BOLD CONCEPTS FOR INTEGRATED WATER SUPPLY AND DRAINAGE USING RAIN WATER HARVESTING

by

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Introduction : Rain Water - The Underutilized Resource

Individual rainwater collection and usage in homes has undergone a renaissance in the past 30 years, throughout the world. It has slowly but surely caught up in Sri Lanka in the 80's & 90's.Locations such as Badulla, Bandarawela, Murutalawa,Yatigmmanna, among others, have benefited from planned domestic rainwater harvesting systems. To Sri Lankans this is a mere extension of the 'tank' concept, which stood the tests of time over two millennia. Sigiriya probably portrays the earliest RWH (Rain Water Harvesting) systems still in use in Sri Lanka, from the 5th century A.D. or earlier.

However, for most professionals' rainwater harvesting is yet new terminology. Hence a brief look at the goals, the technology and strategies is appropriate.

We require having water security without any fear of foreign domination, or being dependent upon capital-intensive projects, which often become subtle avenues of pressure, to satisfy conditions to qualify for the next foreign loan. Policies need to be changed from promoting RWH when other systems are not available, acceptable, or economical, to consider it as the first choice supplemented by others. Simple calculations bear the truth of this, especially for domestic use.

The potential of ones own roof can be ascertained by referring to the rainfall graph, selecting the appropriate requirement of the household, and the rainfall bandwidth of the area. (See figure 1)

A roof area of 50 m2 having an annual rainfall of 1.5m will yield 75m3/year (The minimum requirement of 40 l/capita/day for a family of 5, works out to 72m3/year.

The world average rainfall is about 500mm. In Sri Lanka the minimum (in the Mannar & Hambantota areas) is around 750mm,and scattered throughout the year. The maximum is over 6000 mm. It is no wonder that powerful organizations have scented the potential of water in our country.

The benefits of Rain Water Harvesting

- Being soft, it is of value in cleaning (user less soap) and has benign effects on water using equipment (non scalable)
- Systems are independent, and therefore ideal for scattered settlements.
- Collection systems can be built using simple material & craftsmanship (eg: brick & ferocement) or procured in the forms of fiberglass or plastic tanks, and could be added on progressively, to meet the available finances of the users.
- Conserves energy, as water collected at roof level possesses necessary head.
- Systems are generally privately owned, and hence not a burden on public funds.
- The source literally falling on ones head, accessibility and convenience ranks high. Time and labour for "fetching water" ceases to have meaning. So does the prescribed " minimum distance' between well and latrine pit, especially in diminishing plot sizes.
- The process assists in reducing soil erosion and flooding by leveling out the peaking curves of surface runoff.
- Users will also be their own Managers. Conservation routines are inbuilt, if storage or supply runs low.
- RW (Rain Water)at worst, will have less weedicides, pesticides, synthetic hormones, Mercury, Cadmium etc, compared with treated water from surface sources, which could contain traces, difficult to trace, and rarely tested for anyway.
- RW has a high percentage of heavy water (D2O, T2O) which hasbeen shown to be beneficial for plant growth. 1

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- Water does not have to be transported across river basins, using dams, intake structures, raw water and treated water pumping mains, and their inherent machinery. (Moratuwa, Panadura, Dehiwela, Mt. Lavinia, Kotte, Maharagama, Piliyandala in the Bolgoda basin, is fed by waters of the Kelani basin, with elaborate schemes of pumping, storage and distribution).
- There are no colour, turbidity, excess Fluoride, excess Nitrate, excess Iron, Hardness, algae problems etc, some, or all of which are often prevalent in surface or underground sources.Possible pollution from industrial gases is very slight in the country.
- Does not require "salinity barriers", and will not contribute to secondary salinity problems.
- There is no requirement as in surface and underground sources for flow measuremens, resistivity surveys, test drills, pumping tests, quality testing etc. taking much time and resources, and sometimes proving futile, at the end.
- Expensive treated water (for drinking) is not wasted on secondary purposes.
- Systems are less dependent on foreign loans. Even if they are, they fit in neatly with standard loan covenants that operation and maintenance costs be recovered.

No requirement for expensive continuous monitoring of water quality (as in river intakes at low flow), though random checking at household level would be a necessity.

- Systems do not intrude into other people's domains, such as drying up of adjacent aquifers due to over extraction by pumping. There are no "water rights" issues.
- Source protection is merely keeping the roof, gutter, and filters clean while keeping the storage tanks as secure as possible with simple mosquito and vermin prevention measures, and simple filters diverting the first flush of rain.
- Systems can defer, reduce or even eliminate the requirement of traditional water supply systems.
- Systems are gentle on Mother Nature. Water is collected utilized and drained in the same locality where it falls as rain. Water tables are thus maintained at higher levels in the area.
- Rain considered being a "giftfrom heaven", free of charge, one does not have to worry about fuel surcharges, and other taxes leading to increasing bills, if harvested stored and used.
- Sri Lanka by its geographical location and the central hills, is blessed with two monsoons, where all areas are at least somewhat benefited by either monsoon, which though varying in intensity, never fails.
- There will be no unannounced breakdowns, and water cuts in the system as is fairly common in the traditional water systems in the country Nor will supply be dependent on power generation or distribution restrictions.
- There will be few if any of the illegal tappings, and the vast amounts of time and money spent on curbing it will not be required.
- The storage tank itself could be used also for town water supply (if one exists) as a backup, if rainwater is insufficient.
- In conjunction with "drip irrigation techniques" it can assist in tiding over drought periods for home garden cultivation (similar to the "wewa" being the lifeline of the village).
- Degradation of catchments, siltation of reservoirs, pollution loads, river water levels falling below intakes, lose their meaning with the RWH concept.
- Subsidy projects of different agencies could be harmonized by integrating approaches of improved roofing materials and RWH simultaneously.
- Having a higher level of water security at home, people tend to use more water for sanitation, which they would have curtailed otherwise.
- RW is an inexhaustible source.
- Bacteriological quality of properly collected and stored RW has been found to be superior to that of dugwells, intests conducted in Sri Lanka. 2
- Being low in minerals (necessary for bacterial growth) RW has been proved bacteriological safe even after six months,in properly maintained tanks, in experiments conducted in the country..
- It is a lifetime investment (and beyond).
- Water in bulk is readily available in case of a fire, or to tide over for some time in case of damage(wilful or otherwise) to main supply lines..
- Will assist in more greenery and lessen heating effects caused by asphalt,concrete and similar material.

Disadvantages of rain Water Harvesting

TRADITIONAL RAIN WATER HARVESTING SYSTEMS, BY ITS NATURE, HAS A SUBSTANTIAL DRAWBACK-THAT OF EXCESS DURING RAINY PERIODS, AND LACK DURING DROUGHTS.

To overcome this to a degree, curves for sizing adequate storage size depending on demand, roof catchments area, and rainfall, have been compiled (Mansur curves). 3 This alleviates the situation somewhat, but one ends up with a very large sized storage structures to ensure water security for a substantial part of the year. This is practically not viable due to the constraints of land and

the costs of larger tanks. How do we overcome this impasse?

Bold Concept in Rainwater Harvesting

Suppose each house practiced rain water harvesting, and connected its tank overflow into a common pipe (instead of to the road drain) the water at the end could be collected to a large storage tank. This water could be stored till required, and could be pumped back through a parallel pipeline (after some treatment) to the users who incidentally were the producers as well (see figure 2). This eliminates the requirements for large storage at the household level. If the quantity of rain which could be collected from a roof exceeds the water requirement of the household, the concept of storing the excess, and pumping back, eliminates the need of additional sources altogether ! The system is similar to the well established "cascade system" of our ancient tanks, where the overflow of one, is taken up by the next down the line, leading to larger tanks downstream.

Design Aspects

Now let us consider the design aspects in wider details.

A good topographical plan, with buildings and contours at close intervals (say 1m) would be a pre requisite for fast analysis. If in digital format, using available software, the drainage patterns can be quickly established. Using this information and the roof catchments areas, the sizes and the grades of the collector mains can be established. Concepts such as maximum/minimum velocities may be relaxed as the water will have hardly any particle matter. More than one catchmentcan be considered to minimize the depths of the collector mains,which could be designed as an "open channel" where the hydraulic grade line would lie below the overflow level of the holding tank..

The size of the holding tank (either underground or above ground) will be tradeoffs between availability of land (generally not much of a problem outside big towns), safe storage (depending on demand, rainfall, and periodicity) and budgets available. In any event such a tank would provide storage from any other source, in case of no rain.

As the water will be pumped back through a parallel main, a check needs to be done on the pipe sizes, and adjustments made to sizing if required. This is because the water demand at a location, could be out of proportion to its roof catchment area in some instances, or due to vast differences in levels in the topography Isolated locations faraway, and that at high elevations may not be taken into consideration during the initial phase.

The simplicity and elegance of such a system lies in its upgradability in phases, according to budgets available. Requirement for "refurbishment and renewal" would be minimal, while scope for gradual improvement and extension would be vast.

When new buildings are added and connected to the system, the sources of supply continues to grow, rather than the traditional surface or underground sources, which tend to become more stressed with time. Rainwater is converted into a reusable resource. More large capacity holding tanks could be added at the same location, or the excess transferred to another location where land is found. Balancing tanks could be added in the distribution system, to even out pressure differences. Small-scaled booster stations could be used for serving those who may not be benefited even with balancing tanks,in later phases.

If rainwater by itself is insufficient (as could be the initial phase), supplementary surface or ground water sources could be utilized. Depending on the integrity of the source, (which often varies within the year) whatever the treatment costs, could be reduced, by mixing with the available rain water to bring to required standards. Thus an 'unsafe' source, could be made use of in combination. Rainwater will reduce the stress on existing systems, including groundwater, if used as a supplement. Tampering with deep groundwater has within a short time has brought forth the dormant problems of Arsenic and Fluoride.

Since the user provides the rainwater free of charge, the Operations and Maintenance costs would be in the treatment, (possible only chlorination if only rainwater) pumping, and caretaker costs. Individual household should be required by law to have a minimum storage. Anything above this would be to the benefit of the user himself.

The water pumped back to the user could be charged at a flat rate in most instances, and metered at a few locations, where the cost of meter replacement, and periodic maintenance, would be covered by its income generation. Any overflows due to malfunctioning ball valves at household tanks would not go to waste, but find its way back to the storage tanks though the collector mains!! Sent down the drain, but still productive!

The cost of the individual house tank and the connection to the main collection pipe could be subsidized by the project. The amount of relatively purerain water it will supply continuously over the years will be adequate justification. The local authorities can pass simple laws whereby house hold rain water collection tanks become mandatory for obtaining a service connection. It would be easy to introduce this concept to all structures constructed by the Government Institutions. Such

would be mass advertisement for the general public & private sectors to take cognizance. The scheme would be a relationship between the community and an arm of the government, where the former stakeholders provides the raw source free of charge, whilst the latter acts as the custodian, which collects, stores, treats and delivers the refined product at a cost, the breakdown of which would be less cumbersome and more transparent to the community

As there is less requirement for separate primary, secondary and rider mains, the length of the pipe work will be smaller than conventional network∏ and more optimally utilized with water flowing both ways. Less pipes also means less excavation, less reinstatement costs, less joints (less leaks). The system acts like the internet with flows to & from. (It interestingly follows the Communist Motto" From each according to his ability. To each according to his needs" by contributing according to the area of the roof catchments, but receiving only the requirements of the house storage tank!!!). (See figure 2)

This method is easily adaptable for well planned Housing estates, Industrial Estates, small towns and possibly the devastated towns of the North & East of the country, during a future process of reconstruction. (possibly using the combined energies of the demobilized soldiers and militants). RWH provides immediate relief (politicians would be much interested) by its ability to give a "quick fix" with guaranteed success.

An extension of the same idea could be applied to storm water collection in large under ground tanks, in much large quantities, albeit at a lower quality, but no worse than the surface waterway it would drain to, possibly used as a source downstream. The quality of such storm water can be much improved by using recently developed 'vortex techniques' using just the energy of flow. This would further lessen the dependence on surface or under ground water sources for water supply. Tanks could be conveniently and unobtrusively constructed under playing fields or parks, under integrated projects, with minimal land acquisition delays.

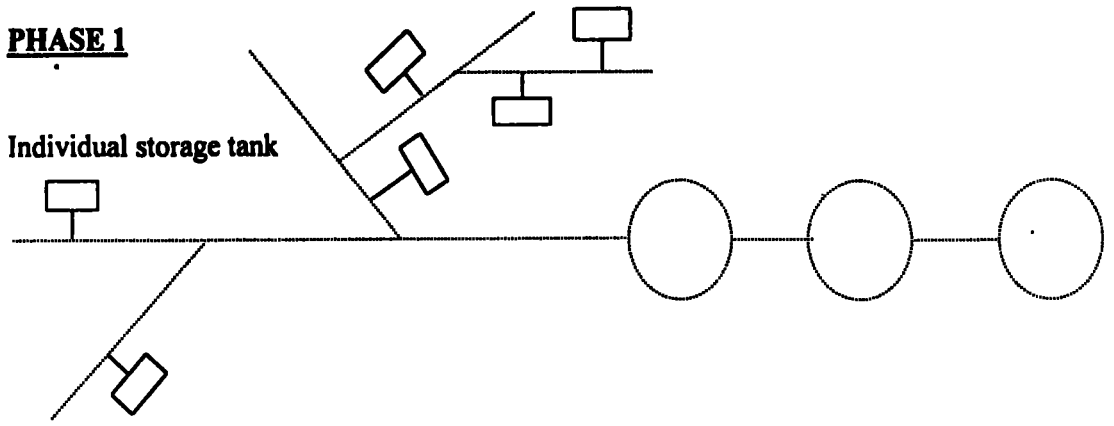
Only the quantity of water necessary for drinking and cooking need to be of "drinking water standard". This is about 2-3 litres /day/person. Traditional water systems , by their very nature is inbuilt to produce all water requirements to this high standard, - a colossal waste often taken for granted. Is it economical to treat large volumes of water, when less than 2% is used for drinking purposes? Treatment for drinking water at the household level is more sensible.

Rain water is easily adaptable to meeting "drinking water standards", by simple techniques known as the SODIS (Solar Disinfection), where bottles of half blackened surfaces filled with water and kept out in the sun for a couple of hours has shown to be sufficient to destroy pathogenic micro-organisms through a combination of heat and Ultra Violet light (provided absolutely free of charge, and guaranteed to continue so!)

Why consultants, both foreign and local have not given RWH its due place could be topics for discussion and debate. Is it a wonder that powerful organizations have scented the potential of water resources in the country? The logic of bringing from faraway, what is literally falling around us also depicts how much common sense has been dulled in the technicalities of Engineering. Would not it be more logical to have better, improved, less costly " on site" sanitation systems to take care of the 'offensive discharges' of human beings, instead of using costly long sewer networks (to convey previously drinking - standard water and the inherent pumping systems, and save such funds presently liberally allocated to collect the more productive rainwater using similar principles?? London, which has an annual precipitation of about 750 mm is considered a "wet"city. In Texas U.S.A., 16 times the size of Sri Lanka ,has rainfall regions classified from 200mm to1300 mm. In SriLanka the figures vary from a minimum of 750mm to around 6000mm. It is not surprising, when figures are compared that the concept of large dams, or river intakes,(and now desalination) solely for drinking water purposes,emanated from the West, took root in our country, and is being blindly replicated, at the expense of rain/storm water harvesting.

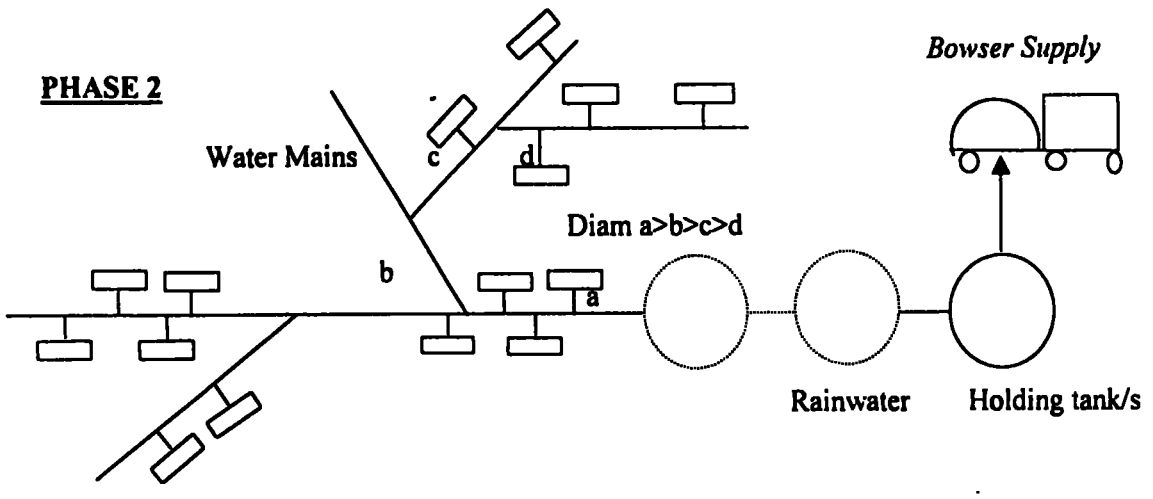
The true capital cost of traditional water schemes is often a subject under wraps. The public is often unaware that in the urban sector, the cost per person of such could range from about 40000 to 100000 Rs. per person ! The never ending and ever increasing operation and maintenance cost is separate. All this very often for limited and curtailed hours of supply! The cost of individual RWH tanks, in contrast, is about 5,000 to 15,000 Rs. per person, sustainable with the minimum, or no outside assistance.

PHASE 1

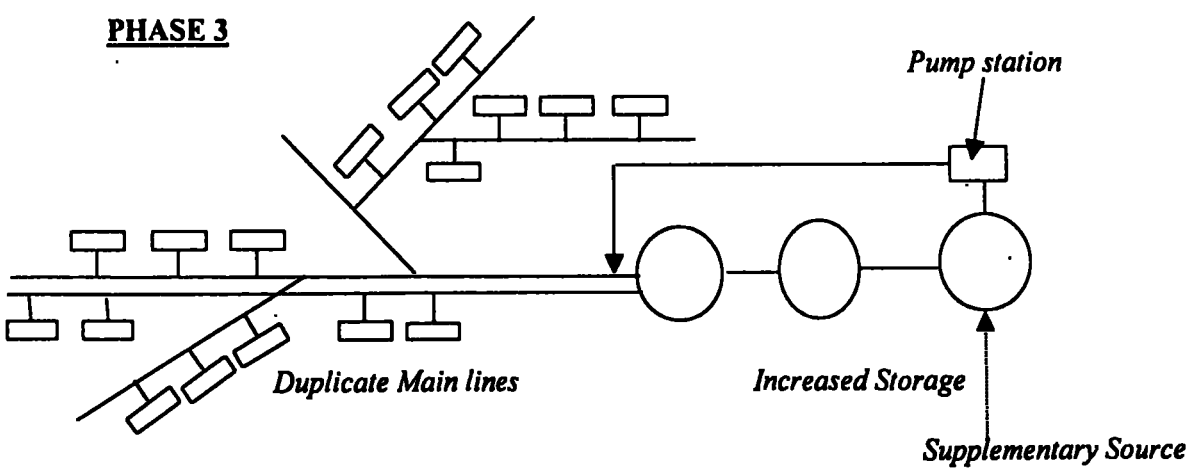


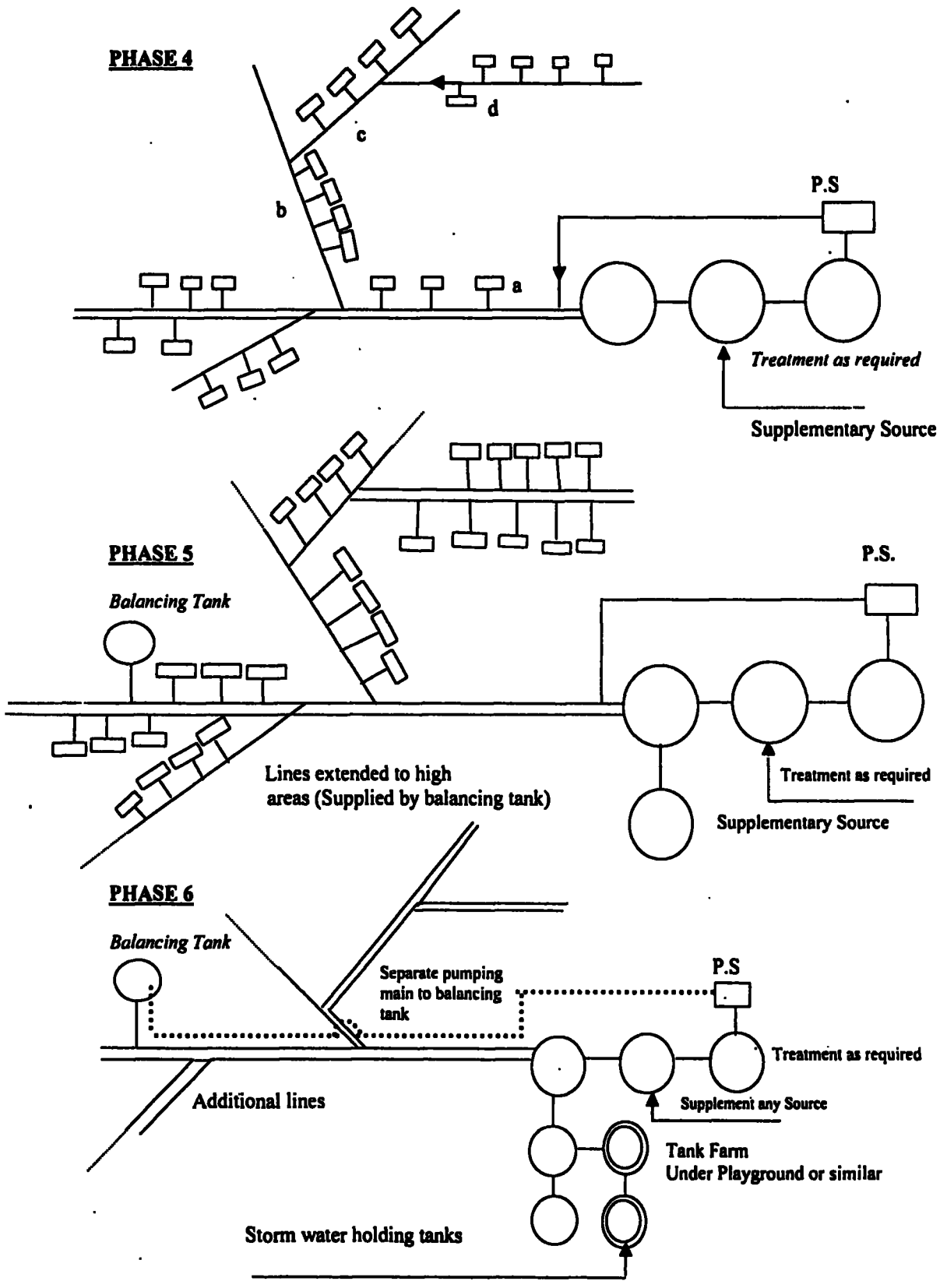
Individual Storage tanks

PHASE 2

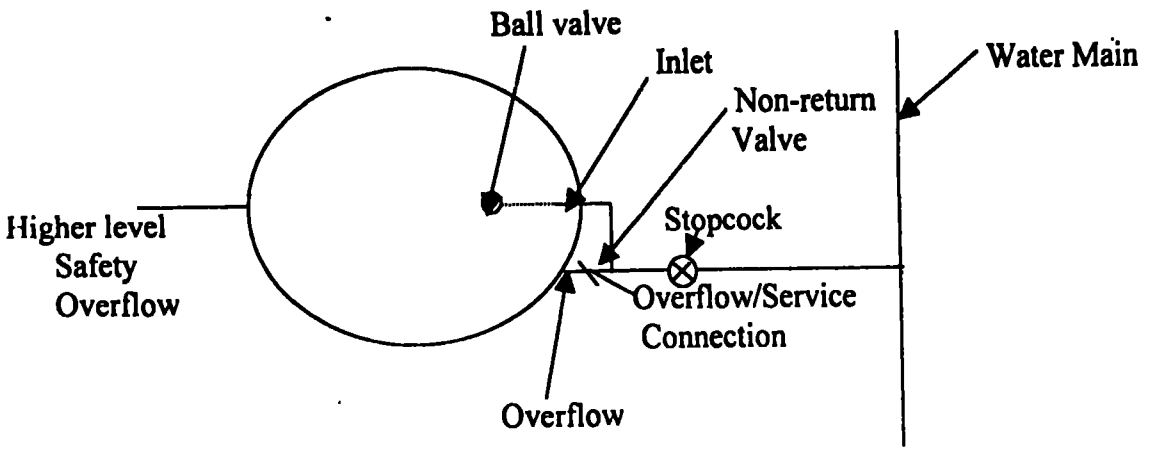


PHASE 3




PHASE 4
d
c
b
a
P.S
Treatment as required
Supplementary Source
PHASE 5
Balancing Tank
P.S.
Lines extended to high
areas (Supplied by balancing tank)
Treatment as required
Supplementary Source
PHASE 6
Balancing Tank
Separate pumping
main to balancing
tank
P.S
Treatment as required
Additional lines
Supplement any Source
Tank Farm
Under Playground or similar
Storm water holding tanks

Possible plan of storage tank and connections.



Conclusion

Experts today agree on vast changes in weather patterns and rising sea levels, debating mainly on how much and when. WHAT IF DURING THE NEXT GENERATION, THE RISE IS SUCH THAT THE EFFECTS OF SALINITY CONTINUALLY REACH THE MAJOR WATER INTAKES FEEDING OUR OVER POPULATED CITIES? Even at present, the effect has been noticed at some of the major river intakes . We hear of the "worst in recorded history" conditions globally - be it, drought, floods, earthquakes and other natural disasters. Our investments in the field of water today MUST take into account the impending global climate changes.

RWH to be meaningful, needs to go hand in hand with responsible living, where conservation is just not a fad, but something attempted from the depths of ones consciousness. Water saving faucets, a bottle in the flushing system, could be simple but effective starting points.

"To compensate for the lack of funds, developing countries will need access to good ideas", stated Lawrence Summers, a former Chief Economist of the World Bank. The above is one such for the bold and enterprising to bring into fruition.

References:-

1. Quality of collected Rain Water in Relation to Household water security - Lanka Rainwater Harvesting forum - Tanuja Ariyananda.

2. RainWater Harvesting System Design for Sri Lanka - U.Mansur