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Design Proposal for Rainwater Collection and Distribution System for Multi-Storey Apartment Building

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***Abstract*— Despite the fact that rainwater harvesting isn't a new concept, it isn't being implemented on a large scale as it should be. It is the most conventional and sustainable way, and may be utilized in both residential and commercial structures for potable and non-potable applications. Water scarcity is a serious issue in a densely populated country like India, thus water resources must be carefully managed. It is the process of collecting and storing rainwater. Groundwater is being used all across the world to meet these growing water demands. To increase the proficiency of these systems, various water collection techniques and tactics have been developed and updated on a regular basis. Groundwater is being used at a faster pace than it is regularly replenished.**

This research aims to study and propose the design of collection and distribution system of rainwater harvesting for a multi-storey apartment building in India. It is organized to compare the cases of three different states w.r.t to the rainwater harvesting collection and distribution systems.

Keywords*— *Rainwater Harvesting, Rainfall, Rooftop, Runoff

I. INTRODUCTION

1.1 Aim

To propose a design scheme of RWH system for collecting and distributing rainwater in a multi-storey apartment building.

1.2 Objectives

- To design plumbing scheme for rainwater collection and distribution system.
- To aid towards the greater objective of water management and conservation and to increase recharge of ground water by capturing and storing rainwater.
- To identify the best systems for maintenance to avoid fouling and clogging.
- To estimate the preliminary cost for proposed RWH plumbing scheme.

1.3 Rationale

Today there is a rapid increase in interest in RWH for water supply, for meeting basic human needs. As an option for development of water resource, RWH presents a number of advantages. It does not require vast quantities of resources. RWH may be the only way to increase availability of water where ground water is depleted and surface water is polluted with unhygienic practices(Mohammad et al., 2017). Most researchers have not explored that RWH collection and distribution systems can be very efficient and cost-effective systems. They can be very important in preventing any calamity and this is by means of artificial groundwater recharge of depleted groundwater aquifers.

1.4 Methodology

1. Formulate the scope of the study and adopt a focused approach.
2. A review of published literature on the subject.
3. Collection of data on rainfall from the Meteorological Department and CPWD manual (Paratkar & Nagarnaik, 2020)
4. Review of the available books and data in the form of primary sources like books, articles and research papers (Rahman, 2010)
5. Drafting of the conceptual framework on the basis of the understanding of the available literature data (Keskar et al., 2016)
6. Designing of the proposed scheme which would be derived from the conceptual and theoretical approach
7. Organizing and validation of the gathered data and check it that whether it is suitable for our research.
8. Recommendations for routing and submission of the thesis proposal.

1.5 Scope & Limitations

- The proposal would be a comprehensive study containing the benefits, features and techniques available in the markets.
- A cost-efficient proposal for an apartment would be given, which will comprise of the data, water demand in LPCD, compensation by rainwater and its benefits.
- Type and selection of the system for efficient and long-lasting plumbing design.
- Expected rise in Groundwater table will be studied.
- The study will be limited to collection and distribution system and to approximate ground water table recharge prediction.
- Within the limitation, treatment system would be limited.
- Proposed scheme will be limited to the schematic design within architectural approach.
- Engineering and other technical details would be limited.

1.6 Expected Outcomes Of The Study

- To help users provide knowledge on how adoption of RWH will lead to drastic reduction in water-shortage and is a viable and a reliable water supply option.
- This will provide knowledge to the users about the benefits of using free rainwater to augment the recharge of ground water.
- Innovation of the research will lie in incorporating the design of RWH systems into an existing multistorey apartment building.
- The findings of this study will illustrate how the design intervention can be cost-effective.

II. LITERATURE STUDY

2.1 Rainfall

It is an environmental phenomenon. It is viewed as the basic source of water tumbling on the Earth's surface for sustaining life. Precipitation is described by its amount, intensity, and distribution over the long run (Haq, n.d.).

2.2 Amount of Rainfall

The measure of rainfall is dictated by adding the entirety of the rainfall occasions that happened during a 24-hour day. A precipitation of 1 mm creates 0.001 m3 or 1 L of water on 1 m2 of a surface. In a day when the precipitation is discovered to be >1 mm, the day is considered a "rainy day"(Rahman et al., 2014).

2.3 Rainfall Intensity

The intensity of rain is calculated by estimating the stature of the water layer aggregated over a surface in a time frame(Keskar et al., 2016). It is communicated in millimetres per hour (mm/h). Based on a specific scope of precipitation intensity, rain is named underneath:

1. Precipitation <2.5 mm/h is named "light rain".

2. Precipitation somewhere in the range of 2.5 and 7.5 mm/h is named "moderate rain".

3. Precipitation 7.6 mm/h and 50 mm is named "hefty rain".

4. Precipitation >50 mm precipitation is named "violent rainfall".

2.4 Annual Rainfall

In a time-frame of a year, absolute estimated precipitation is the yearly or occasional precipitation, which is by and large utilized for expressing the precipitation situation of a country (Rahman et al., 2014)

2.5 Rainfall Distribution

Precipitation doesn't happen consistently all through 60 minutes, the day, the month, or the year. It might fall in isolated examples for a few minutes in 60, a few hours in a day, several days in a month or year. The span of holes between the downpour time frames is critical to know, especially for water collecting. Uniformly conveyed precipitation is superior to inadequately circulated precipitation over time for water stockpiling.

2.6 Rainfall Measurements

The aggregate sum of precipitation during a specific period is estimated as the depth of water covering a region with no overflow, invasion, and vanishing. (Keskar et al., 2016) .The profundity of water is for the most part estimated and communicated in millimetres. Precipitation is dictated by estimating its volume by an instrument called a "rain gauge" (Haq, n.d.)

2.7 Functional Techniques for Groundwater Recharge

Recharging groundwater with rainwater, various functional techniques are involved as follows:

- Collecting rainwater from suitable catchments
- Conveying rainwater to the recharge structure
- Qualifying rainwater according to the method of recharging adopted
- Draining of excess rain water

Technology must be appropriately promulgated to participate in all components of rainwater collection in the buildings mentioned here. It should be noted that among all the components, the use of some components is essential, and the rest are optional.

2.7.1 Direct-Use System

In this methodology, rain is collected directly from the catchments and sub-sequently used. First, rain flushing may be utilized or could also be avoided depending on the aim of the rain use. this can be the best and most basic sort of rain harvesting. during this system, solely a geographic area and storage tank are needed. A screen is provided on the rain recess or gutters. The structure should be unbroken clean, and also the tank must be maintained regularly.

3.7.2 Non-filtered System

In this strategy, sedimentation is worked with in the capacity tank by incorporating the essential components in the capacity tank for the appropriate settling of sus-pended particles present in the water. In this framework, no additional settling tank is fused; rather, the capacity tank is planned so as to assume double part of settling and capacity.

3.7.3 Filtered System

In this strategy, a filtration framework is utilized, which is introduced after the sedimentation tank. Here an additional tank is expected to gather the separated water from where the water is provided to different areas in the structures where the water is required.

3.7.4 Complete System

In this technique, all moulding frameworks of water gathering are incorporated. In this framework, sanitization is joined. This total framework ought to be produced for burning-through water as consumable water.

III. STANDARDS, GUIDELINES AND REPORTS

3.1 Indian standard IS 1172: Code of basic requirements for water supply, drainage and sanitation(IS:1172, 1998)**.**

This standard lays down basic requirements for water supply, drainage and sanitation for residential type of buildings in urban areas.

<u>Water Supply for Residences:</u>

A minimum of 70 to 100 litres per head per day may be considered adequate for domestic needs of urban communities, apart from non-domestic needs as flushing

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requirements. As a general rule the following rates per capita per day may be considered minimum for domestic and non-domestic needs:

- For communities with population up to 20,000 and without flushing system.
- water supply through 40 Lphd (Min) standpost.
- water supply through 70 to 100 Lphd house service connection
- For communities with population 20 000 to 100 to 150 Lphd 100,000 together with full flushing system.
- For communities with population above 100 000 150 to 200 Lphd together with full flushing system.

** The value of water supply given as 150 to 200 litres per head per day may be reduced to 135 litres per head per day for; houses for Lower Income Groups (LIG) and Economically Weaker Section of Society (EWS), depending upon prevailing conditions. ** (IS:1172, 1998).

3.2 Indian standard IS 1579:2008, Rooftop Rainwater Harvesting -- Guidelines

This standard lays down guidelines for roof top rainwater harvesting.

Site Assessment:
Assessing the site conditions is the first step towards a sound system design. The five main site conditions to be assessed are:

- Availability of suitable roof catchment,
- Foundation characteristics of soil near the house,
- Location of trees,
- Estimated runoff to be captured per unit area of the roof, and
- Availability and location of construction material (IS 15797:2008, 2008).

Estimating the Size of the Required System: The size of the catchment area and tank should be enough to supply sufficient water for the users during the dry period. Assuming a full tank at the beginning of the dry season (and knowing the average length of the dry season and the average water use).

The volume of the tank can be calculated by the following formula:

V= t* x *n* x *q(IS 15797:2008, 2008)**.**
where,
V = volume of tank, in litres;
t = length of the dry season (days);
n = number of people using the tank; and
q = consumption in litres per capita per day (IS 15797:2008, 2008).

Water Harvesting Potential is calculated by the Formulae: ***Water harvesting potential in litres = Area of the roof top in x annual rainfall x runoff coefficient for materials x coefficient for evaporation, spillage and first flush*** (IS 15797:2008, 2008).

3.3 Rainwater Harvesting and Conservation Manual 2019, CPWD

This manual provides data techniques and case studies regarding rain water conservation. The basic purpose of this manual is to recharge ground water and to restore supplies from aquifers, depleted due to excessive ground water usage(Manual, n.d.).

The following are the two major strategies described in this manual:

• Rainwater storage on the surface for future use; and

• Groundwater recharge.

Rainwater harvesting from roofs consisting of collecting, storing and putting to use rooftop rainwater from houses or any construction is rooftop rainwater harvesting.

Rainwater harvesting can also be collecting, filtering and recharging groundwater through percolation pits, open wells or bore wells.
Structures of Rain Water Harvesting as mentioned by CPWD for ground water recharge.
• Pits, Trenches, Dug wells,
• Hand pumps, Recharge wells, Recharge shafts,
• Lateral shafts with bore wells,
• Spreading techniques(Manual, n.d.)

3.4 Indian standard IS 1742-1993, Code of practice for Building Drainage

This manual provides data for storm water drainage, Rain water pipes for drainage of roofs, construction relating to conveyance of rain or storm water

3.4.1 Storm Water Drainage

The object of the storm water drainage is to collect and carry, for suitable disposal, the rain water collected within the premises of the building.
1. *Water Precipitation and Runoff*--. Rainfall statistics for the areas under consideration shall be studied to arrive at a suitable figure on the basis of which the storm water drains could be designed. Consideration shall be given to the effects of special local conditions and to the intensity and duration of rainfall(IS: 1742 Drainage requirement, 1983)
2. *Permeability of Surface* - The Impermeability factor, that is, the proportion of the total rainfall discharging to a surface water drain after allowing for soakage, evaporation and other losses, varies with the frequency and duration of rainfall. These factors shall be taken into account in design(IS: 1742 Drainage requirement, 1983)

3.4.2 Construction Related to Conveyance of Rain or Storm Water

<u>1. Roof Gutters</u>
Roof gutters, shall be of galvanized iron sheets not less than l-25 mm in thickness and shall conform to IS:277-1977*. The gutter shall be semi-circular in section with a width at top about twice the diameter of the down pipe. The gutters shall be forced 25 mm below the edge of the roof(IS: 1742 Drainage requirement, 1983).
MS brackets 25 x 6 mm shall be used to support the gutter at about 1.2 m intervals. A convenient method will be to fix the brackets to every alternate after with three 50 mm screws(IS: 1742 Drainage requirement, 1983).

All junctions and joints shall be thoroughly water-tight-riveted, bolted or soldered. All joints between successive lengths of gutters shall have an overlap of at least 50 mm.

2. Rain-Water Pipes

A. Cast Iron Pipes -The shoe may be fixed 150 mm above ground level. Bends and offsets are to be avoided as far as possible(IS: 1742 Drainage requirement, 1983).

B. Galvanized Iron Pipes -Galvanized iron pipes shall conform to IS: 1239 (Part I)-1979. The work will be similar to cast iron pipes except that they are fixed with straps or dogs one for each 2mlength of pipe. Joints between successive lengths of pipes will be by collars at least 10 cm deep riveted tightly and securely to the pipes, and the straps or dogs be riveted or bolted through this collar by 9.5 mm galvanized iron bolts.

C. Asbestos Cement Pipes -Rain-water pipes and gutters shall conform, to IS: 1626 (Part 1). Only the pipes will be fixed with straps or clips(IS: 1742 Drainage requirement, 1983).

All rain-water leaders from roofs or terraces shall be screened off by gratings at the top to prevent leaves, rodents, etc, entering the pipes.

The laying of pipes underground and the construction of chambers and manholes shall be carried out as in the case of sewers for foul water.

IV. COMPARTIVE ANALYSIS

TABLE I. COMPATIVE ANALYSIS OF CASE STUDIES

Comparing Factors	**Case Study 1**	**Case Study 2**	**Case Study 3**
Study Area	Amba township, Gandhinagar, Gujarat	Jnana Niwas Apartment, Bengaluru	Easter Heights, Santa Cruz, Mumbai
Total Area	30,011 Sq.M	1283.92Sq.M	627 Sq.M
Annual Rain	943.51 mm	859 mm	980.60 mm
Total Annual water Demand	10,64,34,000 lit	98,55,000 lit	39,42,000 lit
Annual RWH Potential	1,77,34,620 lit	7,72,021 lit	4,91,860 lit
Can harvest % of Water Demand	16.6% of Water demand	7.8% of Water demand	12.4% of Water demand
Usage of Harvested Rainwater	Ground water recharge	Ground water recharge	Ground water recharge
Type of Existing RWH System	Percolation pit	Recharge pit	Recharge pit Distilling Chamber-Collection Trench
Design Specifications	The pit is 4.0 m long, 3.0 m broad, and 2.0 m deep, with 200 mm PVC strainer pipes installed up to a depth of 12 m before digging.	Diameter of the recharge pit: Width= 1.5m to 3 m; Depth= 2 to 3 m Back filled in graded manner with rocks (5cm - 20cm), gravels (5mm - 10mm), and coarse sand (1.5mm - 2mm). Boulders are at the bottom, gravels are in the center, and coarse sand is at the top, with a pit filled with broken bricks or cobbles for a smaller roof area.	Desilting chamber measuring 0.9 m x 0.9 m x 1.5 m depth and was getting transferred to recharging pit of 3.5 m x 3.5 m x 4 m depth with borewell, using the gravitational force.
Filtration/ Treatment Plant (If Any)	To keep leaves and other debris out of the system, a coarse mesh/leaf screen is used.	Mesh was used to prevent leaves & other debris from entering the recharge pit, and a desilting chamber could be built at ground level to prevent finer particles from entering the recharge pit.	The filtration of water for removing the salt and other debris was done through wire screens, which were installed at the mouth of the borewell. The wire screens measured 6"dia x 12"dia x 1 m length.

V. DESIGN CASE

5.1 Description of the Study Area

- The Mount Ville is a group housing in sector-79, Gurugram (Haryana).
- The Group Housing consists of 8 high rise Residential Towers, for 3BHK & 4BHK type flats. The Five towers for 3BHK and three towers for 4BHK. Commercial areas are under various blocks.

5.2 Rainfall

TABLE II MONTHLY RAINFALL IN GURUGRAM

	Jan	Feb	Mar	Apr	May	June
Rainfall mm (in)	23 (0.9)	31 (1.2)	20 (0.8)	13 (0.5)	19 (0.7)	71 (2.8)
Rainy days (d)	2	3	2	2	4	7
	July	Aug	Sep	Oct	Nov	Dec
Rainfall mm (in)	197 (7.8)	180 (7.1)	90 (3.5)	14 (0.6)	5 (0.2)	7 (0.3)
Rainy days (d)	14	15	8	2	1	1

5.3 Calculations

TABLE III RUNOFF COEFFICIENT OF DIFFERENT AREAS W.R.T. THE MATERIALS

Runoff Coefficient of Different Areas w.r.t. the Materials			
Description	**Area (SqM)**	**Material**	**Run off coefficient**
Roof	5,449.51	Tiles	0.8
Green Area	6,322	Grass	0.25
Surface Parking	531.73	Grass paver block	0.6
Paved Area	343.14	Concrete paver block	0.8
Internal Road	415.40	Asphalt	0.9
Total Plot Area	**13,061.57**		

TABLE IV RAINWATER RUNOFF ANNUALLY

Description	Area (SqM)	Average Annual Rainfall (M)	Run off coeff.	First Flush Coeff.
Roof	5,449.51	0.714	0.8	0.7
Green Area	6,322	0.714	0.25	0.7
Surface Parking	531.73	0.714	0.6	0.7
Paved Area	343.14	0.714	0.8	0.7
Internal Road	415.40	0.714	0.9	0.7

Description	Total Rainwater Harvested Annually (CuM)	Total Rainwater Harvested Annually (Litres)
Roof	3,112.76	31,12,758.45
Green Area	1,128.44	11,28,441.31
Surface Parking	227.79	2,27,791.05
Paved Area	196.00	1,96,001.57
Internal Road	266.94	2,66,936.04
Total Rainwater Runoff	**4,931.93**	**49,31,928.42**

TABLE IV RAINWATER HARVESTED FROM ROOF ANNUALLY

Description	Area (SqM)	Avg. Annual Rainfall (M)	Run off coeff.	Total RW Harvested Annually (Litres)
Roof	5,449.51	0.714	0.8	31,12,758.45

TABLE V RAINWATER HARVESTED FROM SURFACE ANNUALLY

Description	Area (SqM)	Avg. Annual Rainfall (M)	Run off coeff.	Total Rainwater Harvested Annually (Litres)
Green Area	6,322	0.714	0.25	11,28,441.31
Surface Parking	531.73	0.714	0.6	2,27,791.05
Paved Area	343.14	0.714	0.8	1,96,001.57
Internal Road	415.40	0.714	0.9	2,66,936.04
Total Rainwater Runoff				**18,19,169.96**

TABLE VI RAINWATER PERCOLATION FROM SURFACE FOR GROUNDWATER RECHARGE ANNUALLY

Description	Area (SqM)	Avg. Annual Rainfal(M)	Perco-- lation coeff.	Total Rainwater Harvested Annually (Litres)
Green Area	6,322	0.714	0.75	33,85,323.93
Surface Parking	531.73	0.714	0.4	1,51,860.70
Paved Area	343.14	0.714	0.2	49,000.39
Internal Road	415.40	0.714	0.1	29,659.56
Total Rainwater Runoff				**36,15,844.58**

TABLE VII RAINWATER PERCOLATED FROM COLLECTION PITS IS 80% OF RAINWATER HARVESTED FROM SURFACE FOR GROUNDWATER RECHARGE AS PER CPWD MANUAL & IS:1579

Total Rainwater Harvested (Litres)	Total Percolated Rainwater (Litres)
18,19,170.00	14,55,336.00

TABLE VIII STORMWATER TANK FOR 20% SURFACE WATER WHICH DOES NOT PERCOLATED

Total Rainwater Harvested Annually (Litres)	Total Percolated Rainwater Annually (Litres)	Remaining water for storage Annually (Litres)
18,19,170.00	14,55,336.00	3,63,834.00
Seven Stormwater Detention Tank 4M x 4M x 3M (48 CuM, 48,000Ltrs)		

TABLE IX RAINWATER TANK FOR WATER HARVESTED FROM ROOF

Dry Days	Total Population	Water Availability (per person per day)	Safety factor of 20%	Size of Storage Tank (Litres)
295	850	7	3,51,050.00	2,10,63,00, 000.00
Rainwater Storage Tank 6M x 6M x 6M (216CuM, 2,16,000Ltrs)				

TABLE X TOTAL AMOUNT OF RAINWATER HARVESTED ANNUALLY

Rooftop water annually (Litres)	% of water harvested from Roof out of total Runoff	Surface Water annually (Ltrs)	% of water harvested from surface out of total Runoff
31,12,670.00	63.10%	18,19,170.00	36.90%

TABLE XI GENERAL DESCRIPTION

Description	Units	Quantity
Total Population	Persons	850
Total Water Demand (per year)	Ltrs	4,18,83,750.00
	CuM	41883.75
Total Water Demand (per day)	Ltrs	1,14,750.00
	CuM	114.75
Total Water Availibility from Roof (per year)	Ltrs	21,78,930.92
	CuM	2178.93092
Total Water Availibility from Roof (per day)	Ltrs	5969.673753
	CuM	5.969673753
Water Availibility percentage of total demand after rainwater harvesting from roof	%	5.2
Water Availibility (per person per day) from roof water	Ltrs	7
Water Availibility (per person per day) from surface water	Ltrs	5.86
Total water Availibility (per person per day)	Ltrs	12.86
Usable water availibility percentage (per day) of total demand after rainwater harvesting	%	9.5

5.4 Expected Groundwater Recharge and Water Table Rise

Sehgal Formula for Ground Water Recharge & Expected Rise in Water Table

$R = 2.5(P-0.6)^{0.5}$
R=Expected Groundwater Recharge (Inches)
P=Annual Precipitation (Inches)

TABLE XII EXPECTED RISE IN WATER TABLE

Year	P (In)	$(P-0.6)^{0.5}$	R (In)	Current water Table (M)	Expected water Table (M)
2021	28.11	5.24	13.63	25.35	25.696
2022	28.11	5.24	13.63	25.696	26.042
2023	28.11	5.24	13.63	26.042	26.388
2024	28.11	5.24	13.63	26.388	26.734
2025	28.11	5.24	13.63	26.734	27.08
Final Expected Rise in Groundwater Table after Five Years					27.08
Total Rise in water table from 2021 to 2025					1.73

5.5 Cost Estimation

Estimated cost of proposed plumbing design scheme for rainwater harvesting system

TABLE XIII ESTIMATED COST OF PROPOSED DESIGN FOR RAINWATER HARVESTING SYSTEM

Item	Unit	Qty.	Rate	Total
Excavation				
Earthwork in excavation by mechanical means (Hydraulic excavator) /manual means over areas (exceeding 30cm in depth, 1.5m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50m and lift upto 1.5m, as directed by engineer-in-charge				
All kinds of soil				
Rainwater Drain	CuM	253.8	125	31,725.00
Rainwater Tank	CuM	216.00	125	27,000.00
Stormwater Tank	CuM	363.83	125	45,478.75
Catch Basin	CuM	27.2	125	3,400.00
Brickwork				
Brickwork with common burnt clay F.P.S (non-modular) bricks of class designation 7.5 in foundation and plinth in				
Cement mortar 1:4 (1 Cement: 4 Coarse sand)				
Catch Basin	CuM	30.8	4970	1,53,076.00
Rainwater Tank	CuM	216	4971	10,73,736.00
Stormwater Tank	CuM	363.83	4972	18,08,962.76
PVC Pipe (RDP)				
Providing and fixing on wall face unplasticised rigid PVC rainwater Pipes conforming to IS:13592 Type A, including jinting with seal ring conforming to IS:5382, leaving 10mm gap for thermal expansion, (i) single stacked pipes				
75mm dia	Rmt	32	148	4,736.00
PVC Pipe for Rainwater Drain				
P&F rigid PVC pipe (IS:4985 mark) Class II/ (4kg/sqcm) approved quality/make including joining the pipe with solvent cement rubber ring and lubricant				
250mm dia		901	565	5,09,065.00
Ferro Cement Tank				
as per market rate				
Rainwater Tank	CuM	216.00	450	97,200.00
Stormwater DetentionTank	CuM	363.83	450	1,63,723.50
Rain Head				
Blue mountain Rainhead as per market rate	Nos	122	730	89,060.00
3-Way Sluice Valve				
Fluidtech 3-way Sluice Valve	Nos	6	5800	34,800.00
Total Amount			**Rs**	40,41,963.01
Escalation of 18% on Total Amount			**Rs**	7,27,553.34
5% Contingency over Total Amount			**Rs**	2,02,098.15
5% Management reserve over Total Amount			**Rs**	2,02,098.15
Final Total Amount			**Rs**	**51,73,712.65**

5.6 Maintenance and Treatment

- During rainy season: The entire RWH framework (rooftop catchment, drains, pipes, screens, first-flush and flood) ought to be outwardly checked after each rain and if necessary, should be cleaned after each dry period more than one month.
- End of dry season: The capacity tank ought to be cleaned out and flushed of all sediment and trash toward the finish of each dry season not long before the rain comes. A full assistance of all tank highlights is suggested not long before the first rains are about to start, including substitution of every ragged screen and adjusting of the power source or hand pump.
- Treatment: There are a few sorts of treatment conceivable, the most well-known being chlorination, boiling, filtration and openness to UV or regular daylight.
- SODIS: Solar disinfection strategy utilizes sun's UV radiation to improve the microbiological nature of water

VI. CONCLUSION

Water sources are frequently affected by garbage from facilities in emerging regions with an increasing residential and apartment complex population. Waterways used for drinking water are overdrawn in high-population areas and are used for other uses such as laundry and bathing. Rainwater collection can enhance communities' general health and growth by reducing the need to travel long distances for water. The scarcity of ground water is exacerbated by the scarcity of open places for ground water recharging.

We discovered that 20% of the water we collect from the surface is used for storage, while the remaining 80% is used for groundwater recharge. Alternatively, the water we collect from the rooftop (catchment) is solely used for recharging.

As a result, we conclude that water collected from rooftops will be used for groundwater recharge, while water collected from the surface will be used for storage or household purposes in order to meet future needs. As a result, we infer that, depending on the kind of climatic zone, the larger the catchment area (rooftop), the bigger the amount of water that may be captured.

Artificial recharge, the report concludes, can be one of the best options in an integrated strategy to optimize total water resource management, and it believes that with pre-treatment, soil aquifer treatment, and post-treatment as appropriate for the source and site, it can be one of the best options.

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