Training on

Roads for Water and Resilience

ROADS CROSSING RIVER BEDS

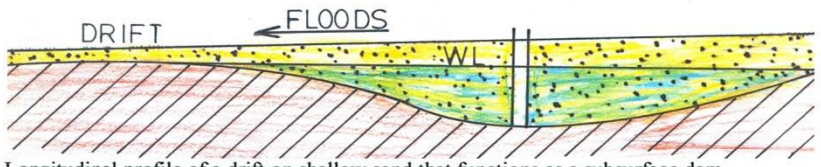
NATURAL SUBSURFACE DAMS

To avoid getting stuck in deep sand when passing over riverbeds without fords, everybody tries to pass where the sand is shallowest, which is where there is an invisible underground dyke.

Such underground dykes are natural subsurface dams that traps water upstream of them.

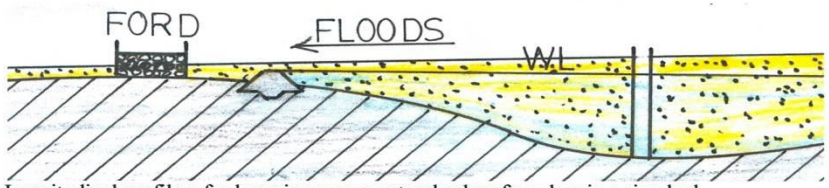
Natural subsurface dams can be heightened to half a meter below the surface of a riverbed by adding clayey soil upon an underground dyke. The next slide explains what subsurface dams are.

Source:waterforaridland.com



Longitudinal profile of a drift on shallow sand that functions as a subsurface dam.

Proposal
A hand-dug well could be sunk at the deepest point upstream of such drifts.



Longitudinal profile a ford passing over a natural subsurface dam in a riverbed.

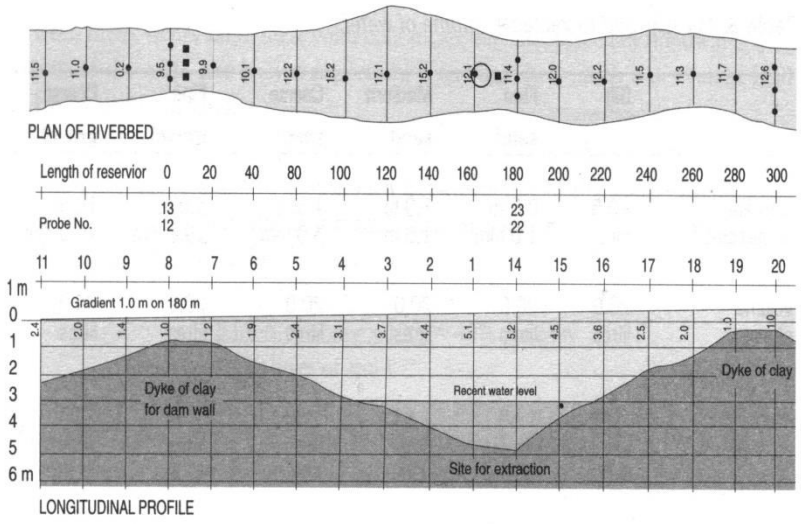
Proposal
A subsurface dam could be built of soil upon the natural dyke to protect the base of the ford from flood damage and a well could be sunk upstream in a riverbank of such fords.

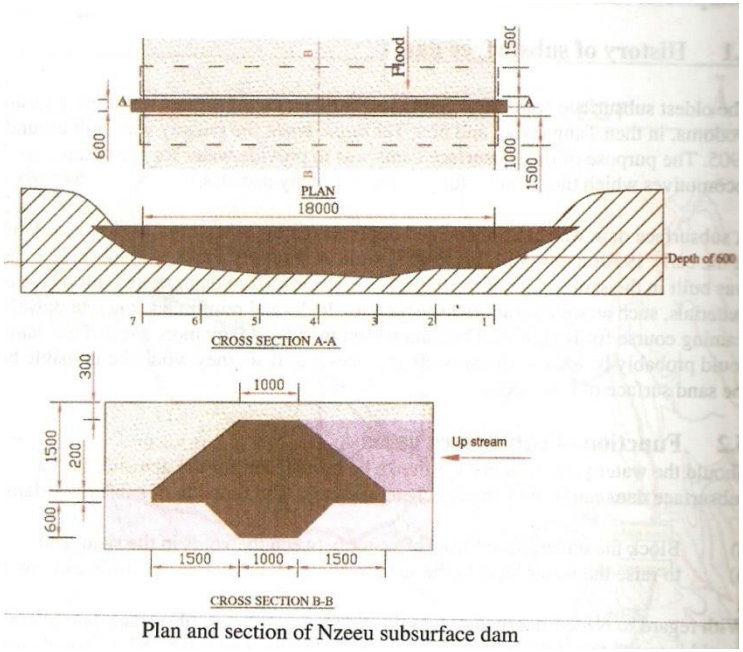
WHAT IS A SUBSURFACE DAM?

This longitudinal profile of a 'dry riverbed' shows a water-filled depression between two natural subsurface dams. Data for the profile was found by probing a potential section of a riverbed as explained on next slide.

This is the design of Nzeeu subsurface dam from where 16 m^3 of clean water is pumped per hour for 6 hours daily throughout the year.

Source:www.waterforaridland.com



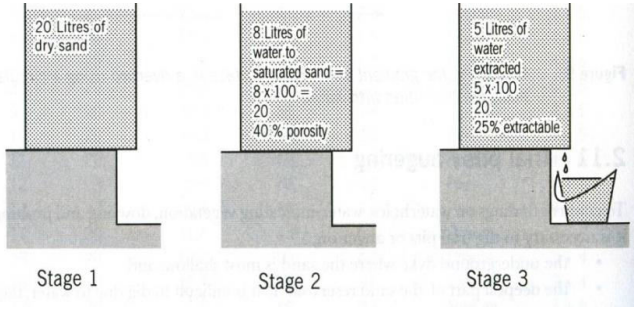


Plan and section of Nzeeu subsurface dam

ESTIMATING YIELD OF EXTRACTABLE WATER

At 20 m intervals a pointed iron rod is hammered down into the sand until it reaches the floor under the sand. When the rod is pulled up the depths of water and sand is measured on the rod and is used to draw a longitudinal profile of the probed section of a riverbed.

The percentage of extractable water from a sand reservoir is found by draining a sample of saturated sand.
Source:www.waterformaridland.com



The volume of a sand reservoir is found using this formula:

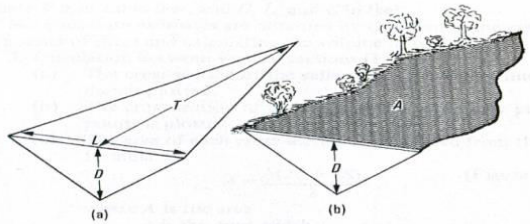


Figure 5.1. Estimating the storage capacity of a reservoir.

2. A slightly more accurate estimate is obtained by measuring the surface area at full supply level, and using the formula

$$Q = \frac{A \times D}{3},$$

where D is the maximum depth in metres and
A is the surface area in square metres.
This assumes that the basin is a pyramid whose base is the water surface (Figure 5.1 (b)).

SUBSURFACE DAM UPSTREAM OF A FORD

This concrete ford at Dire Dawa was built upon a natural subsurface dam because that is where the sand is shallowest.

Two options are recommended: 1) Plaster the upstream side the ford 2) and/or built a subsurface dam upon the natural subsurface dam near the upstream side of the ford .

IMPROVE FORDS TO BECOME SAND DAMS

Although this ford functions as a sand dam, the foundation leaks and the dirt road acting as one of its wing wall is being eroded by floods.

Options: 1) Plaster the upstream side of the ford with ferro-cement, 2) extend the concreted road and/or 3) sink a hand-dug well in a riverbank next to a depression upstream of the ford.

Source:www.waterforaridland.com

HAND-DUG WELLS UPSTREAM OF FORDS

This high ford could also be plastered with ferro-cement on the upstream side to seal the seepage through the foundation thereby making it a sand dam.

A hand-dug well sunk in the riverbank at the depression situated upstream of the ford would supply clean water for domestic use.

Source: www.waterforaridland.com

POND DOWNSTREAM OF A CULVERT

A small culvert under a sandy road as this one can deliver sufficient runoff water to fill a pond with water.

However, the required silt traps must be cleaned after rains to prevent siltation of the dam reservoir.

A TANK UPSTREAM OF A CULVERT

A small culvert can also supply runoff water from a road to a tank downstream of the culvert.

A tank can be made by plastering a cylindrical excavation covered with chicken mesh.

Source: www.waterforaridland.com

BERKAD TANK DOWNHILL OF CULVERT

Supply capacity of a road: Runoff from 10 mm of rain on a 5 m wide road sloping uphill for 500 m can produce: 10 mm rain x 5 m x 500 m x 0.7 %/ 1000 = 175 m^3

This berkad tank can store 130 m^3 of runoff water for a construction cost of about US$ 1,200.

Source: www.waterforairdland.com

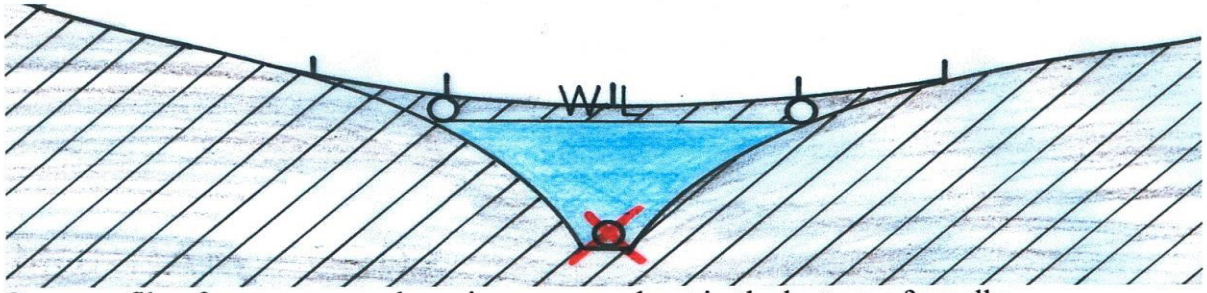
MULTI CULVERT FORD

These large culverts discharge so huge volumes of water that the best option is to construct a series of weirs or subsurface dams upstream of the ford.

A weir is a sand dam built of a 0.6 m thick wall of reinforced concrete protruding maximum 0.6 m above the level of sand in riverbeds.

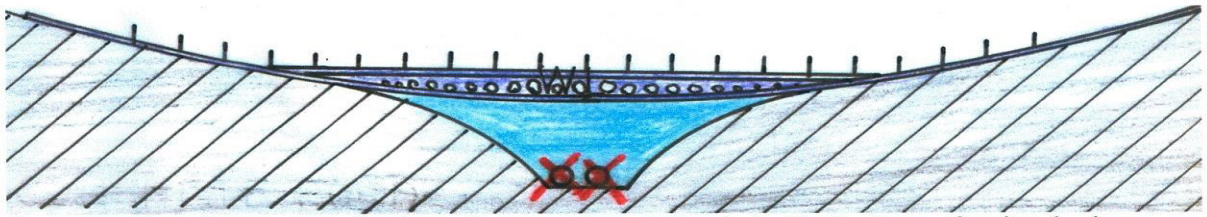
Source:www.waterforaridland.com

TWO MORE PROPOSALS



Cross profile of a murram road passing over a culvert in the bottom of a gully.

Proposal
Install two new culverts below the surface of the murram road. When the old culvert is closed an earth dam is created on the upstream side of the road.



Cross profile of a concrete ford passing over two culverts in the bottom of a riverbed.

Proposal
Place different sizes of PVC pipes across the road and fill concrete in and above the pipes to make a new horizontal ford. When the two culverts are closed a sand dam is created on the upstream side of the road.

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