TD 603
Water Resources

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Lecture 10: Minor Structures for Ground and Surface Water

Classification by Purpose

We may classify structures/procedures by their primary objective.

Groundwater Recharge: These are implementations to enhance the recharge of groundwater or to improve soil moisture. This is usually done either by

(i) reducing the velocity of water-flow

(ii) increasing the infiltration coefficient

(iii) explicit groundwater recharge structure

Examples: Contour bunding, furrowing, well-recharge structures, percolation tanks.

Reducing Soil Erosion: This is usually to improve agriculture, protect building etc., or to protect downstream water structures. Examples:

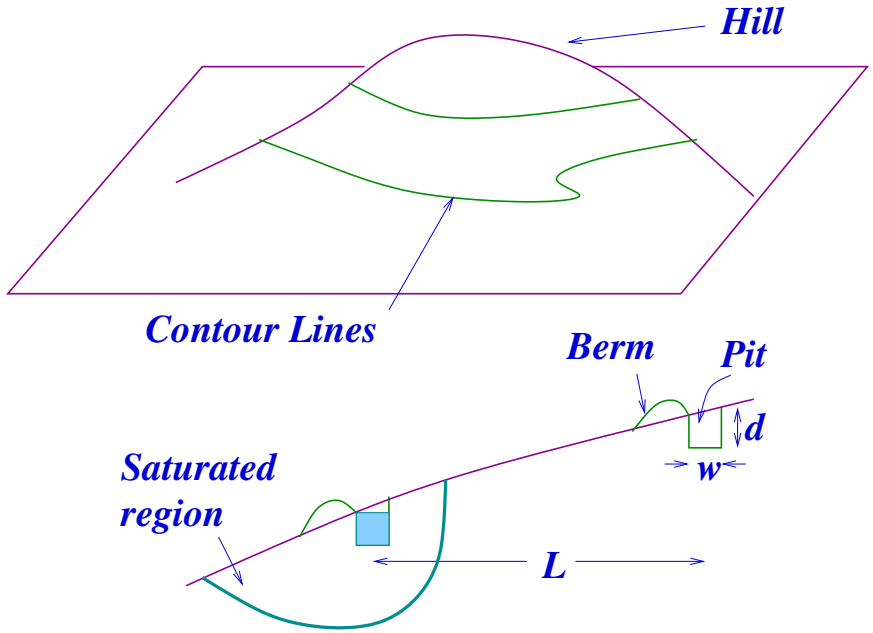
- Terracing, contour bunds.
- Gabions and gully plugs.

Surface Storage: These intend to store water on the surface. Some examples are:

- Check-Dams, Weirs
- Rainwater harvesting
- Bunds, Farm-ponds.

Contour Trenches

source:FAO



Parameters L, d, w depend on the slope, rainfall etc.
Working: Pits fill with water and remain so till the end of monsoon. This creates a local saturated layer which helps percolation. Also used alongside tree-plantation.

Hill-sides

Baner, Pune. source:http://stuffido.wordpress.com/2009/07/

Contour-bunds

This is formed by firming the berms to create obstructions to water flow. It is especially useful for tree-planting.

source: Ray Weil, Picasa

Terracing

This is largely about preventing soil-erosion and utilizing the land for agriculture. It is used when the gradients are small.

source: FAO

Terracing and gullies

Top view source: FAO

Terracing is an involved and delicate construction. Special care must be taken for the inlet and outlet of water.

Here is an example of gully formation in an agricultural field. Gullies may form in a single monsoon in fields with even a small gradient. These get reinforced and cause substantial loss of water and soil, besides damaging the field.

source: FAO

Furrowing

Soil may get compacted by overgrazing and animal/human use. This reduces infiltration coefficients substantially. For level lands, furrowing is a useful technique for increasing infiltration. In fact, agricultural land is excellent for recharge.

source: FAO

Percolation Tanks and Bunds

source:
`http://forest.ap.nic.in/Sparks of Success APFD-02-05/007-Nallavally.htm`

- Dug-outs or obtained by bunding an existing flow to create a pond.
- If bunded, then the design of the bund needs some care. It should have a spillway, and usually a foundation.
- Primary objective is to recharge groundwater by holding it during the monsoons and after it.
- Also serves as farm-ponds to *protect* kharif crops.
- Periodic de-silting important for purpose.

Percolation Tank and Check-Dams

source: http://test1.icrisat.org/satrends/ jan2006.htm

- Note the spillways and pitching.
- Most dry up in 3 months post-monsoon.

source: http://washim.nic.in/DOC/Egs_ files/image007.jpg

- A *check-dam* is designed differently.
- The bund is deeper with a clay core.
- The above from Washim is probably a check-dam.

The principle

- During the monsoons, connect the water-table and the pond.
- Increase recharge during the monsoons.
- Helps reduce crop stress in lean periods in monsoons.
- Post-monsoon, a perched saturation region.
- Increases soil moisture.
- Silts are small size particles and have low conductivity. Must be removed from tank bottoms to aid percolation.
- Evaporation losses about 5mm/day.

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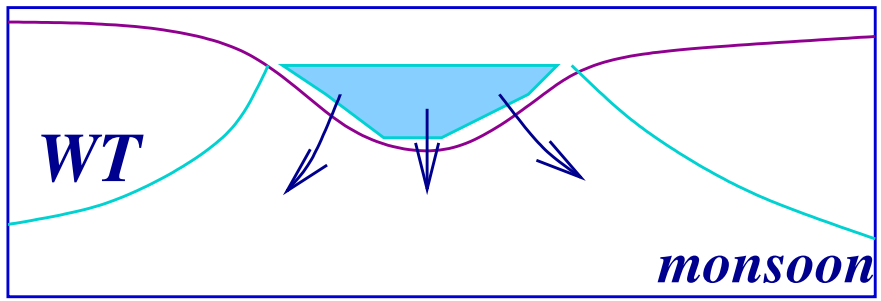
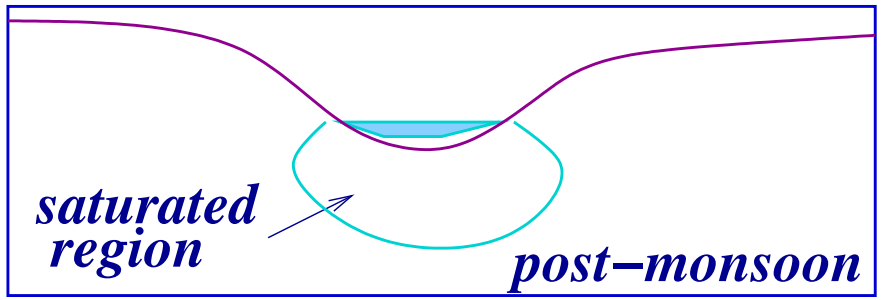
- For long monsoons, tank may recharge several times its own volume.
- Poor ambient conductivity $\Longrightarrow$ Wet longer





Vanrai Bandhara

- Temporary, must be installed after every monsoon.
- $<$ 2m in height, and may be used on top of existing bunds.
- Installed just after monsoons get over, but stream flows remain.
- Mainly to achieve/increment some recharge and some storage.

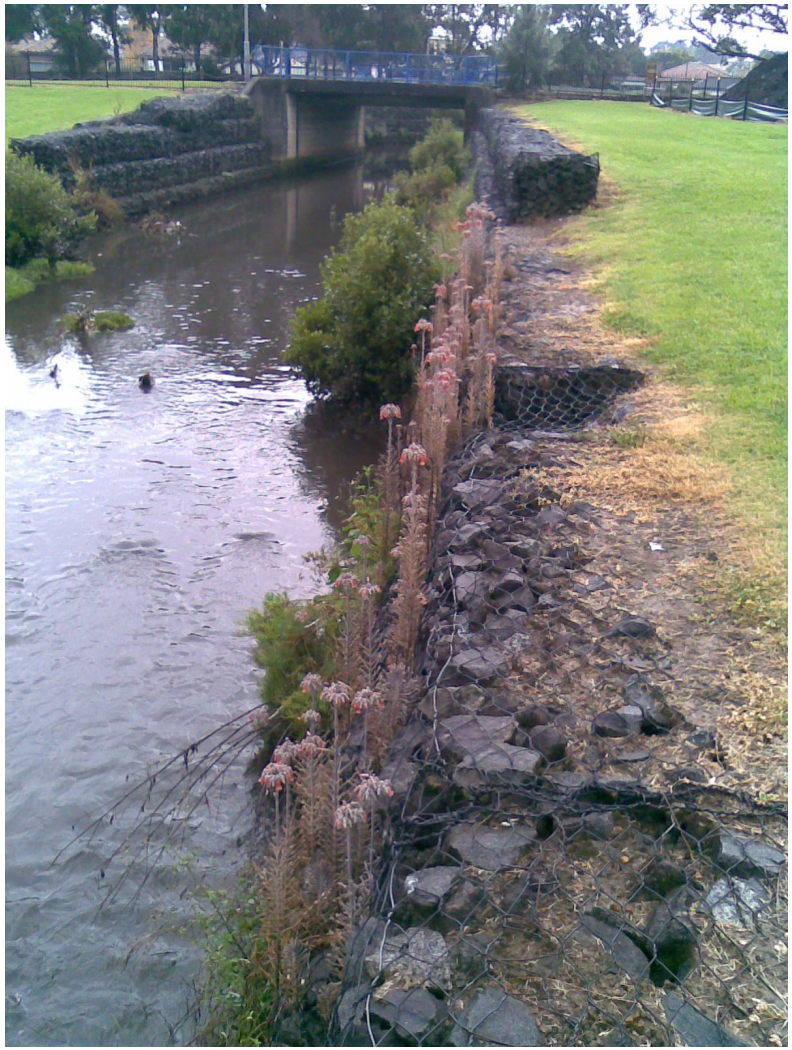
source: `http://washim.nic.in/DOC/ Egs_ files/image010.jpg`

Gabions

Gabions are loose rock structures to prevent soil erosion.

- Located along/across gullies or stream banks.
- They trap soil and reduce water velocities.
- They help maintain and control stream flow.
- Typically built using wire-meshes.
- A cage is built which encloses rocks suitably arranged.
- Manual construction.

- Porous, does not hold water.



source:
http://lh4.ggpht.com/_KsQX_iKm6hw/S

Across streams: an overflowing gabion

source: http://www.bridgetrust.org/images/Gabion (1).jpg

Rooftop Rainwater Harvesting

This is especially useful in urban residential situations. Aim:

- To collect rainwater for domestic use.
- also to use it for recharging groundwater.
- Example from Bangalore. Small (250L?) since (i) frequent use, and (ii) frequent rains.
- Systems can be big, but cost Rs. 3-4 per liter!.
- At this price, highly expensive for general use ($\sim$ 100 LPD).

source:

http://bangalore.citizenmatters.in/pics/

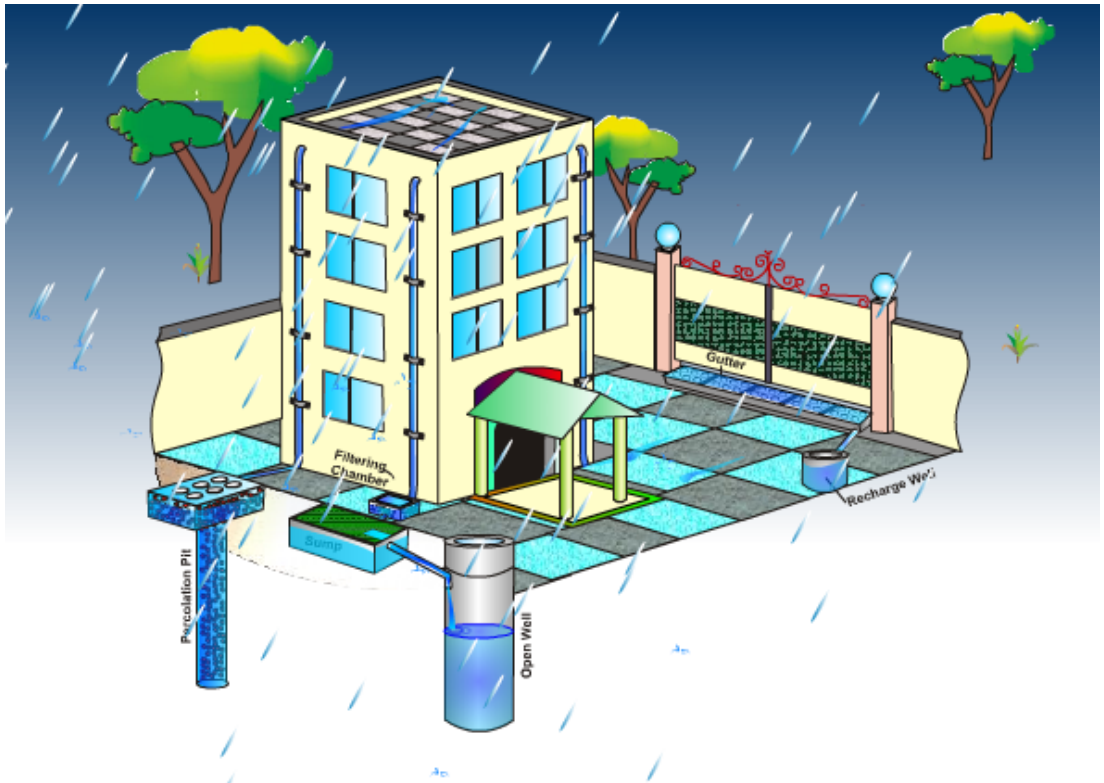
A novel idea: The TIDE polyhouse

Drip Irrigation, greenhouse and rainwater harvesting.

source: http://www.tide-india.org/products/06polyhouse.html

Urban Rainwater collection

- Compulsory in many cities.
- Collected water either (i) drains into existing wells, or (ii) into a specially designed percolation structure.
- In Chennai, used primarily to push back saline water.
- Percolation well: about 1m wide, 5-10m deep, unlined, and filled with boulders, stones and gravel.
- About Rs. 10-20 /sq.ft, percolation tank most expensive.
- Expect to recharge about 80% of the rainfall

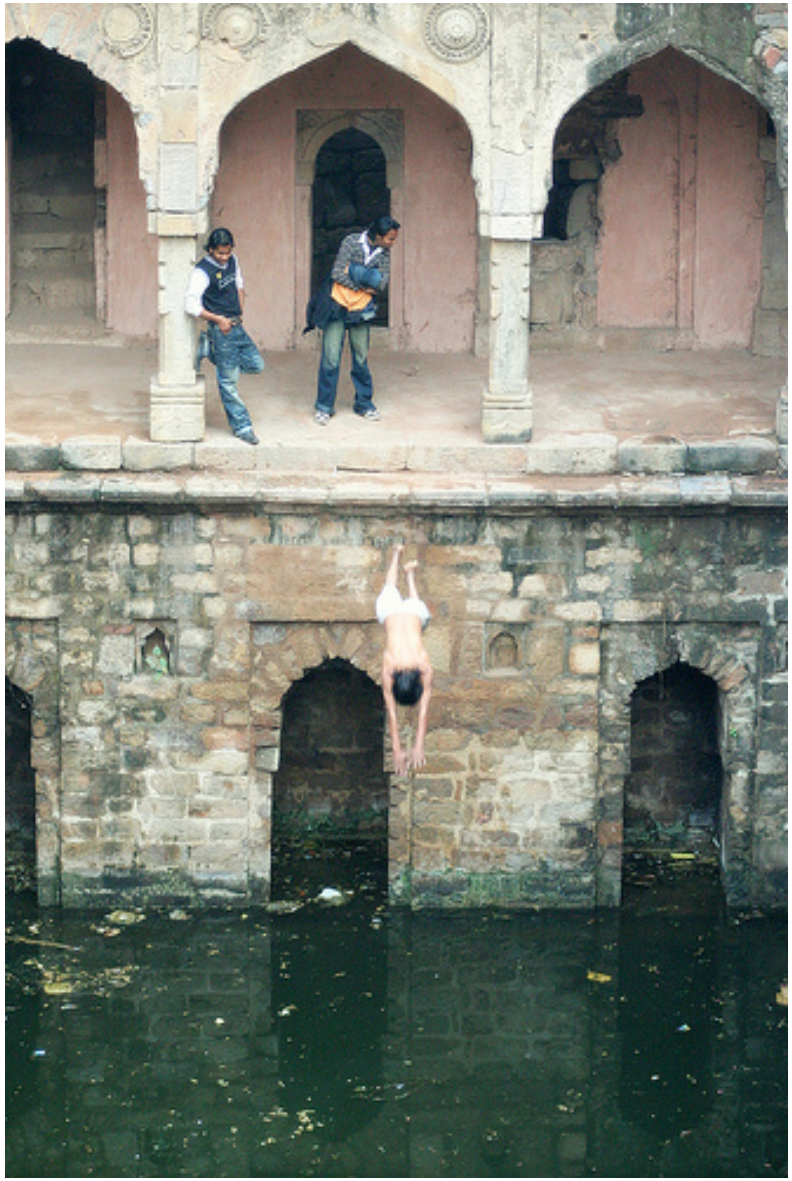


Rainwater Collection in Multistoried Roofs

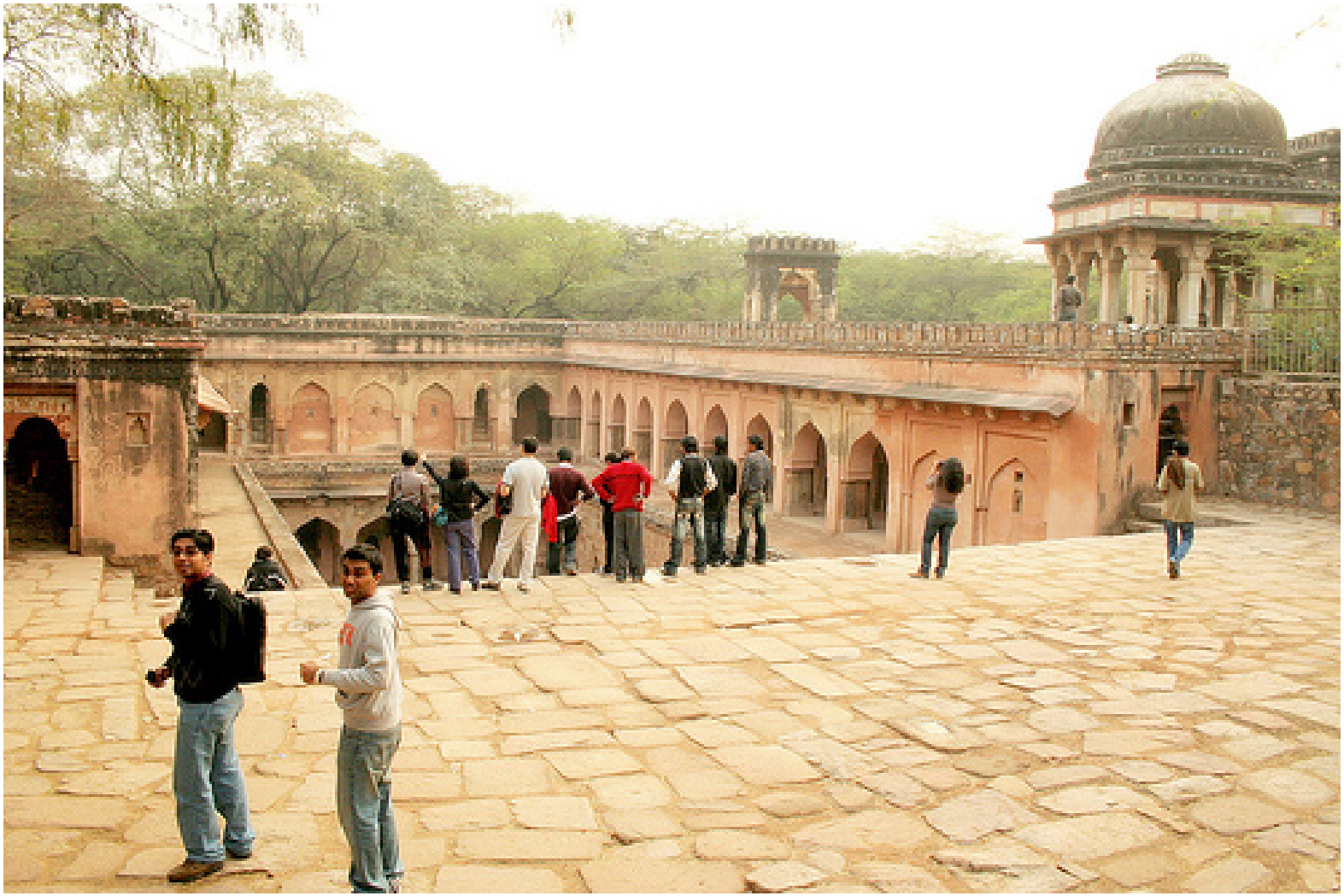
source: unknown!

Traditional: Baulis

- Historical examples of urban residential rainwater storage: *Baulis*.
- Storage in the basement of homes/special buildings.
- Intricate network of drains leading to the basement, and also tapping groundwater.
- Popular all over India, esp. Delhi, Rajasthan and also in the South.
- Example here: Rajon ki bauli, Mehrauli. In Maharashtra: Panhalgad.
- source: `http://www.flickr.com/photos/saad/`



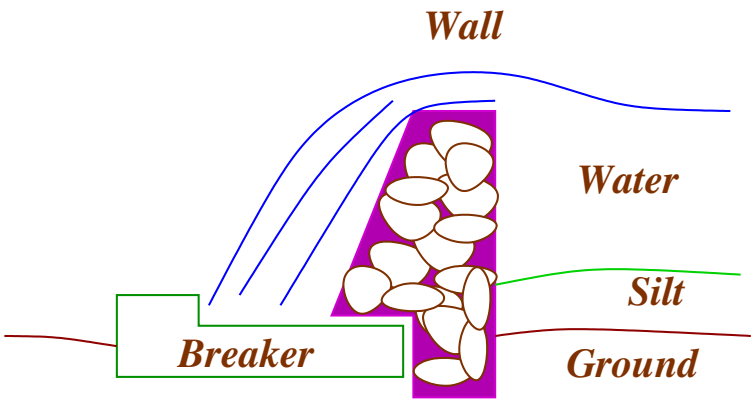
Rajon ki Bauli from Outside



source: `http://www.flickr.com/photos / saad/`

Masonry Structures

source: http://www.gomukh.org/images/index_02.jpg



- Boulder and concrete wall with a concrete breaker.
- Foundation and Key-wall to prevent leakage around the wall.
- Overflow structure, used as storage and silt trap.

Dams and Weirs-The Kolhapur Type Bandhara

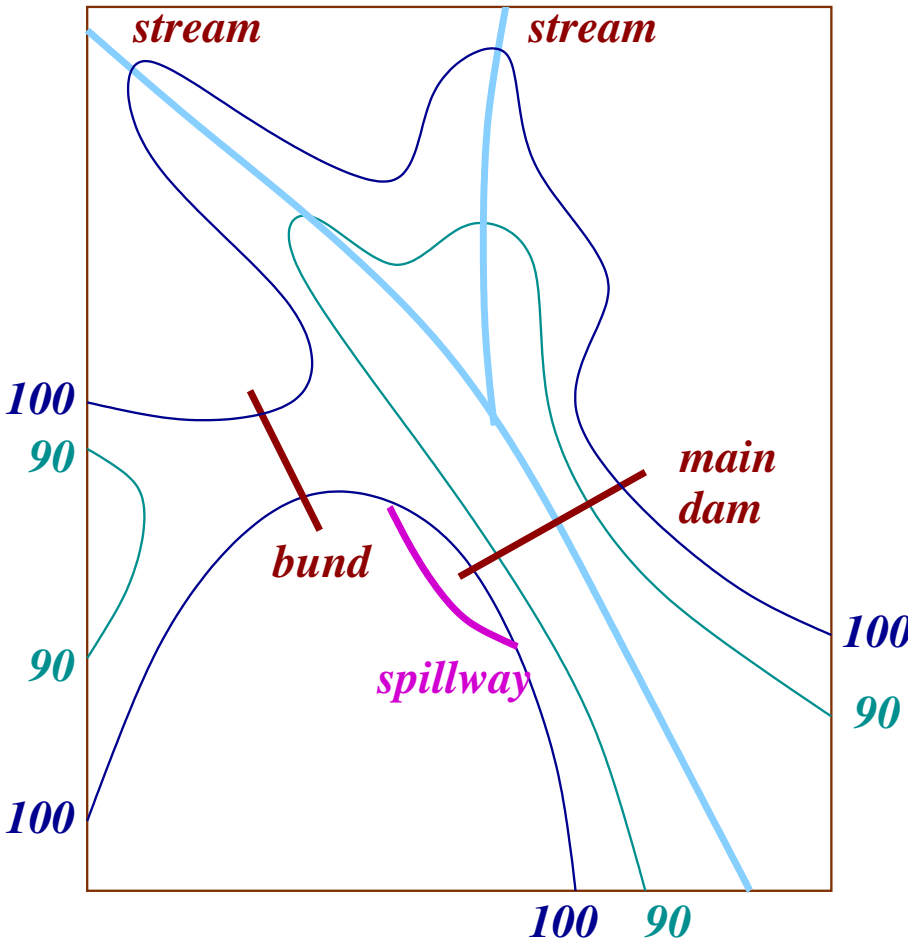
source: http://www.maharashtra.gov.in/english/ gazetteer/ Nanded/images/kholhapur-dam.jpg

The principle

source: `http://ahmednagar.nic.in/html_docs/images Ralegan.png`

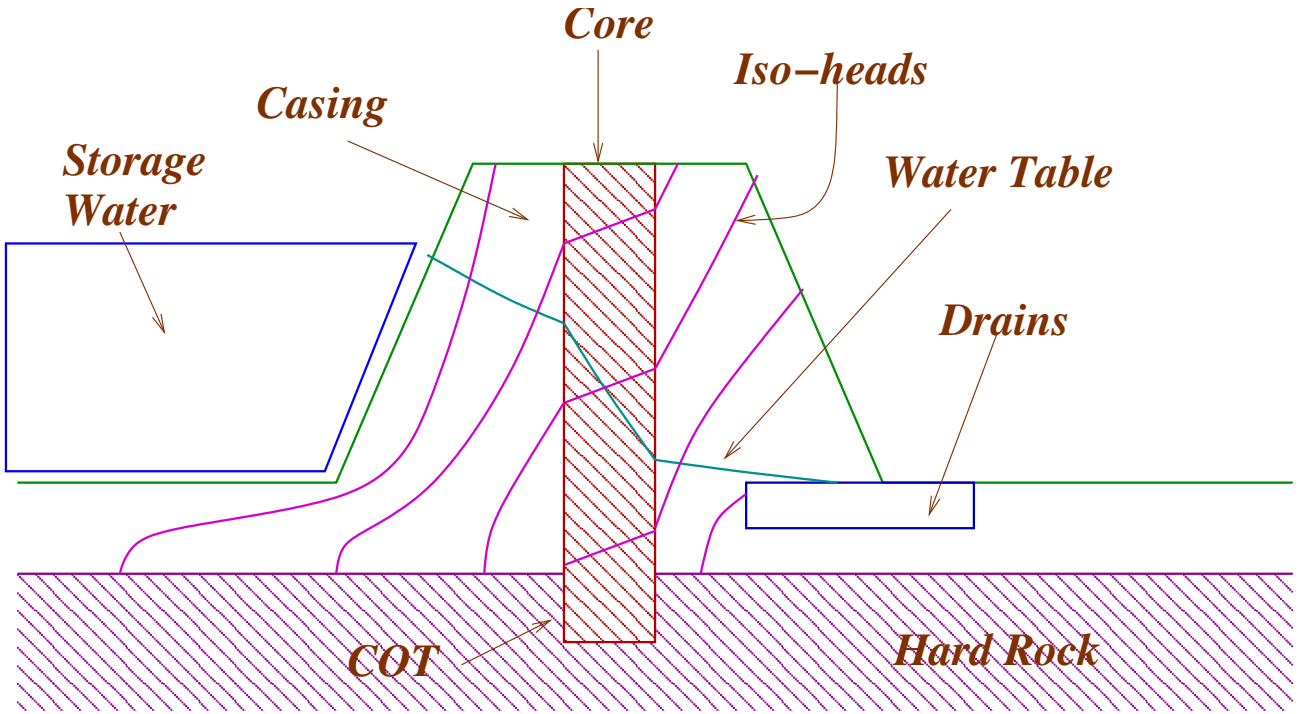
- Largely stone and masonry structure within the river bed.
- Gates open during monsoons and shut *just after*.
- This creates a head which is typically used for agriculture.
- The storage is largely confined to the river bed. No land need be acquired.
- Used by upstream people!
- Usually appear as a sequence
- Fairly cheap and useful. Very popular in India.

A Small Dam



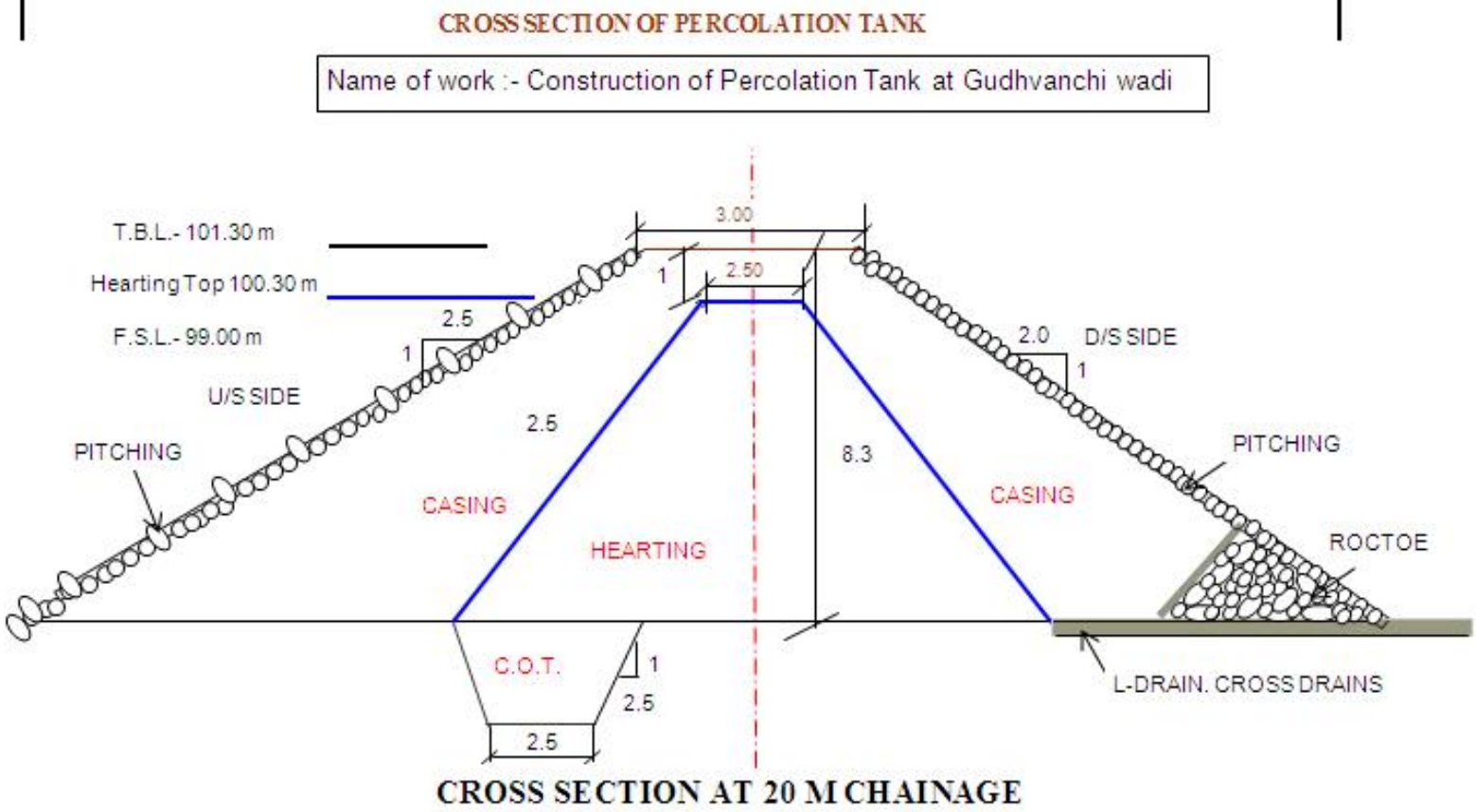
- The FSL (full storage level) of the dam is the height at which water is stored, in this case, 100.
- The dam and the bund are higher. The bund was needed to achieve an FSL of 100.
- The storage is the modified contour at 100.
- The spillway is at 100 and cuts into the old contour at 100. Excess water overflows from here.
- The Key-wall protects the dam from the spillway.

Cross-Section

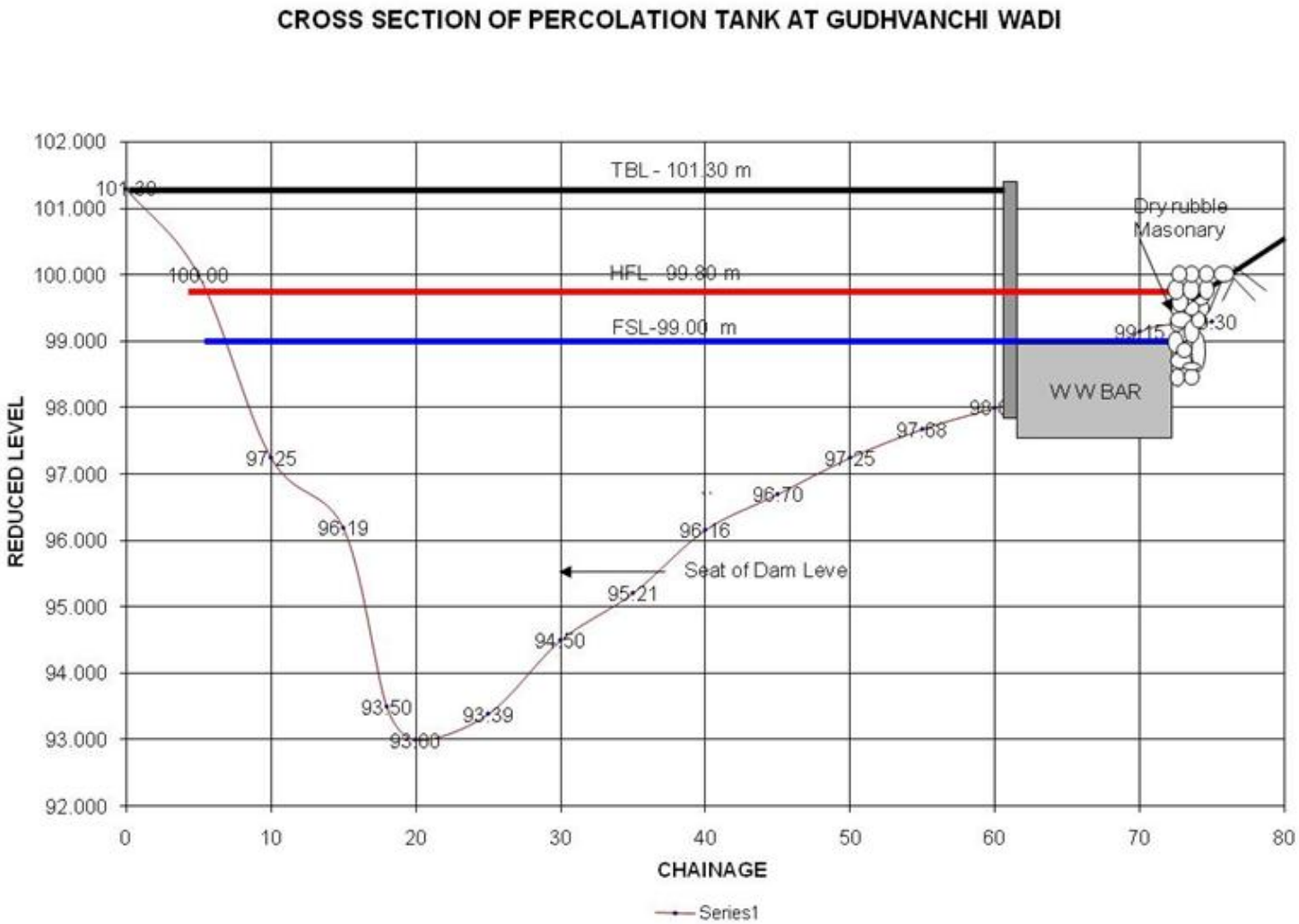


- **Core** : a wall of clay/low conductivity soil.
- **COT** : Cut-off trench as an insert into hard-rock.
- **Drains** : To keep the dam dry and prevent seepage flows.
- **Casing** : Muram like soil, supports the core.
- Note the water-table and the iso-head lines.
- Note the rapid drop in the water table in the core.

Section


CROSS SECTION OF PERCOLATION TANK
Name of work :- Construction of Percolation Tank at Gudhvanchi wadi
T.B.L.- 101.30 m
Hearting Top 100.30 m
F.S.L.- 99.00 m
U/S SIDE
PITCHING
2.5
1
2.5
CASING
HEARTING
3.00
1
2.50
8.3
CASING
2.0
D/S SIDE
1
PITCHING
ROCTOE
C.O.T.
1
2.5
2.5
L-DRAIN. CROSS DRAINS
CROSS SECTION AT 20 M CHAINAGE

COT-Section


CROSS SECTION OF PERCOLATION TANK AT GUDHVANCHI WADI
TBL - 101.30 m
HFL - 99.80 m
FSL-99.00 m
Dry rubble Masonary
WW BAR
Seat of Dam Leve
101.30
100.00
97.25
96.19
93.50
93.00
93.39
94.50
95.21
96.16
96.70
97.25
97.68
99.15
.30
REDUCED LEVEL
CHAINAGE
Series1
102.000
101.000
100.000
99.000
98.000
97.000
96.000
95.000
94.000
93.000
92.000
0
10
20
30
40
50
60
70
80

Gudwanwadi Dam

- 85m long, 8m high, earthen.
- Storage 2 acres, 20K cu.m.
- Cost: 24 lakhs.
- Construction time: 6 mo.

- Note Spillway, and Key-wall.
- Note Pitching (stones) on the dam walls.

Bushy Dam-Masonry

source: http://travel.sulekha.com/lovely- lovely-lonavala_maharashtra-travelogue-4508.htm

Nira-Deoghar-Earthen

source: http://www.abilgroup.com/images/Nira-Deoghar.png

The Earthen Bund at Khubi

source:

http://thdc.gov.in/Writereaddata/Projects/English/Images/PG_291.jpg

Discussion

1. How would you go about selecting a particular structure/apparatus for water supply.
2. One item not covered is: piped water supply schemes.