નવસારી મહાનગરપાલિકા

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Rain Water Harvesting Policy & SOP

1 Introduction

Rainwater harvesting refers to the collection and storage of rainwater either on the surface or within sub-surface aquifers before it is lost as surface run-off. The stored water becomes an additional resource that can be utilized during periods of need. Artificial groundwater recharge further enhances this process by increasing the natural replenishment rate of groundwater reservoirs.

Water harvesting emphasizes the importance of valuing rainwater and ensuring its optimal use at the point where it falls. Typically, it involves directly capturing rainwater, which can then be stored for immediate use or diverted to recharge groundwater. One effective method of improving the groundwater table is to capture rainwater and channel it into aquifers for natural storage.

All authorities, including the Navsari Municipal Corporation, must strive to strengthen groundwater levels and expand water storage capacity to meet present and future requirements.

1.1 Importance/Need of RWH

The importance and need of Rainwater Harvesting (RWH) are outlined below, highlighting its critical role in sustainable water management and long-term resource conservation.

- To overcome the inadequacy of waters to meet our demands.
- To arrest decline in ground water levels.
- To enhance availability of ground water at specific place and time and utilize rain water for sustainable development.
- To increase infiltration of rain water in the subsoil which has decreased drastically in urban areas due to paving of open area
- To improve ground water quality by dilution
- To increase agriculture production.
- To improve ecology of the area by increase in vegetation cover, etc.

1.2 Advantages of RWH

The advantages of Rainwater Harvesting (RWH) are summarized below, emphasizing its benefits for efficient water use and enhanced environmental sustainability.

- Cost of recharge to sub-surface reservoir is lower than surface reservoirs.
- The aquifer serves as distribution system also
- No land is wasted for storage purpose and no population displacement is involved
- Ground water is not directly exposed to evaporation and pollution
- Storing water underground is environment friendly
- It increases the productivity of aquifer
- It reduces flood hazards
- Effects rise in ground water levels
- Mitigates the effects of drought
- Reduces soil erosion

1.3 Where to install RWH structures

Rainwater harvesting structures can be installed anywhere. It includes:

- Individual homes
- Colonies
- Apartments
- Institutions
- Schools/colleges/universities
- Clubs
- Hospitals
- Industries
- Slums
- Everywhere

2 Types of rain water harvesting system

Rainwater harvesting can be categorized in a number of different ways, the most important of which are according to the type of catchment used and second based on type of collection system.

Broadly there are two methods of rainwater harvesting system based on type of catchment:

(i) Roof top rainwater harvesting: It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building.

(ii) Surface runoff harvesting: In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

For each type of catchment system different type of collection systems can be adopted. Rainwater harvesting system based on type of collection systems are:

(i) Storage : Harvested rain water can be stored in tanks or lakes and can be used for direct consumption

(ii) Storage and groundwater recharge: In this method rainwater is first stored in tanks or other system and surplus water is conveyed to recharge groundwater. Recharged groundwater can be used for consumption at later stage with handpumps or tubewells.

(iii) Groundwater recharge only: In this method collected rainwater is directly conveyed to recharge groundwater without making any storage provision. Eg: groundwater recharge through storm water drains or conveying water from road run-off to recharge pits.

3 Technical details of Rainwater Harvesting system

3.1 Roof-top Rain water harvesting system:

Among various techniques of water harvesting, roof top rainwater harvesting needs special attention because of the following advantages:

a) Roof top rainwater harvesting is one of the appropriate options for augmenting ground water recharge/ storage in urban areas where natural recharge is considerably reduced due to increased urban activities.

b) Rainwater runoff which otherwise flows through sewers and storm drains and is wasted, can be harvested and utilized.

c) Rainwater is bacteriological safe, free from organic matter.

d) It helps in reducing the frequent drainage congestion and flooding during heavy rains in urban areas where availability of open surfaces is limited and surface runoff is quite high.

e) It improves the quality of ground water through dilution.

f) The harnessed rainwater can be utilized at the time of need.

g) The structures required for harvesting rainwater are simple, economical and eco- friendly.

h) Roof catchments are relatively cleaner and free from contamination compared to the ground level catchments.

i) Losses from roof catchments are much less when compared to other catchments.

Collection of rainwater from roof tops for domestic needs is popular in some parts of India. The simplest method of roof top rainwater harvesting is the collection of rainwater in a large pot/vessel kept beneath the edge of the roof. The water thus collected can meet the immediate domestic needs. Tanks made of iron sheets, cement or bricks can also be used for storing water. In this method, water is collected from roofs using drain pipes/gutters fixed to roof edge.

Though the practice of roof top rainwater harvesting is an age-old one, systematic collection and storage of water to meet the drinking water needs has become popular only recently. The popularity of this practice is limited by the costs involved in collection of water by gutters/pipes and its storage in underground tanks made of iron or brick. Use of Ferro-cement technology in construction and

maintenance of storage tanks has become popular in recent years as the strength and durability of ferro- cement structures have been found to make the schemes cost-effective.

Rainwater harvesting practices vary widely in size, type of construction material used and methods of collection and storage. Easy availability of know-how on systematic and economic methods of construction will encourage the user households to adopt this practice. There is also a need for creating awareness and for development of simple techniques of construction/fabrication of the components of rainwater harvesting system for popularizing this technique as a potential alternative source of drinking water, at least for part of the year.

Design considerations for Roof-top Rain water harvesting:

- The material of the catchment surfaces must be non-toxic and not contain substances which impair water quality.
- Roof surfaces should be smooth, hard and dense since they are easy to clean and are less likely to be damaged and shed materials into water
- Precautions are required to prevent the entry of contaminants into the storage tanks.

  - No overhanging tree should be left near the roof

  - The nesting of the birds on the roof should be prevented

  - A first flush bypass such as detachable downpipe should be installed

- All gutter ends should be fitted with a wire mesh screen to keep out leaves, etc.
- The storage tank should have a tight-fitting roof that excludes light, a manhole cover and a flushing pipe at the base of the tank.
- The design of the tank should allow for thorough scrubbing of the inner walls and floor or tank bottom. A sloped bottom and a provision of a sump and a drain are useful for collection and discharge of settled grit and sediment.
- Taps/faucets should be installed at 10 cm above the base of the tank as this allows any debris entering the tank to settle on the bottom where it remains undisturbed, will not affect the quality of water.

Components of Roof Top Rainwater Harvesting System

In a typical domestic roof top rainwater harvesting system, rainwater from the roof is collected in a storage vessel or tank for use during periods of scarcity. Such systems are usually designed to support the drinking and cooking needs of the family and comprise a roof, a storage tank and guttering to transport the water from the roof to the storage tank. In addition, a first flush system to divert the dirty water, which contains debris, collected on the roof during non-rainy periods and a filter unit to remove debris and contaminants before water enters the storage tank are also provided. Therefore, a typical Roof top Rainwater Harvesting System comprises following components:

1. Catchment
2. Transportation: Conveyance system and gutter
3. First flush
4. Filter
5. Storage facility

Roof Catchment: The surface that receives rainfall directly is the catchment. Sloping roof or flat roof. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting. Coarse mesh at the roof to prevent the passage of debris. Since rainwater is pure as it falls from the sky it is necessary that the roof be kept clean for it to remain pure when it is collected. This means the roof will need to be swept and cleaned daily during the rainy season.

2. **Transportation -Conveyance system and gutter:** 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:

a. Locally available material such as plain galvanised iron sheet (20 to 22 gauge), folded to required shapes.
b. Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
c. 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.

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.

The following table gives an idea about the diameter of pipe required for draining out rainwater based on rainfall intensity and roof area:

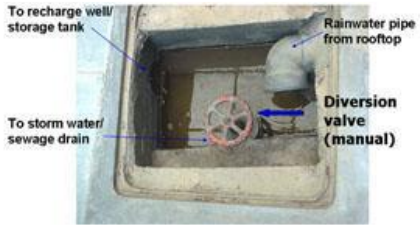
Sizing of rainwater pipe for roof drainage

Diameter Of pipe (mm)	Average rate of rainfall in mm/h					
	50	**75**	**100**	**125**	**150**	**200**
50	13.4	8.9	6.6	5.3	4.4	3.3
65	24.1	16.0	12.0	9.6	8.0	6.0
75	40.8	27.0	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	-	-	80.5	64.3	53.5	40.0
150	-	-	-	-	83.6	62.7

mm/ h - millimeters per hour; m - meters

Source: National Building Code

3. **First flush:** 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. **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**.**

Selection of a filter depends on followings:

1. Type of catchment

2. Amount of silt load

3. Quality of runoff

4. Purpose of storage

5. Type of recharge structure

(i) Cloth filter: The simplest form of filter is a piece of fine cloth which is even now used in areas like the north-east where they collect rainwater directly form the roof into storage tanks. It is also known as saari filter in Gujarat where people use a piece of saari filter (attire worn by Indian women) or dhoti filter (attire worn by Indian men).

(ii) 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.

(iii) 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.

(iv) Inverted sand filter: It can filter medium to coarse sized sand & silt particles, other floating debris along with bacterial contamination to limited extent.

(vi) Desilting chambers- Very effective & essential for runoff from unpaved and paved areas or from storm water drains carrying huge amount of silt, tree leaves and other debris

(vii) Weave wire filter: It is made up of stainless steel and also of rigid PVC. It can filter out suspended solids coming with runoff. This type of filter is incapable for filtering any bacteriological contaminants if presents. The degree of filtration is 100- 200 microns and capacity ranges between 5000- 45000 litres / hour. Therefore it can be used in the systems where rainwater is harvested for non potable purpose only.

(viii) Pop up filter: The filtration is the nylon sieve (60 mm dia.) inserted inside rainwater pipe to arrest coarse particles. The advantage with this filter is that whenever the filter gets clogged, it comes out of the casing and easy to maintain.

5. **Storage facility:** The rainwater storage tank collects all the filtered rainwater and keeps it for future use. The storage tank is made above the ground and on a platform. It can also be an underground sump.

Generally, Two basic types of storage system:

- Underground tank or storage vessel
- Ground tank or storage vessel

A variety of materials and different shapes of the vessels are available for the storage of rainwater. The choice of the system will depend on several technical and economic considerations like, space availability, materials and skill available, costs of buying a new tank or construction on site, ground conditions, local traditions for water storage etc.

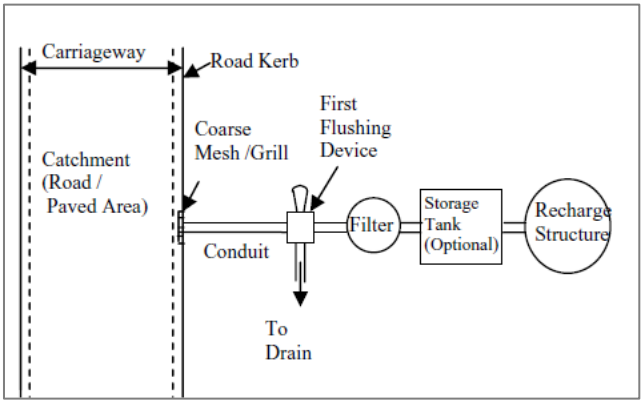
3.2 Surface run-off Rain water harvesting system

Surface run-off rain water harvesting system is also sometimes called as stormwater harvesting. Stormwater is generally harvested from roads, parks, garden, parking spaces, etc.

Rainwater Harvesting from Roads:

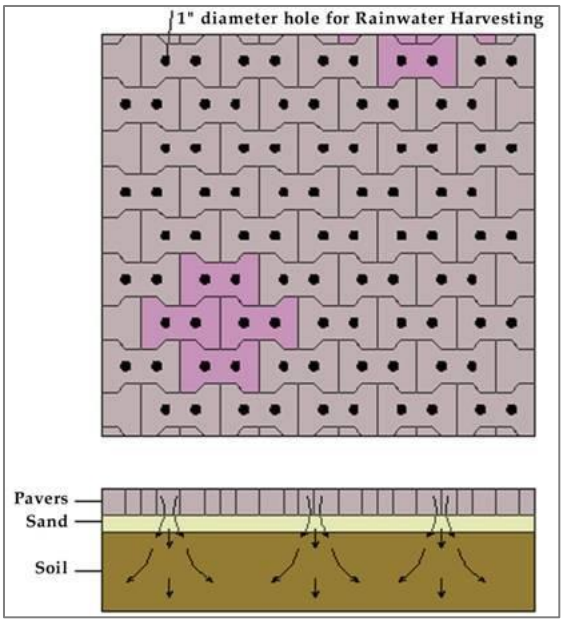
In the recent past, rapid growth in the urban areas has led to asphalted roads and stone slabs or pavers for footpaths. Consequent to this, the rainwater run-off has increased and ground water recharge has declined. As the roads are built sloped towards the sides, rainwater falling on the road is guided to the side drains. When it rains, water flows from the apex to the sides and collects in the sidewalk area and subsequently flows to the storm water drains.

Storage facility in the system may not be provided if stored water is not needed for immediate use. The filter unit and recharge structure may sometimes be combined depending upon the quantity of run-off and the availability of the space. A rainwater harvesting system for an urban road is shown in Figure below. In this case, an open unlined channel is used as conduit. The coarse mesh / grill to arrest the debris is installed at the inlet of the recharge structure. The first flushing device and the storage tank are optional. The filter unit may also be combined with the recharge structure.



Rainwater harvesting system for urban roads:

To increase ground water recharge by percolation and decrease the flooding of storm water drains, an infiltration trench could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 2 feet wide and 2 feet deep and filled with pebbles or aggregates with a top layer of coarse river sand.



As the rainwater from the road flows into the infiltration trench, water percolates into the ground. During heavy rainfall, excess water spills over to the storm water drains. The infiltration trenches store water temporarily during rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches.

Rainwater Harvesting from Parks and Open Spaces:

Water harvesting methods in parks and open spaces involve micro-watershed management methods that allow rainwater infiltration and percolation into the ground. The runoff has to be minimized by providing adequate number of percolation pits and dispersion trenches. In large parks, storage of rainwater in small ponds is also possible since the ponds can be integrated with the landscape of the park. Mapping of the contours, planning for rainwater outflow in consonance with natural drainage patterns, identifying appropriate areas for percolation pits / dispersion trenches will be required.

Recharge of pits or trenches : Ground water recharge in parks can be enhanced by a simple technique of providing recharge pits or a trench.

- Width of pit: 1.2 to 1.5 m. Depth: 2.5 to 3.0 m.
- Material: 40-60 mm coarse gravel followed by 20 mm aggregates and 2 mm sand. Pits are conveniently made at suitable low-level micro-watershed locations as collection centers of surface runoff.
- A splash pad is provided on top of the sand layer to cut off the velocity of entry of water to the pit.
- The number of such pits is based on the park area and the small rivulets dissecting the landscapes into micro-watersheds.

Requirements

- Creation of water harvesting ponds in concave depression and low-lying areas.
- Allowing groundwater recharge by the creation of seepage pits.
- Allowing surface runoff to enter into existing wells or artificial water bodies.

Natural flow of water :

Surface runoff water should be trapped in ponds, tanks and lakes when available, so that it can be used for maintenance during dry periods. This practice is similar to dry land technology of agricultural belts. Low-lying areas and drainage channels are earmarked and convenient micro-watersheds are prepared. Water harvesting is followed based on natural flow and surface accumulation of the runoff water. Water follows the lowest contour gradient available for that area. These structures not only provide water for the park, but also increase groundwater recharge. Providing a bore well in these areas will enhance the availability of water in its vicinity. Rainwater run-off from open space and paved areas can be stored in underground sumps by filtering through sand-bed filters and guiding the filtered water through channels.

3.3 Storage Units

Types of storage system:

The storage tanks are provided if the water is intended to be stored for ready use. 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, ferrocement, masonry, plastic (polyethylene) or metal (galvanised iron) sheets are commonly used.

Comparison of different storage tank materials				
	Brick	**RCC**	**Ferro cement**	**Plastic**
Durability Water tightness	Durable Prone to leaks	Durable Less resistant than ferro cement and plastic	Durable Excellent	Durable Very good but leaks can occur near outlet pipe
Cost	Cheap	Between ferro cement and plastic	Cheap	Expensive
Above or below ground	Above ground	Above of below ground	Above or below ground (above ground preferred)	Above ground
Installation time and ease of installation	Minimal construction skills required; takes a little time since curing is required	Construction skills required and long curing time required	Construction skills required and time required is between that of brick and RCC	Easiest to install and takes least time
Material and labour availability	Easy -locally available	Easy -locally available	Easy -locally available	Easy -locally available
Tensile strength to weight ratio	Law and a thick wall is therefore neded	High	Very high	High
Affected by weather conditions	Not affected	Not affected	May be affected in dry areas	Not affected
Shape	Suitable only for cuboid	Cylindrical	Different shapes possible, but cylindrical is best	Specific shapes available

Position of tank: Depending upon space availability and the level of the catchment surface, these tanks could be constructed above ground, partly underground or fully underground.

Comparison of different storage tank positioning		
Position	**Advantages**	**Disadvantages**
Above ground	• Tanks can be bought off-the-shelf • Easy to install and takes lesser time if bought off-the-shelf • Easy to inspect • Ground-level contaminants cannot enter the tank • Pumping systems may not be required and gravity flow can be used for water distribution	• Generally more expensive • Can affect the aesthetics of the building • Space taken up by the tank cannot be used for any other purpose • It is usually not recommended if the storage volumes are very high • Cannot be used to capture rainwater from ground catchments • Cover can be easily removed and cases of the cover being damaged during rough weather have been reported
Below ground	• Generally cheaper than above-ground storage tanks • Water cannot leak out through an open tap • Does not affect the aesthetics of the building and the space above the tank can be utilized for other purposes • Most suited for large volume storage tanks (10000 liters and above)	• Construction is the time consuming • Can affect the foundation of the building if constructed very close to the building if constructed very close to the building • Pumping system required to take out the water •Not easy to detect or repair leaks •Cannot be drained easily and hence cleaning is a problem •More prone to contamination •If the rank or manhole is left uncovered, it can be a safety hazard •The tank can be damaged by tree roots. If not constructed properly, the pressure exerted by the earth can also cause damage to the tank •Heavy vehicles cannot be driven over the tank, since the exerted pressures can cause damage
Partially above the ground	• Generally cheaper than above-ground storage tanks • Water cannot leak out through an open tap •Affects the aesthetics of the building minimally and portion of the tank that is above the ground can be camouflaged easily and used for other purposes	• Construction is time consuming • Pumping system required to take out the water •Not easy to detect or repair leaks • Cannot be drained easily and hence, cleaning is a problem • The tank can be damaged by tree roots if not constructed properly, the pressure

		exerted by the earth can also cause damage to the tank

Some maintenance measures like cleaning and disinfection are required to ensure the quality of water stored in the container.

Design of storage tanks: The volume of the storage tank can be determined by the following factors:

1. Number of persons in the household: The greater the number of persons, the greater the storage capacity required to achieve the same efficiency of fewer people under the same roof area.

2. Per capita water requirement: This varies from household to household based on habits and also from season to season. Consumption rate has an impact on the storage systems design as well as the duration to which stored rainwater can last.

3. Average annual rainfall

4. Period of water scarcity: Apart from the total rainfall, the pattern of rainfall -whether evenly distributed through the year or concentrated in certain periods will determine the storage requirement. The more distributed the pattern, the lesser the size.

5. Type and size of the catchment: Type of roofing material determines the selection of the runoff coefficient for designs. Size could be assessed by measuring the area covered by the catchment i.e., the length and horizontal width. Larger the catchment, larger the size of the required cistern (tank).

Dry season demand versus supply approach In this approach there are three options for determining the volume of storage:

1. Matching the capacity of the tank to the area of the roof

2. Matching the capacity of the tank to the quantity of water required by its users

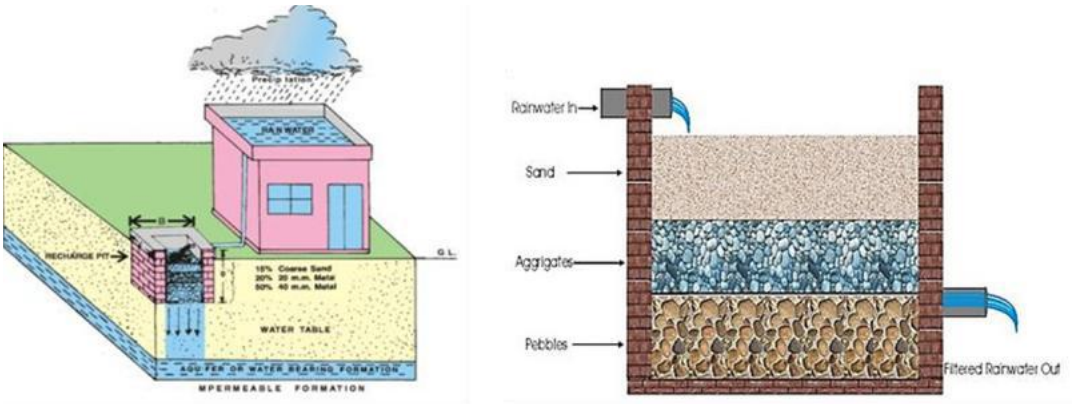
3. Choosing a tank size that is appropriate in terms of costs, resources and construction methods

In practice the costs, resources and the construction methods tend to limit the tanks to smaller capacities than would otherwise be justified by roof areas or likely needs of consumers. For this reason elaborate calculations aimed at matching tank capacity to roof area is usually unnecessary. However a simplified calculation based on the following factors can give a rough idea of the potential for rainwater collection.

3.4 Recharge units

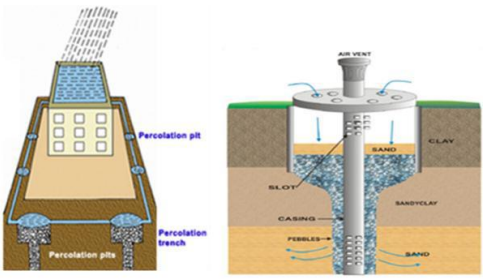
Rainwater may be charged into the groundwater aquifers for withdrawal later. Various recharge structures are possible - some which permit the percolation of water through soil strata at shallower depth (e.g., recharge trenches, recharge pits and permeable pavements) whereas others conduct water to greater depths from where it joins the groundwater (e.g. recharge wells: dug wells and bore wells). At many locations, existing structures like wells, pits and tanks can be modified as recharge structures. Here are a few commonly used recharging methods:

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.



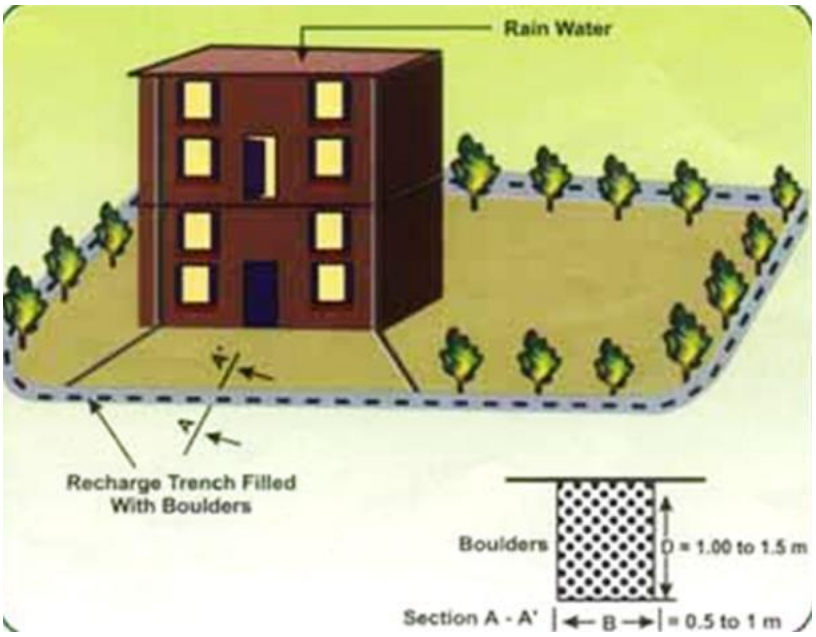
Details of Recharge pit

Percolation pits: 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, filled with pebbles or brick jelly and river sand, covered with perforated concrete slabs wherever necessary.



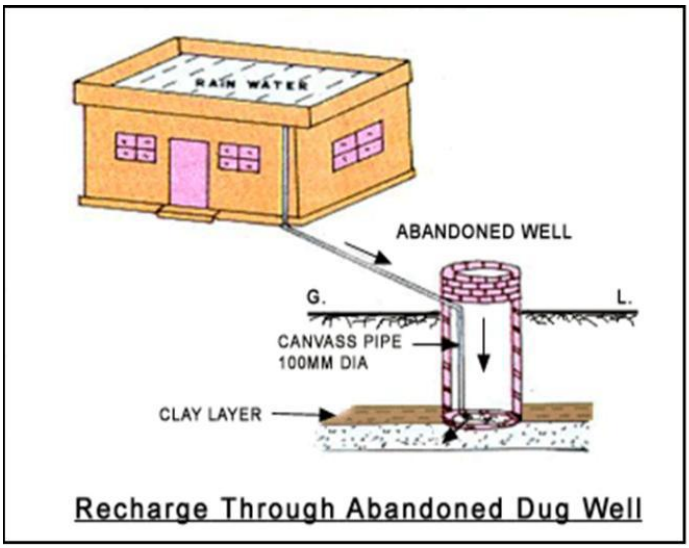
Details of Percolation pit

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 quantity of runoff expected. The recharge trench should be periodically cleaned of accumulated debris to maintain the intake capacity.

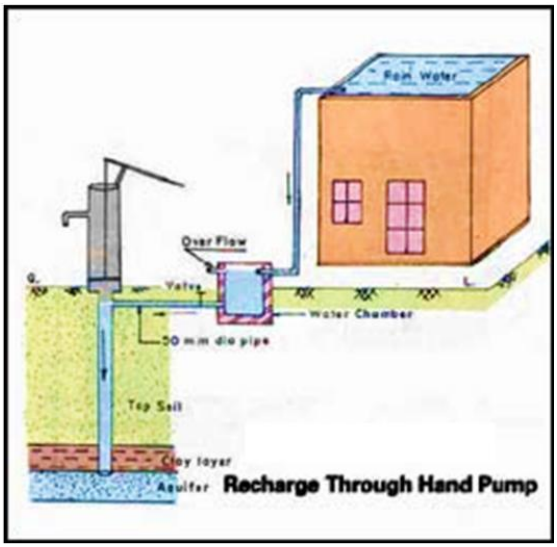


Recharge troughs: To collect the runoff from paved or unpaved areas of a compound, recharge troughs are commonly placed at the entrance of a residential / institutional complex. These structures are similar to recharge trenches except for the fact that the excavated portion is not filled with filter materials. In order to facilitate speedy recharge, boreholes are drilled at regular intervals in this trench. This structure is capable of harvesting only a limited amount of runoff because of the limitation with regard to size.

Recharging of dugwells and abandoned tubewells: Rainwater that is collected on the catchment is diverted by drain pipes 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. Dug wells 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.



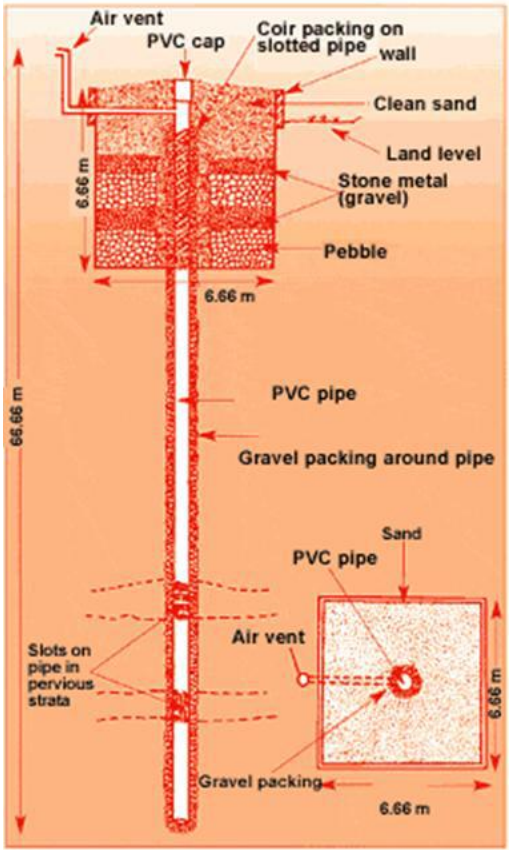
Recharge Through Abandoned Dug Well



Recharge Through Hand Pump

Recharging through tubewells: In this case the catchment 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 soil, if the stratum is loose. A filter chamber comprising of sand, gravel and boulders is provided to arrest the impurities.

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.



3.5 Maintenance of Rainwater Harvesting systems

Parts	Maintenance	Frequency
Roof	Wash off roof with water when dust/dirt accumulated diverting run-off away from tank inlet. Sweep off leaf litter Trim and cut trees around roof Fix damage to roof (broken tiles, cracked water-proofing , etc.) Paint if rust is present using lead-free paint	Monthly and especially after a long period of dry weather or heavy wind. Regularly, especially after heavy winds and just before the rains set in, Check daily for leaf litter accumulation during rainy season When required At the earliest and definitely before the rainy season At the earliest and definitely before the rainy season
Gutter and down take pipe	Clean and wash out bird droppings, leaves, etc., with water Check and repair gutter and downtake pipes Ensure guttering /downtake pipes are sloped to ensure steady flow and avoid pooling of water, collection of dirt, debris, etc. Repairs leaks at elbows	Check monthly and especially after a long period of dry weather or heavy wind. Check daily during rainy season When required During installation and after periods of heavy rain When Required
Filters First-flush devices	Clean Check and clean	Before and after rainy season Before and after the rainy season and after every rooftop cleaning session
Tank	Clean Repair leaks Cut nearby tree roots(if underground tank) Ensure lid is sturdy and secure Ensure there are no gaps where insects can enter or exit Securely fasten insect screen over the end of the overflow pipe/valve	Before and after rainy season At the earliest At the earliest At all times At all times At all times

4 Enabling Environment for implementing Rainwater Harvesting system

An enabling environment and governmental support are essential for spreading the concept and implementation of rainwater harvesting systems on a city level scale. Mainstreaming in policy agendas, facilitating regulations, awareness raising, capacity building and technical know-how are all important for enhancing the use of rainwater harvesting systems. It is also necessary to ensure sustainability of rain water harvesting movement. Following main measures can be taken

Regulations for Rain water Harvesting system:

In India under the constitutional set up, water is a state subject. In urban areas its governance rests with urban local bodies in their areas of jurisdiction as per the 74th constitutional amendment. The need for a policy framework and proper regulations amendment for rain water harvesting system arises mainly because the existing regulation is not very effective along with lack of implementation and monitoring mechanism.

Based on this argument, review was carried out for rain water harvesting regulations in different cities (Details in Annexure-7.1). Following actions need to be adopted in order to implement RWH in Bhuj city.

- Make appropriate provision and regulations for rainwater harvesting– based on review of DCRs from other cities.
- Introduce tax incentives for stipulated timeframe to promote Roof rain water harvesting
- Need to introduce rational tariff structure to promote RRWH
- Introduce urban design/ landscape guideline to increase ground water recharge – Define ratio for unpaved area to total open area & Increase permeable surface area to recharge more water through appropriate selection of material.

Set Up RWH Cell:

In order to make RWH effective, Bhuj Municipal council should Set up technical cell at ULB level for Capacity building and sensitize ULB staff towards promotion of rain water harvesting system. The main objective for setting up the RWH Cell is to create awareness and to offer technical assistance to the residents and also to provide to the citizens 'cost effective solutions'. The RWH cell should undertake following points:

- RWH Cell should have representatives from public, NGOs, Technical representatives, Development Authority
- Develop material for technical details of implementing RWH structures
- Provide RWH information on a website
- Host a list of Architects, Contractors, NGOs, etc. qualified in undertaking design and implementation of RWH structures.
- Plumber and contractor training programme on RWH component – Certification/ Empanelment of contractor and plumber for RWH
- Demonstration models for RWH implementation should be demonstrated in schools buildings, government buildings, etc.

IEC Campaign:

- IEC is an important component in influencing public to adopt Rainwater Harvesting. As they are the direct beneficiaries of these structures, more information dissemination would be required to make them construct Rainwater structures. Public awareness and education are essential in order to improve acceptance of rainwater collection and utilization.
- Efforts should be made to change public perception of rainwater from being viewed as a nuisance to being viewed as an asset. IEC campaign in form of Organization of Seminars/ Workshop, Massive rallies and Human Chains, Advertisement through Papers / Dailies, Booklets / Pamphlets, Posters and Wall Paintings, Door to Door campaign (Chennai Model) need to be undertaken.
- Vigorous IEC campaign should also be adopted to bring awareness among the public
- Conduction of awareness program with the coordination of Self Help Groups, Welfare Associations, NGO's and school children.
- Erection of hoardings displaying the importance and benefits of the Rain Water Harvesting.
- Door to Door campaign on Rainwater Harvesting with the participation of NGOs.

Standard Operating Procedure (SOP)

1. Purpose

To establish a standardized procedure for the design, installation, operation and maintenance of Rainwater Harvesting Systems across all buildings under the jurisdiction of Navsari Municipal Corporation (NMC) to enhance water conservation, promote groundwater recharge, and ensure sustainable urban water management**.**

2. Scope

This SOP applies to:

- All NMC-owned buildings (offices, schools, hospitals, community centres).
- Government-funded institutions within the NMC area.
- New construction approvals (mandatory provision for RWH).
- Awareness and implementation drive for private buildings, residential societies, and commercial complexes.

3. Responsibility

Role	Responsibility
Municipal Commissioner	Overall supervision and policy implementation.
Executive Engineer (Civil)	Technical oversight of Rooftop RWH systems' design and execution at exis ting and proposed Municipal Buildings.
Building Officer (NMC)	Ensure RWH compliance in building permissions.
Town Planning Departm ent	Integrate RWH planning in urban layouts.
Garden Department	Integrated Surface Ground Water Recharge system in all existing and prop osed Municipal Gardens and Urban Forests.
Nodal Officer (Rainwater Harvesting/ Town Planner)	Coordinate awareness programs, training, reporting, and audits.
Maintenance Staff	Routine inspection and upkeep of all types of RWH systems.

4. Definitions

- **Rainwater Harvesting (RWH):** Collection and storage of rainwater from surfaces (typically roofto ps) for future use or groundwater recharge.
- **Recharge Pit/Trench:** A structure allowing rainwater to percolate into the ground.
- **First Flush Device**: Mechanism to divert the initial runoff of rainwater.
- **Filter Unit:** Removes debris, sediments, and pollutants from harvested water.

5. Procedure

a. Site Identification & Feasibility Study

- Conduct surveys of all municipal buildings and identify feasible sites for RWH.
- Assess catchment area, existing drainage system, and ground percolation capacity.
- Categorize sites based on potential: Storage-based I Recharge-based systems.

b. System Design Guidelines

- Adhere to BIS Code IS 5797:2008.
- Design should include:
  - Rooftop catchment system
  - Gutters and downpipes
  - First flush diverter
  - Multi-layer filtration system
  - Recharge pit/soak well or storage tank with overflow mechanism
- Water Harvesting Potential Formula:
  - Rainwater (litres) = Roof Area (m2) x Average Annual Rainfall (mm) x Runoff Coefficient

c. Installation

- Execute construction through empanelled contractors or in-house engineering department.
- Prioritize implementation before the monsoon season.
- Install signage showing system diagram, purpose, and contact for maintenance.

d. Operation

- Direct rainwater to the harvesting system during rainfall.
- First flush system to discard initial rainwater.

- Filter remaining water before diverting to storage/recharge.
- Use stored water for non-potable purposes (gardening, toilets, cleaning).

6. Maintenance Protocol

Frequency	Task
Monthly	Check filters and clean debris. Inspect downpipes for blockage.
Pre-Monsoon (May-June)	Clean roof surfaces, gutters, flush tanks, recharge pits. Test all systems.
Post-Monsoon (Oct-Nov)	Inspect for siltation in pits and tanks. Perform deep cleaning.
Annual	Structural inspection and desilting of recharge structures.

7. Monitoring & Compliance

- **The Nodal Officer (RWH}** to maintain an annual status report of all RWH systems in NMC buildin gs.
- **Third-party audits** to be conducted every two years.
- **Compliance reports** to be submitted to Commissioner NMC

8. Awareness & Capacity Building

- Conduct training workshops for building supervisors, engineers, and school staff.
- Promote RWH through public campaigns, IEC materials, and local media.
- Offer technical assistance to private societies and businesses for adopting RWH.

9. Incentives & Penalties

- Propose property tax rebates for buildings implementing RWH.
- Strict enforcement of RWH provisions in building permission process.
- Issue notices and impose penalties for non-compliance as per NMC bylaws.

10. Documentation

Each site must maintain a Rainwater Harvesting Logbook including:

- System layout and capacity
- Date of installation

- Monthly maintenance records
- Photos of pre-monsoon/post -monsoon activities

11. References

- Bureau of Indian Standards (BIS) Code IS 15797:2008
- Central Ground Water Board (CGWB) Guidelines
- Gujarat State RWH Guidelines
- NMC Water Conservation Policy, 2025

12. Review & Updates

- This SOP shall be reviewed **annually** by the Town Planning and Garden Departments.
- Revisions shall be made in line with new technologies, state policies, or environmental requirem ents.

Municipal Commissioner
Navsari Municipal Corporation