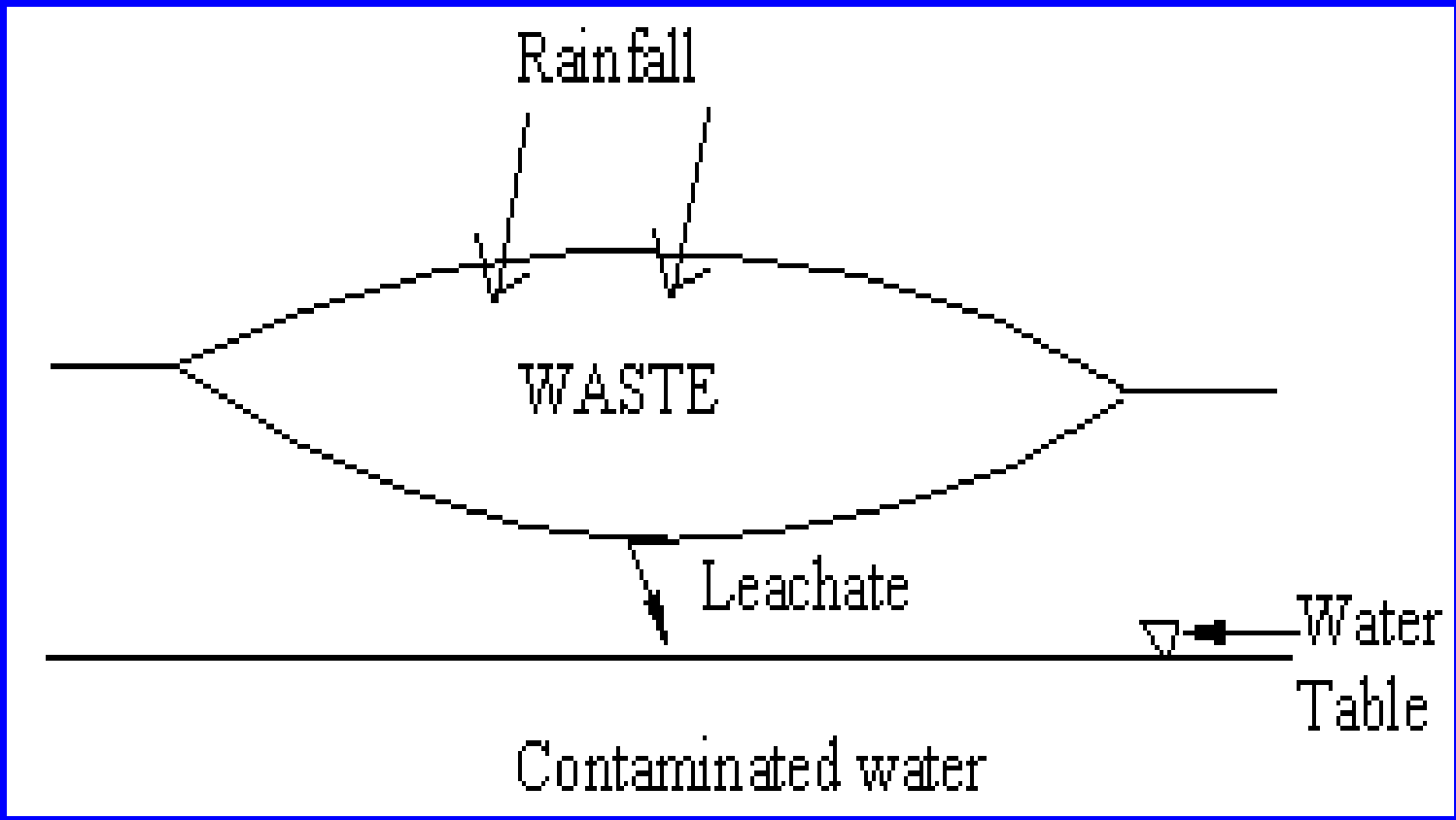
Waste Interaction with the Hydrologic Cycle



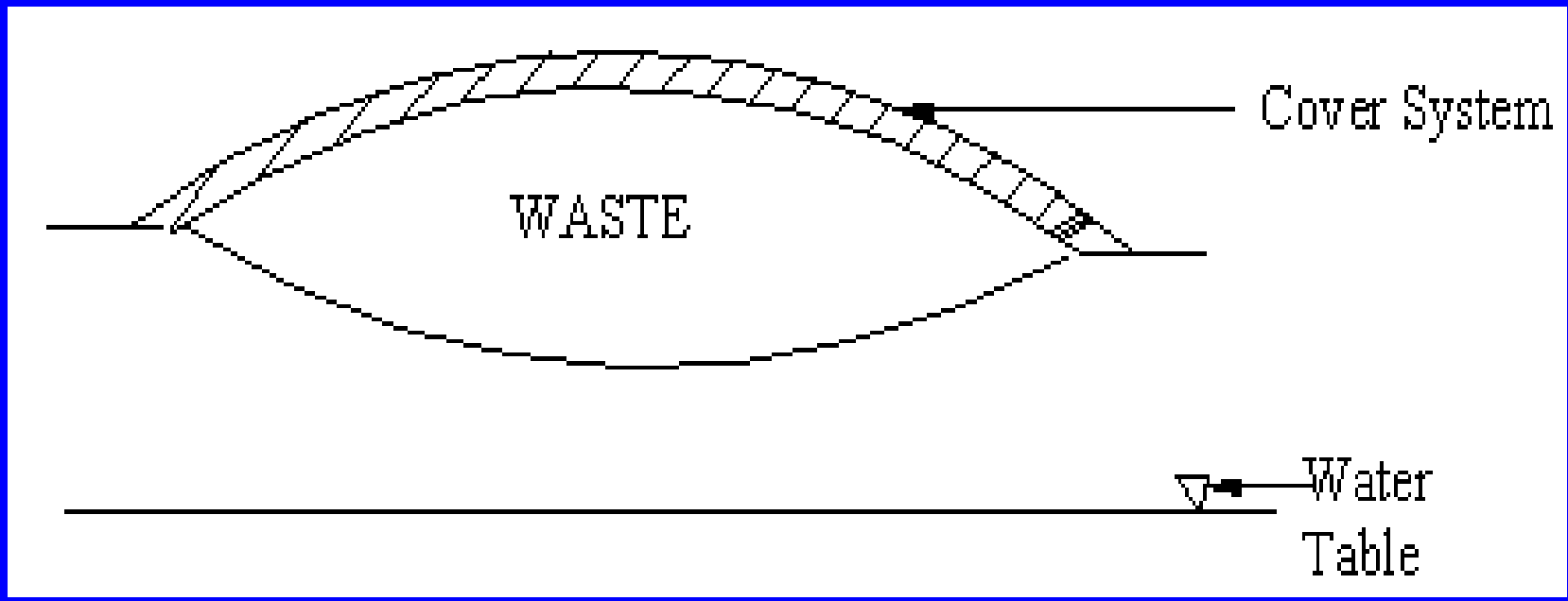
Impact of a Waste Dump on the Environment



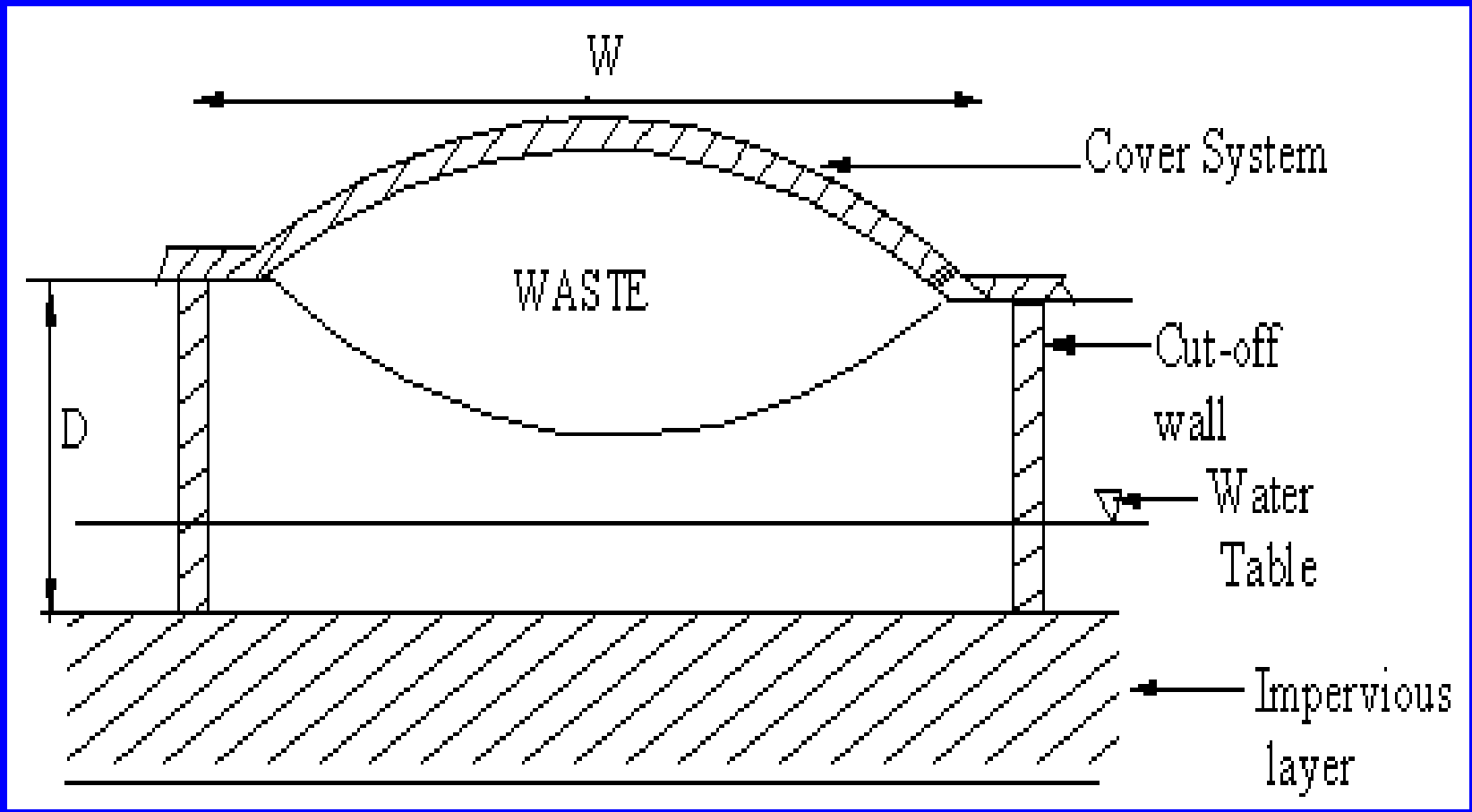
Concept of Waste Containment



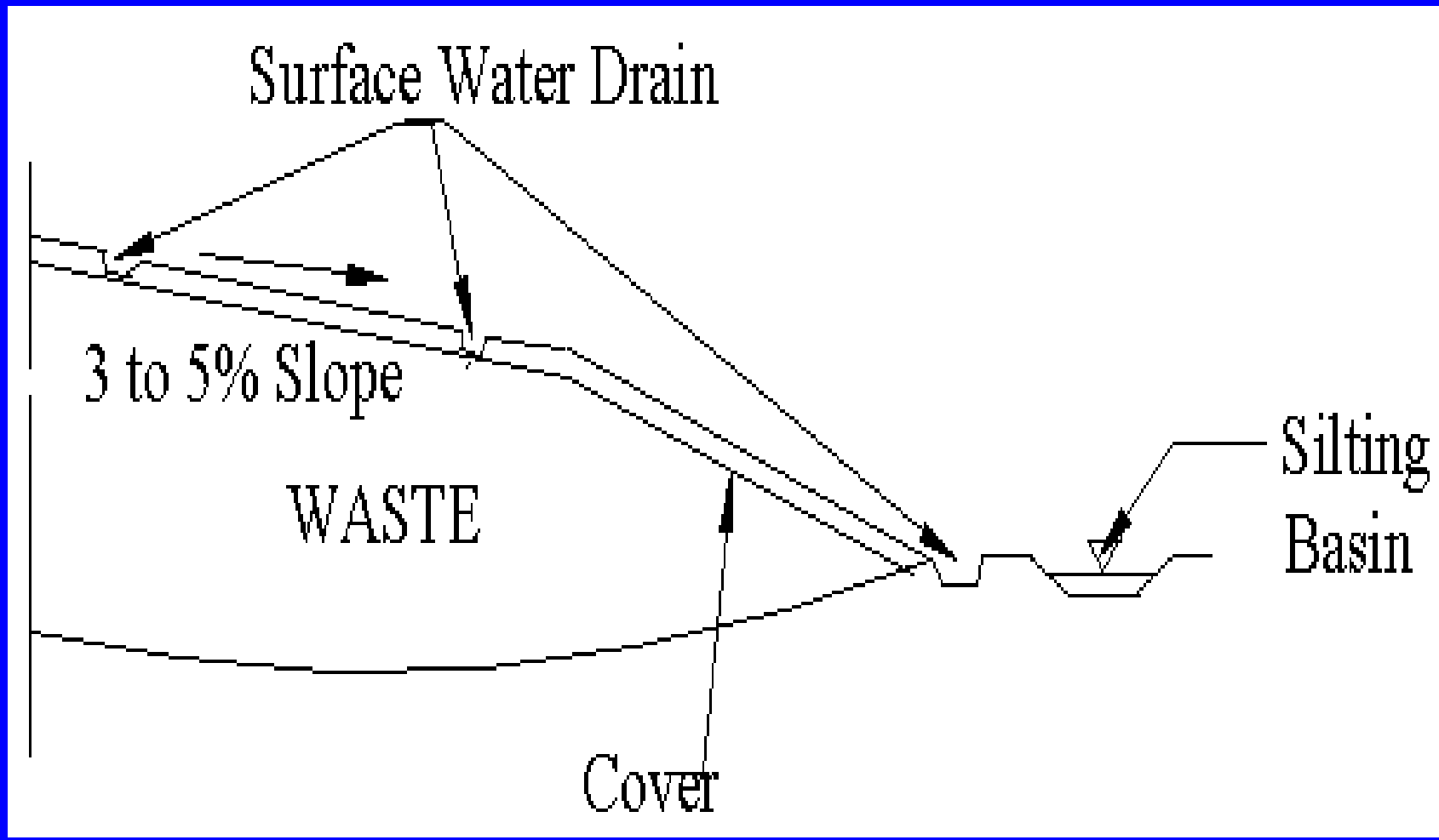
Old Landfill Without Cover and Cut-off



Old Landfill with Cover System



Old Landfill with Cover System and Vertical Cut-off Wall



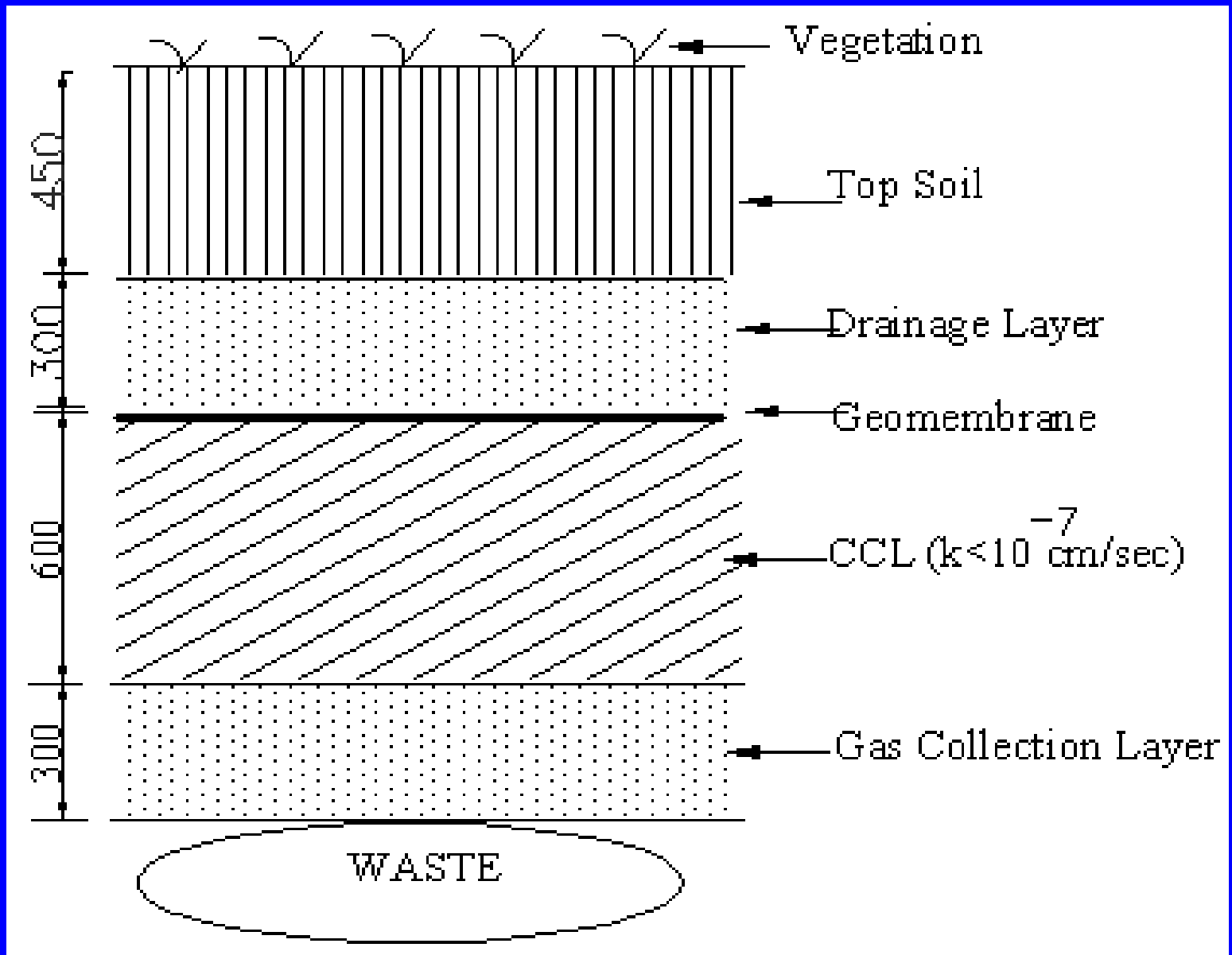
Old Landfill with Cover and Surface Water Drainage System

TYPES OF COVER SYSTEMS

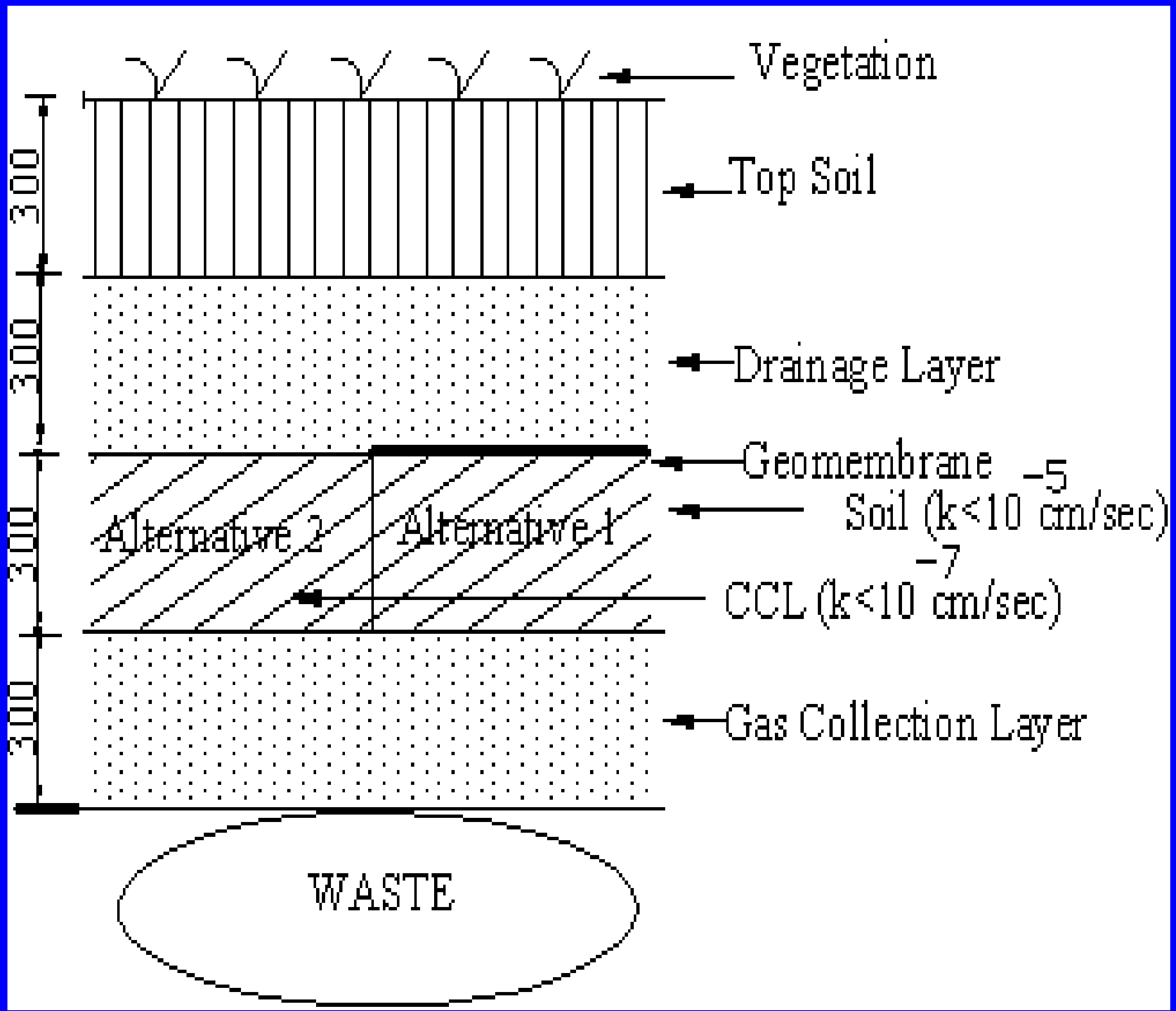
- **Cover system A – is the most impervious one and based on the type of cover system used for Hazardous waste landfills. (*also recommended for MSW landfills for better gas recovery).***

- **Cover system B – is less impervious than cover system A and is based on cover system adopted for MSW landfills.**

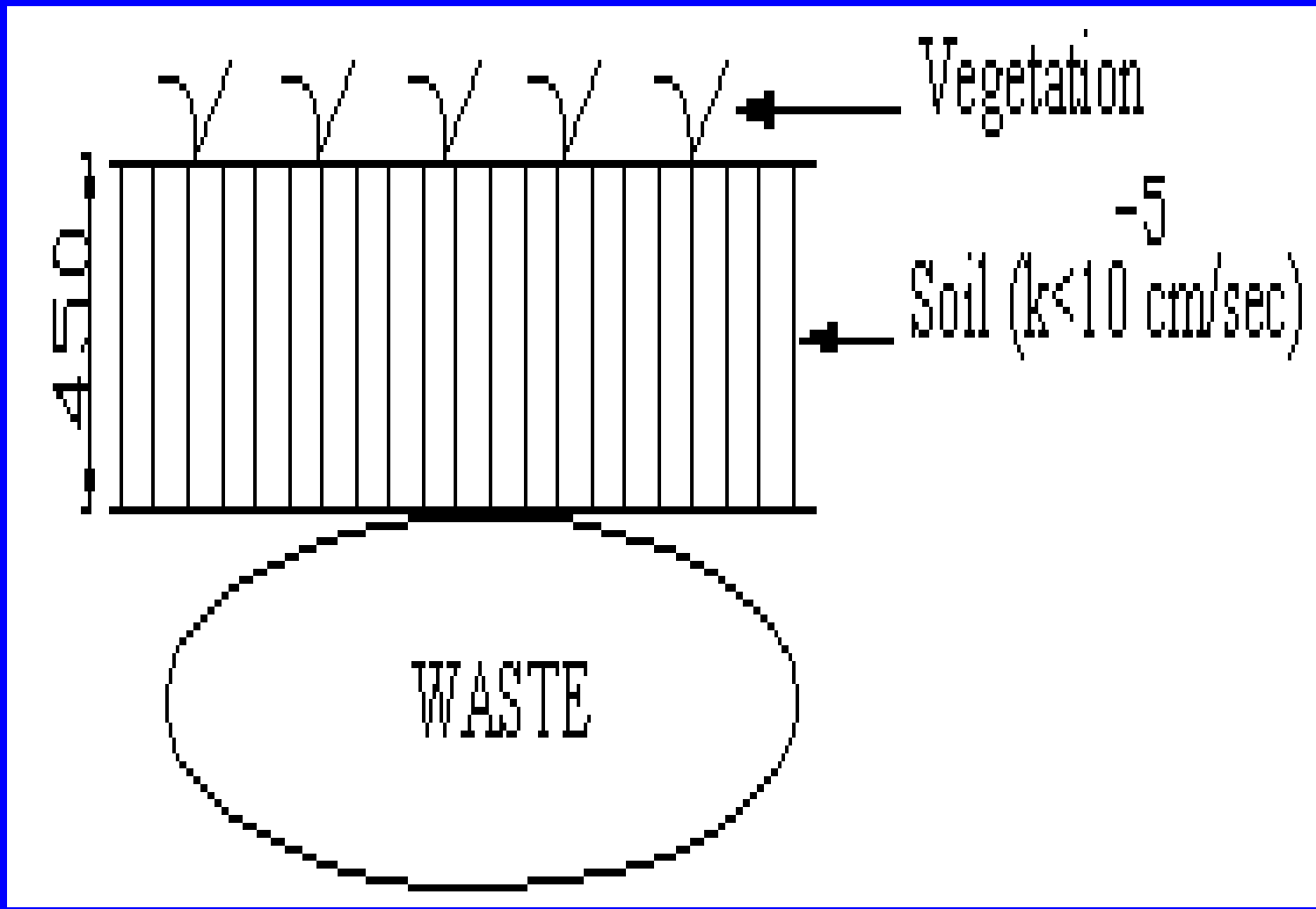
- **Cover system C – does not have very low permeability and is suitable for wastes that have very low potential for contamination.**



Cover System A



Cover System B

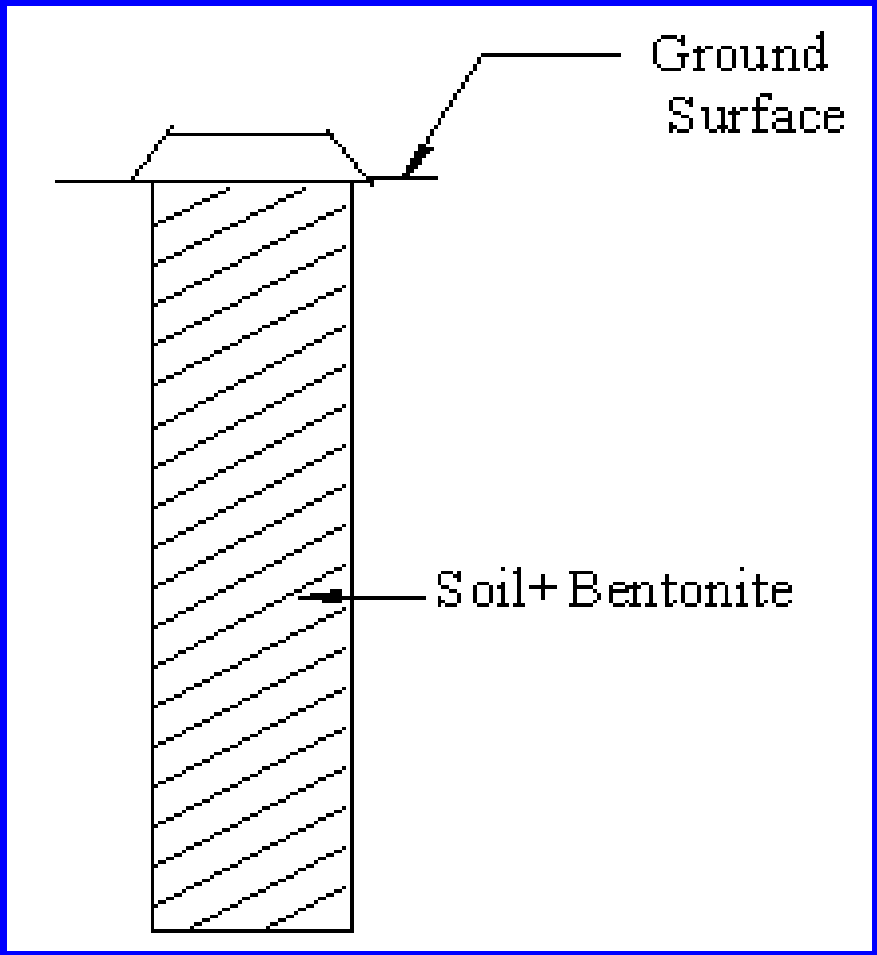


Cover System C

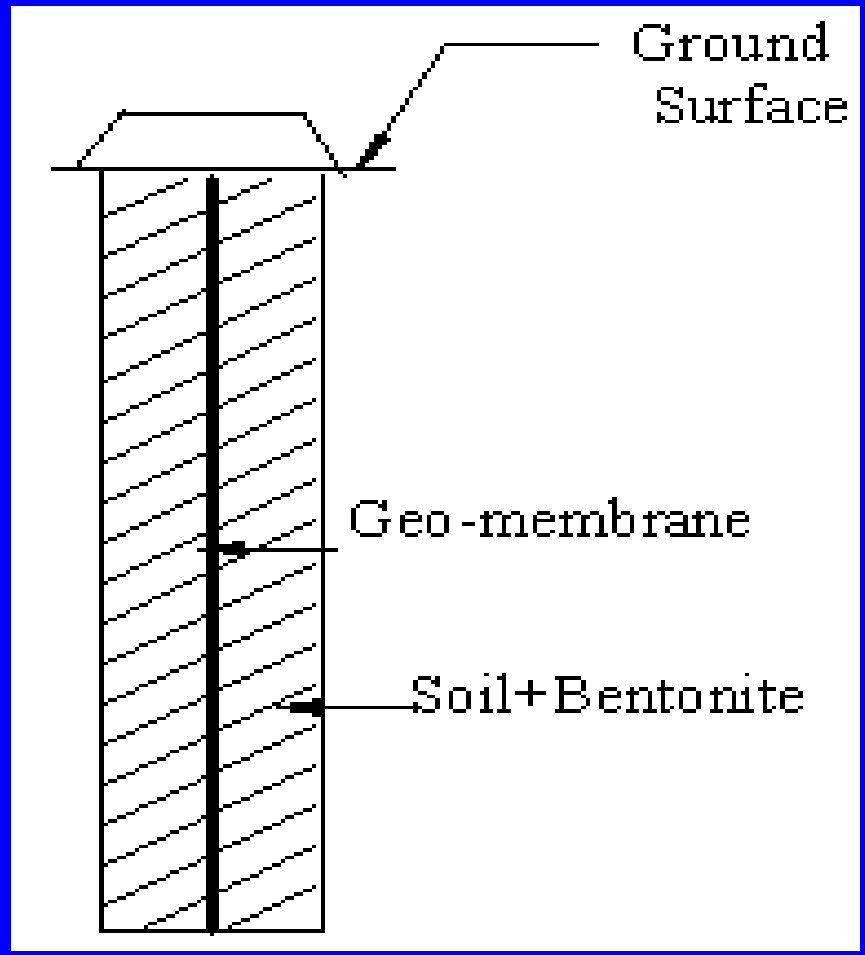
TYPES OF VERTICAL CUT-OFF BARRIERS

- Soil-bentonite walls
- Cement-bentonite walls
- Vibrating beam walls
- Composite walls
- Sheet pile walls
- Soil-cement jet grouted walls

Amongst the above barriers soil-bentonite barrier and composite barrier have been chosen for the present study.



Soil-Bentonite Wall



Composite Wall

FACTORS AFFECTING CHOICE OF CONTROL MEASURES

- Type of waste and its condition
- Rainfall condition
- Subsoil condition
- Ground water table
- Depth to bedrock
- Topography
- Distance from nearest habitat
- Distance from nearest drinking water well
- Others e.g. possibility of flooding

RANGE OF RAINFALL AND SUBSURFACE CONDITIONS IN INDIA

- **Rainfall – varies from 0-50 cm annually in Rajasthan to 400 cm in Cherapunji.**

- **Soil condition – coefficient of permeability of different soil varies from 10^{-7} cm/sec for black cotton soil and marine clay to 10^{-2} cm/sec for alluvial sand and aeolian sand.**

- **Depth of water table – 0-5 meter below ground surface to large depth.**

THREE LEVEL GROUPING OF DIFFERENT PARAMETERS

	High Contaminant potential	Moderate Contaminant potential	Low Contaminant potential
Type of Waste	Hazardous waste	Contaminant Potential MSW	Contaminant Potential Construction & Demolition waste
Rainfall	>200 cm wet	50 –200 cm	< 50 cm dry
Location of G.W. table	Ground surface to 5 m	Ground surface to 5 m – 30m	> 30m from ground surface
Sub-soil permeability	k > 10^{-3} cm/sec	k - 10^{-3} to 10^{-7} cm/sec	K< 10^{-7} cm/sec

RECOMMENDATIONS FOR DIFFERENT GROUPINGS

Type of Waste	Rainfall Condition	Location of Water Table	Sub-soil Permeability	Cover System	Vertical Cut-off Barrier
Hazardous Waste	Wet	High	High	Cover A	Composite
			Low	Cover A	Composite
		Low	High	Cover A	Composite
			Low	Cover A	Composite
	Dry	High	High	Cover A	Composite
			Low	Cover A	No cutoff
		Low	High	Cover A	Soil Bentonite
			Low	Cover A	No cutoff

RECOMMENDATIONS FOR DIFFERENT GROUPINGS

Type of Waste	Rainfall Condition	Location of Water Table	Sub-soil Permeability	Cover System	Vertical Cut-off Barrier
Municipal Solid Waste	Wet	High	High	Cover A	Soil Bentonite
			Low	Cover A	No Cutoff
		Low	High	Cover B	Soil Bentonite
			Low	Cover B	No Cutoff
	Dry	High	High	Cover B	Soil Bentonite
			Low	Cover B	No Cutoff
		Low	High	Cover B	No Cutoff
			Low	Cover C	No Cutoff

COST ESTIMATES

Unit Rates Used in Cost Estimation

Item	Rate
Local Soil	Rs. 120/- per cu.m
Yamuna Sand	Rs. 200/- per cu.m
Badarpur Sand (Quarried)	Rs. 400/- per cu.m
Stone Dust (Gravel)	Rs. 550/- per cu.m
Clay from upto 200 km	Rs. 600/- per cu.m
Ammended Soil (Delhi Silt+5% Bentonite)	Rs. 250/- per cu.m
Ammended Soil (Delhi Silt+10% Bentonite)	Rs. 350/- per cu.m

Unit Rates Used in Cost Estimation

Item	Rate
1.5 mm HDPE Geomembrane	Rs.250/- per sq.m
2.0 mm HDPE Geomembrane	Rs.450/- per sq.m
Protective Non-Woven Geotextile	Rs. 100/- per sq.m
Excavating trench, stabilizing with bentonite slurry and backfilling with Soil+10%Bentonite	Rs.1000/- per cu.m
Lined Surface Drain	Rs. 700/- per m
Regrading and Establishing Vegetation	Rs. 50/- per sq.m

Cost Estimate for Waste Dump (500m x 500m in plan) with cover and Vertical Cut-off Wall (Depth 25 m)

Case	Cover System	Vertical Cut-off Barrier	Cost of Cover (Rs x 10^5)	Cost of Vertical Cut-off (Rs.x10^5)	Total Cost (Rs.x 10^7)	Cost per unit area Rs./sq.m	Applicability
V	Cover A	Composite	2242.2	850	30.92	1236	HW, Wet area, High W.T., High Perm.
VI	Cover A	Soil-Bentonite	2242.2	600	28.92	1156	HW, Dry area, Low WT, High Perm.

Cost Estimate for Waste Dump (500m x 500m in plan) with cover and Vertical Cut-off Wall (Depth 25 m)

Case	Cover System	Vertical Cut-off Barrier	Cost of Cover (Rs x 10^5)	Cost of Vertical Cut-off (Rs.x10^5)	Total Cost (Rs.x 10^7)	Cost per unit area Rs./sq.m	Applicability
VII	Cover B	Soil-Bentonite	1912.2(Alt 1) 1384.7(Alt 2)	600	25.12 19.84	1004 793	MSW, High cont. potential
VIII	Cover B	No cut-off	1912.2(Alt 1) 1384.7(Alt 2	Nil	19.12 13.84	764 553	MSW, Moderate cont. potential.

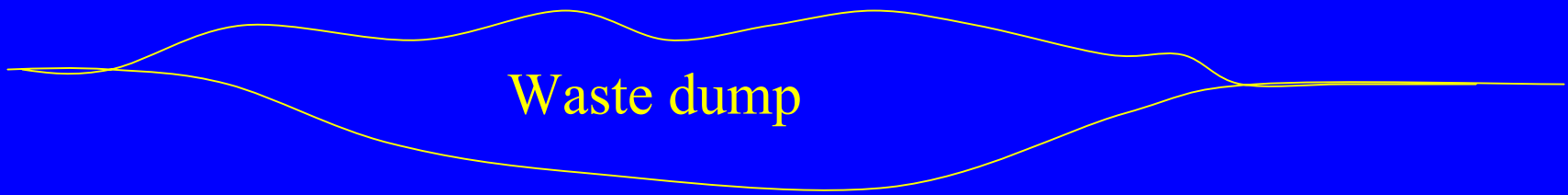
CONCLUSIONS

- depending on the meteorological and sub-soil condition as well as type of waste, significant financial resources are required for control measures at old waste dumps.

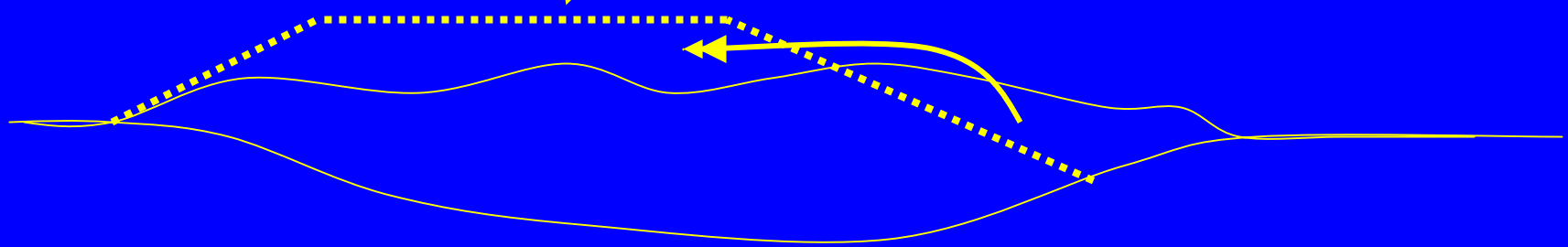
- when the waste is hazardous, region is wet with high water table and high permeability soil, the cost of providing cover and vertical cut-off wall lies in between Rs.1200 to Rs. 2000 per square meter of waste surface area.

- for municipal solid waste potential, the cost of control measures lies in between Rs.600 to Rs. 1000 per square meter of waste surface area.

Closure and Horizontal Expansion

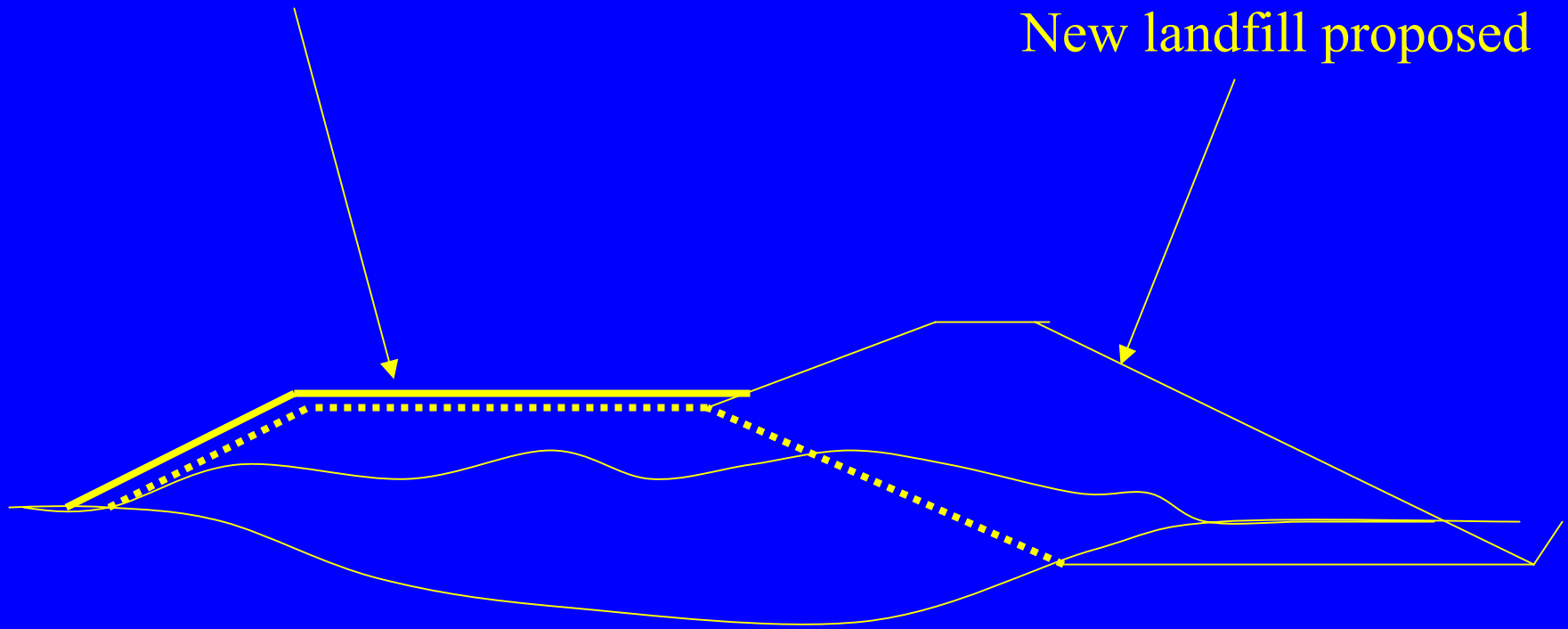


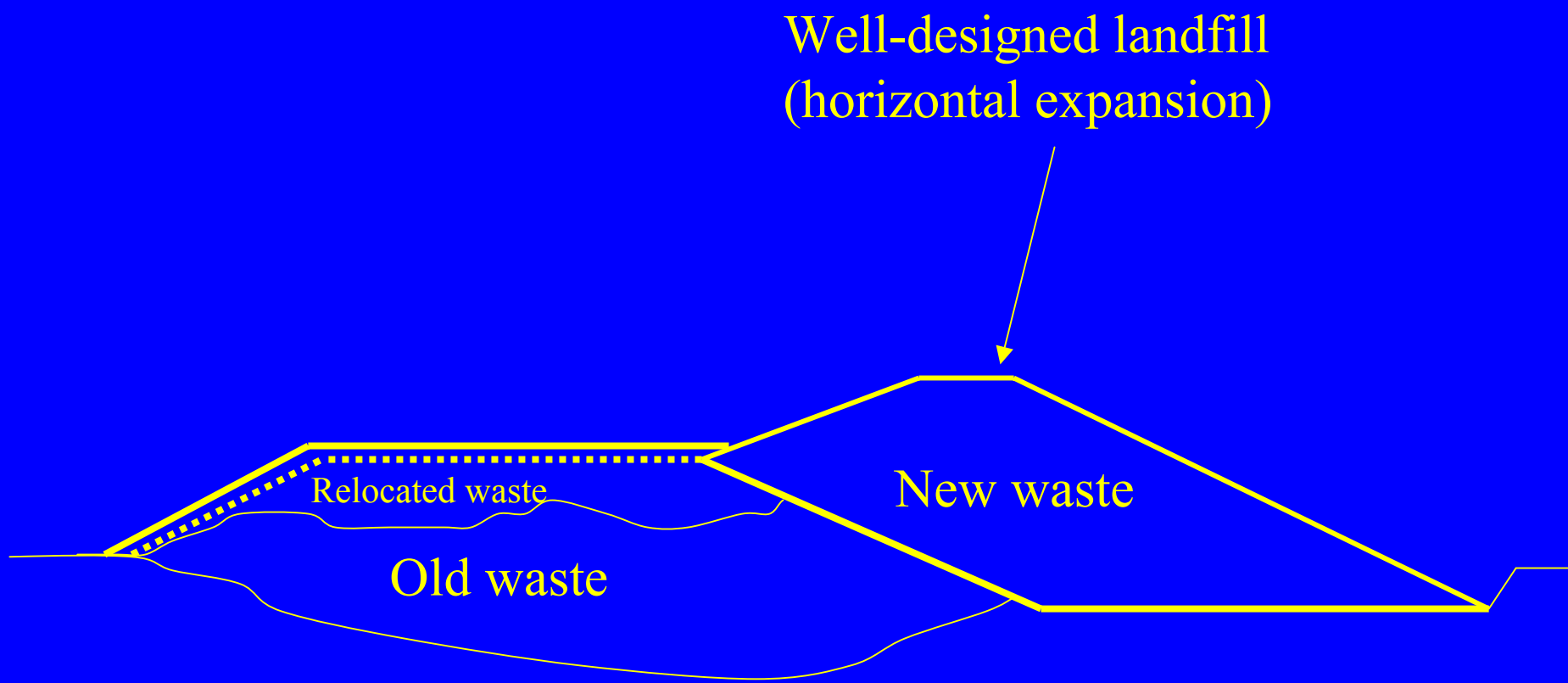
Relocation of waste and
re-grading of landfill



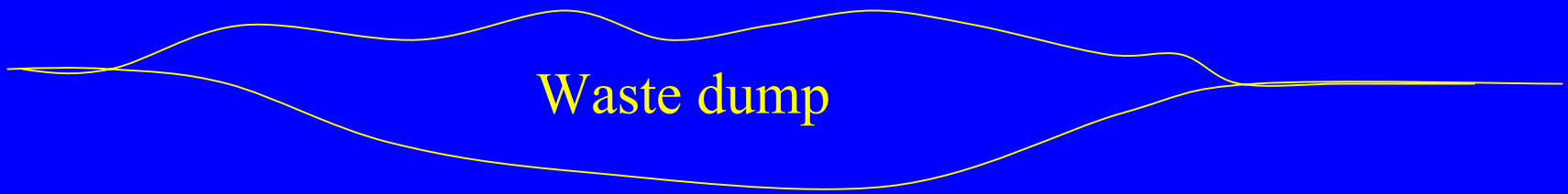
Cover for old waste

New landfill proposed

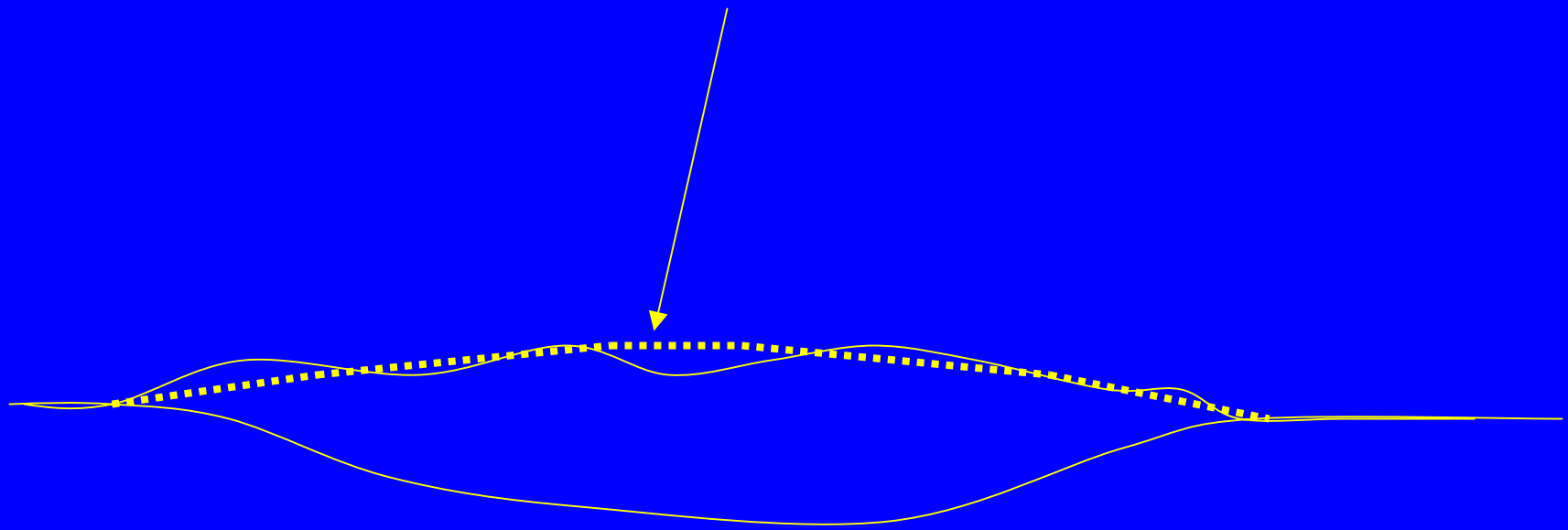



Well-designed landfill
(horizontal expansion)
Relocated waste
New waste
Old waste

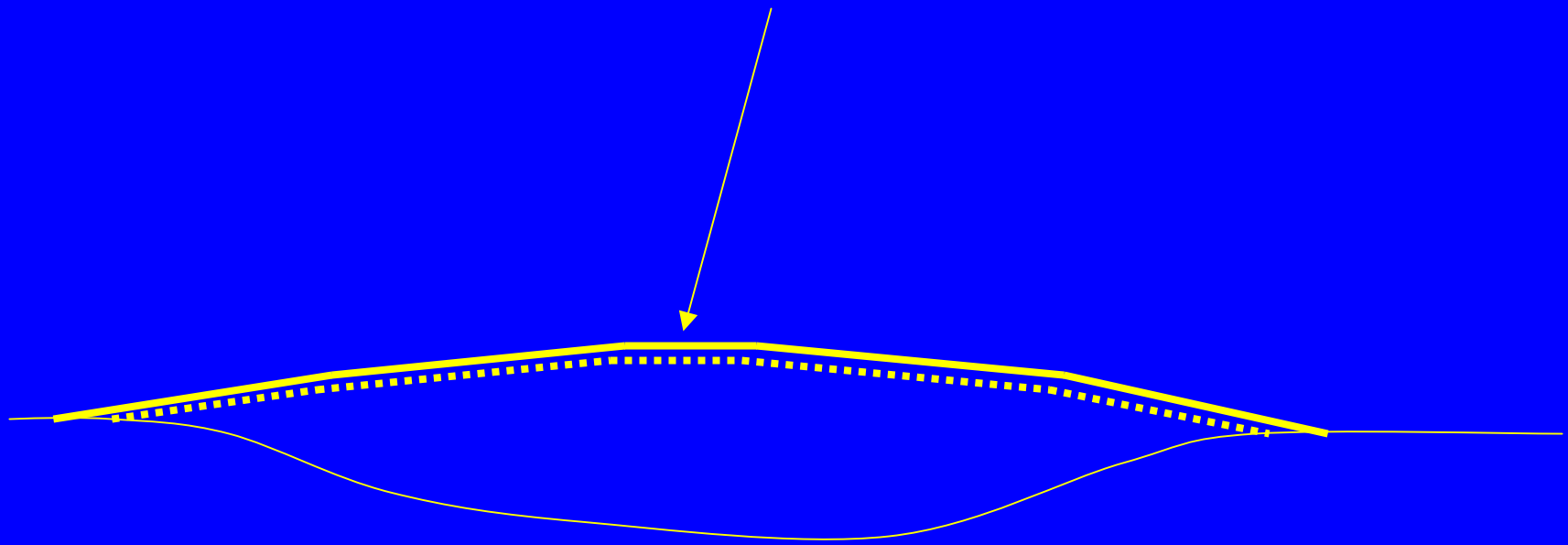
Closure and Vertical Expansion

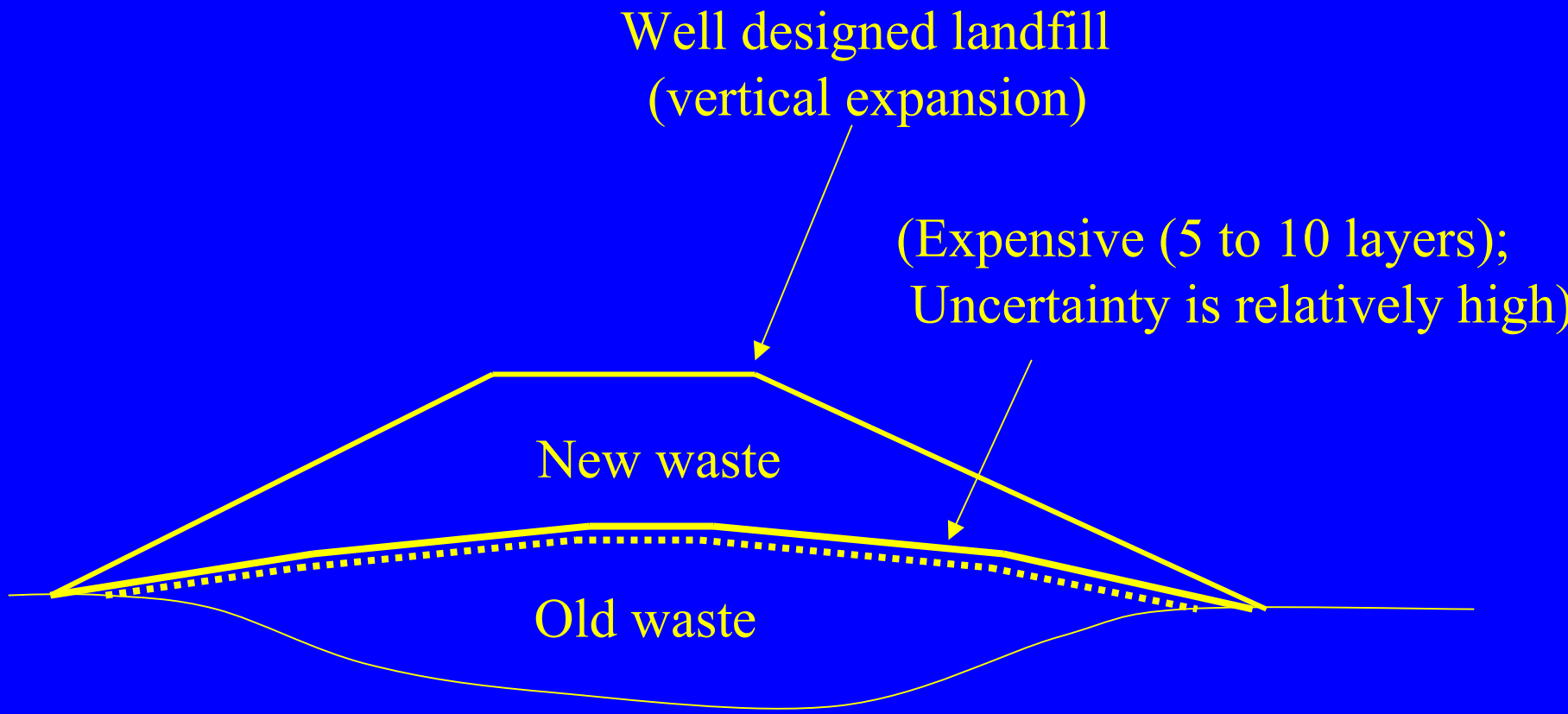


Re-grading of top surface



Cover for old waste and
liner for new waste




Well designed landfill
(vertical expansion)
(Expensive (5 to 10 layers);
Uncertainty is relatively high)
New waste
Old waste

Case Study : Ghazipur Landfill


FREIGHT COMPLEX GAZIPUR
मुर्गा एवं अण्डा मार्किट
CHICKEN & EGG MARKET
गाजीपुर पाकेट ए
GAZIPUR PKT. A
MARKET

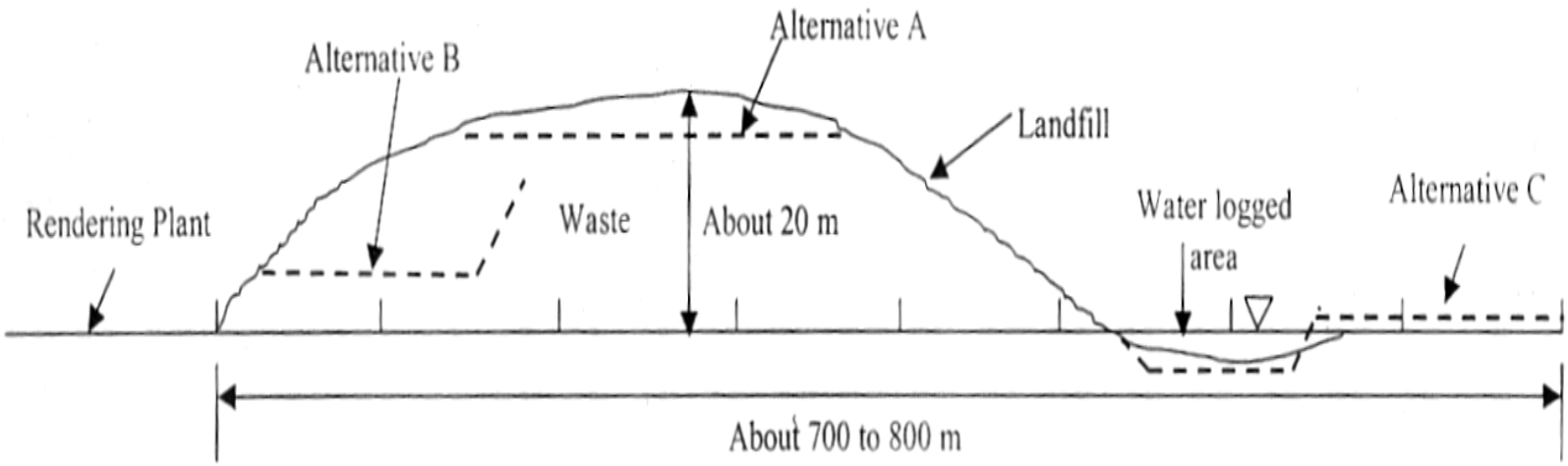


Fig 2. Visual Impression of Landfill section along alignment of Alternatives A, B and C

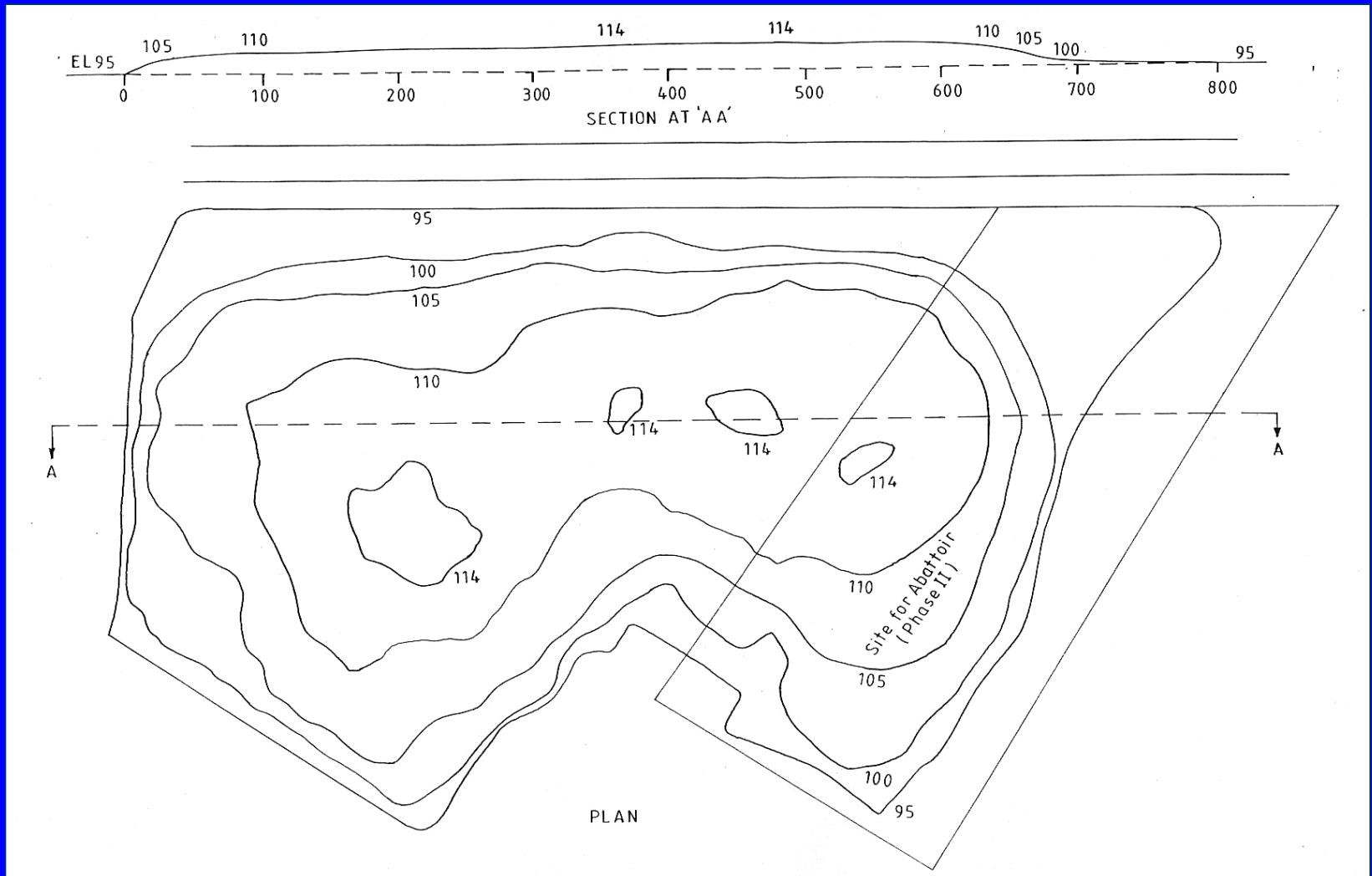


Fig. 1 PLAN AND SECTION OF EXISTING LAND FILL AT GHAZIPUR.

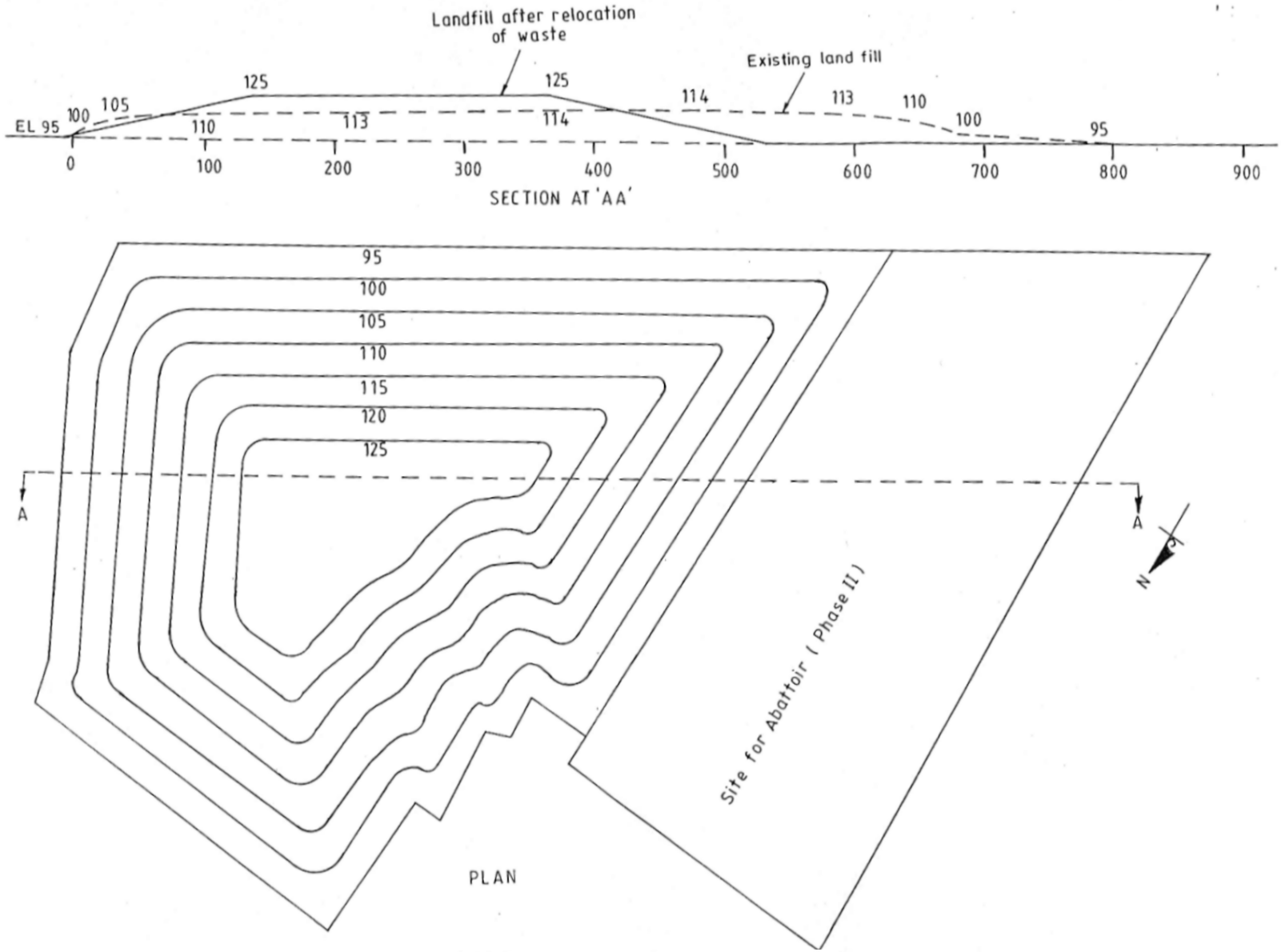


Fig. 2 PLAN AND SECTION OF LANDFILL AFTER RELOCATION OF WASTE.

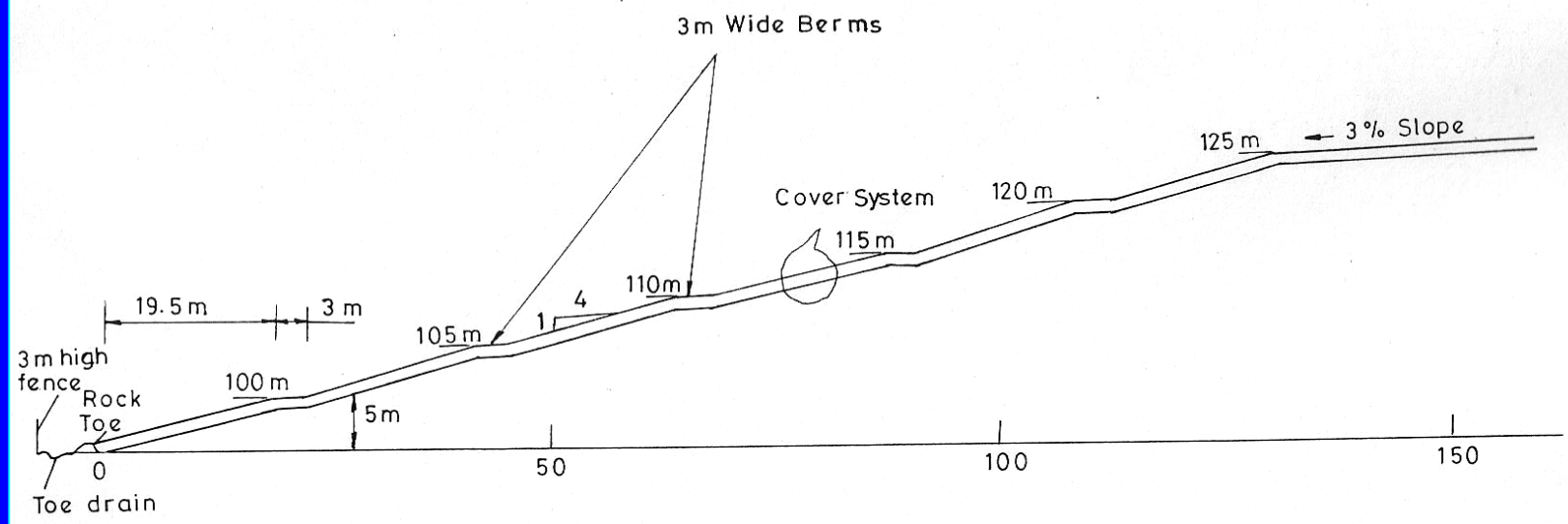


Fig. 3 SECTION OF LAND FILL

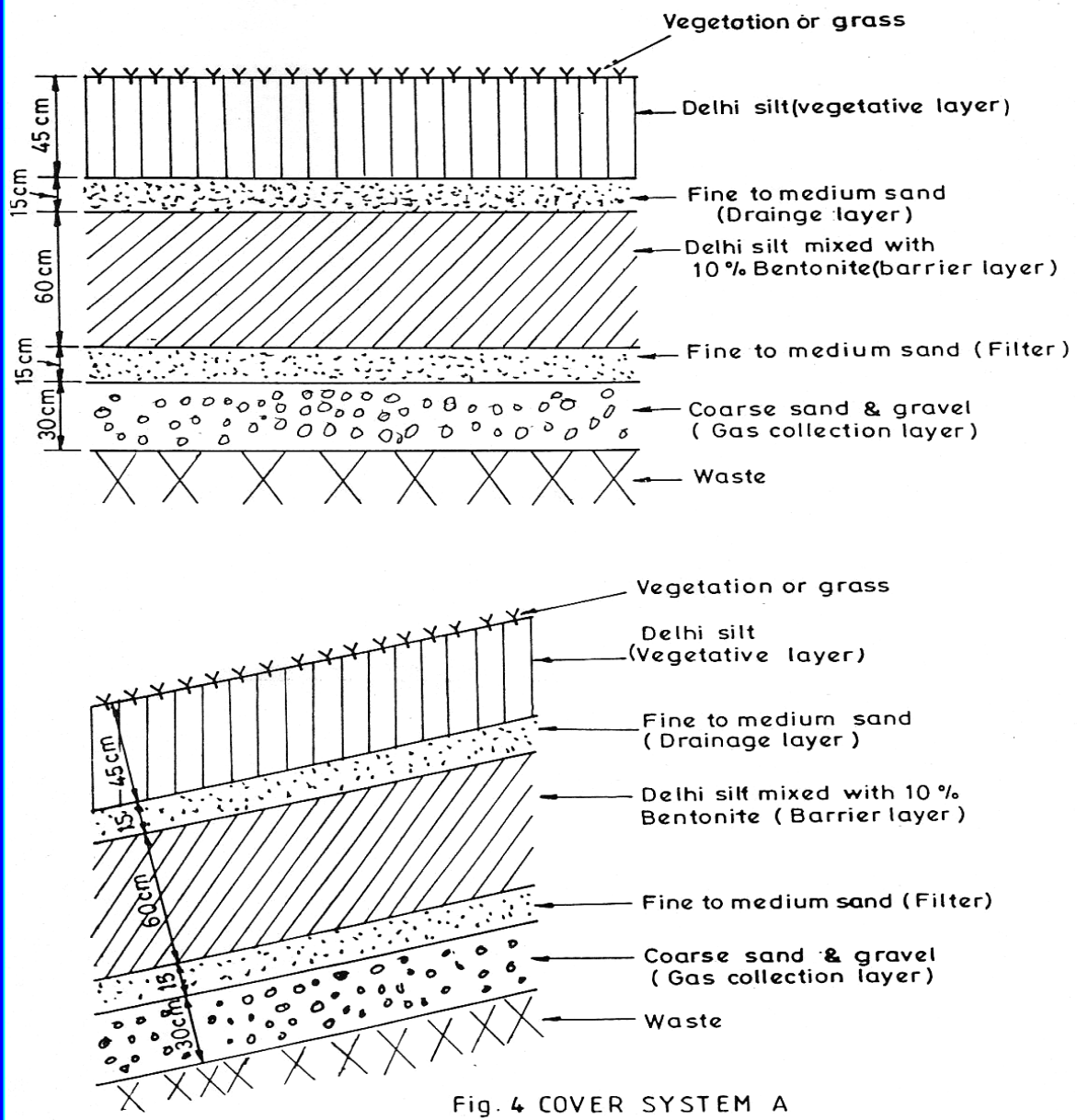
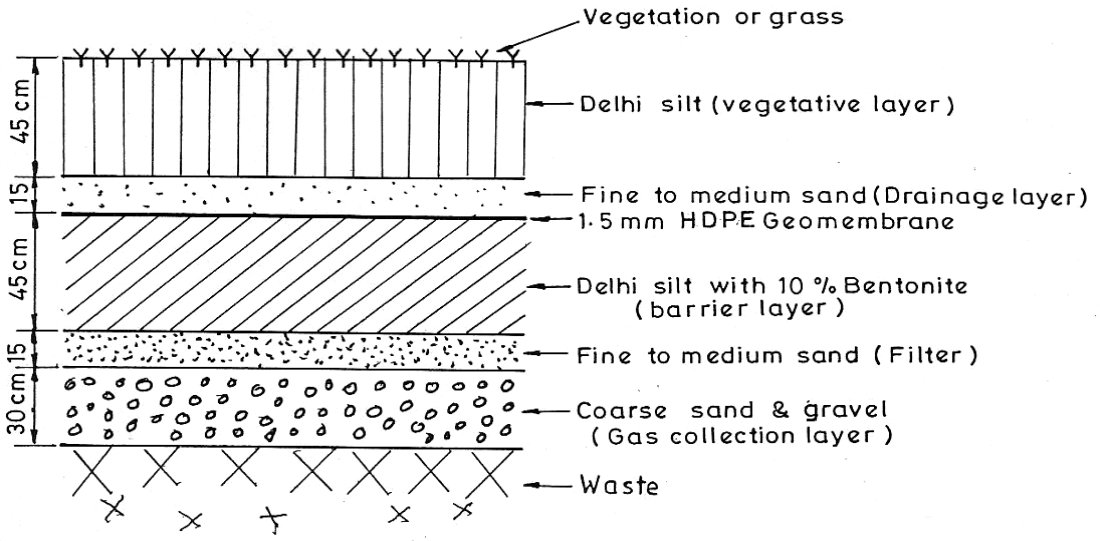
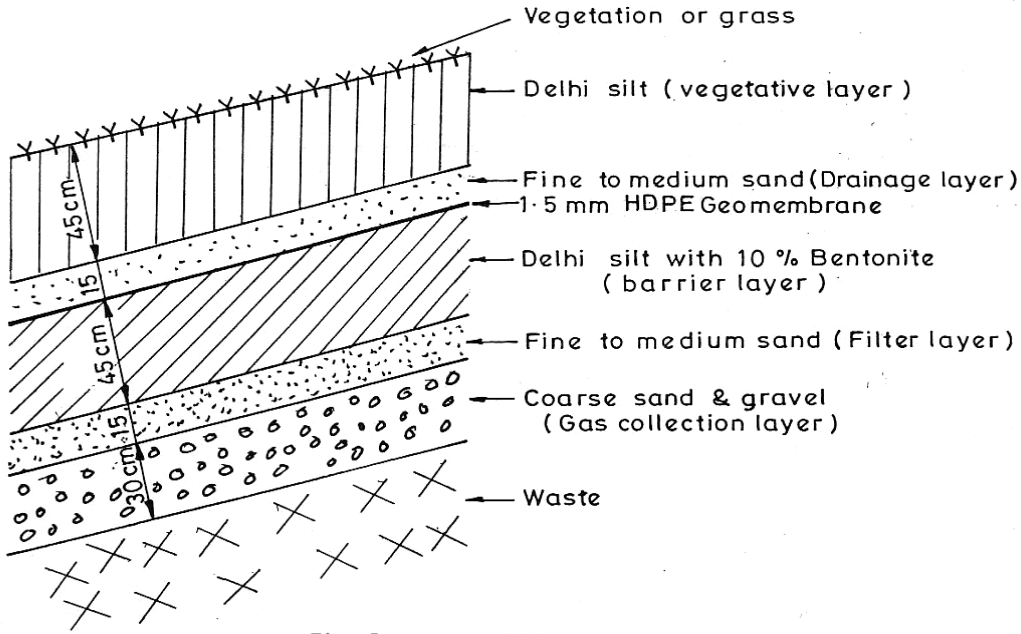


Fig. 4 COVER SYSTEM A





Fig·5 COVER SYSTEM-B

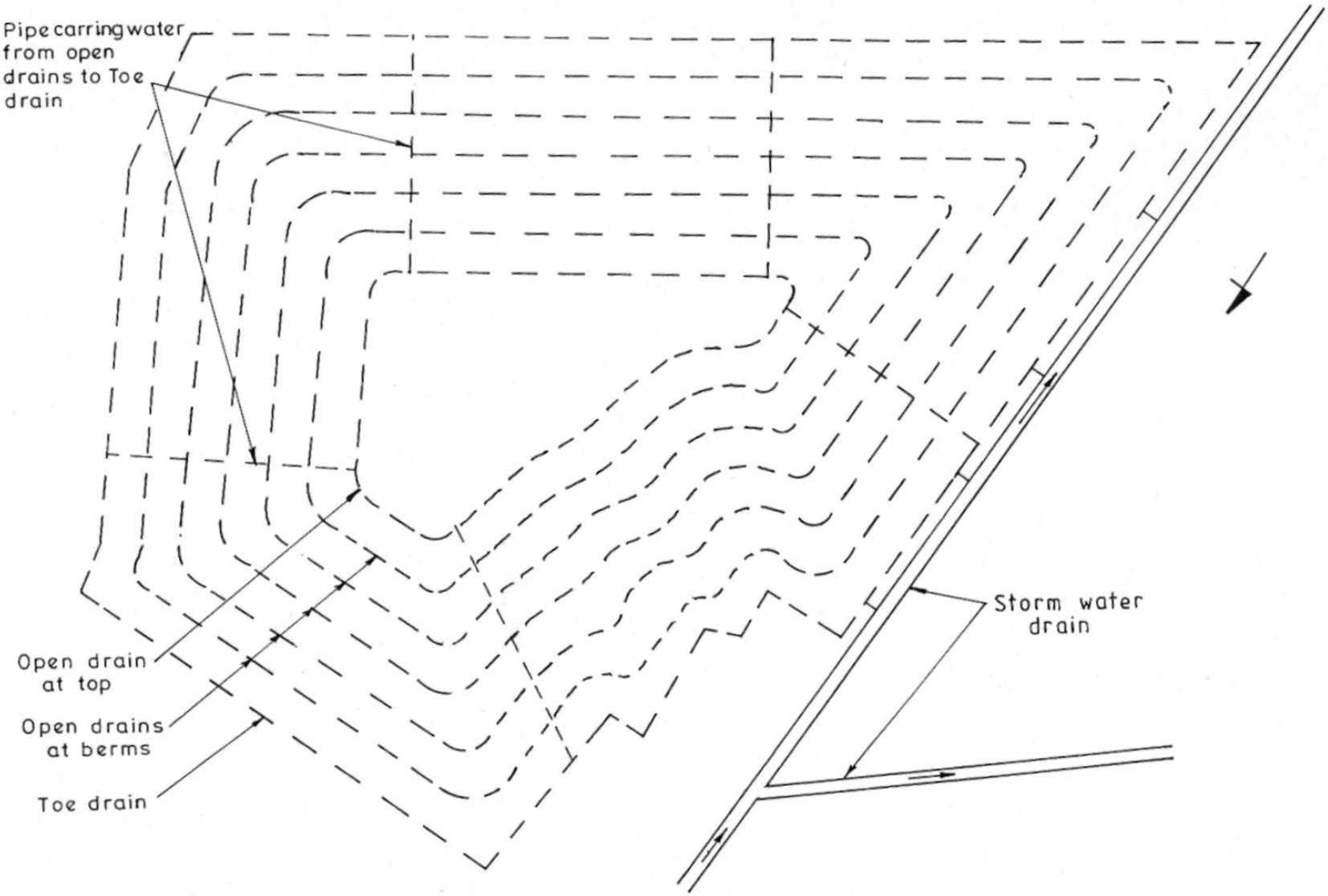


Fig. 11 LOCATION OF DRAINS.

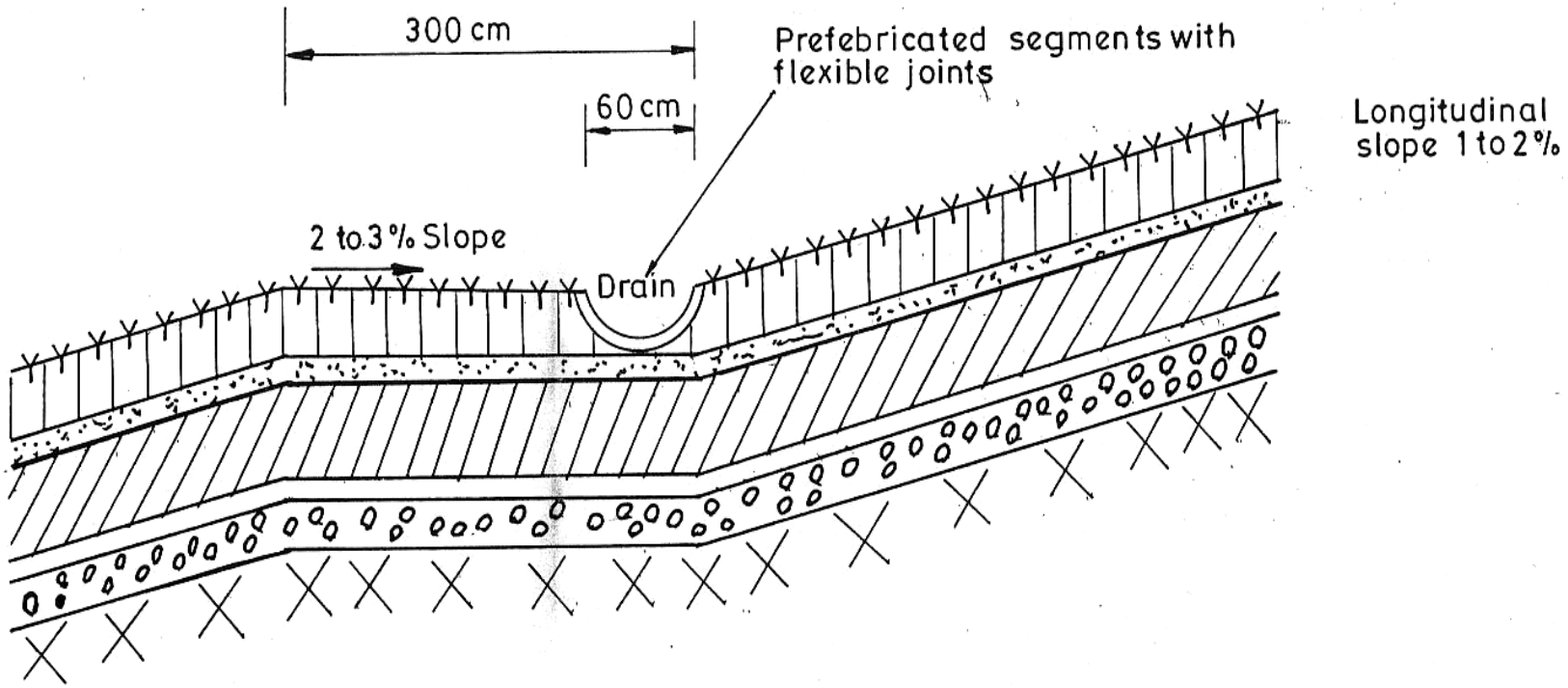


Fig. 9 DRAINS AT BERMS

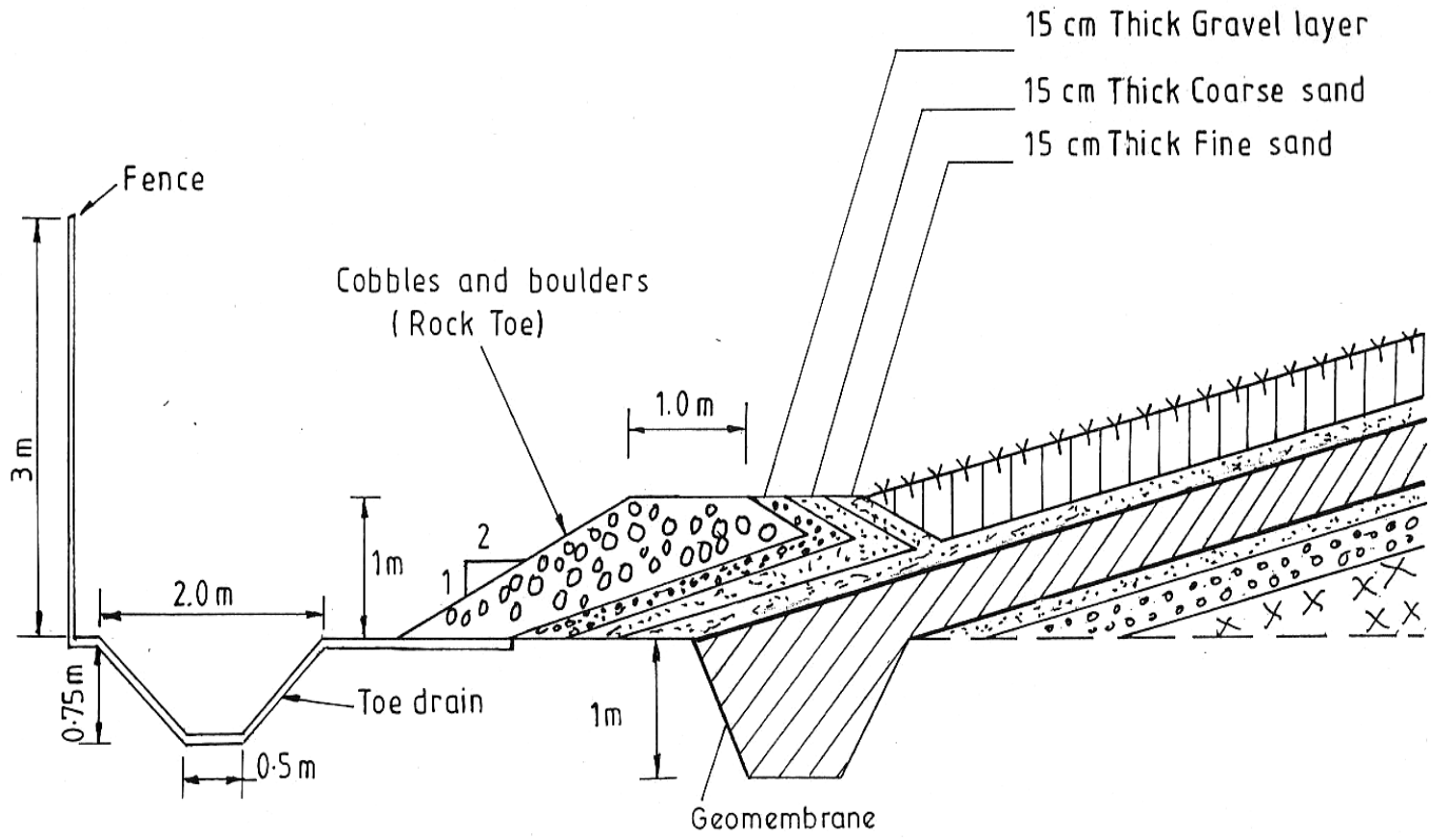
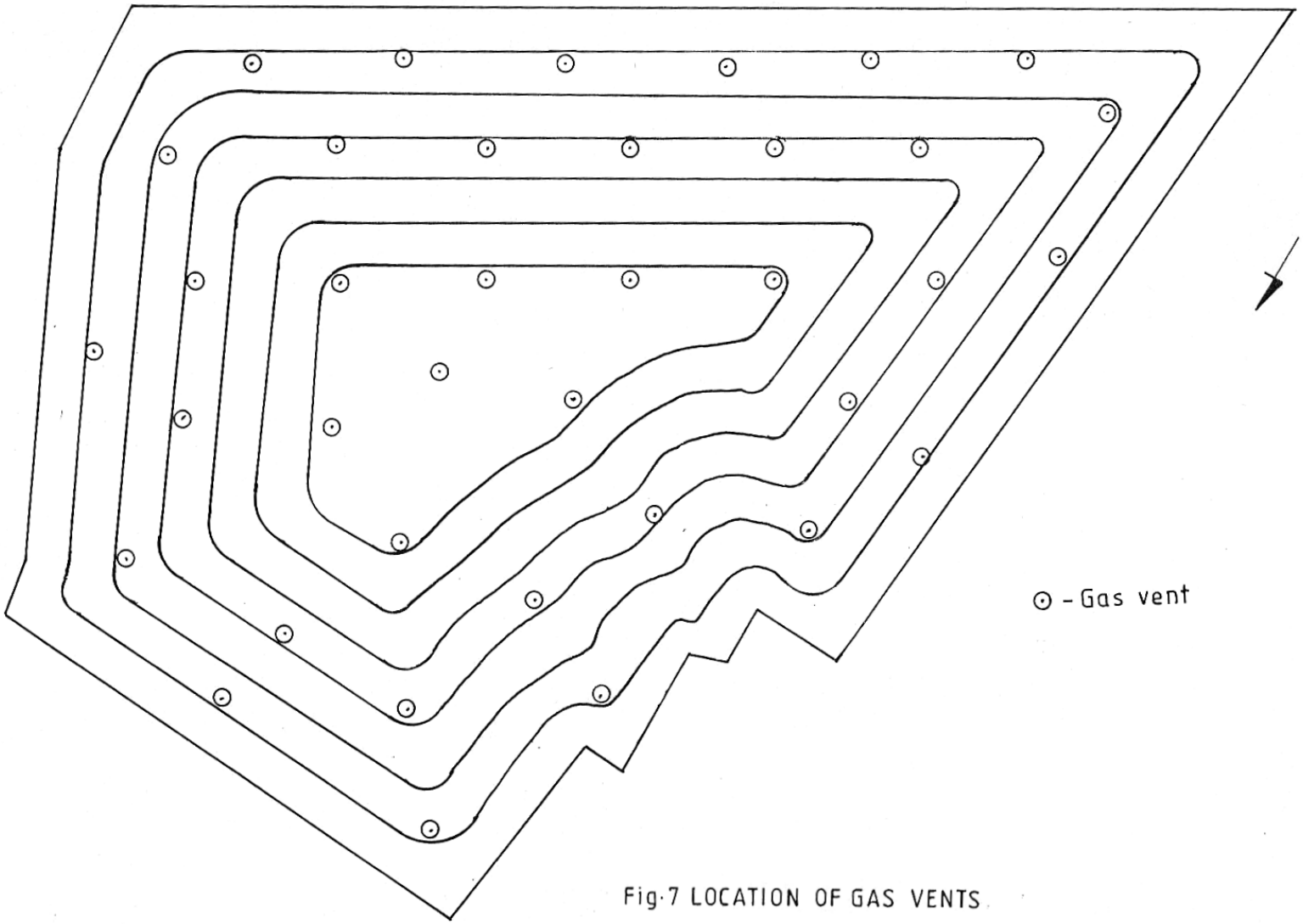


Fig. 10 DETAILS OF ROCK TOE AND TOE DRAIN.



Fig·7 LOCATION OF GAS VENTS

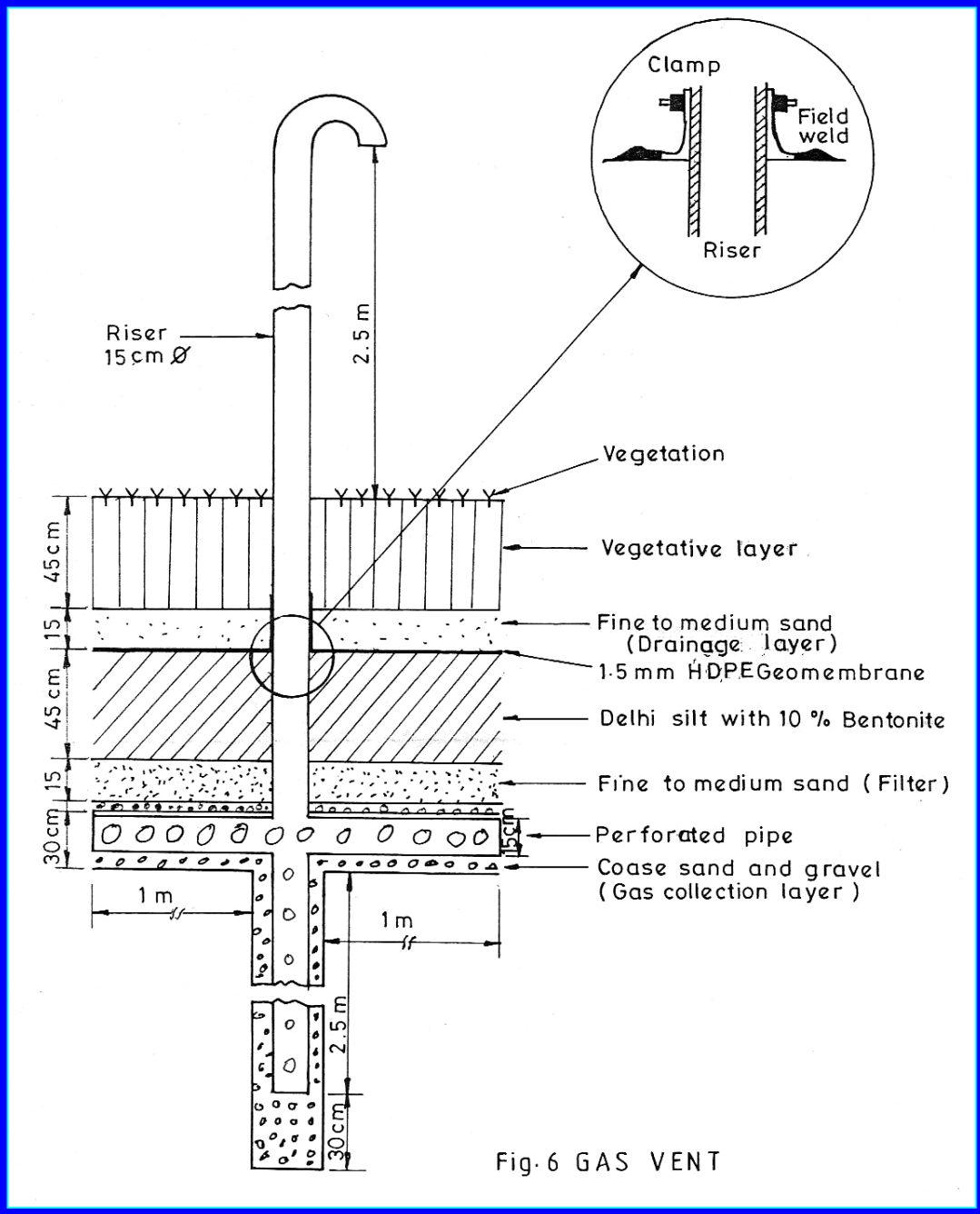


Fig. 6 GAS VENT

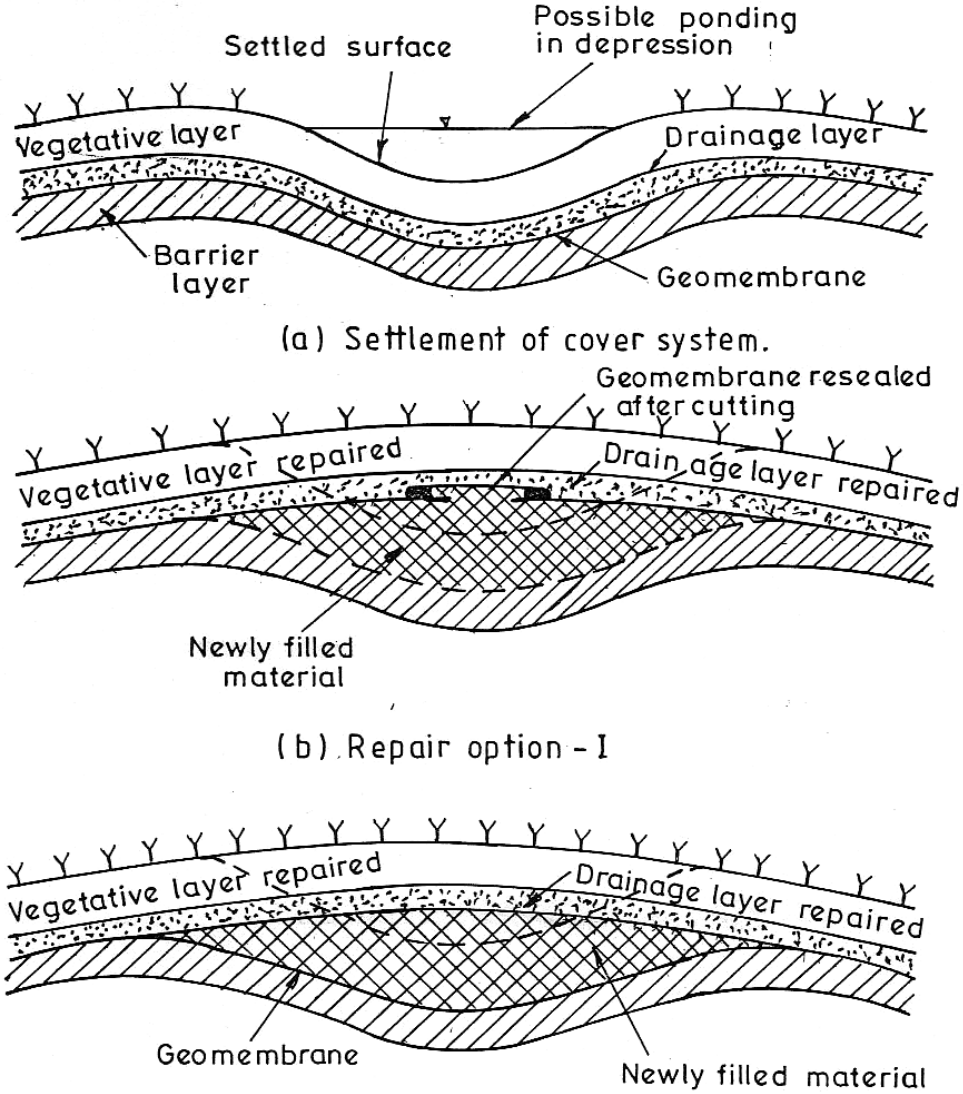


Fig. 8 Repair of cover

Control Measures at Gorai Waste Dump (Landfill), Mumbai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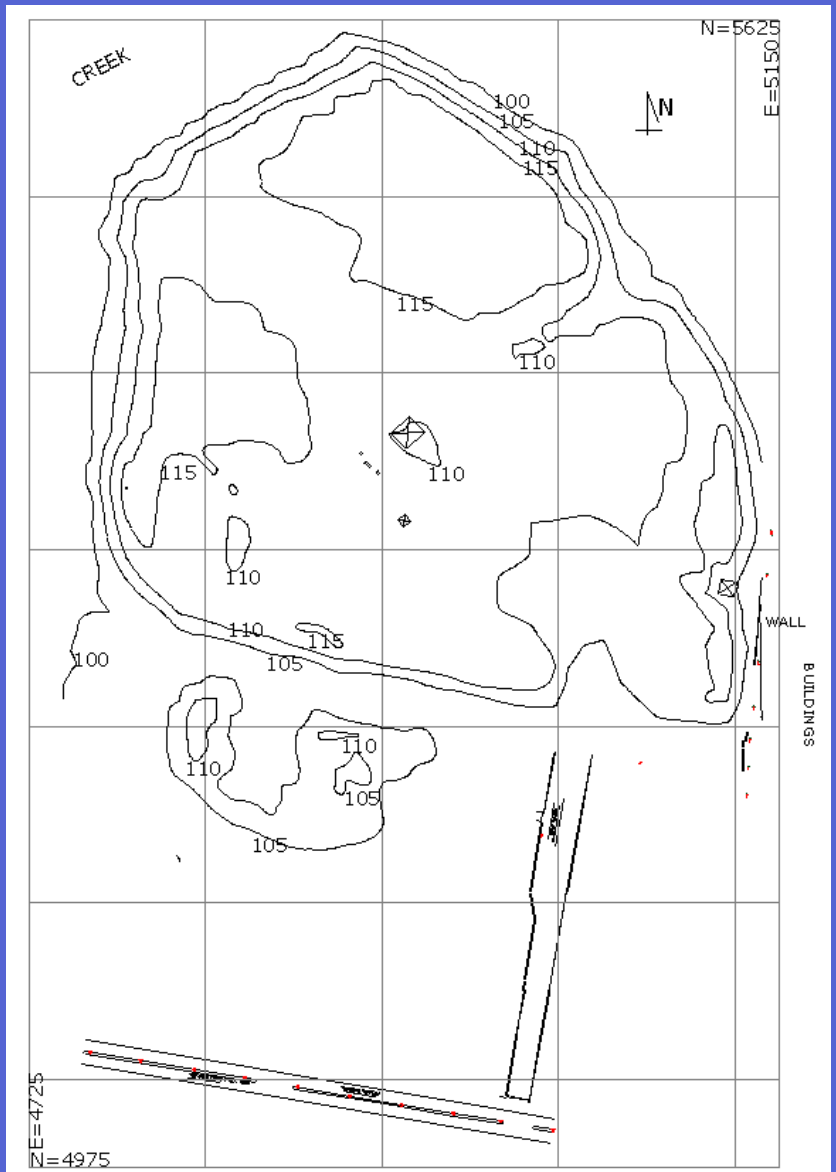
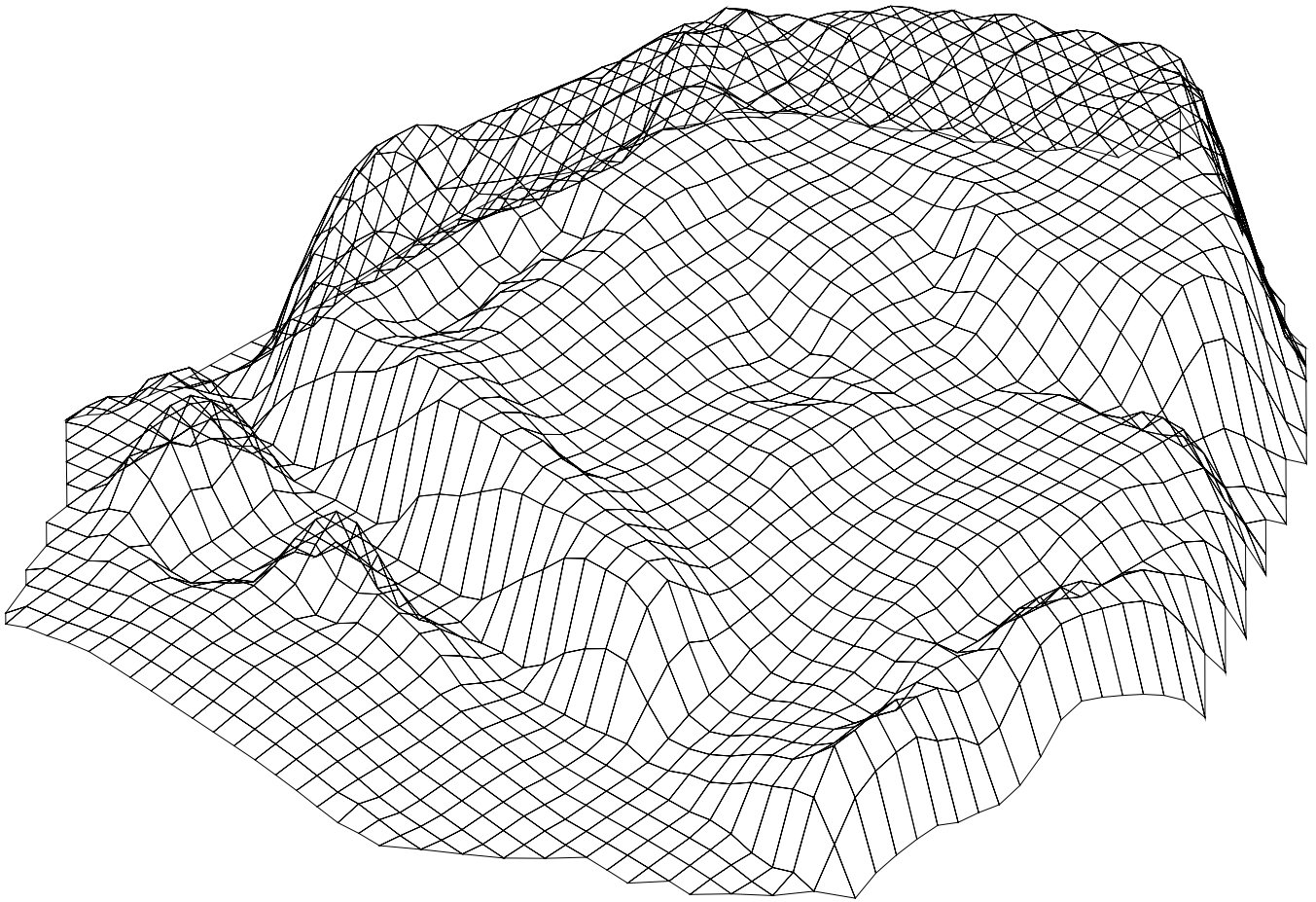
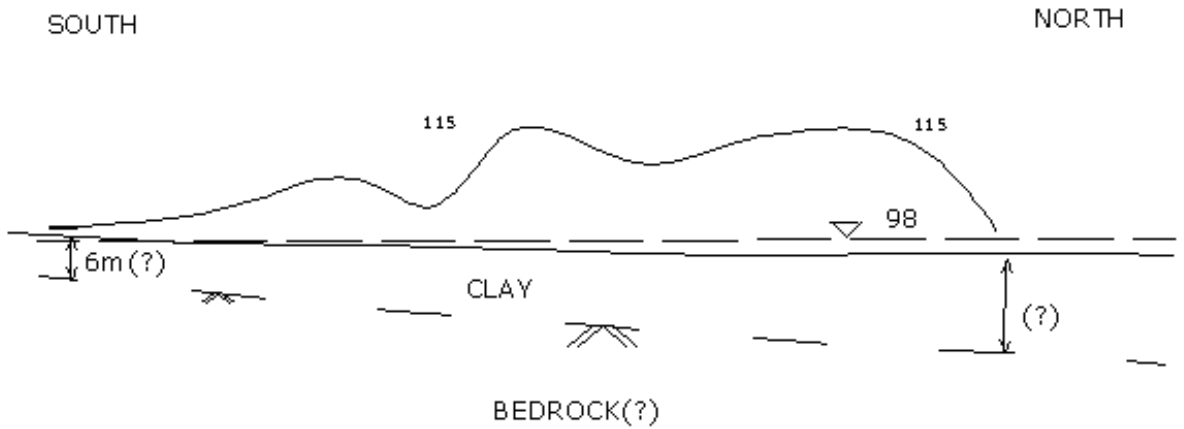
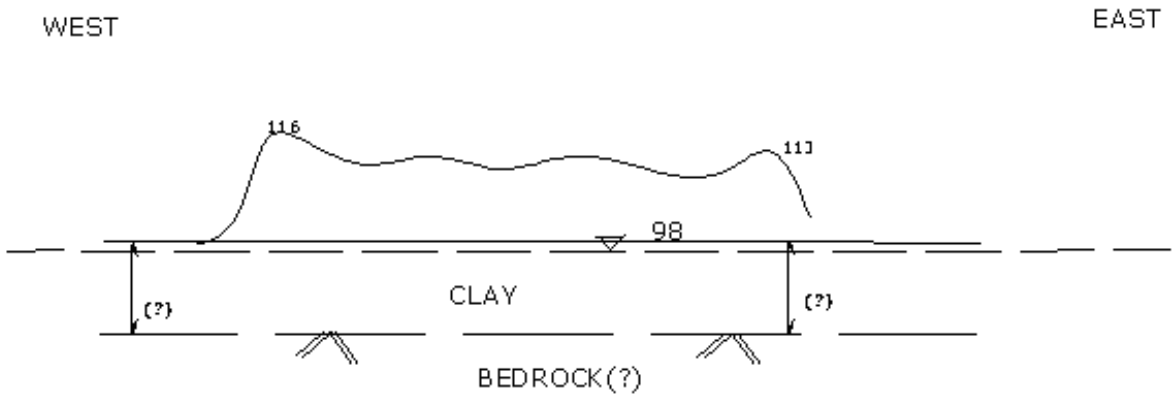


FIG 1:PLAN VIEW OF EXISTING LANDFILL



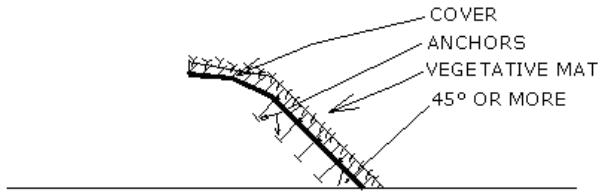


(a) NORTH SOUTH SECTION

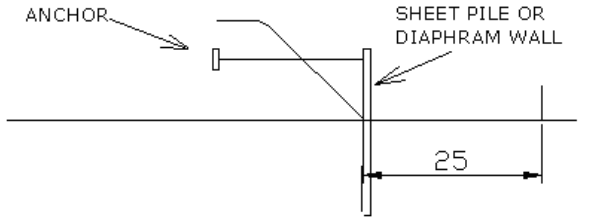


(b) EAST WEST SECTION

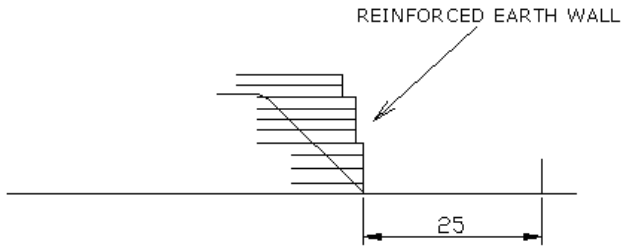
FIG:2 LANDFILL SECTIONS



(a)ANCHORED OR NAILED SLOPE

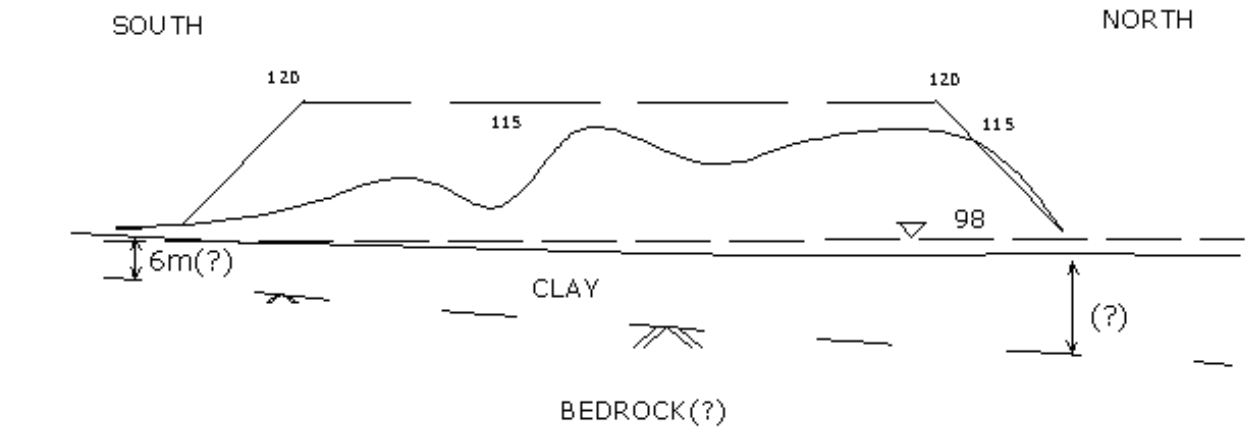


(b)ANCHORED WALL

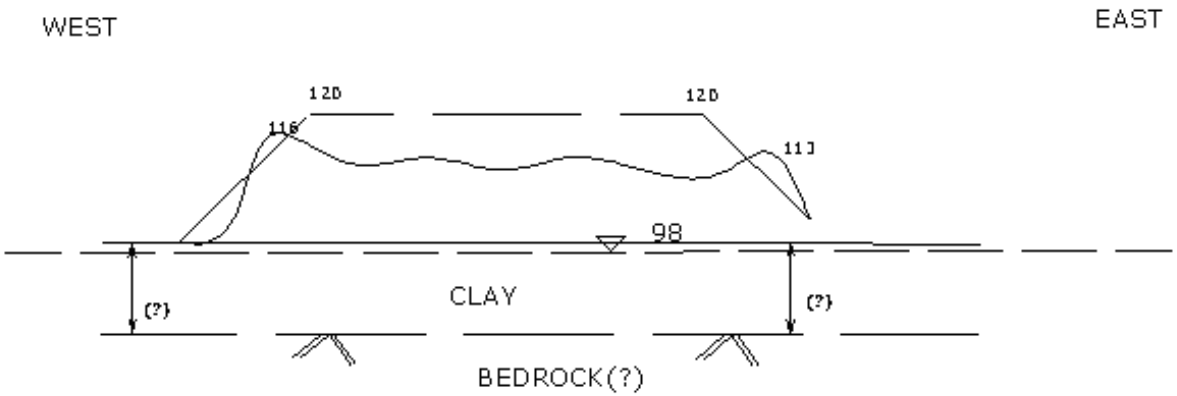


(c) REINFORCED EARTH WALL

FIG 3: STABILISATION OF EXISTING SLOPE

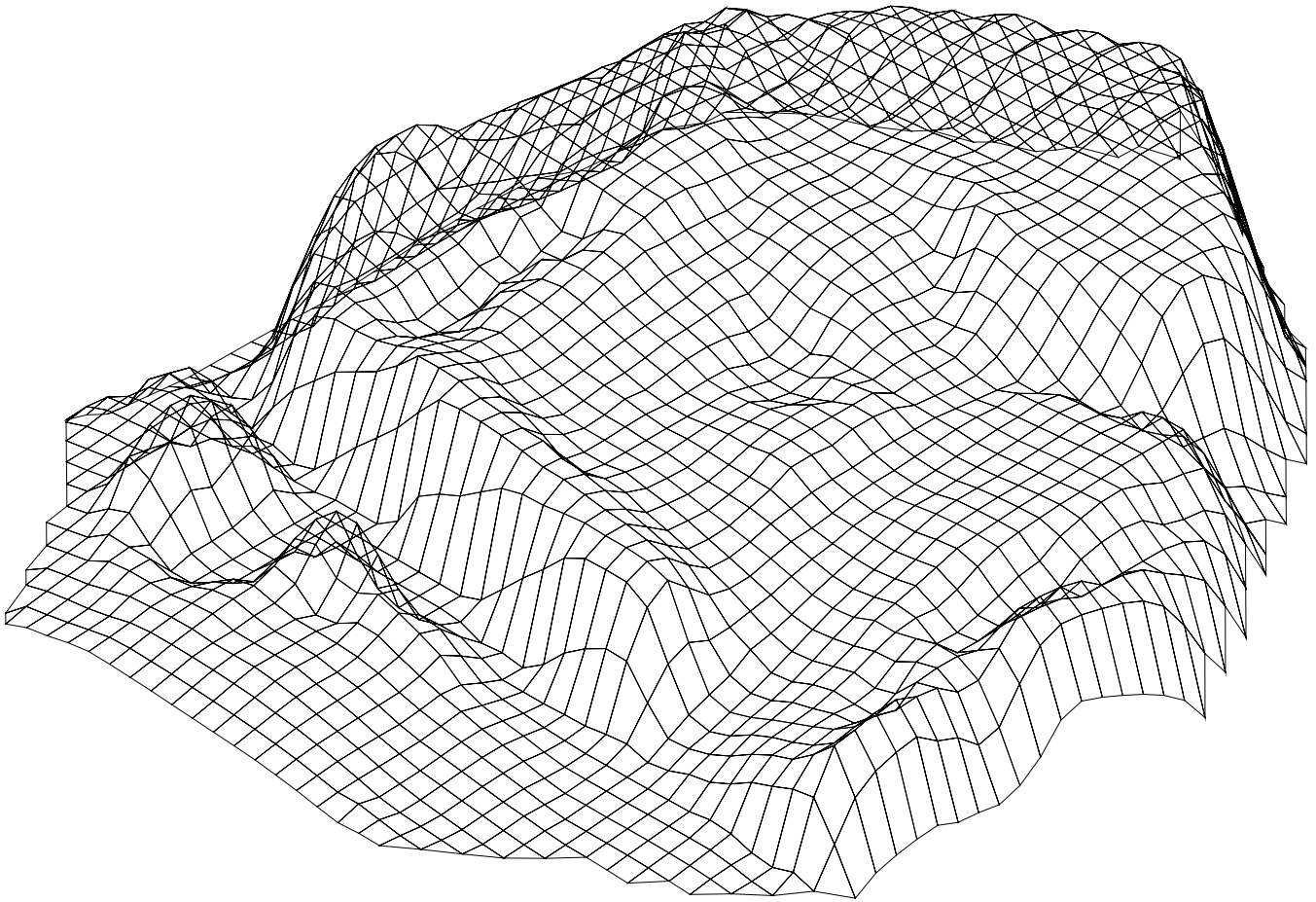


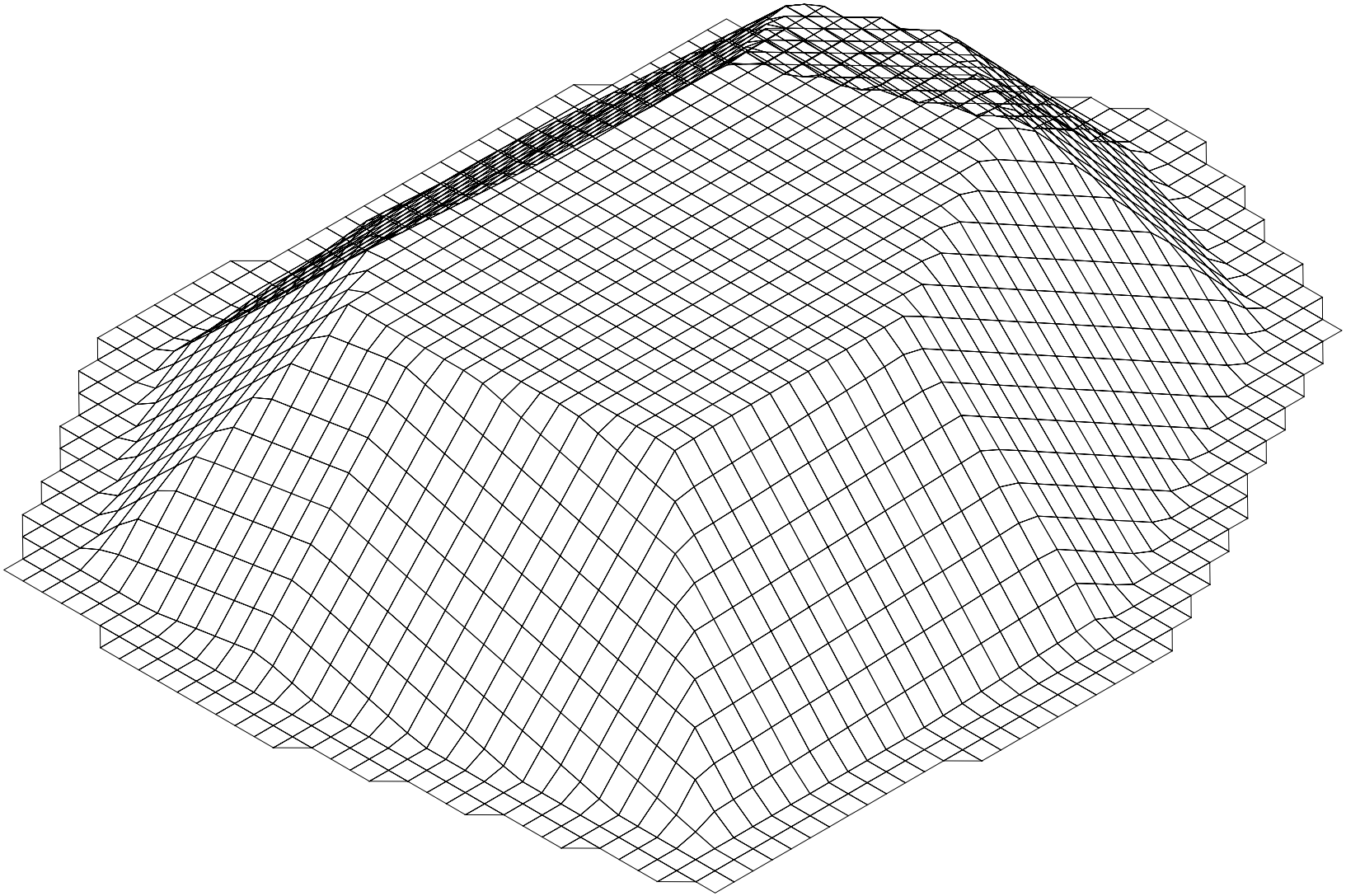
(a) NORTH SOUTH SECTION WITH REGRADED SLOPE

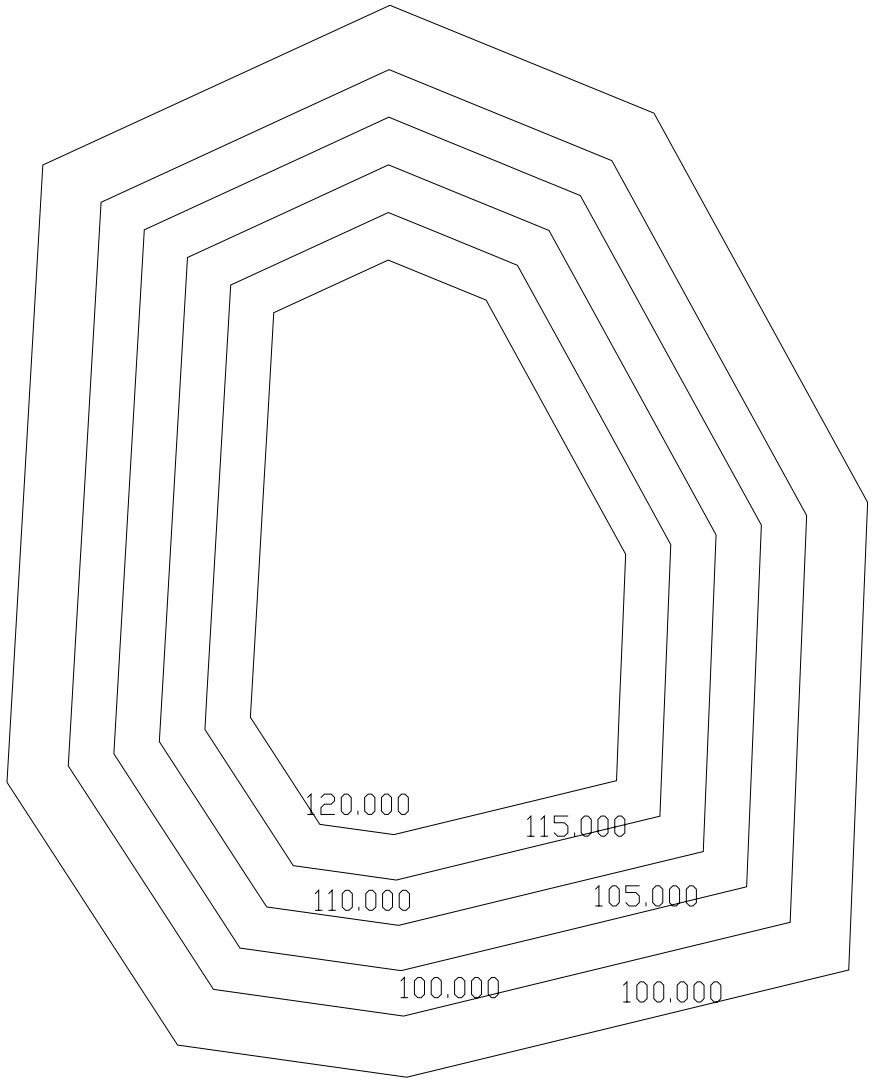


(b) EAST WEST SECTION WITH REGRADED SLOPE

FIG 4: LANDFILL SECTIONS AFTER REGRADING



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115.000
110.000
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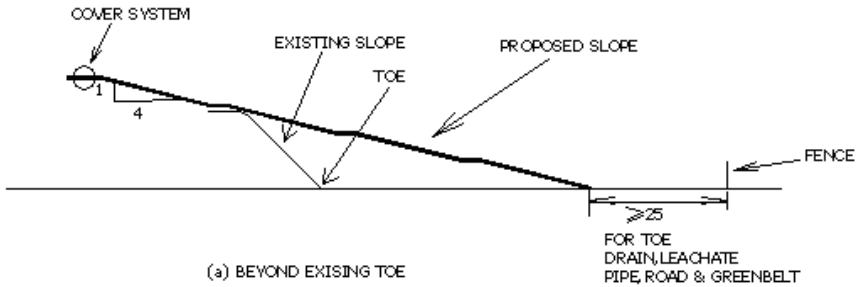
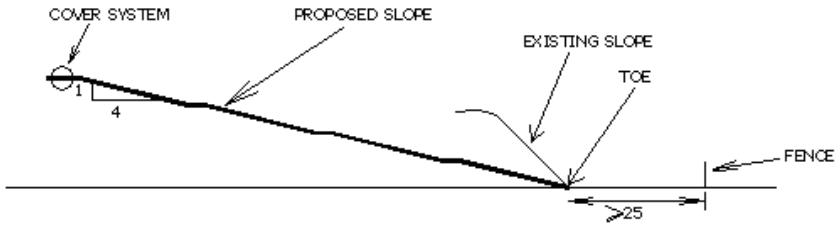
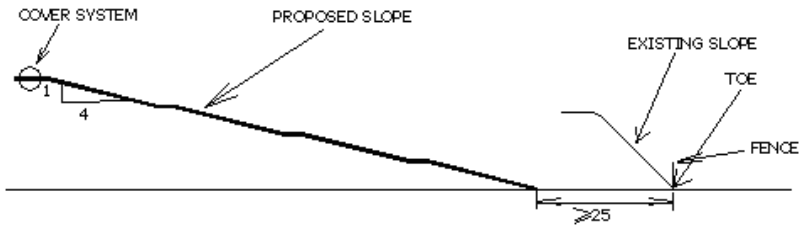
100.000
100.000



(a) BEYOND EXISING TOE



(b) AT EXISTING TOE



(c) INSIDE EXISTING TOE

FIG 5: REGRADATION OF SLOPE

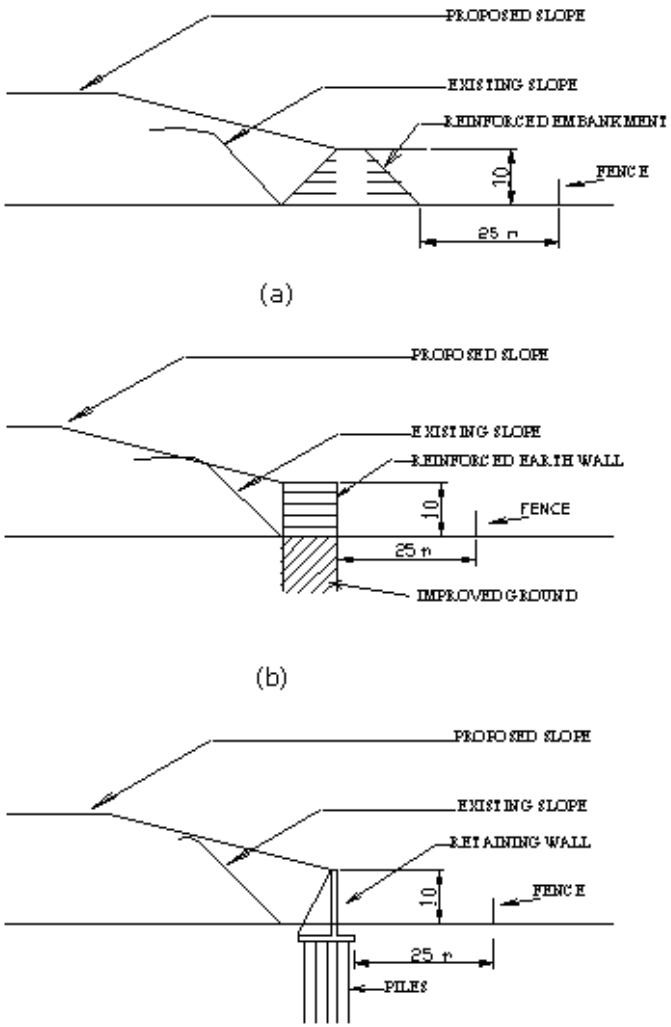


Fig 6: REGRADING WITH STRENGTHENING OF TOE

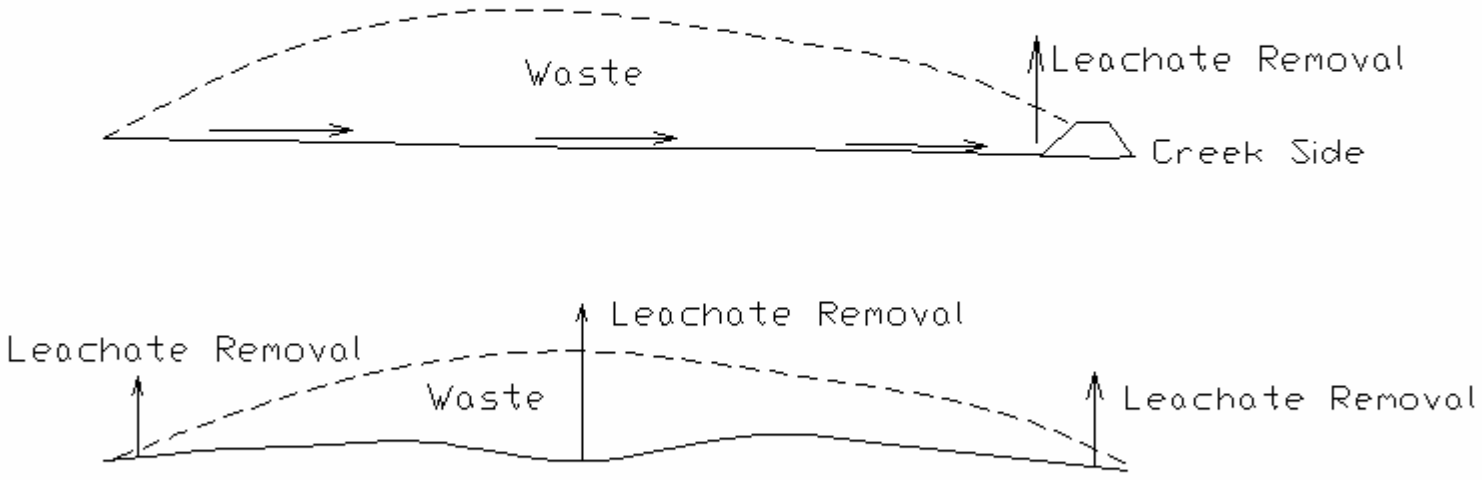


Fig10: LEACHATE REMOVAL

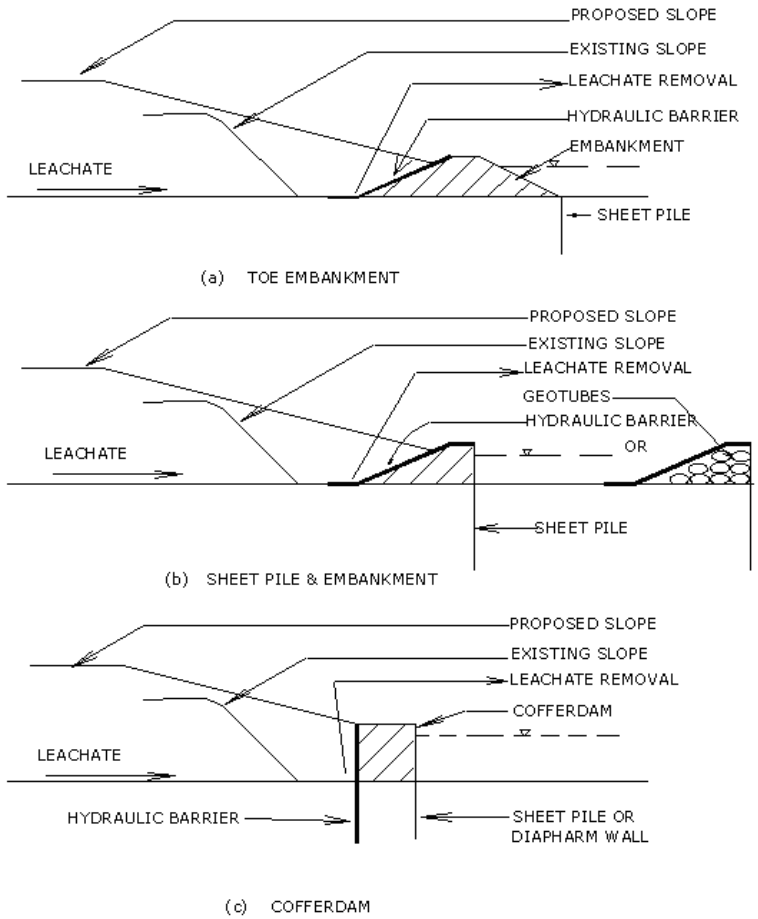


FIG7: ARRANGEMENT ON CREEK SIDE

Some Lessons Learnt

- Some old waste dumps have heights in the range of 10 to 20m with good potential for gas recovery.
- They have steep side slopes.
- Slopes have to be flattened to ensure stability of covers.
- Composite covers + active gas collection (wells with suction) can result in efficient methane recovery.
- Cost of covers and cut-offs (upto Rs 2000/- per sqm (USD 50)) should be offset by gas collection.

Thank you