Mini project on

Rain Water Harvesting Techniques for Domestic use

Submitted in fulfilment of the requirements for the award of the degree

Of

BACHELOR OF TECHNOLOGY IN CHEMICAL ENGINEERING

Submitted by

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DECLARATION CERTIFICATE

This is to certify that the thesis entitled **"Rain Water Harvesting Techniques for Domestic use",** submitted by **B. Bhargav(N160153), to** the Department of Chemical Engineering, Rajiv Gandhi University of Knowledge Technologies, Nuzvid for the submission of a mini project report in III-year BTech in Chemical Engineering is a bonafide work carried out under our supervision and guidance during the academic year 2021. This report is, in my opinion, is worthy of consideration for the credits of the Mini project for Semester-II, III-year B-Tech in Chemical Engineering following the regulations of the unit.

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DISSERTATION APPROVAL CERTIFICATE

This is to certify that the thesis, **"Rain Water Harvesting Techniques for Domestic use", was** submitted by, **B. Bhargav(N160153),** the Department of Chemical Engineering, Rajiv Gandhi University of Knowledge Technologies, Nuzvid, for the award of Bachelor of Technology in Chemical Engineering, has been accepted by the external examiners and that these students have successfully defended the project viva in the Viva-Voce Examination held today.

External examiner.

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ABSTRACT

Rainwater is a free source of nearly pure water and rainwater harvesting refers to the collection and storage of rainwater and other activities aimed at harvesting surface and groundwater. It also includes prevention of losses through evaporation and seepage and all other hydrological and engineering interventions, aimed at conservation and efficient utilization of the limited water. In general, water harvesting is the activity of the direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater.

CHAPTER 1

INTRODUCTION

1.1 Background

Did you know that the best water on Earth isn't found in the ground? It's found in the sky, where pure, soft water is transported back to Earth's surface in the form of rain. For many people, this rain is an underused resource that soaks back into the soil or gets drained into a nearby sewer. But with more than 120,000 gallons of contaminant-free rainwater falling on the roof of every average-sized home in the Midwest and Eastern U.S. each year, many homeowners have recently begun to realize rainwater's potential as a clean, environmentally friendly water source.

1.2 What is Rainwater Harvesting?

Rainwater harvesting is the collection of rooftop rainwater for detention (for stormwater management) and/or retention for future use. You might be thinking that is too simple, but that is one of the beautiful things about rainwater harvesting, its simplicity. After the water is collected on the rooftop, it travels to your gutters and through conveyance pipes that will carry the water to your water storage tank. Before entering the tank, the water is sent through a large contaminant filter that keeps any debris, leaves or other unwanted waste from entering the water tank. This helps in maintaining clear and odourless water while in storage. The water is then pumped out of the tank, through a simple but highly effective series of filtration and ultra-violet sterilization making your water crystal clear and safe to drink! The water is then ready to use. Systems are connected directly to your household plumbing. Simply turn on the faucet, and drink the rain.

1.3 The Need for Water

Why collects rainwater? Civilizations, settlements, countries, and empires of the past had basic needs to survive just like we do in the present day. Water, food, and shelter were a continuous struggle to provide, especially in dry climates where water was scarce. But there were a solution and people of the past came up with brilliant methods of solving these issues. One idea that became a sustaining source throughout thousands of years was rainwater collection and diversion.

1.4 Origin of Rainwater Harvesting

It is nearly impossible to trace back to which civilization used the method of rainwater harvesting first, but evidence shows that different types of rainwater collection systems were used in 2000BC in India, Mesopotamia, China, and modern-day Israel. The basic design of these systems often involved a large rock formed into a basin using clay and other rocks to seal it from leaking. And then, using different diversion tactics, water would be stored and used for drinking, washing, agriculture, and more.

1.5 Middle East

The middle east has a rich history in the rainwater harvesting timeline. Dating back to 2000 B.C., people in the Negev Desert, which is modern-day Israel, survived by capturing water from the hillside and storing it in Cisterns. Back then, water availability was truly a life-or-death situation. According to Heather Kinkade-Levario in *Design for Water Rainwater Harvesting, Stormwater Catchment, and Alternate Water Reuse*, in tales of a war for the land east of Jordan, King Mesha of Moab used reservoirs to capture rain and gave his warriors the ability to survive in the dry heat. In the civilizations, rainwater harvesting cisterns were common on a home-by-home basis, based on a historical document of that time in the Middle East. These cisterns would range from 10,000 gallons to 50,000 gallons, and would often be stored underground. Community cisterns were also common. They used technologies such as sediment traps before entering the large cistern, which could hold as much as 1,000,000 gallons of water. And even larger reservoirs would hold 11,000,000 gallons of water such as one in Madaba, Jordan.

FIG 1.1: - picture showing a collection of water from slab to tanks

1.6 India

Many rainwater harvesting roots can be traced back to India. Including systems that are built on top of homes that are still used to this day. Many homes with aspects of these systems are used. Ancient India also developed technology such as large reservoirs to hold rainwater and dams to divert and capture rainwater.

1.7 Ancient Rome

The Romans excelled in many technological advancements, including rainwater harvesting and aqueducts. They would build entire cities with the infrastructure to divert rainwater into large cisterns. The Romans would use this collected water for drinking, bathing, washing, irrigation, and livestock. They were master engineers. There is a rainwater collection cistern built to capture rainwater from the streets above in the Sunken Palace, Istanbul that remains to this day, and it is so large that you can sail in it.

1.8 North America

Ancient Native Americans used the natural flow of mountain rainwater runoff to collect and use throughout villages. In central Mexico, underground cisterns have been found that were used for collecting rainwater. In the 16th-17th century, early settlers began to use rainwater for laundry due to it being naturally soft. They were the ones who started using the term “hard water” and “soft water” because of the trouble that would occur from trying to use mineral-rich water for washing laundry. Soap would react with the hard water, causing a build-up to occur, unlike when they used soft rainwater, which allowed the soap and dirt to wash off easily. Settlers and Natives would not have been able to survive in certain areas without the collection of rainwater.

CHAPTER 2
METHODS OF RWH

1. Surface Runoff Harvesting: -

In urban areas, rainwater flows away as surface runoff. This runoff can be caught and used for recharging aquifers by adopting appropriate methods.

2. Rooftop Rainwater Harvesting: -

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchment, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to an artificial recharge system. This method is less expensive and very useful and, if implemented correctly, helps in augmenting the groundwater level of the area.

Components of the Rooftop Rainwater Harvesting

The illustrative design of the essential components of the rooftop rainwater harvesting system is given in the typical schematic diagram shown in Fig 2.1. The system mainly consists of the following sub-components:

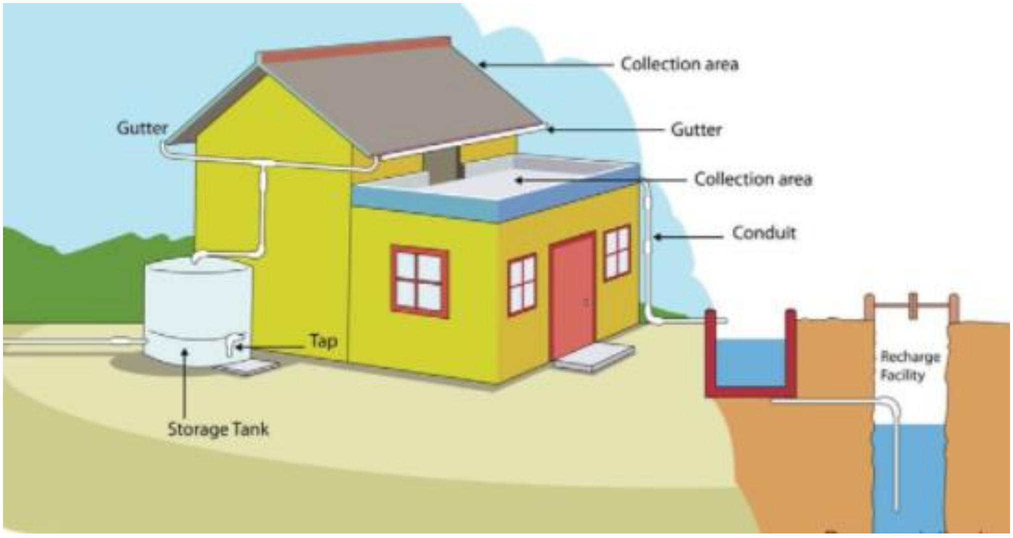


Fig 2.1: Components of Rainwater Harvesting

1. Catchment

The surface that receives rainfall directly is the catchment of the rainwater harvesting system. It may be a terrace, courtyard, or paved or unpaved open ground. The terrace may be a flat RCC/stone roof or sloping roof. Therefore, the catchment is the area, which contributes rainwater to the harvesting system.

2. Transportation

Rainwater from the rooftop should be carried down to take water pipes or drains to the storage/harvesting system. Water pipes should be UV resistant (ISI HDPE/PVC pipes) of the required capacity. Water from sloping roofs could be caught through gutters and down the pipe. At terraces, the mouth of each drain should have wire mesh to restrict floating material.

3. First Flush

The first flush is a device used to flush off the water received in the first shower. The first shower of rain needs to be flushed off to avoid contaminating storable/rechargeable water by the probable contaminants of the atmosphere and the catchment roof. It will also help in the cleaning of silt and other material deposited on the roof during dry seasons. Provisions of first rain separators should be made at the outlet of each drainpipe.

4. Filter

There is always some scepticism regarding Roof Top Rainwater Harvesting since doubts are raised that rainwater may contaminate groundwater. There is a remote possibility of this fear coming true if the proper filter mechanism is not adopted. Secondly, all care must be taken to see that underground sewer drains are not punctured, and no leakage is taking place in close vicinity. Filters are used for the treatment of water to effectively remove turbidity, color, and microorganisms. After the first flushing of rainfall, water should pass through filters. Gravel, sand, and ‘netlon’ mesh filter are designed and placed on top of the storage tank. This filter is very important in keeping the rainwater in the storage tank clean. It removes silt, dust, leaves, and other organic matter from entering the storage tank. The filter media should be cleaned daily after every rainfall event. Clogged filters prevent rainwater from easily entering the storage tank and the filter may overflow. The sand or gravel media should be taken out and washed before it is replaced in the filter. A typical photograph of the filter is shown in Fig 2.2

Fig 2.2: Photograph of Typical Filter in Rainwater Harvesting.

There are different types of filters in practice, but the basic function is to purify water. Different types of filters are described in the following section:

1. Sand Gravel Filter

These are commonly used filters, constructed by brick masonry and filleted by pebbles, gravel, and sand. Each layer should be separated by wire mesh.

2. Charcoal Filter

Charcoal filters can be made in-situ or in a drum. Pebbles, gravel, sand, and charcoal as shown in the figure should fill the drum or chamber. Each layer should be separated by wire mesh. The thin layer of charcoal is used to absorb odors if any.

3. PVC –Pipe filter

This filter can be made by PVC pipe of 1 to 1.20 m in length; the Diameter of the pipe depends on the area of the roof. Six inches dia. pipe is enough for 1500 Sq. Ft. roof and 8 inches dia. pipe should be used for roofs more than 1500 sq. Ft. Pipe is divided into three compartments by wire mesh. Each component should be filled with gravel and sand alternatively as shown in the figure. A layer of charcoal could also be inserted between two layers. Both ends of the filter should have a reduction of the required size to connect the inlet and outlet. This filter could be placed horizontally or vertically in the system. A schematic pipe filter is shown in Fig 2.3.

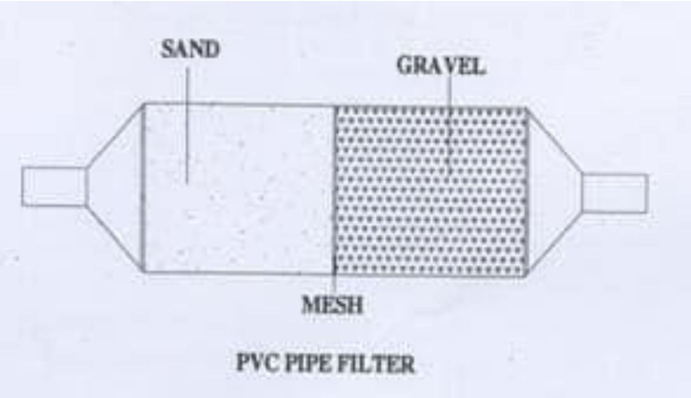


Fig 2.3: PVC-Pipe filter

4. Sponge Filter

It is a simple filter made from a PVC drum having a layer of sponge in the middle of the drum. It is the easiest and cheapest form filter, suitable for residential units. A typical figure of a sponge filter is shown in Fig 2.4.

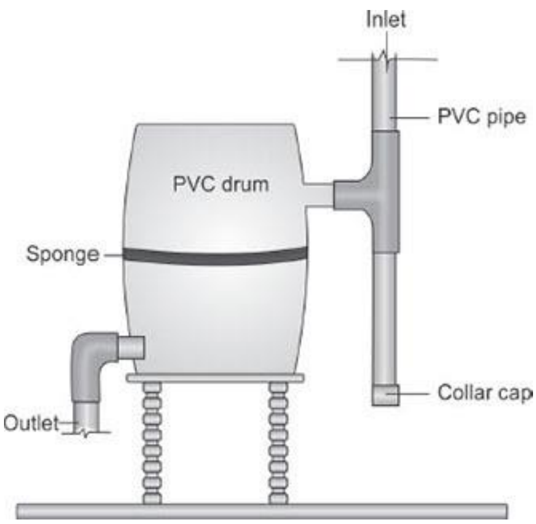


Fig 2.4: Sponge Filter

Various methods of using rooftop rainwater harvesting are illustrated in this section.

1. Storage of Direct Use

In this method, rainwater collected from the roof of the building is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall, and catchment availability. Each drainpipe should have a mesh filter at the mouth and first flush device followed by a filtration system before connecting to the storage tank. Each tank should have an excess water overflow system. Excess water could be diverted to the recharge system. Water from storage tanks can be used for secondary purposes such as washing and gardening etc. This is the most cost-effective way of rainwater harvesting.

The main advantage of collecting and using rainwater during the rainy season is not only to save water from conventional sources but also to save energy incurred on transportation and distribution of water at the doorstep. This also conserves groundwater, if it is being extracted to meet the demand when rains are on. Fig 2.5 shows a typical fig of a storage tank.

Fig 2.5: A storage tank on a platform painted whit

2. Recharging Groundwater Aquifers

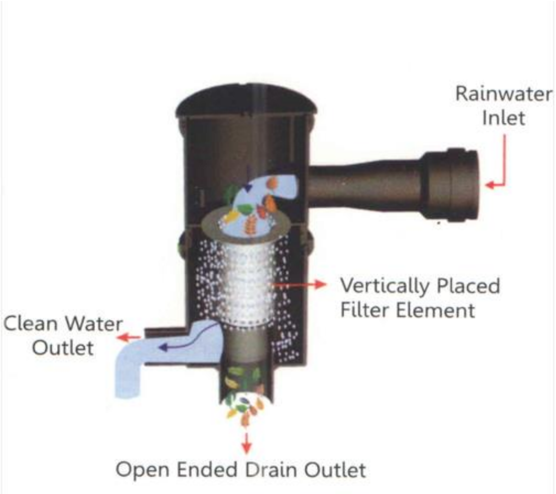
Groundwater aquifers can be recharged by various kinds of structures to ensure the percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are: -

- Recharging of bore wells
- Recharging of dug wells.
- Recharge pits
- Recharge Trenches
- Soakaways or Recharge Shafts
- Percolation Tanks

3. Recharging of Bore Wells

Rainwater collected from the rooftop of the building is diverted through drain pipes to the settlement or filtration tank. After settlement, filtered water is diverted to bore wells to recharge deep aquifers. Abandoned boreholes can also be used for recharge. The optimum capacity of the settlement tank/filtration tank can be designed based on the area of catchment, the intensity of rainfall, and the recharge rate. While recharging, the entry of floating matter and silt should be restricted because it may clog the recharge structure.

The first one or two showers should be flushed out through a rain separator to avoid contamination. Fig. 2.6 indicates a schematic diagram of a filtration tank recharging to the bore well.



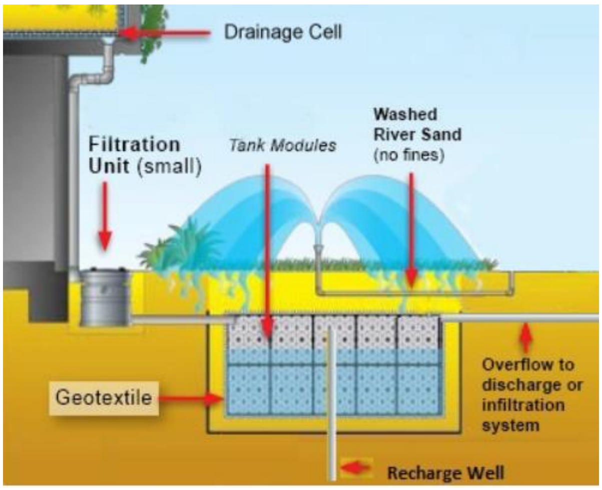


Fig2.6: Filtration Tank Recharging to Bore Well

4. Recharge Pits

Recharge pits are small pits of any shape rectangular, square, or circular contracted with a brick or stone masonry wall with a weep hole at regular intervals. The top of the pit can be covered with perforated covers. The bottom of the pit should be filled with filter media.

The capacity of the pit can be designed based on the catchment area, rainfall intensity, and recharge rate of the soil. Usually, the dimensions of the pit maybe 1 to 2 m in width and 2 to 3 m deep, depending on the depth of previous strata. These pits are suitable for recharging shallow aquifers, and small houses. A schematic diagram of the recharge pit is shown in Fig 2.7.

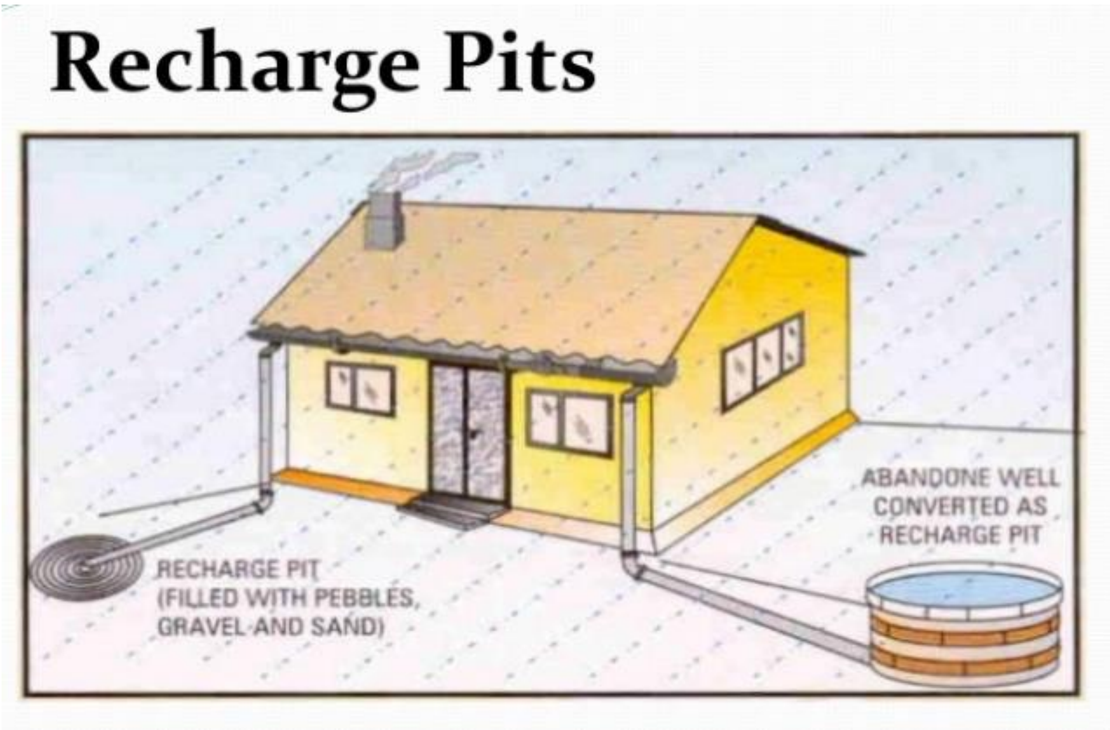


Fig 2.7 recharge pits connection from home.

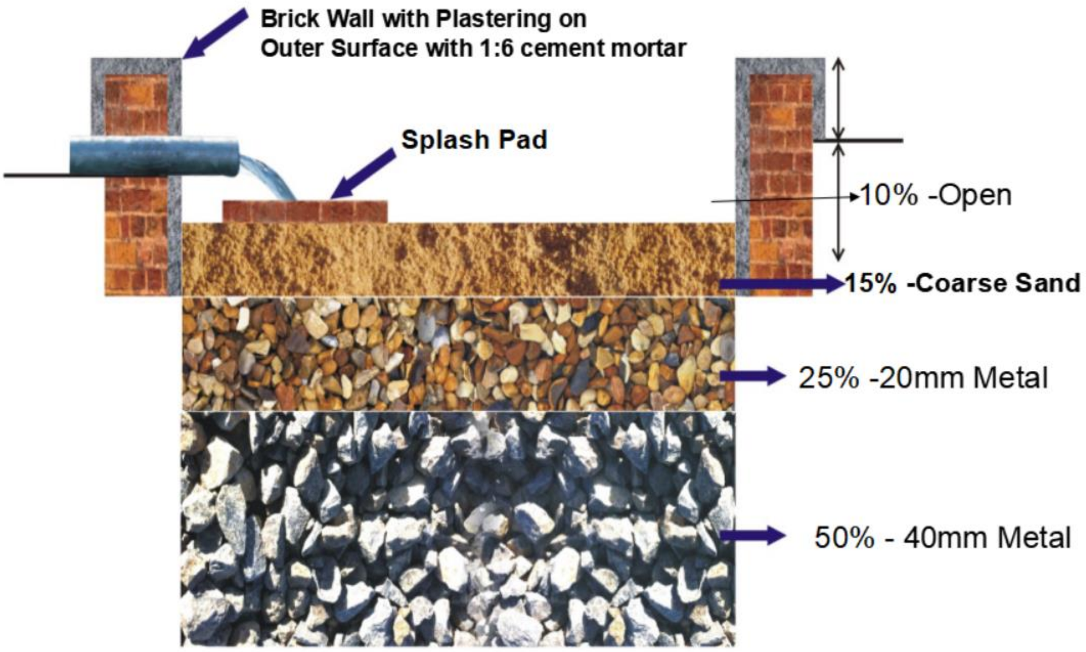


Fig 2.8: Recharge pit

Fig 2.9: Building a recharge pit for real.

step1: Digging of the pit to a depth of a minimum of 2.0m (Dimensions are variable, site-specific).

step2: Fill with 40 mm metal (50%).

Step 3: Fill with 20mm metal (25%) and construct a brick wall.

Step 4: Fill with coarse sand (10%) and construction and plastering of brick wall with an opening.

5. Soakaway or Recharge Shafts

Soak away, or recharge shafts are provided where the upper layer of soil is alluvial or less porous. These are the boring holes of 30 cm dia. up to 10 to 15 m deep, depending on the depth of the previous layer. The bore should be lined with slotted/perforated PVC/MS pipe to prevent the collapse of the vertical sides.

At the top of the soakaway, the required size sump is constructed to retain runoff before the filters through the soakaway. The sump should be filled with filter media. A schematic diagram of the recharge shaft is shown in Fig2. 8.

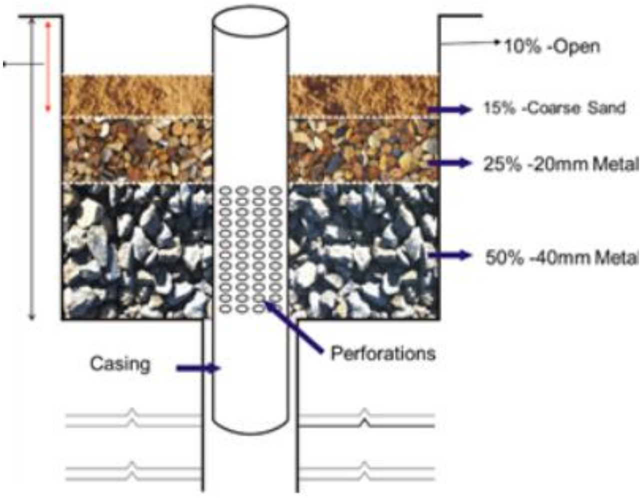


Fig 2.10: Schematic Diagram of Recharge shaft

Fig 2.11: Building a recharge shaft for real.

Step 1: Drilling of bore well to a depth of 60m (200') Lowering of Casing (6 to 10m based on collapsing) Digging of pit to a depth of minimum 2.0m around the drilled bore well (Dimensions are variable).

Step 2: Drilling of 10 to 12mm holes to PVC Casing (up to 1.0m from the bottom of the pit) Fixing of rabbit wire mesh (SS) around casing at holes portion) Filling of a pit with metal as per specification (50% of the depth with 40mm and 25% with 20mm metal).

Step 3: Construct a brick wall and link it with rooftop pipes into the pit.

Step 4: Filling the coarse sand of 15% and the rest 10% is vacant (as per sketch) Close it with perforated removable slabs.

6. Recharging of Dug Wells

Dug wells can be used as a recharge structure. Rainwater from the rooftop is diverted to drilled wells after passing it through the filtration bed. Cleaning and desalting of dug wells should be done regularly to enhance the recharge rate. The filtration method suggested for bore well recharging could be used. Fig 2.9 shows a schematic diagram of recharging into a well.

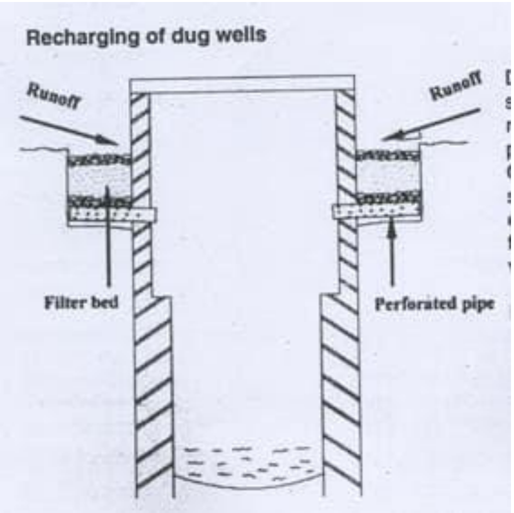


Fig 2.12: Schematic Diagram of Recharging to Dug Well

Fig 2.13: Recharge well

7. Recharge Trenches

The recharge trench is provided where the upper impervious layer of soil is shallow. The recharge trench was excavated on the ground and refilled with porous media like pebbles, boulders, or brickbats. It is usually made for harvesting the surface runoff.

Bore-wells can also be provided inside the trench as recharge shafts to enhance percolation. The length of the trench is decided as per the amount of runoff expected.

This method is suitable for small houses, playgrounds, parks, and roadside drains. The recharge trench can be of size 0.50 to 1.0 m wide and 1.0 to 1.5 m deep. Fig. 10 presents a schematic diagram of recharging to trenches.

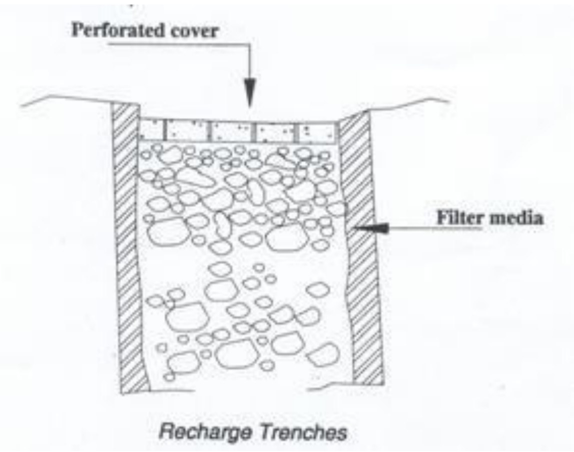


Fig 2.14: Recharging to Trenches

8. Percolation Tank

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the groundwater. These can be built on big campuses where land is available, and topography is suitable. Surface runoff and rooftop water can be diverted to this tank. Water accumulating in the tank percolates in the solid to augment the groundwater. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces, and roadside greenbelts of urban areas.

CHAPTER 3
RWH FOR HOUSES AND APARTMENTS

3.1 For Houses:

Harvested rainwater can provide a source of alternative water to federal facilities. Alternative waters are sustainable sources of water, not supplied from fresh surface water or groundwater, that offset the demand for freshwater. Rainwater harvesting captures, diverts, and stores rainwater from rooftops for later use.

These are the Rooftop method calculations for my home.

The Design and Construction Indicators:

(i) Water Demand Determination: Daily water quantity needed in a house of 4 people.

3.1: Water Demand determination for Houses:

S. No	**Use**	**Input(litres)**	**Output (litres)**
01.	Washing clothes	60-70	40-50
02.	Cleaning utensils	30	30
03.	Cooking	15	15
04.	Drinking	20	10
05.	Bathing	60	60
06.	Sanitation and washroom	80	50
Total:		265	205

(ii) Runoff Coefficient

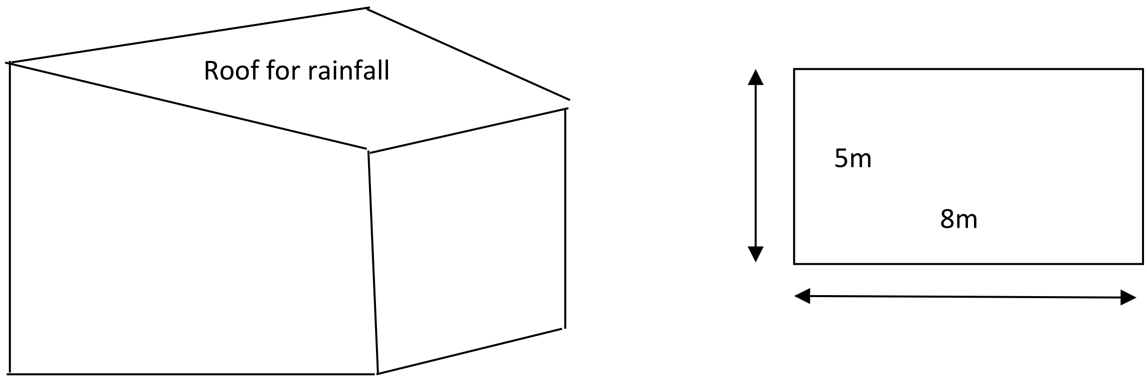
A runoff coefficient of 0.8 was adopted to account for losses due to spillage, leakages, infiltration, roof surface wetting, and evaporation which would reduce the amount of rainwater that entered the storage tanks.

(iii) Roof Catchment Area

The approximate size of the existing roof catchment area is 40 m^2 (5 m x 8 m) as measured in the house plan.

(iv) Potential Rainwater Supply from the Roof Catchment

An estimate of the mean annual runoff from the roof area was obtained using the following equations:



S = *R.A. C* Where: S = Mean Rainwater (m^3);

R= Mean Annual Rainfall (m/year);

A = Roof Catchment Area(m2);

C = Runoff Coefficient Supply;

S = Rainfall x Area x Coefficient (runoff) Mean annual rainfall,

R for yearly = 990 mm/year = 0.99m/yr.

Area, A = 40m^2

Coefficient, C = 0.8. Hence,

Supply, S = 0.990 x 40x 0.8 = 31.68 m^3/year = 31680 litres/year= 86 litre/day.

NOTE: R is taken on an annual basis to calculate the average supply for a day in a year, but due to heavy rains sometimes you may have a chance to fill the whole 3 thousand litre tank in a day. We can't predict the rainfall.

(v) Water Demand

Since the catchment area is fixed and the amount of rainfall cannot be changed, the only variable that can be used to influence the available rainwater supply is the volume of the storage tank. The total household water demand is estimated at 265 litres/day.

(vi) Water Supply

Assuming a four-month (120days) dry period for storage (June to September), storage requirements are 86 x120 = 10320 litres.

(vii) Gutters and Downspouts

A gauge seven (7) aluminium sheet (section 150mm x 150mm) gutter was used; the largest roof catchment section area being 35m^2. The gutters were hung firmly in position with metal hangers fixed to the fascia board.

(viii) Roof washers

Roof washing is of particular importance since the first flush picks up most of the dirt, debris, and contaminants that have collected on the roof and in the gutters during the dry season. The downspout was extended down with a Tee joint to serve as a Roof-washer. Below the Tee was a valve that could be opened or closed to flush out the dirt without getting into the cistern.

(ix) Storage Tanks

The storage tanks used for the projects were 3,000 litres capacity and 2,000 litres-capacity plastic tanks. The tanks were placed about half a meter above the ground. A tight-fitting cover was provided for each tank to prevent evaporation, mosquito breeding and to keep insects, birds, lizards from entering the tanks. There were two outlets in the tanks; one outlet was connected to the pipe network and finally to the pump, while the other fitted with a tap.

(x) Water Conveyance

Water from the storage tanks could not flow by gravity to the house where it would be used. Then, a small 0.5 horsepower electric pump can be fitted to convey water from the storage tanks to the 1200 litre-elevated tank placed on the roof.

Fig3.1 example for pipe connection to tank and gutter in the right on the roof

3.2 For apartments:

Rainwater harvesting becomes an increasingly important method for water conservation in apartments. Preserved water through rainwater harvesting method can be used at the time of drought.

The Design and Construction Indicators:

(i) Water Demand Determination
Daily water quantity needed for a student in RGUKT-NUZVID for a day.

3.2: Water Demand determination for Apartments

S. No	Use	Input(litres)	Output (litres)
01.	Washing clothes	40-50	40-45
04.	Drinking	10	5
05.	Bathing	20-30	20-30
06.	Sanitation and washroom	10	10
Total:		100	90

And in the hostel, there will be approximately 1600 students will be staying in I1 hostel of RGUKT-NUZVID.
And the requirement is 160000 litres of water.

(ii) Runoff Coefficient

A runoff coefficient of 0.8 was adopted to account for losses due to spillage, leakages, infiltration, roof surface wetting, and evaporation which would reduce the amount of rainwater that entered the storage tanks.

(iii) Roof Catchment Area

The approximate size of the existing roof catchment area is 30m^2 (5 m x 6 m) as measured for one room in I1 hostel plan.

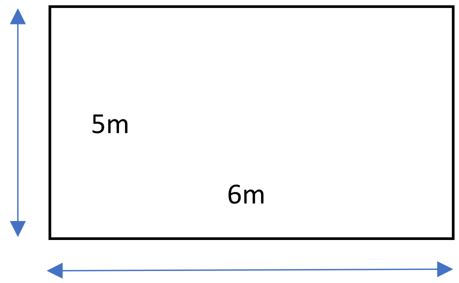
The total catchment area was =104(30)

=3120 m^2

Because there are 104 rooms below the roof top in our hostel.

(iv) Potential Rainwater Supply from the Roof Catchment

An estimate of the mean annual runoff from the roof area was obtained using the following equations:



S = *R.A. C* Where: S = Mean Rainwater (m^3);

R= Mean Annual Rainfall (m/year);

A = Roof Catchment Area(m2);

C = Runoff Coefficient Supply;

S = Rainfall x Area x Coefficient (runoff) Mean annual rainfall,

R for yearly = 784 mm/year = 0.784m/yr.

Area, A = 3120m^2

Coefficient, C = 0.8. Hence,

Supply, S = 0.784 x 3120 x 0.8 = 1956.864 m^3/year = 1956864 litres/year= 5361 litre/day

NOTE: R is taken on an annual basis to calculate the average supply for a day in a year, but due to heavy rains sometimes you may have a chance to fill the whole 7 thousand litter tank in a day. We can’t predict the rainfall.

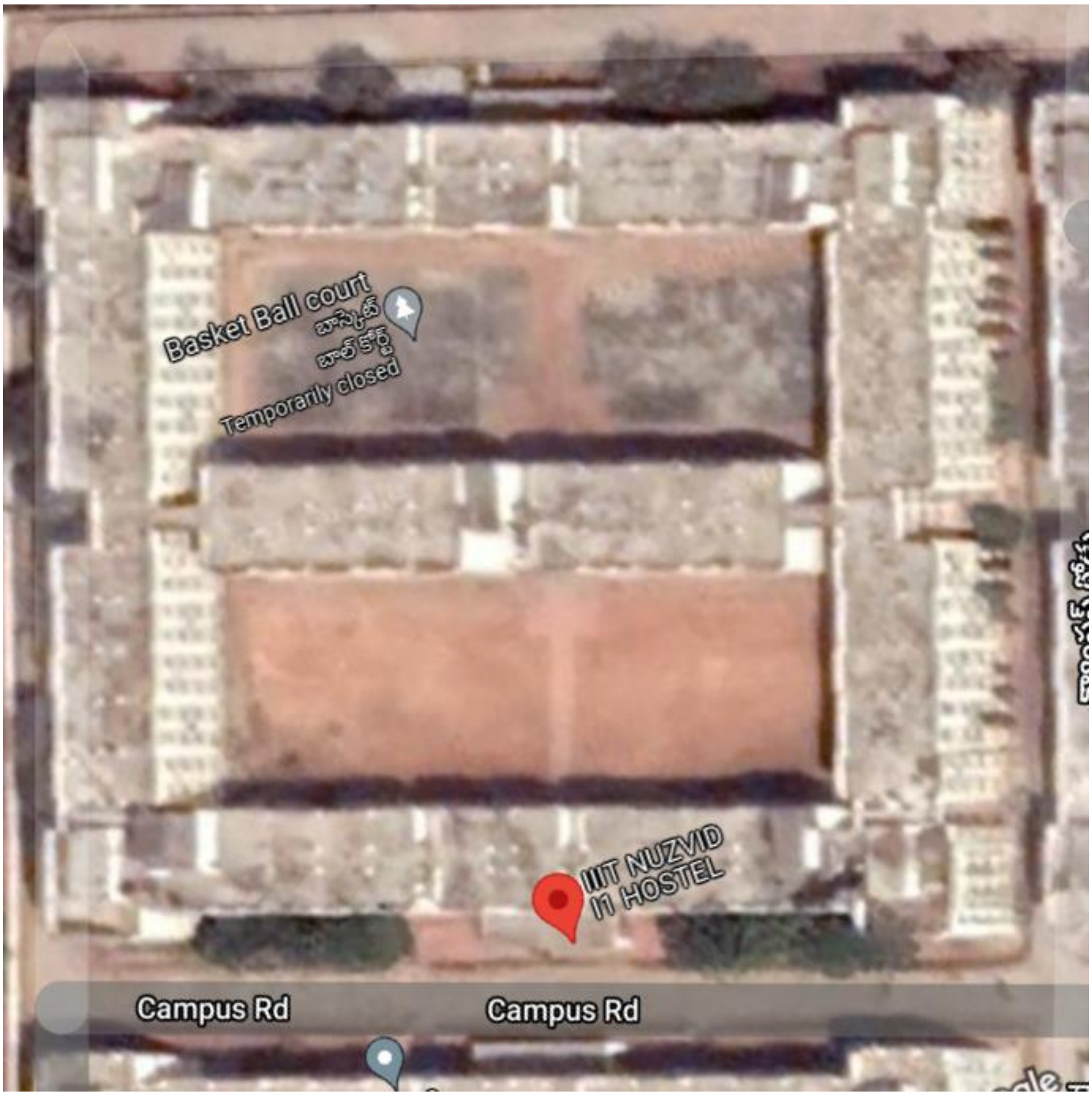


Fig 3.2 campus I1 hostel view form google maps

(v) Water Demand

Since the catchment area is fixed and the amount of rainfall cannot be changed, the only variable that can be used to influence the available rainwater supply is the volume of the storage tank. The total water demand is estimated at 160000 litres/day.

(vi) Water Supply

Assuming a four-month (120days) dry period for storage (June to September), storage requirements are 5361 x120 = 643352 litres.

(vii) Gutters and Downspouts

A gauge seven (7) aluminium sheet (section 150mm x 150mm) gutter was used; the largest roof catchment section area being 3120m^2. The gutters were hung firmly in position with metal hangers fixed to the fascia board.

(viii) Roof washers

Roof washing is of particular importance since the first flush picks up most of the dirt, debris, and contaminants that have collected on the roof and in the gutters during the dry season. The downspout was extended down with a Tee joint to serve as a Roof-washer. Below the Tee was a valve that could be opened or closed to flush out the dirt without getting into the cistern.

(ix) Storage Tanks

The storage tanks used for the projects were must be cement tanks above 2 lakh litres capacity and. The tanks have to be constructed in the underground. A tight-fitting cover was provided for each tank to prevent evaporation, mosquito breeding and to keep insects, birds, lizards from entering the tanks. There were two outlets in the tanks; one outlet was connected to the pipe network and finally to the pump, while the other fitted with a tap.

(x) Water Conveyance

Water from the storage tanks could not flow by gravity to where it would be used. Then, a small 2 horsepower electric pump can be fitted to convey water from the storage tanks to the 6000 litre-elevated tank placed on the roof on 4 corners of the hostel.

CHAPTER 4
RESULTS AND DISCISSIONS

4.1: For Houses

From the calculations according to our water demand, and final water quantity I obtained using the rooftop method, we can place a rainwater system at our place just for limited purposes, also we can store rainwater using the rooftop method even though it is not reaching our limit. Normally to store large quantities of water, surface area and storage must be in big numbers so we can capture and store more rainwater and can be used for our day-to-day activities.

4.1: For Apartments

Rainwater Harvesting should be seen as a viable and reliable water supply option in Nuzvid with abundant rainfall potentials.

Government should recognize and adopt rainwater harvesting technology in our collage by undertaken initiative that will facilitate its use as it is commonly done in some other developing countries, we have I1, I2, I3, K1, K2, K3, K4, A2, A3, A4, if we can install rain water harvesting methods we can have abundant source of water in our collage.

CHAPTER 5
CONCLUSION

Advantages of implementing rain-water harvesting:

Reduced Water Bills:

Rainwater harvesting systems are cost-effective, provide high-quality water, lessens dependence on wells and are considerably easy to maintain since they are not utilized for drinking, cooking or other sensitive uses. The all-around expenditures used in setting up harvesting methods are much cheaper compared to other purifying or pumping means. The cost of recharge to the subsurface reservoir is also lower than the surface reservoirs.

Ecological benefit:

Storing water underground is environment-friendly. The ecological benefits of rainwater harvesting are immense. It minimizes the impacts of flooding by funnelling the off water into large tanks for recycling and helps reduce the load placed upon drainage systems. No land is wasted for storage purpose and no population displacement is implicated therefore, groundwater is not directly exposed to evaporation and pollution. Additionally, it helps minimize the possibility of rivers drying up.

Reduces erosion and flooding around buildings:

It reduces soil erosion and flood hazards by collecting rainwater and reducing the flow of stormwater to prevent urban flooding. Most buildings that utilize rainwater harvesting systems have a built-in catchment area on top of the roof, which has a capacity of collecting large volumes of water in case of rainstorms.

An adequate means for Irrigation purpose:

Harvesting rainwater allows the collection of large amounts of water and mitigates the effects of drought. Most rooftops provide the necessary platform for collecting water. Rainwater is mostly free from harmful chemicals, which makes it suitable for irrigation purposes.

Reduces demand on Ground Water:

Another vital benefit is that it increases the productivity of aquifer resulting in the rise of groundwater levels and reduces the need for potable water. It is extremely essential, particularly in areas with low water levels.

Disadvantages of Rainwater Harvesting

1. Unpredictable Rainfall:

Rainfall is hard to predict, and sometimes little, or no rainfall can limit the supply of rainwater. It is not advisable to depend on rainwater alone for all your water needs in areas where there is limited rainfall. Rainwater harvesting is suitable in those areas that receive plenty of rainfall. If rain is unpredictable, the use of a rainwater harvesting system can be critical to capturing the rain when it does fall.

2. Regular Maintenance:

Rainwater harvesting systems require regular maintenance as they may get prone to rodents, mosquitoes, algae growth, insects and lizards. They_can_become breeding grounds for many animals if they are not properly maintained.

3. Roof Types:

Certain types of roofs may seep chemicals, insects, dirt or animals droppings that can harm plants if it is used for watering the plants.

4. Storage Limits:

The collection and storage facilities may also impose some kind of restrictions as to how much rainwater you can use. During the heavy downpour, the collection systems may not be able to hold all rainwater, which ends in going to drains and rivers

Do's

1. The roof should be kept clean before rains.
2. Suitable filtration methods have to be adopted to filter rainwater.
3. Filters have to be regularly maintained /cleaned.
4. All plumbing works have to be done properly using appropriate materials.
5. Suitable clamps for all pipes and gutters have to be fixed at a maximum interval of 1m.
6. Storage devices like sumps/tanks/vessels need to be cleaned before storing filtered rainwater.
7. Rainwater storage devices must have proper manhole covers, which should not permit sunlight into the tank.
8. Paint the surfaces (inside and outside) of masonry tank/sump with lime every year.
9. Provide good quality, leak proof taps that are convenient for use.
10. Check the quality of stored rainwater for bacterial contamination every year if used for drinking.
11. The first flow of rainwater that contains contaminants from the roof must be allowed to drain out (first flush).
12. Sand bed filters need to be installed with properly cleaned riverbed sand and aggregates. The sand, aggregates and plastic mesh of the filter have to be washed, sun dried and refilled every month.
13. Rainwater is pure and can be used for drinking, cooking and all other purposes, as it is free from fluoride, arsenic, bacteria, etc., However, contaminants may get added over the collection surface like roof / open space.
14. Wherever possible ground water recharge methods have to be adopted for rooftop rainwater or overflow of rainwater from tanks/sumps.
15. The sand and aggregates used in infiltration gallery should be cleaned, washed and sun dried before placing them in the infiltration gallery.
16. The open wells have to be desilted and cleaned before being used for ground water recharge.

DONT'S

1. Rooftop rainwater or surface runoff should not be directly consumed without filtration and proper disinfection.
2. The tanks/sumps used for storing rainwater should not have any opening that permits sunlight inside. Entry of sunlight into the sump/tank encourages bacterial and algal growth.
3. Collection of water by vessels/buckets from tanks/sumps through manholes has to be avoided and taps/pumps/hand pumps must be used.
4. Rainwater from the roof or open spaces must not be directly allowed to flow into the bore well casing pipe. Preferably an infiltration gallery method must be adopted for ground water recharge.

CHAPTER 6
FUTURE SCOPE

The fact that we use too much water has not escaped the government's official bodies in recent years. With the growth in population and changes in our climate, we all need to be more responsible when it comes to how much water we use. Rainwater harvesting is now being reinvented for many new builds with the robust guidelines for sustainable housing.

At the present time, we all find it easy to switch on the tap and use what seems to arrive in our homes and businesses as if by magic. The future may well see a more sustainable and efficient way of collecting rainwater and combining it with the mains supply to help reduce our overall usage. Other developments that may ease the pressure on our heavily populated urban areas are projects such as permeable pavements that can be used to collect water for washing cars and watering the garden.

CHAPTER 7
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