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Different Techniques of Water Harvesting and Reuse of Water

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ABSTRACT

Water is the most important element for human life on earth. The latest scientific data confirm that the earth's climate is rapidly changing. Global temperatures increased by about 1 degree Fahrenheit over the course of the last century, and is predicted to rise even more rapidly in coming decades. This is leading to temperature increase and droughts, which in turn makes water of utmost importance. Growing demand from agriculture, industry and a growing population, have increased the problem. According to international reports, industry and householders are using increasing amounts of water. As a result, there is a push for new sustainable water supplies taking place at all levels, and in every part of the world. This paper gives an account of the problem, reviews the developments of remedial measures, and describes in detail the various techniques used today to recycle water.

KEYWORDS: *water harvesting, grey water treatment, water management*

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1. INTRODUCTION

Water is most essential for sustaining life in all its manifestations. With the rapid growth of urban population, the demand of potable water for domestic and other uses has increased many fold and shortage of water is becoming more acute in almost all the cities and towns. Large quantities of water also required for industries and community activities, which are expanding at a fast pace and for parks, gardens and trees, which are integral part of urban development for a healthy living environment. Water is central to many national concerns, including energy, food production, environmental quality and regional economic development. "Water is highly variable and mobile resource in the widest sense. Not only is it a commodity which is directly used by man but it is often the main spring of extensive economic development, commonly as essential element in man's aesthetic experience, and always a major formative factor of the physical and biological environment which provides the stage for his activities."

India's Rainfall Pattern

The rainfall pattern in India is highly irregular in space and time. Most of it is concentrated during just a few months of the year and that too, in a few regions - 70% of the rainfall occurs in about four months. So, even in a year of normal rainfall, some parts of the country face severe drought. Incredible but true! Cherrapunji, the wettest place in the world, (receiving about 15,000 mm of annual rainfall) faces an acute shortage of water every year.

India is a land of diverse agro-ecological systems, ranging from the hot desert of Rajasthan to the cold desert of the Trans-Himalayan Ladakh, from the subtemperate Himalayan mountains to the tropical mountains of the south, from the various hill and mountain ranges to the plateaus and plains.

2. A Brief History of Water Harvesting in Our Country

The nature of Indian ecology had forced Indians to develop and perfect the art of water harvesting, best suited to their region. India has had a tradition of water harvesting which is more than two millenia old. Evidence of this tradition has been found in ancient texts, inscriptions and archaeological remains. The Kuhals of Jammu, Kuls of Himachal Pradesh, Guls of UttarKhand, Pats of Maharashtra, Zings of Ladakh, Zabos of Nagaland, Eris of Tamilnadu, Keres of Karnataka, Tankas, Kundis, Bawdis, Jhalaras, etc. of Rajasthan are but a few of the traditional rain harvesting systems, which existed in India but now, dying a slow death.

In the mountains and hill regions of India, people direct water into artificial channels which flows into agricultural fields. In the arid and semi-arid regions, where streams are seasonal, the water is led into a storage structure which provides for the dry period. In certain villages of the *Eastern Himalayan states of Nagaland and Arunachal Pradesh*, the water channel is taken through a cattle shed which enriches the water with nutrients before it is led to the fields. Due to uneven terrain these people use bamboo for their water channels; this resembles the modern drip irrigation system. Apatanis, the tribals of Arunachal Pradesh combine wet rice cultivation and pisciculture. By using temporary walls, they divert the water flow of the streams from the hills towards the terraced and valley lands.

In the Haveli system of *Madhya Pradesh*, the nature of the soil and crops allows storage of rain water in the agricultural land itself, enabling complete percolation of water. This provides adequate moisture for the following dry period. Water is shared between fields through embankments.

Maldharis of the Kutch region in *Gujarat* have developed a system called 'Virda', which is based on the difference in the density of sweet water and salt water. In this system, wells dug on the beds of ponds allow percolation of rain water. The ponds remain filled during the rains, while during the dry periods, people draw water from the wells.

In the state of *Tamilnadu*, a big stream collecting water from a large catchment area is diverted to feed a chain of 25 to 30 tanks called the 'System Tank'.

People of dry areas of *Rajasthan* have traditionally used a combination of surface water and ground water for their needs. Wells and stepwells have been built below tanks and other water storage structures, so that clean ground water can be harvested on drying of tank water. In many towns of Rajasthan rooftops have been used as catchments to collect rainwater. In the town of Phalodi there are cases of 'borrowing' one's neighbour's roof to collect rain water.

The tribals of Kikruma village of *Nagaland* have not spared even the roads. They have constructed a series of speed breakers at about every 10 metres to block the runoffs. These are then led into ponds by means of channels.

In the town of Aizwal in *Sikkim* all houses have corrugated iron sheets to collect the water from the skies.

There are several more unique and effective methods of water harvesting which had been and in a few cases, are still being followed throughout the country.

3. RAIN WATER HARVESTING

3.1. WHAT IS RAINWATER HARVESTING?

In scientific terms rainwater harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater, prevention of losses through evaporation and seepage and all other hydrological studies and engineering interventions, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit such as watershed.

Rain water is the ultimate source of fresh water**.** We have greatly hampered the natural ground water recharge by drawinf excessive water and covering / paving up all available open land. Rain Water Harvesting, is merely "**putting back rain water into the soil, where it will be stored in underground reservoirs and rivers, so that we can draw it whenever we need it**".

With the water table falling rapidly in most parts of the world, and with concrete buildings, paved car parks, business complexes, and landfill dumps taking the place of water bodies, Rainwater Harvesting is the most reliable solution for augmenting groundwater level. It is the means to attaining self-sufficiency in public distribution of water in drought-prone areas.

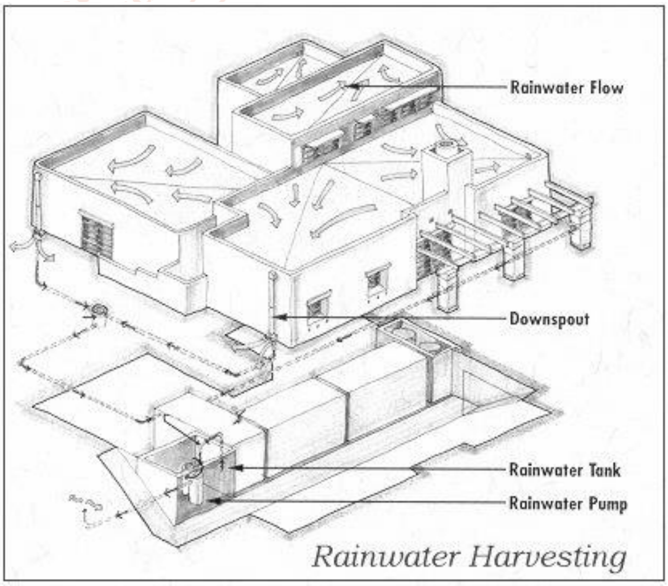
It is a cost-effective method of obtaining water, thereby solving the water crisis. It saves the investor more money than what he or she has hitherto spent on water. It is neither energy-intensive nor labour-intensive, thus making it an eminently feasible alternative to other water-accruing methods, such as desalination of seawater and interlinking of rivers.

Rainwater harvesting has been used for many centuries as a way to take advantage of seasonal precipitation that otherwise would be lost to runoff or evaporation. People, like the modern Hopi and O'Odham farmers, as well as ranchers in the Southwest United States, construct dams, terraces, ditches, cisterns and ponds to collect and store rainfall for use on their farms and ranches. Rainwater harvesting is a major source of drinking water for many people around the world.

The Desert House rainwater system can be divided into two components. First, rainfall that lands on the landscape is diverted to plants via contoured slopes and berms. Plants needing relatively more water are placed to collect more runoff. Basins have been built around particular plants to collect water and allow it to percolate slowly through the soil. This method insures that plants receive the water they need and very little water is wasted.

The second component of rainwater harvesting at Desert House uses the roof to collect and divert rainwater through downspouts, into a sand filter and store it in a 4,700-gallon cistern located in the basement. When necessary, the stored rainwater is pumped to the surface for landscape irrigation. Stored rainwater also can be used for evaporative air conditioners or fish ponds, or to water sensitive plants.

Rainwater Harvesting is, of course, feasible in regions that receive moderate to heavy rainfall.



For an average rainfall of 1,000mm, approximately four million litres of rainwater can be collected in a year in one acre of land (4047m2), post-evaporation.

Water from rainfall infiltrates into an aquifer through an artificial recharge structure, thus recharging the aquifer. The water is stored in the aquifer, from where it can be retrieved for future use.

Rainwater Harvesting can be undertaken through a variety of ways…

- Capturing run-off from rooftops.
- Capturing run-off from local catchments.
- Capturing seasonal floodwaters from local streams.
- Conserving water through watershed management.

These techniques can serve the following purposes:

- Provide drinking water
- Provide irrigation water
- Increase groundwater recharge
- Reduce storm water discharge, urban floods and overloading of sewage treatment plants
- Reduce seawater ingress in coastal areas

In general, Rainwater Harvesting is the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater.

3.2. How much water can be harvested and stored using the Desert House roof?

Average annual precipitation for the Phoenix area is around 7.5 inches; with this annual rate each square foot of the Desert House can accumulate four gallons per year. The Desert House roof, measuring 2,208.93 square feet can amass 9,277 gallons per year, half of which, about 4,700 gallons, can be stored. If the rainwater tank is full, the downspouts can be adjusted to divert water directly onto the landscape.

The Desert House landscape needs approximately 104,860 gallons of water per year. Rainwater can account for 9,277 gallons or 9%. Graywater can account for 11,370 gallons or 11% of total irrigation demand. Combined rainwater and graywater harvest can save 20,647 gallons of water per year that would have normally come from the city water supply.

3.3. WHY RAIN WATER HARVESTING ?

Water scarcity is a serious problem throughout the world for urban and rural communities. With a burgeoning population, more and more water is required for domestic, industrial and agricultural purposes. In most communities, the rate of withdrawal is far in excess of the rate of recharging the water table.

Urbanization has led to overexploitation of groundwater reserves, reduction in open soil surface and water infiltration rate, and a resultant deterioration in water quality. Apartments and industrial units face acute water shortage, forcing them to spend considerable amounts of money for purchasing water from municipal and private water suppliers.

Water covers about 3/4 of the earth's surface, but only about 2% is fresh water, and a larger portion of it is polar ice. 86% of Asia's fresh water is used for agriculture, 8% for industry and 6% for domestic purposes.

Our country uses 83% of fresh water for agriculture.

Fresh water, once considered an inexhaustible resource, is now fast becoming a scarce commodity. The main source of freshwater is precipitation, in the form of rain or snow. When it rains, only a fraction of the water percolates and reaches aquifers; the major portion of rainwater drains out as run-off and goes unused into the ocean. Further, lack of adequate storage facilities necessitate the procedure of letting rainwater into the sea to prevent breaching and flooding. The water policy of the Government of India puts a norm of 180 litres per capita for our domestic needs. But it is not possible to supply even 100 litres per day even in urban areas. 30 million Indians spread out over an area of 7 lakh sq. km., mostly in the west and north west regions, face an acute scarcity of potable water especially in the summer months.

In India owing to erratic monsoon rains, sudden and heavy downpours result in flash floods and voluminous flow in the rivers. Ultimately the water is let into the sea, even though many parts of the country have little or no drinking water for almost six months in a year. Village women walk miles to fetch a pot of drinking water while city dwellers lose sleep and time waiting in serpentine queues for a bucket of water. Access to sufficient clean water is everyone's right.

An United Nations estimate says that by the year 2025 two thirds of humanity will face a shortage of fresh water. At present one third of the global population is facing water stress.

The problem is compounded by a burgeoning and over-consumptive population, which has led to a spurt in bore-wells and also an increase in depth of bore-wells. The two phenomena are manifestations of over-pumping of groundwater reserves. The unrestricted use of bore-wells threatens groundwater resources.

The problem of groundwater depletion in cities and elsewhere can be best tackled by harnessing every drop of rainwater for the purpose of artificial recharge of the water table.

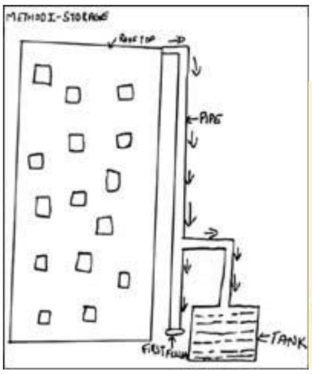
4. ELEMENTS OF TYPICAL WATER HARVESTING SYSTEM

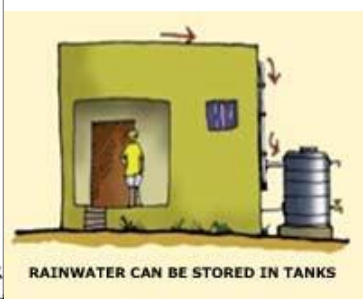
4.1. HARVESTING SYSTEM

Rainwater harvesting methodologies are a function of the point of application (e.g. rural or urban setting) and whether the technique is to be applied to existing structures or new structures. Another classification involves two broad approaches used in rainwater harvesting

Method I: Storage

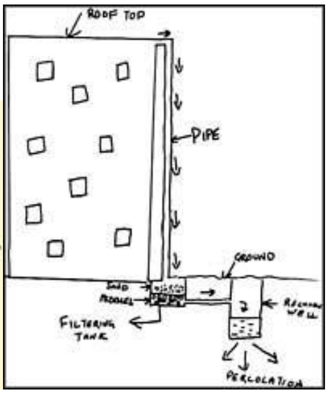
Storing rainwater for ready use in containers above or below ground. In places where it rains very frequently like Kerala and Meghalaya, rainwater can be harvested by the storage method. In this method, we collect rain water falling on the roof through a pipe which goes down to a storage tank. The water of the first rains are let out as the first flush.





Method II: Recharge
Charged into the soil for withdrawal later (groundwater recharging).

In regions where we get rainfall only during a few months of the year, we collect rainwater indirectly through the recharge method. Rainwater falling on the roof is carried through a pipe to an underground filtering tank, from where it goes into the recharge well and recharges the ground water.



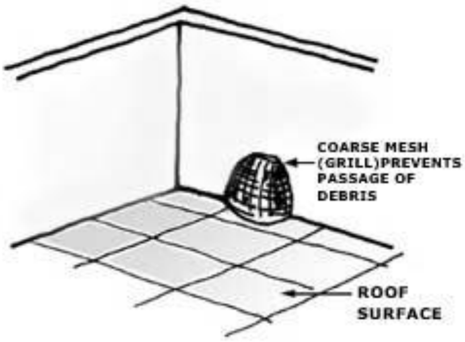
4.2. ELEMENTS OF TYPICAL WATER HARVESTING SYSTEM :

Catchment of a water harvesting system is the surface which receives rainfall directly and contributes the water to the system. Conduits are the pipelines that carry the collected rainwater from the catchment to the harvesting system. Then come the storage and recharging facilities.

4.2.1. CATCHMENTS

The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.

4.2.2. COARSE MESH



At the roof to prevent the passage of debris.

4.2.3. GUTTERS

Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.

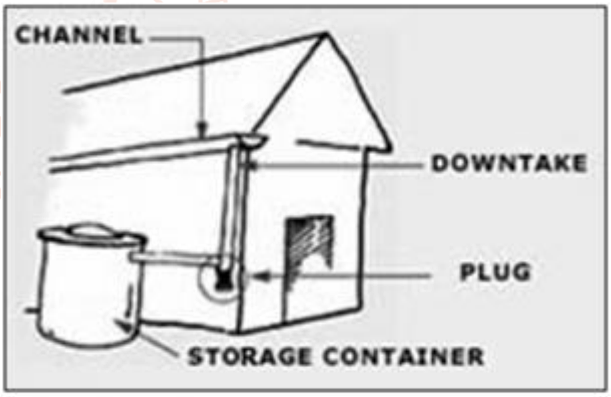
Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depends on the construction of the house; it is possible to fix iron or timber brackets into the walls, but for houses having wider eaves, some method of attachment to the rafters is necessary.

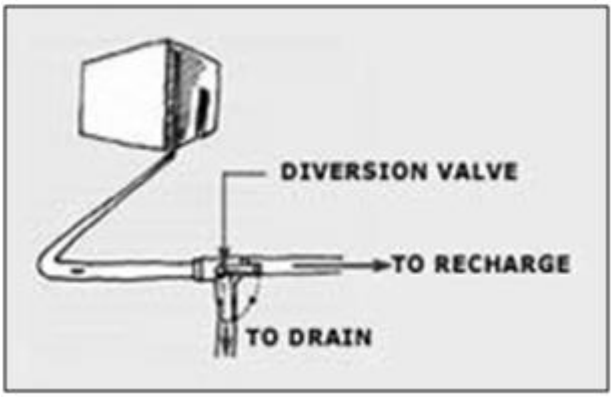
4.2.4. CONDUITS

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

4.2.5. FIRST-FLUSHING

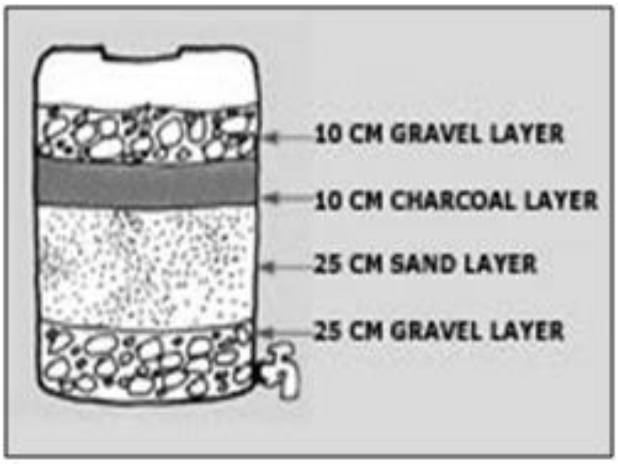
A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system.





This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.

4.2.6. FILTER



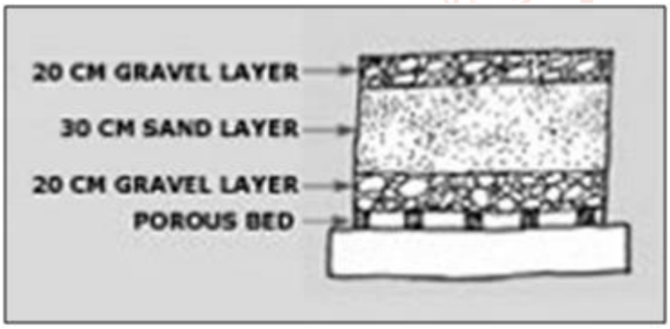
The filter is used to remove suspended pollutants from rainwater collected over roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand and gravel layers.

to remove debris and dirt from water before it enters the storage tank or recharge structure. Charcoal can be added for additional filtration

4.2.6.1. SAND FILTERS

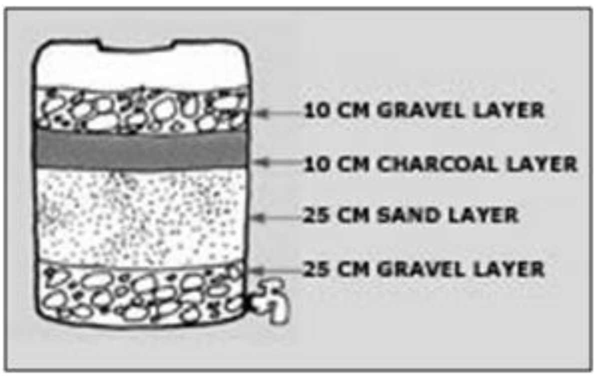
Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms.

In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders.

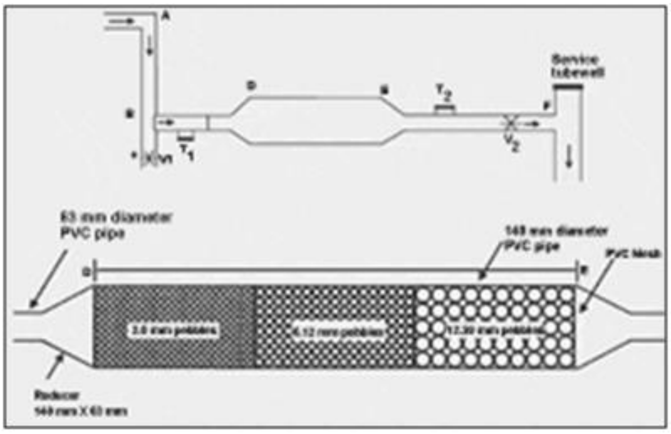


4.2.6.2. CHARCOAL WATER FILTER

A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.



A. DEWAS FILTERS

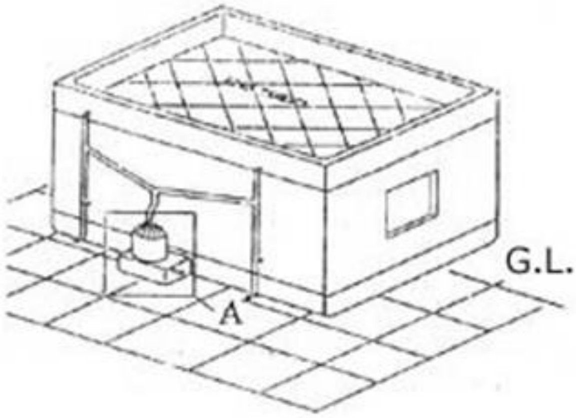


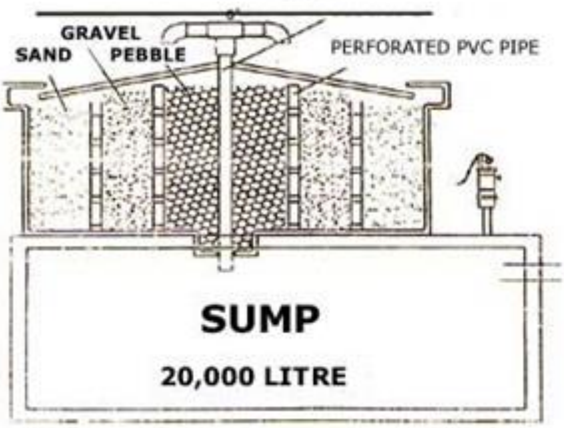
Most residents in Dewas, Madhya Pradesh, have wells in their houses. Formerly, all that those wells would do was extract groundwater. But then, the district administration of Dewas initiated a groundwater recharge scheme. The rooftop water was collected and allowed to pass through a filter system called the Dewas fillter, designed by Mohan Rao, district collecter of Dewas, and engineers of the rural engineering services. The water thus filtered is put into the service tubewell.

The filter consists of a polyvinyl chloride (PVC) pipe 140 mm in diameter and 1.2m long. There are three chambers. The first purification chamber has pebbles varying between 2-6 mm, the second chamber has slightly larger pebbles, between 6 and 12 mm and the third chamber has the largest - 12-20 mm pebbles. There is a mesh at the outflow side through which clean water flows out after passing through the three chambers. The cost of this filter unit is Rs 600.

B. FILTER FOR LARGE ROOFTOPS

When rainwater is harvested in a large rooftop area, the filtering system should accommodate the excess flow.



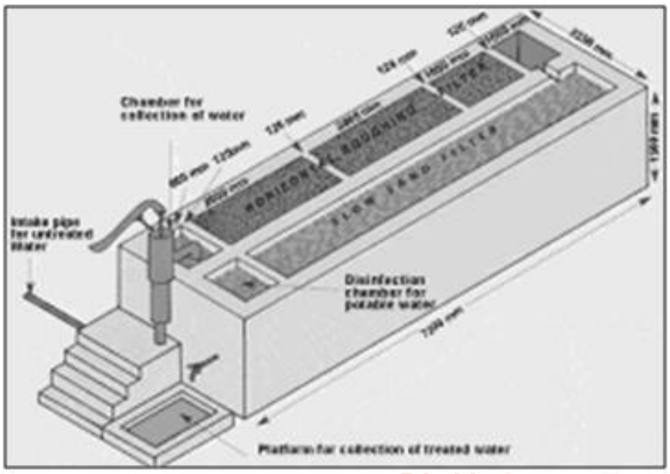


System is designed with three concentric circular chambers in which the outer chamber is filled with sand, the middle one with coarse aggregate and the inner-most layer with pebbles.

This way the area of filtration is increased for sand, in relation to coarse aggregate and pebbles. Rainwater reaches the centre core and is collected in the sump where it is treated with few tablets of chlorine and is made ready for consumption. This system was designed

C. HORIZONTAL ROUGHING FILTER AND SLOW SAND FILTER

The introducton of horizontal roughing filter and slow sand filter (HRF/SSF) to treat surface water has made safe drinking water available in coastal pockets of Orissa. The major components of this filter are described below.



1. FILTER CHANNEL:

One square metre in cross-section and eight m in length, laid across the tank embankment, the filter channel consists of three uniform compartments, the first packed with broken bricks, the second with coarse sand, followed by fine sand in the third compartment. The HRF usually consists of filter material like gravel and coarse sand that successively decreases in size from 25 mm to 4 mm. The bulk of solids in the incoming water is separated by this coarse filter media or HRF. At every outlet and inlet point of the channel, fine graded mesh is implanted to prevent entry of finer materials into the sump. The length of a channel varies according to the nature of the site selected for the sump.

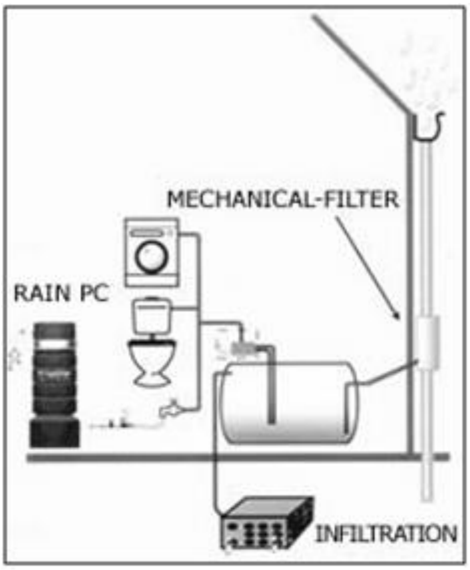
2. SUMP:

A storage provision to collect filtered water from the tank through the filter channel for storage and collection.

While HRF acts as a physical filter and is applied to retain solid matter, SSF is primarily a biological filter, used to kill microbes in the water. Both filter types are generally stable, making full use of the natural purification process of harvested surface water and do not require any chemicals.

4.2.6.3. RAIN PC

AcquaSure, a consortium of three specialist Netherlands-based companies, has developed a system for the conversion of rainwater to drinking water in the form of a Rainwater Purification Centre (RainPC). RainPC is developed by scaling down the multi-staged water treatment method (MST), which involves screening, flocculation sedimentation and filtration and incorporating existing technologies like upward flow fine filtration, absorption and ion exchange. Coming in a small compact 26 kg unit, the RainPC offers an affordable solution by converting rainwater into drinking water.



RainPC is made of ultra violet resistant poly-ethylene housing and cover, stainless steel rods and bolts, a nickel-brass valve and an adapter for maintaining constant volume. Xenotex-A and activated carbon catridges along with ultra membrane filtration or micro-membrane filtration modules incorporated in the RainPC has the capacity to deal with E-coli and the potential of meeting the Dutch as well as World Health Organisations (WHO) water regulation standards. The components can also be transported individually to be assembled at the site. Three product types are available based on their microbial contaminant removal capacity. This technology is ideally suited for virtually any situation and is a blessing particularly for those who have little or no access to regular safe drinking water.

THE SALIENT FEATURES OF RAIN PC ARE:

- Simple straight-forward installation
- Easy to operate and maintain
- Needs no power and operates at low gravity pressure (0.1 bar upward).
- The system is capable of providing a constant flow of about 40 liters of rainwater per hour, enough for a family of five for drinking, cooking and bathing purposes.
- Maintains nearly constant volume irrespective of water pressure.
- The Xenotex-A and activated carbon cartridge processes up to 20,000 liters and can be regenerated up to 10 times.

Cost per 1000 litres is as low as US$ 2 to 3.

4.2.6.4. RAINWATER HARVESTER

EA Water Pvt Ltd has launched a unique Rainwater Harvester, which filters runoff water from roads, which generally contains oil and grease. This system has been installed in the Gymkhana club, Sector-15, Faridabad, Haryana. Rajit Malohtra, project in charge, of this company explained that the water harvesting system installed at the club has a sand filter, which filters silt from runoff harvested from roof, lawns and parking area. The cost of the filter is around Rs 60,000

4.2.7. STORAGE FACILITY

There are various options available for the construction of these tanks with respect to the shape, size and the material of construction.

Shape: Cylindrical, rectangular and square.

Material of construction: Reinforced cement concrete, (RCC), ferrocement, masonry, plastic (polyethylene) or metal (galvanised iron) sheets are commonly used. Position of tank: Depending on space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like cleaning and disinfection are required to ensure the quality of water stored in the container.

4.2.8. RECHARGE STRUCTURES

Rainwater may be charged into the groundwater aquifers through any suitable structures like dugwells, borewells, recharge trenches and recharge pits.

Various recharge structures are possible - some which promote the percolation of water through soil strata at shallower depth (e.g., recharge trenches, permeable pavements) whereas others conduct water to greater depths from where it joins the groundwater (e.g. recharge wells). At many locations, existing structures like wells, pits and tanks can be modified as recharge structures, eliminating the need to construct any structures afresh.

Few commonly used recharging methods are:

4.2.8.1. Recharging of dugwells and abandoned tubewells.

In alluvial and hard rock areas, there are thousands of wells which have either gone dry or whose water levels have declined considerably. These can be recharged directly with rooftop run-off. Rainwater that is collected on the rooftop of the building is diverted by drainpipes to a settlement or filtration tank, from which it flows into the recharge well (borewell or dugwell).

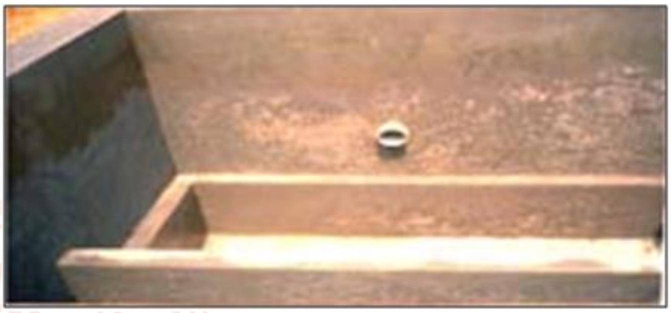
If a tubewell is used for recharging, then the casing (outer pipe) should preferably be a slotted or perforated pipe so that more surface area is available for the water to percolate. Developing a borewell would increase its recharging capacity (developing is the process where water or air is forced into the well under pressure to loosen the soil strata surrounding the bore to make it more permeable).

If a dugwell is used for recharge, the well lining should have openings (weep-holes) at regular intervals to allow seepage of water through the sides. Dugwells should be covered to prevent mosquito breeding and entry of leaves and debris. The bottom of recharge wells should be desilted annually to maintain the intake capacity.

Providing the following elements in the system can ensure the quality of water entering the recharge wells:
1. Filter mesh at entrance point of rooftop drains
2. Settlement chamber
3. Filter bed

4.2.8.2. Settlement tank

Settlement tanks are used to remove silt and other floating impurities from rainwater.



A settlement tank is like an ordinary storage container having provisions for inflow (bringing water from the catchment), outflow (carrying water to the recharge well) and overflow. A settlement tank can have an unpaved bottom surface to allow standing water to percolate into the soil

In case of excess rainfall, the rate of recharge, especially of borewells, may not match the rate of rainfall. In such situations, the desilting chamber holds the excess amount of water till it is soaked up by the recharge structure. Thus, the settlement chamber acts like a buffer in the system.

Any container, (masonry or concrete underground tanks, old unused tanks, pre-fabricated PVC or ferrocement tanks) with adequate capacity of storage can be used as a settlement tank.

4.2.8.3. Recharging of service tubewells.

In this case the rooftop runoff is not directly led into the service tubewells, to avoid chances of contamination of groundwater. Instead rainwater is collected in a recharge well, which is a temporary storage tank (located near the service tubewell), with a borehole, which is shallower than the water table. This borehole has to be provided with a casing pipe to prevent the caving in of soil, if the strata is loose. A filter chamber comprising of sand, gravel and boulders is provided to arrest the impurities.

4.2.8.4. Recharge Pits

A recharge pit is 1.5m to 3m wide and 2m to 3m deep. The excavated pit is lined with a brick/stone wall with openings (weep-holes) at regular intervals. The top area of the pit can be covered with a perforated cover. Design procedure is the same as that of a settlement tank.

4.2.8.5. Soakways / Percolation Pit

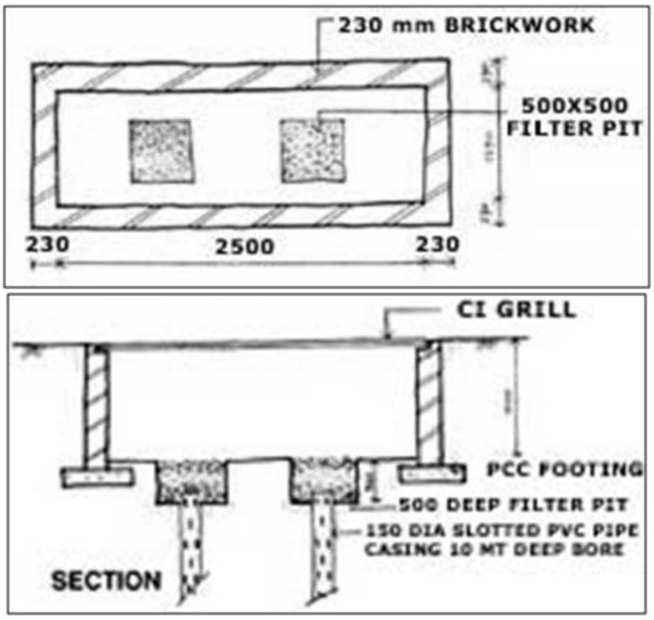
Filter materials in a soakaway

Percolation pits, one of the easiest and most effective means of harvesting rainwater, are generally not more than 60 x 60 x 60 cm pits, (designed on the basis of expected runoff as described for settlement tanks), filled with pebbles or brick jelly and river sand, covered with perforated concrete slabs wherever necessary.

4.2.8.6. Recharge Trenches

A recharge trench is a continuous trench excavated in the ground and refilled with porous media like pebbles, boulders or broken bricks. A recharge trench can be 0.5 m to 1 m wide and 1 m to 1.5 m deep. The length of the recharge trench is decided as per the amount of runoff expected. The recharge trench should be periodically cleaned of accumulated debris to maintain the intake capacity. In terms of recharge rates, recharge trenches are relatively less effective since the soil strata at depth of about 1.5 metres is generally less permeable. For recharging through recharge trenches, fewer precautions have to be taken to maintain the quality of the rainfall runoff. Runoff from both paved and unpaved catchments can be tapped.

To collect the runoff from paved or unpaved areas draining out of a compound, recharge troughs are commonly placed at the entrance of a residential/institutional complex.These structures are similar to recharge trenches except for the fact that the excavated portion is not filled with filter materials. In order to facilitate speedy recharge, boreholes are drilled at regular intervals in this trench.



In design part, there is no need of incorporating the influence of filter materials. This structure is capable of harvesting only a limited amount of runoff because of the limitation with regard to size.

4.2.8.7. Modified Injection Well

In this method water is not pumped into the aquifer but allowed to percolate through a filter bed, which comprises sand and gravel. A modified injection well is generally a borehole, 500 mm diameter, which is drilled to the desired depth depending upon the geological conditions, preferably 2 to 3 m below the water table in the area. Inside this hole a slotted casing pipe of 200 mm diameter is inserted.

The annular space between the borehole and the pipe is filled with gravel and developed with a compressor till it gives clear water. To stop the suspended solids from entering the recharge tubewell, a filter mechanism is provided at the top.

5. CONCLUSIONS

5.1. ADVANTAGES

1. It gives good drinking water in the area where the ground water is not in potable condition.
2. It recharges the Aquifer and avoids depletion of ground water level.
3. It retains dampness in the ground / compounded area that is highly contributing for the added lifespan of the buildings / structures & their allied foundations intact, avoiding crack formation in the foundation / building / ground – otherwise created by dry condition of the subsurface.
4. It prevents seawater entering into the land when the ground water is getting depleted in absentia re-charging of the Aquifer.
5. It improves the soil condition & fertility of the land.
6. For Urbanites, it is considerably reducing their water supply & electric bills.
7. It makes us more self-sufficient and less-dependant on the Govt.'s supply.
8. Above all, we feel proud of offering RWH as our humble contribution to 'Our Mother Earth' that will stand as an invaluable service in concerning this 'Natural Resource'.

AND, after all we can't live even for a single day without water ?!

Harvesting and conserving water is every individual's duty. Every drop of rainwater is precious – save it. It might be the very drop that will quench your thirst one day.

5.2. DRINKING WATER

The priceless commodity of yesterday & the cheaper commodity of to-day – is going to become the costliest commodity of to-morrow.

Recharge the Ground water to
Remove the thirst of our Mother Earth!
After all she keeps it safely for us
And only for our comfortable Life!

5.3. SOLUTIONS

We can make a comprehensive Technical Feasibility Study which can cover the following:

- Identify Hydro geologically potential zones for few water extraction structures like bore wells, dug wells (open wells)
- Design of site specific Artificial Recharge Structures for recharging your water extraction structures like bore wells, dug cum bore well, hand pump, etc.
- Conversion of defunct bore wells and dry dug wells into recharge wells
- Introduction of roof water harvesting systems for all available individual and multistoried buildings.
- Design of Structures to recharge the available lineaments and deep buried pediments.
- Recharge Structures for available storm water drains.
- Recommendations for Biological Treatment of Sullage water and introduction of Soil Aquifer Treatment (SAT).
- Preparation of necessary maps.
- Identifying areas for check dams, barriers, gully plugs, etc.

5.4. CONCLUSIONS

If technically sound system is implemented, - though the initial investment will be slightly high – no repair / repetition / alteration expenditure: no recurring expenditure will be involved and it will surely be an **'one time investment & life time service'**.

Each one of us must not only (i) take an oath that "From to-day onwards, I will do my might to contribute to the Mother Earth" which in turn will contribute to the harmonious living of the society, but also (ii)

Let us become one amongst the 'Great' men, as:

Whatever action a 'Great' man performs, Common men follow And, whatever standards he sets by his Exemplary Acts, all the World pursues.

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