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Drainage Engineering (BTAI3103)

Module 3

Surface and Subsurface Drainage Systems (Lecture-07: Introduction to sub-surface drainage)

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Subsurface Drainage



What is Subsurface Drainage?

- ✓ The purpose of a subsurface drainage system is to lower the groundwater table and removal of excess salts beyond the crop root zone.
- ✓ Agricultural lands affected by high water table



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Groundwater table may rise due to :

- ✓ Flood irrigation method
- ✓ Seepage from unlined channels
- ✓ Percolation of rain and runoff water
- ✓ Subsurface flow from higher areas.



Size, spacing and depth of drains depends:

- ✓ Infiltration
- ✓ Saturated hydraulic conductivity
- ✓ Drainable porosity
- ✓ Requirement of removal of water



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Advantage of sub-surface drainage system

- ✓ Aeration of root zone for maximum development of plant roots.
- ✓ Opportunity for desirable soil micro-organisms to develop through aeration and higher soil temperature.
- ✓ Removal of undesirable salts from the root zone.
- ✓ Greater storage of rainwater in the root zone because of a low initial water table before the rains.
- ✓ Reduces soil erosion due to reduction of overland flow.
- ✓ Once constructed requires less maintenance attention compared to surface drains.
- ✓ No loss of land for cultivation.
- ✓ No hindrance to movement of farm machinery or other farming operations.



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Classification of sub-surface drainage system

(A) Based on the direction of drain

I. Relief drainage:

- (a) To lower the water table
- (b) the drains move along the direction of GW flow

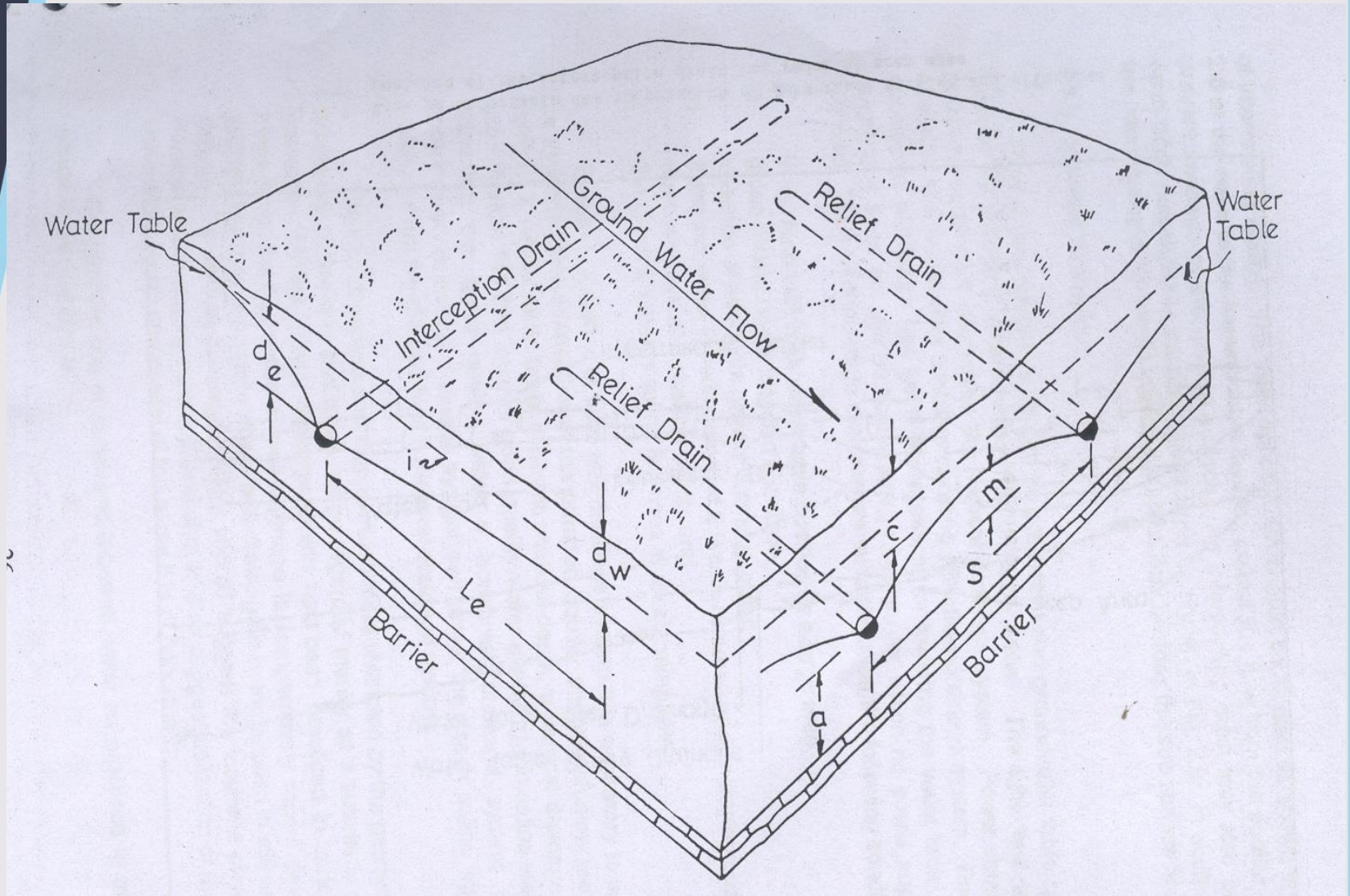
II. Interception drainage:

- (a) To intercept, reduce the flow and lower the flow line
- (b) the drains move against the direction of GW flow.



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Relief Drainage

- ✓ Field lateral, Collectors, Main drain
- ✓ Examples: Tile drain (30 to 90 cm), perforated pipes (continuous), mole drain, drainage well.
- ✓ Cylindrical channels formed by mole plough
 - Buried drains – Required grade 0.1%
 - Open ditches – grade 0.01%



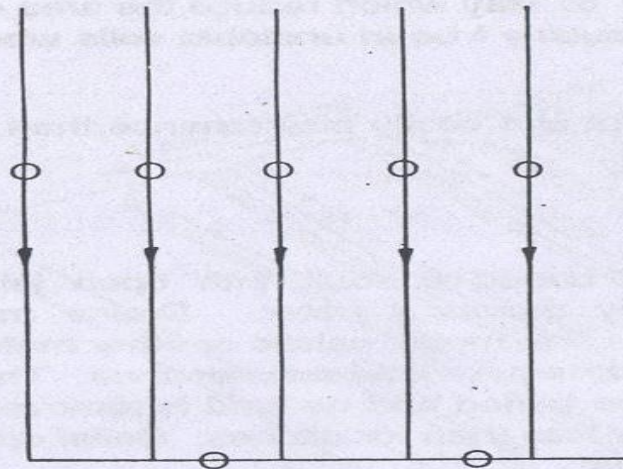
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(B) Based on layout of the buried Drains

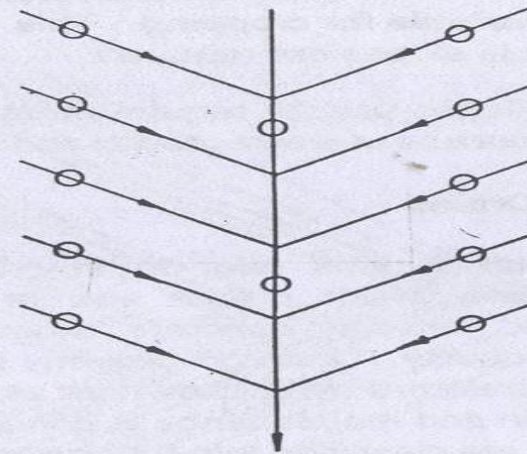
- ✓ Parallel /Gridiron
- ✓ Herringbone
- ✓ Double main
- ✓ Random



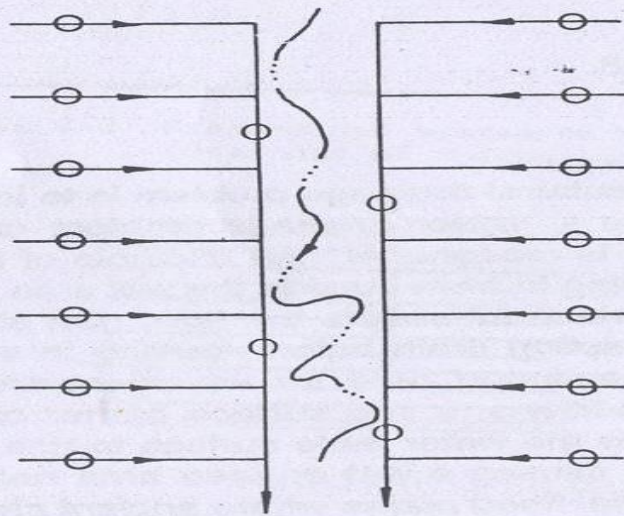
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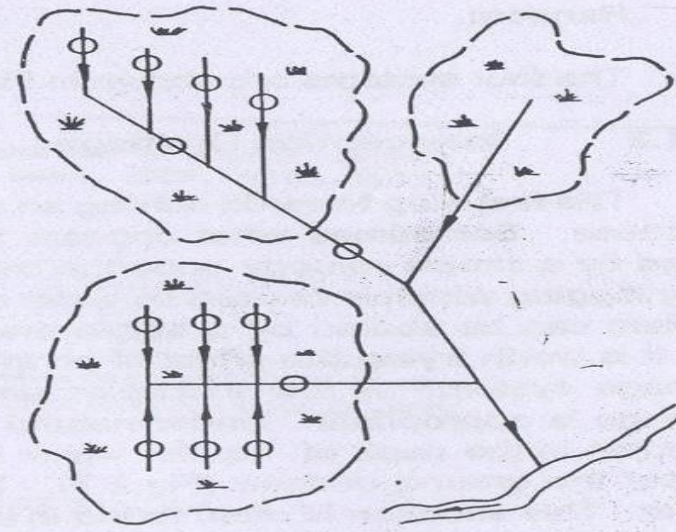
(a) PARALLEL



(b) HERRINGBONE



(c) DOUBLE MAIN



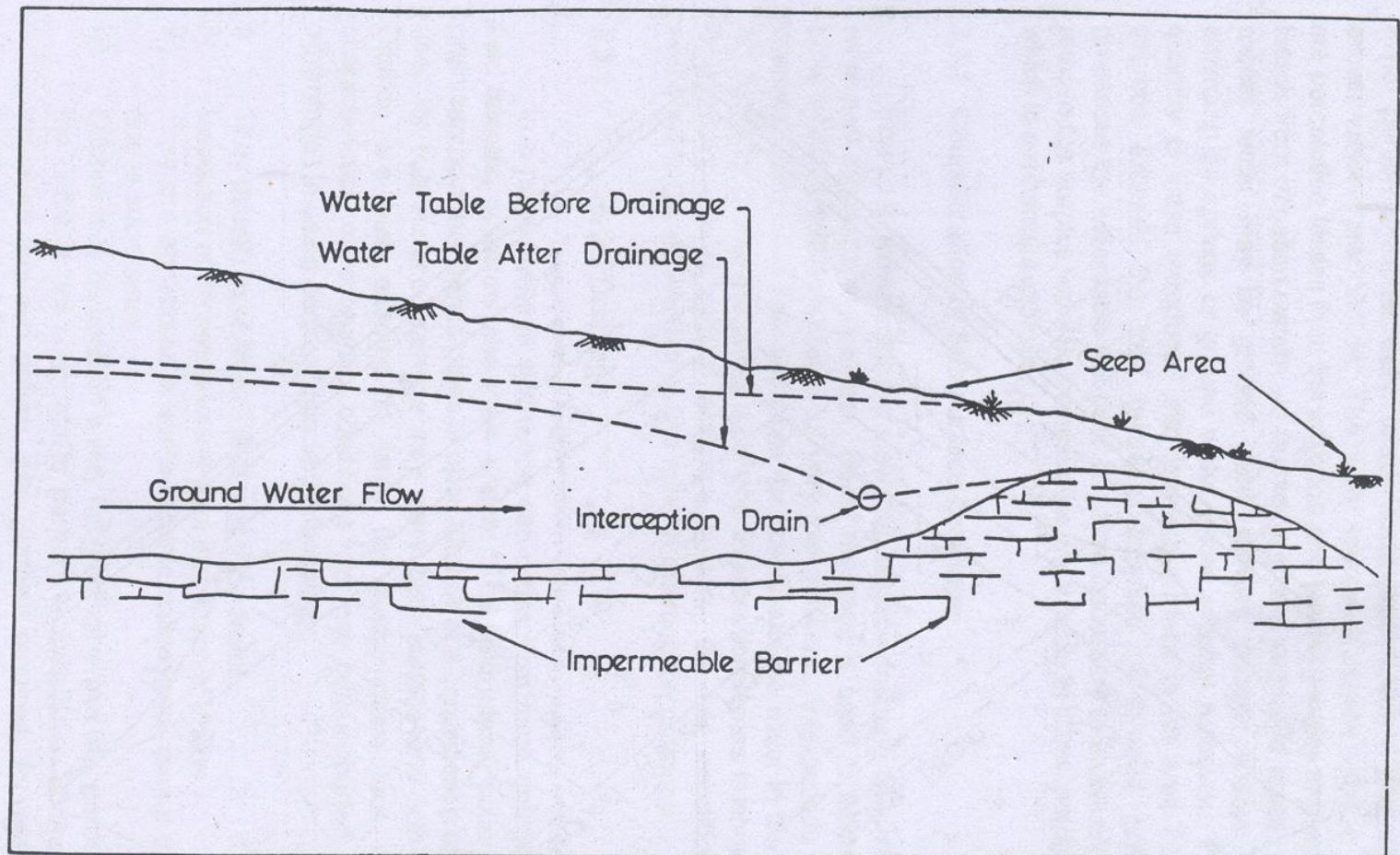
(d) RANDOM



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Interception drainage: when waterlogging is caused by seepage from higher elevation, interception drainage is recommended.





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Investigations for Sub-Surface Drainage

Groundwater studies

- ✓ Topographic map
- ✓ Degree of salinity and alkalinity of the soil
- ✓ Fluctuation of water table and artesian pressure
- ✓ Groundwater quality
- ✓ Logs of soil and sub-soil material
- ✓ Soil physical properties
- ✓ Crops proposed and their drainage requirement
- ✓ Irrigation practices



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Topographic map: It shows details of the features on land, land slope, possible outlets, existing drainage pattern and serves as the base map for preparing water table contour maps and iso-bath maps.

Groundwater Studies:

- Groundwater depths
- Fluctuation
- Direction of flow
- Quality

Piezometer:

Hydraulic head of groundwater

Observation well:

Depth of Water table. data used for preparing GW hydrograph, GW contour maps and Isobath maps



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Groundwater contour map:

- ✓ The configuration of water table surface.
- ✓ The direction of groundwater flow.
- ✓ The location and extent of high water table areas.

Water table Iso-bath map:

- ✓ Iso-bath lines are lines of equal depth to water table.
- ✓ Indicates at a glance the areas affected with high water table problems.



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Soil Physical Properties:

- ✓ Hydraulic conductivity
- ✓ Drainable porosity

Hydraulic conductivity:

Rate of flow of water through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Its magnitude depends on:

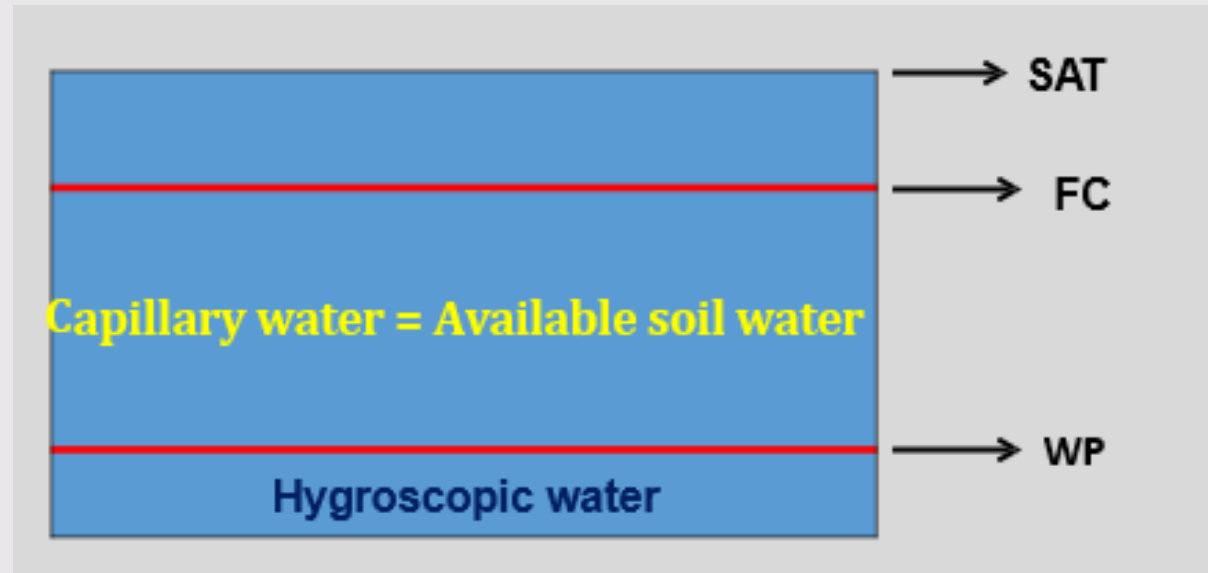
- ✓ **texture of the soil**
- ✓ **density** and **viscosity** of the groundwater



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Drainable porosity / Drainable Pore volume / Drainable pore space / Effective porosity



Volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer under gravity per unit decline of the water table.

$$\text{Drainable porosity} = \frac{\text{Drainable pore water}}{\text{drop in water table}}$$

It is dimensionless & expressed in %. Its value ranges from less than **5%** for clayey soil to **35%** for coarse and gravelly sandy soils.



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Crops and their drainage requirement

Crops	Period of disposal	Remarks
Paddy, sugarcane	7 days	Panicles not to be submerged
Cotton	3 days	3 days rainfall to be drained in 3 days
Maize	2 days	2 days rainfall to be drained in 2 days
Vegetables	1 day	1 day rainfall to be drained in the same day



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