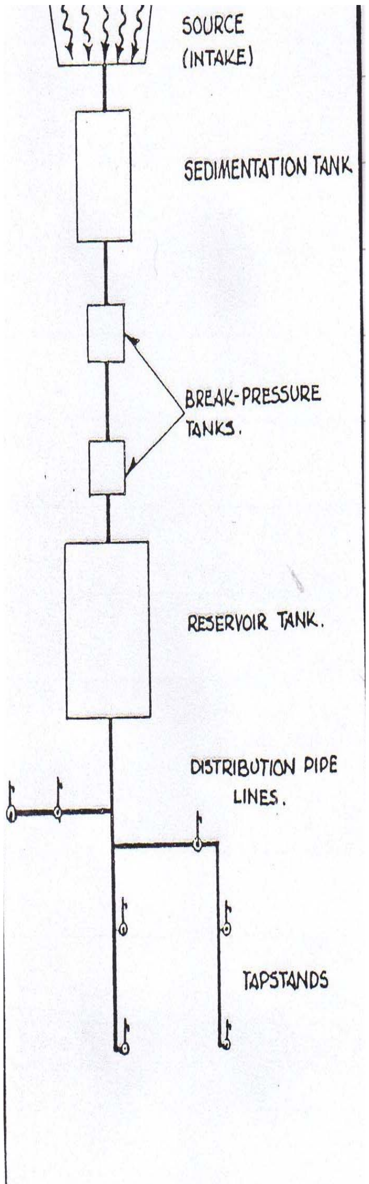
DESCRIPTION OF SYSTEMS

This concerns with constructure a community water supply (CWS) system to meet the drinking water requirments for rural village of small moderate population .the systems described herein are of the gravity flow type: that is the action of gravity is used to move the water downhill from the source to the village.



TYPICAL CWS SYSTEM

This type of system is shown schematically : a suitable source is located at an elevation higher than the village .

An intake structure is built to collect the water ,which is then piped down to the village through a buried pipeline of high –Density polyethylene (HDP) pipe .if needed ,a reservoir tank is built above the village .from there ,the water is distributed to several public tapstands that are scattered throughout the village via the mainline ,branchlines ,and taplines .where multiple sources are used ,a collection tank may be built ,and due the topograghy of the land ,at certain points break –pressure tanks may be required to prevent excessive pressure from bursting the HDP pipe .if the water is carrying a lot of suspended particles ,a sedimentation tank required to clean the flow of these .

TYPES OF SYSTEMS

There are several types of gravity –flow water systems, each type being determind by certain design characteristics.

These systems fall into general catagories:

Open system ,and closed

-An open systems derives from the concept that the taps can be left open and flowing continuously all day long ,and still provide constant and steady flow . This means that the safe yield of the source (s) is sufficient enough to supply all tapstands directly ,without requiring a reservoir tank.

-A closed system is one where the safe yield of the source cannot provide continous flow to all taps ,or where the safe yield is such that a reservoir tank is necessary to store water for peak demand periods which the source alone could not meet .All tap stands the systems must have a faucet ,either of the self closing or manually –operated type.

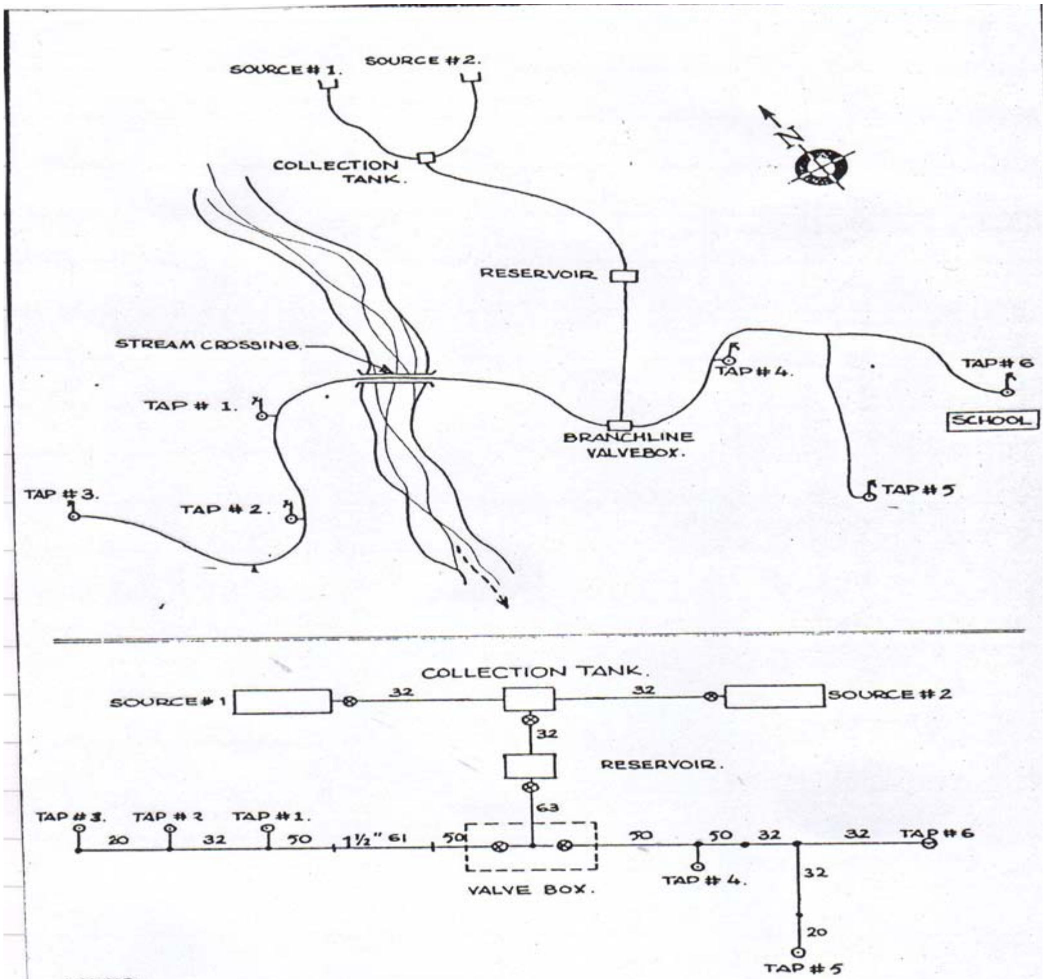
Both catagories of systems may require break- pressure tanks ,but an open system will never require a reservoir tank .At all tap stands ,regardless of the type of system: a control valve must be installed to proportion and regulate the flow between taps.

DESING EXAMPLE:
MAINLINE

The basic procedure for designing a pipeline is to divide it at strategic points (usually tanks and tapstands) .The pipeline section between each of these points is called a reach .For each reach. determine the descried amount of head to be burned off .and the leugth of pipeline ,and with these determine the desired frictional headloss factor. From the Head loss Table ,select the pipe size which is closest to that desired frictional factor .If no size is suitable ,then using tow different pipes in the reach can be done.
When designing the pipe line ,the designer can begin at the source and plot his way down stream or begin at the end and plot his way upstream ,or begin at the end and plot towards the middle ,depending upon his intuitive feelings ,with experience he will develop more intuition at where to best begin.
*In this example ,however ,plotting will begin at the source and proceed down stream.

Reservior calculations:
Safe yield of source =١.٤LPS (litter \second)Demand by ٦ tops ٠.٢٢٥LPS=١.٣٥LPS Therefore reservoir tank not required.

Preliminary pressure analysis:
This profile contains a major U-profile ,so it is best to begin by examining it there .If class III pipe were used along the bottom of the U- profile.

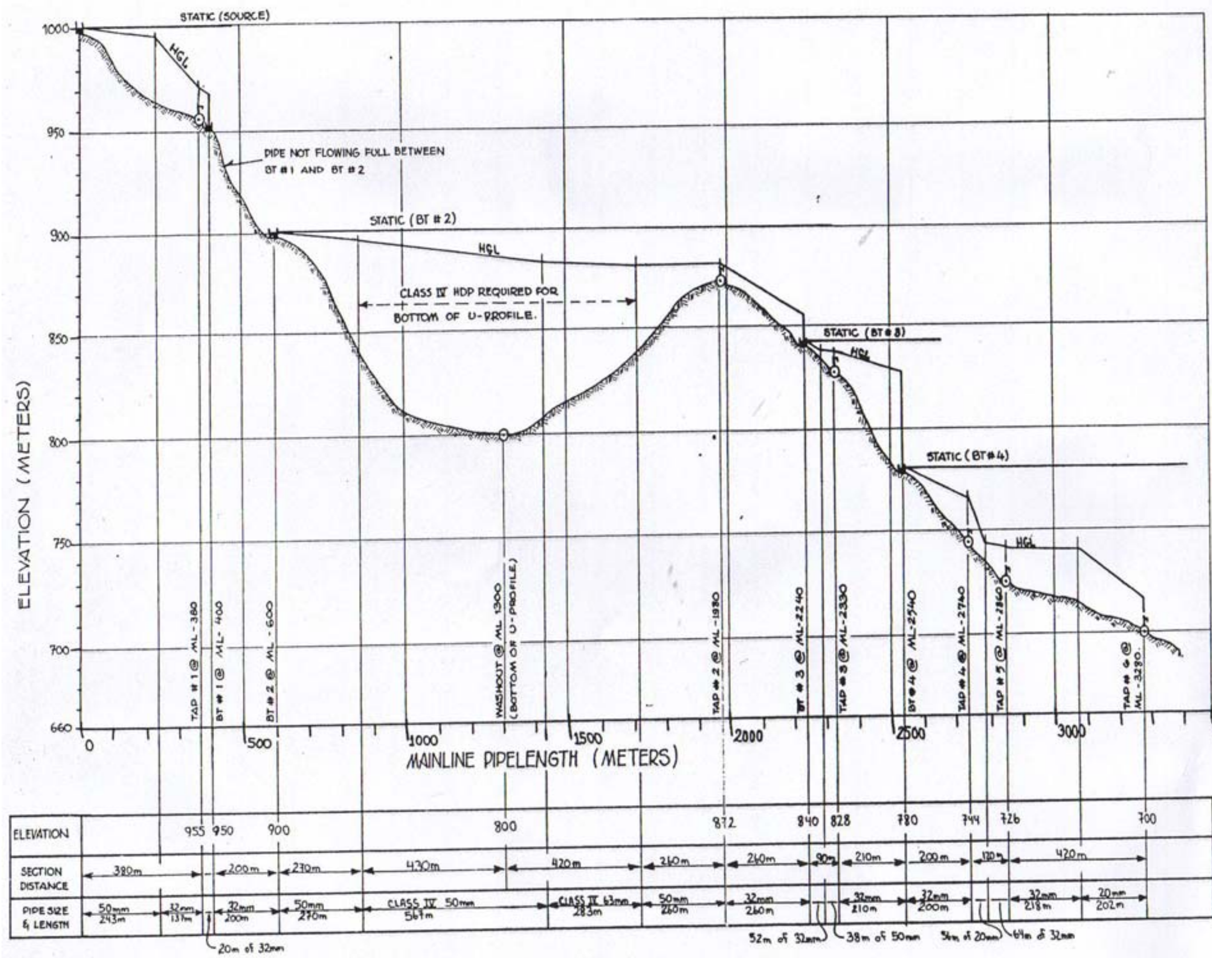


NOTES:
1. ALL PIPE CLASS III HDP, SIZE IN MM.
2. ALL CONTROL VALVES SHOWN ARE GATE VALVES OF CORRESPONDING PIPE SIZES.
3. SEE DESIGNS FOR INTAKES, COLLECTION TANK, RESERVOIR, & VALVEBOX DETAILS.

PLAN VIEW & KEY PLAN OF EXAMPLE SYSTEM

The pressure in the pipeline would exceed ٦٠m of head before the flow could make it back out of the U-profile.
Therefore ,class IV pipe must be used ,with a break –pressure tank located ١٠٠m above the bottom of the u-profile .this tank would therefore be located at ML-٦٠٠,elevation of ٩٠٠ m. The class IV pipe would have to begin at ML-٨٧٠(which is at an elevation ٦٠m below the break –pressure tank)and run until ML-١٧٢٠.

NOTES:
1. ALL TAP FLOWS = 0·225 LPS
2. ALL PIPE IS CLASS III HDP EXCEPT WHERE. NOTED OTHERWISE.
3. SAFE YIELD OF SOURCE = 1·40 LPS.

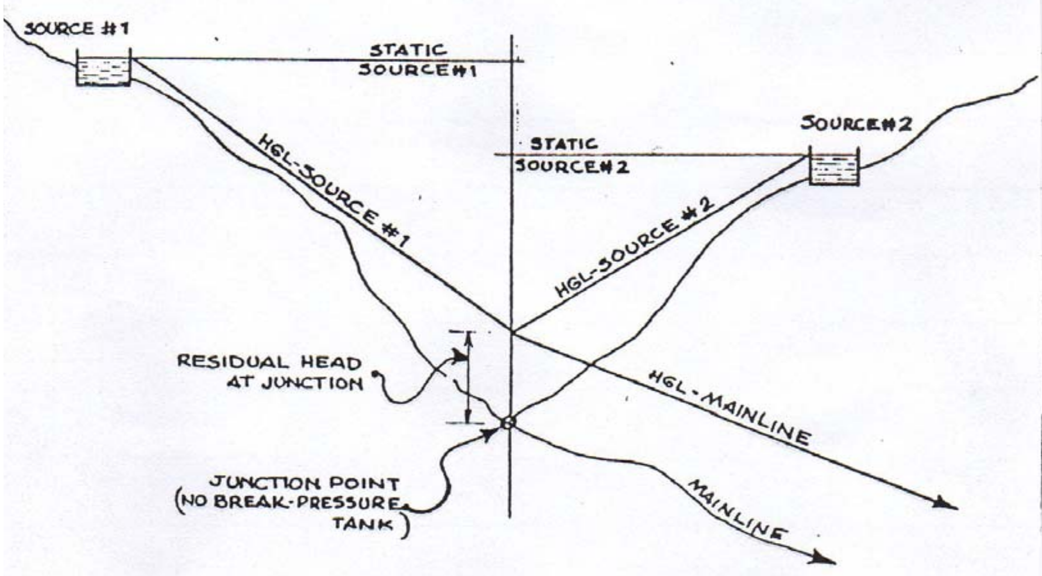


DESIGN EXAMPLE: MAINLINE

*Collection Lines :

It is not uncommon to have a system which must combine several small source to obtain a useful safe yield flow .In such cases, it is easiest to bring the individual sourcelines together at a common collection or sedimentation tank .This tank,ofcourse , acts as a break –pressure point and the HGL(Hydraulic Grade Line) would have to be plotted as such .if the sources were at different elevations , there would be no problem of hydraulic interference between the sources.

However ,it is not always possible to install such a break –pressure point .In such cases ,the source lines are joined together directly to the mainline as shown figure below:



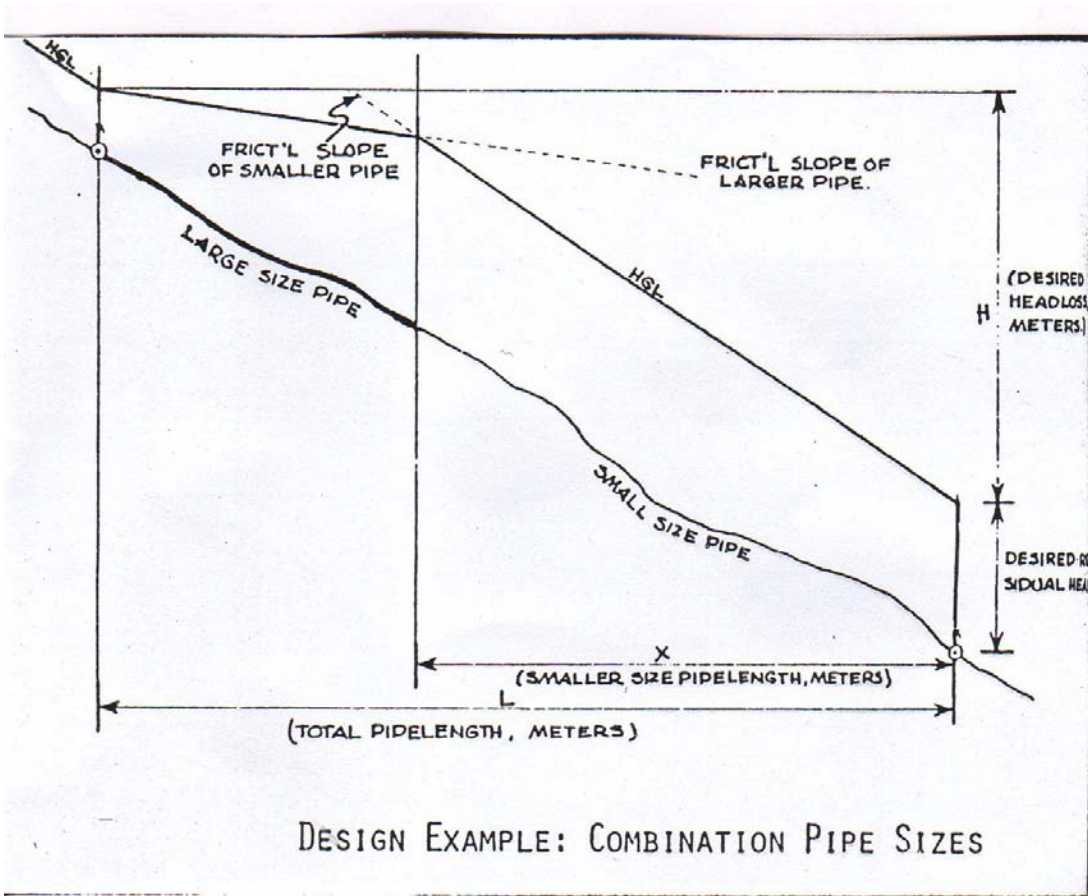
DESIGN EXAMPLE: COLLECTION LINES

With this type of junction ,if the sources are different elevations then it is possible that the pressure from one will interfere with the flow from the other .

The principle of properly joining the sources at a common point is to realize that the flow from each source will be such that there will be only one possible residual head at the junction . Thus it is necessary to design the source lines in such a way that they all meet at a common residual head at the junction . Procedure ; plot the HGL from a single source to the junction. Then select the other pipe sizes of the sources so that ,for the desired flow out of each source. The HGL all intercept the HGL of the first source; that is ,they all have an equal residual head .form that point ,continue plotting the HGL for the mainline using the total flows.

-Design Example: combination pipe sizes

when designing a pipeline section ,there maybe no single pipe size available that gives the desired frictional headloss factor .In that case ,a combination of pipe sizes is used; one pipe which is" too small" and one which is "too large" .The lengths of each pipe mast be long enough so that the sum of the headloss of each is equal to the total desired headloss .Refer to next figure:



DESIGN EXAMPLE: COMBINATION PIPE SIZES

since the total pipe length ,design flow ,and desired headloss are all known ,the lengths of the two pipe sizes can be determined by the following equation ;

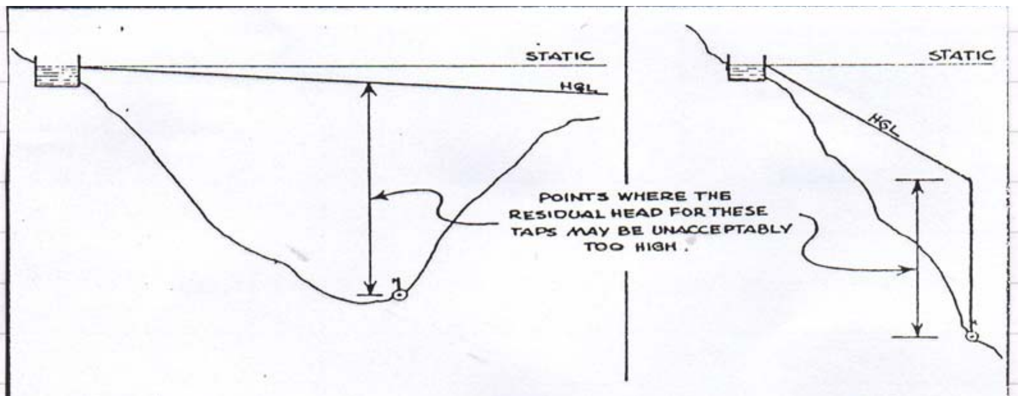
$$X=\frac{\text{١٠٠}H-(Fl\ xL)}{Fs-F\text{١}}$$

Where;
H= desired headloss (m)
L= total pipe enough (m)
X= small-size pipe length (m)
F١= frict΄l factor large pipe (%)
Fs= frictl factor small pipe(%)

When the length of the smaller – sized pipe is calculated, it is then subtracted from the total pipe length to determine the length of the larger –sized pipe .

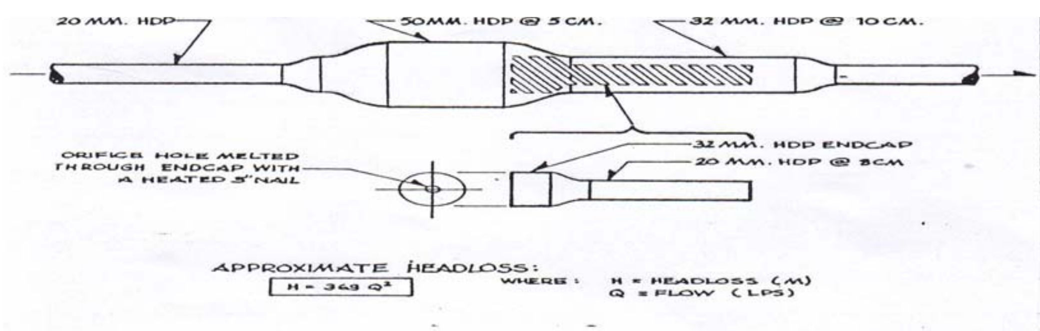
Excessive Residual Head:

There may be points in a system where the residual head at a discharge point is excessively high .this can particularly happen to tap stands located in positions such as shown in figure below :



EXAMPLES OF HIGH RESIDUAL HEADS AT TAPS

For such case it is possible to install a device which creates high frictional losses in only a short length of pipeline .This sort of frictional diffuser can be easily manufactured in the field.Using HDP pipe and fittings .A design for this shown below:



FRICTIONAL DIFFUSER

AIR- BLOCKS

I considers the details of determining whether or not a pipeline is likely to be affected by trapped pockets of air which could interfere with the flow.
If the designer determines that his system is a likely victim of air –blocks ,he can then refer to technical
Appendix for the analysis and procedures needed to deal with these air-blocks.

Air-blocks ;An air-block is a bubble of air trapped in the pipeline ,whose size is such that it interferes with the flow of water through the section.

When the pipeline is first constructed, or subsequently drained for maintenance purposes ,it is (dry),that is ,all Points within are filled with air at atmospheric pressure when water is allowed to refill the pipeline ,air cannot escape from certain sections and is trapped.As pressure builds up ,these air pockets are compressed to smaller volumes .In the process, some of the hydrostatic pressure of the system is absorbed by compressing these air packets ,reducing the amount of energy available to move water. If too much energy is absorbed by compressing air ,then no flow will reach the desired discharge point until something is done about the air-blocks.

Generally, there will be no problems of air-blocks in a system where atank is located at an elevation lower than the air-blocks .As long as he air-blocks are at least ١٠ meters below the static level .This is shown in figure below;

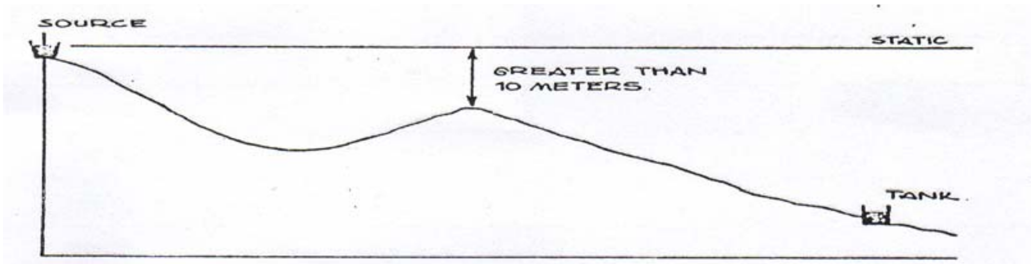
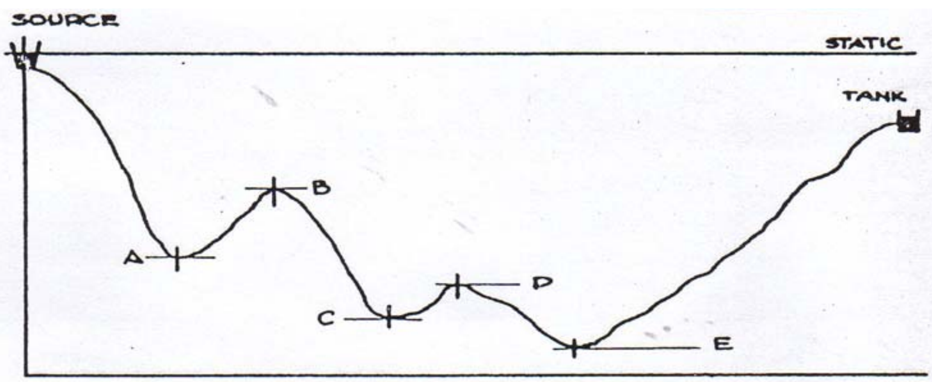


FIGURE PROFILE WHERE AIR-BLOCKAGES WILL NOT INTERFERE WITH FLOW

Air-blocks analysis should be done in U-profile systems similar to that shown below :



– · PROFILE WHERE AIR-BLOCKAGES MAY INTERFERE WITH FLOW

Pipeline design practice:

These are guidelines for arranging pipe sizes in such away so as to minimize trapped air and potential air –blocks . only after such an arrangement has been analyzed and found indequate Should air-valves be installed.

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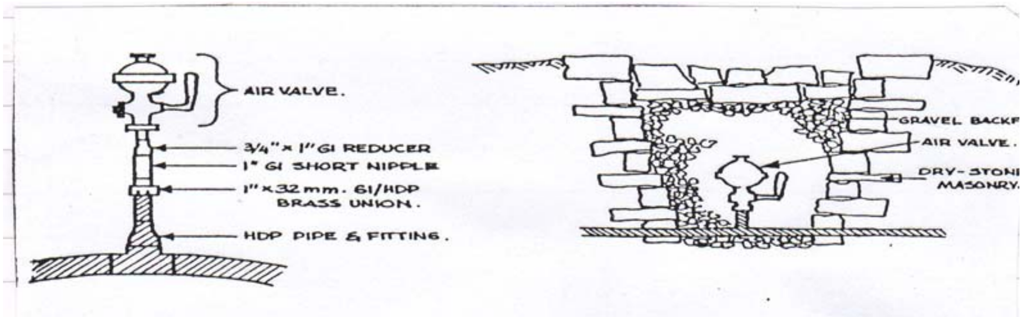
١-Arrange the pipe sizes to minimize the frictional headloss between the source and first air-blocks.

٢-Use larger-sized pipe at the top ,and smaller sized pipe at the bottom of the critical sections where air is going to be trapped (sections BC and DE in figure above).pipe sizes elsewhere do not affect the air-blocks.

٣-The "higher" air-blocks (closer to the static level)are the more critical ones .Eliminate or minimize them first.

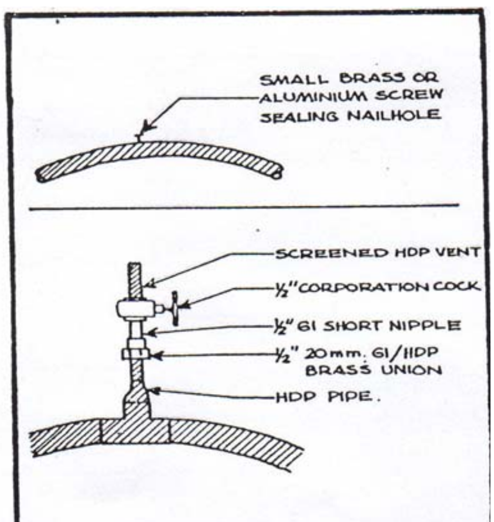
*Air -valves

Air-valves installed below operate automatically. Maximum pressure rating is ٦٠m of head .Details of installation are shown in figure below:



DETAILS OF AIR-VALVE & INSTALLATION

* ALTERNATIVE AIR-RELEASES:



ALTERNATIVE AIR RELEASES

At times when the above air-valves are not available ,there are two alternative methods for allowing trapped air to be released from the pipe line : install a normal control valve , or puncture the pipe with a brass or aluminum screw .Although these alternative methods are not as expensive as an air-valve,they are not automatic, and require manual operation by the villagers. At times when the pipe line is being refilled with water, the valve is opend(or the screw is removed), allowing trapped air to escape .To discourage tempering with these air-release devices, they should be well buried (removing the handle from the valve will also keep unauthorized persons from opening it).